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Twitter in the collaborative classroom: micro-blogging for in-class collaborative discussions

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Abstract: While small group discussion during undergraduate classes is an important pedagogic strategy, there are two primary concerns for instructors – how to monitor the conversation that goes on within groups and how to ensure that ideas that emerge within the groups become part of the classroom discourse. In this paper, we describe a design-experiment conducted in two sections of the same undergraduate education class, exploring the use of Twitter and a shared display of the Twitter-chat, to address these issues. We describe three iterations of the use of Twitter in the classes and our reflections on how it influenced the teaching experience. Data from student surveys indicates that students had minimal experience using Twitter for academic activities prior to participation in this class and that they felt Twitter was a valuable tool to support their in-class learning activities. The teaching team found that the use of Twitter kept students on task and focused on the activity, but expressed some concern about the depth of engagement with ideas during the task.

Keywords: Twitter; CSCL; collaborative learning; micro-blogging; higher education; technology-enhanced learning in classrooms; social media; interactive learning environments.

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Julie Rattray is a Lecturer in Psychology and Education and Director of postgraduate taught programmes in the School of Education at Durham University. A strong desire to establish synergy between her research and teaching interests has resulted in a research agenda that focuses on aspects of teaching and learning pedagogy in higher education. Of particular interest are the ways that different mediating artifacts, including technology, might be used to support students' engagement with difficult or troublesome knowledge and the part that affect and emotion might play in students' willingness to engage with this knowledge.

Janet Lavery is a Learning Technologist at Durham University collaborating with academics and student support services staff to find individualised solutions to specific problems related to learning and teaching, discover and remove the issues that are impeding best practice and research and promote the use of emerging technologies in simple and effective ways. She conducts reviews and reports on trends and issues in higher education and technology. Her long term interest in technology enhanced learning grew from previous work as a teaching fellow in computer science and research she conducted in how designers use models to gather their understanding of problem spaces and communicate proposed solutions.

1 Introduction

Research on collaborative learning indicates that it is a productive pedagogic technique (see Barron and Darling-Hammond, 2008; O'Donnell, 2006 for reviews) and one that is increasingly being used in university settings (Brooks et al., 2014). However there are still many issues in its implementation that make it a risky option, particularly when it is being used during class time that would otherwise be spent in more traditional, lecture-type activities. Primary issues for instructors include a concern about whether students are engaged in on-topic discussion or talking about unrelated ideas and the facilitation of whole class discussion in such a manner that elicits the key ideas or misconceptions from all groups and creates a context for deeper engagement with the ideas. In this paper, we report on a design-experiment focused on using Twitter to support live updates from small discussion groups in a class, in an effort to allow instructors to have some insight into the discussion groups and to provide a representation of the discussions for whole class conversations.

Micro-blogging tools, in particular Twitter, have become an important part of the Web 2.0 and social media environment. Twitter, which allows users to create short comments, or tweets of 140 characters or less, reports having 250 million active monthly users and over 500 million tweets sent per day (Twitter, 2014). Personal account holders can post tweets and follow the tweets of other account holders. In addition, Twitter chats – meetings or discussions held on Twitter – allow account holders to participate in

conversations with experts or peers with related interests. The potential of these features, which have been used extensively for business and social purposes, have been recognised within education, with increasing examples of their use in a range of settings (e.g., Ally, 2012; Dhir et al., 2013; Gao et al., 2012; Junco et al., 2013; Markham and Belkasim, 2011; Tiernan, 2014).

Dhir et al.'s (2013) review of Twitter as a learning tool, provides ten potential benefits for using this tool in education settings. Many of these are focused on the ability for rapid and frequent communication between instructors and students, between students, or with the wider professional community. However, they also suggest that it can support academic skills, such as writing concisely and increased fluency of reading and comprehension.

In a review of Web 2.0 tools for collaborative learning, Hsu et al. (2014) identified six practices that were supported through the use of Web 2.0 tools, including Twitter. These included:

- 1 publishing and sharing learning progress
- 2 supporting and achieving collaborative tasks
- 3 making thinking, collaborative processes and products visible through tangible artifacts
- 4 communicating ideas and disseminating artifacts
- 5 social networking in authentic learning environments
- 6 building communities of practice.

They report Twitter as being used for the fourth of these purposes – communicating ideas and disseminating artifacts – allowing students to share ideas and work in progress.

Additional research points towards Twitter being useful for a number of other practices, including developing social networks (5) and building communities of practice (6). For example, Carpenter (2014) reported on the use of Twitter by teacher education students, during a course in which they were required to follow each other on Twitter, post tweets and participate in tweet-chats during the semester. Carpenter reports that, while participation varied, the use of Twitter was positively received by the students, who reported that it supported their interaction between students and also their participation in the wider community of practice of teachers within their disciplines.

Twitter has also been used to support in-class activities, particularly to elicit opinions and reactions during lectures. Welch and Bonnan-White (2012) report on a study of student engagement, comparing lectures in which students used Twitter and lectures in which they did not tweet as part of a backchannel discussion during lectures. The authors reported a relationship between students' enjoyment of using Twitter and their perceived engagement with the course, but they did not find that using Twitter, regardless of students' enjoyment of the tool, was associated with perceived engagement. Tiernan (2014) reports on the use of Twitter in lectures to ask questions of the lecturer, respond to questions posted by the lecturer and comment or share experiences related to the topics being discussed. While not all students used Twitter and some chose to voice their response or questions during discussions rather than tweet, the additional mode of engagement appeared to increase overall feelings of engagement in the course.

These prior uses of Twitter and the reviews of their value, have all focused on the asynchronous aspect of Twitter or maintain the traditional authority structure of a classroom, with the instructor as mediator of the discussion. The use of Twitter as a between-group tool has not yet been explored. In addition, while the use of technology to support online collaborative activities, Web 2.0 tools to support out-of-class activities and collaboration and tools such as audience response systems (clickers) have been developed to support individual activities during class, less attention has been paid to developing tools that support collaborative learning in classrooms.

A primary concern for instructors is monitoring and supporting the conversations that occur during small group work, as both experience and prior research indicates that the quality of collaboration may vary between groups (e.g., Summers and Volet, 2010). The potential of technology to provide insight into group processes is in an early stage. Martinez-Maldonado and colleagues (2013) report on the development of a tool that allows instructors to monitor participation and task progress of groups working on multi-touch tables, which allowed the teacher to assign their attention to groups who appeared to be struggling either with the task or with the collaborative process. Mercier and Higgins (2013) report on the development of a mathematics activity, also using multi-touch tables, where teachers receive live updates of each students' work on their tablet, allowing them to intervene if students are making the same mistakes repeatedly. Further work in this area will need to explore ways in which automated data can be taken from groups and provided to teachers, or ways in which simple actions made by students can be interpreted to provide insight into the group process and highlight groups who need to be refocused on the activity.

A second issue in orchestrating collaborative learning activities in classrooms is aggregating the ideas discussed across small groups to facilitate a whole class conversation that allows all groups to engage with key ideas and for the instructor to identify misconceptions or difficulties that emerge within groups. As reported by Slotta, Moher and colleagues, the use of tools in the elementary classroom to aggregate observations and ideas from students can facilitate deep engagement in the content and allow students to engage in whole class collaborative scientific activities (e.g., Cober et al., 2013; Fong et al., 2013). Mercier and colleagues (2012) report on the use of a shared display to project the activities of groups in a multi-touch classroom, finding that the ability to share the representation created by the group supported whole class conversation about ideas.

These novel tools provide ways in which instructors can view the progress and processes of collaborative groups in classrooms and allow deeper conversation at the whole class level. However, these specific tools are not yet widely available or suitable for all activities. The adaptation of commonly used tools, such as Twitter, allows for exploration of these issues in a typical classroom environment.

1.1 The present study

Most uses of Twitter in educational settings falls into two categories. The first is the standard use of Twitter outside of the classroom, to create opportunities for continued discussion or feedback about a topic, to develop a sense of belonging to a group and to encourage students to reach out to experts in their field. The second maintains the standard classroom practice of teacher-student interaction, with tweets used primarily as a form of communication between the instructor and individual students. In this design

experiment, we explored whether Twitter could be used as part of the small group discussion to support whole class interaction around the ideas being raised within each group and to provide insight for instructors into the discussion of groups. The main research questions addressed were:

- 1 Can Twitter be used to provide insight for instructors and students about the discussion activities of groups during class time?
- 2 What are students' impressions of using Twitter during class activities?

2 Method

2.1 Design

The experimentation with Twitter to support collaborative group activity in a classroom used an iterative design-research approach (e.g., Anderson and Shattuck, 2012). Three implementations of the activity were conducted with changes to the protocols between each implementation based on the research team's observations and experiences. A survey was conducted at the end of the academic year, to assess students' attitudes towards using Twitter in the course.

2.2 Participants

Participants were 54 undergraduate students enrolled in the learning and teaching course during the 2012/13 academic year. Most students in the programme were traditionally aged students, with less than 10% of enrolled students classified as non-traditional. All students who were present in class participated in the use of Twitter as part of normal class activities.

Thirty-six students who attended the final review sessions for the class completed the survey and consented to participate in this stage of the study.

Sixteen of the students had not used Twitter before using it in this class (44.4%); 20 reported that they had used Twitter before (55.6%). The students who had accounts ranged from half a year to three years in the time they reported having them and most reported using Twitter once a week (see Table 1 for frequency data). Only one student reported using Twitter in another class, stating it was rarely used in an economics class to communicate about economics-related news items.

Table 1 Time Twitter account held and frequency of use.

<i>Time account held</i>		<i>Frequency of use</i>	
About six months	3	More than once a day	2
One year	7	Daily	2
Two years	8	Weekly	9
Three years	1	Monthly	5
No response	1	Used in the past but not now	2

While the majority of students reported owning laptop computers or tablets and most students owned smart phones, students rarely brought any technology to their classes. Most took notes on paper and there were rarely any problems with students attending to their phones during classes.

2.3 The course design and groups

The course focused on theories of learning and teaching and was a year long required course for first year undergraduate students in a non-credential education studies programme. This programme was always taken jointly with another programme (e.g., education studies and psychology; education studies and physics). A small number of students also took the class as an elective. The course had been redesigned in earlier years to move away from the traditional lecture format and focus more on group projects and discussion. The redesign was grounded in a social constructivist theory of learning (Vygotsky, 1978), with the instructors' assumption that learning occurs through social interaction and the active construction of knowledge. Class sessions were held every two weeks for three hours and met 11 times over the course of the academic year.

Two separate sections of the class were held, with between 25 and 30 students in each section. The sections covered the same content and students self-selected into the class that was most convenient for them based on their other courses. While the instructors made no attempt to differentiate between the two classes, the classes reflected the students, with Monday's class being more enthusiastic and engaged in discussions throughout the year than Tuesday's class. The discussions throughout the year took on different issues and so slightly different content was covered in each section.

Students were assigned to groups of between four and five students after the first class. As all students studied another subject in addition to education studies, the groups were formed with an emphasis on creating groups that represented a range of subject areas. Groups sat together during all classes and many of the homework assignments needed to be completed within the groups. The intention was for groups to remain stable, however, one group of four, lost one member when she dropped out of the course and the remaining three students encountered significant in-group conflict. The group was disbanded and the three remaining students were relocated to existing groups after the third week of class.

Frequent in-class activities included discussing questions within groups, before a whole class conversation about the topic. The instructors became concerned during the first weeks of the course, as many students struggled to contribute to whole class discussions, but also were often observed to be engaged in off-topic conversations during the small group discussion. Students noted that they wanted more small group discussions to help them prepare for the whole class conversation with many students having little prior experience in this type of classroom activity.

The course was taught by two members of staff in the school of education and was supported by a member of the learning technologies team. Both instructors were present in all classes throughout the year and the learning technologist participated in the class as often as her schedule allowed.

The course was structured so that all of the first semester and the first class of the second semester were instructor led activities, while the final four classes of the second semester were student-led. Thus, the final implementation of Twitter was during the first class after the winter break.

2.4 Set-up of the tweet-chat and Twitter in the classroom

Before the first class in which we used Twitter, students were asked to make sure at least one member of each group had a Twitter account and that each group had access to at least one internet-enabled device when they attended class. On the first day, all but one group connected to Twitter without any difficulty and in subsequent classes, all groups had at least one member active on Twitter. Students used their own laptops, tablets or smart phones to access Twitter.

The students were given a hashtag to use for the class period (different ones for each section). A Twitter chat room (tweetchat.com) was established for this hashtag and projected to the shared display, allowing everyone in the room to see what the groups were tweeting.

2.5 Data collection

The teaching team had a discussion after each implementation of the activity, reflecting on what they thought had worked and considering changes for the next iteration. The learning technologist also wrote up observation notes after each session she attended and shared these with the team. Screen shots of the tweetchat webpage were collected after the class for future reference. These data were used to address the first research question.

A student survey was conducted during the last class session of the year. As this was a review session, not all students attended, decreasing the response rate for the survey (66%). The survey contained items about the students' prior use of Twitter. A five point Likert scale was used to assess their opinions about using Twitter in the class and an open-ended item allowed for additional comments. Sixteen (44%) of respondents completed the open-ended item. The survey data were used to address both research questions.

3 Results

3.1 Description of implementation

3.1.1 Implementation one

The first implementation of Twitter for between-group collaboration occurred during the third week of the class, where the focus of the class was the design of learning environments and cross-context learning. The chapter under discussion was by Esmonde and colleagues (2013) and focused on informal mathematics practices in families. The data presented in the chapter was collected using interviews, which was used to introduce this data collection method, as students would conduct interviews about learning environments as their next homework activity. The students were asked to discuss the reading, with a couple of guiding questions provided at the beginning of the session and tweet their ideas every couple of minutes.

In the class that met on the Monday, five out of the six groups easily participated in the activity, while one group struggled to connect to Twitter using a phone and then, once connected, had difficulty posting their tweets. Tuesday's class did not encounter technical issues.

The differences between the two classes, which we had observed in the previous two weeks, emerged during the activity with Twitter. Monday's class asked more questions and appeared to be more deeply engaged with the ideas, asking questions not just about the topic, but also querying the validity of interview techniques for data collection. Tuesday's class tended to skim the surface of the topics and although our sense was all groups were focused on the activity the conversation lacked the depth of Monday's discussion.

3.1.2 Reflections on implementation one

Despite the difficulties one group had getting online, the overall reaction from the students and teaching staff was positive after the first implementation of Twitter. One concern, however, was that students were focused on summarising the reading in their tweets, but were not engaging in the discussion questions we wanted them to consider. We decided to stagger the discussion questions, giving students time to work on each one and then asking the next question when we felt their conversation was waning, or the tweets became less frequent.

3.1.3 Implementation two

We returned to using Twitter in the fifth class of the year, the final one before the winter break. The topic for that week was assessment and a book chapter by Coffey (2003) about assessment practices in a progressive education classroom, was the basis of the Twitter activity. Having used this chapter in previous years, we recognised that students struggled to understand how assessment could take place outside formal exams and the idea that learners could participate in the assessment process. As planned after the first iteration, we staggered the questions that we asked, giving the students time to discuss each question before asking the next one.

Questions that arose from the groups included asking at what stage class discussions become assessments and at what age learners could be responsible for their own learning. Monday's class appeared to have less difficulty with the reading, although they struggled with the idea of assessment occurring in forms other than within a formal exam context. Due to issues with classroom assignments, the Tuesday's class was assigned to a classroom without any heating, on a very cold day. Thus, the tweets were littered with comments about the temperature and complaints about being cold. As with the first implementation, there was a sense of skimming the topic within this class, with students less willing to think about the difficult questions of assessment.

3.1.4 Reflections on implementation two

After the second implementation, the teaching team were concerned that, although students were reacting to our questions during the activity and focused on discussing the reading, they were not attending to the substantive tweets posted by their classmates. While we had hoped that the use of Twitter would keep groups on task, we also wanted to explore its value in supporting between-group learning during collaborative activities. As a result, we decided that rather than provide our question prompts verbally during the activity, we would post them to Twitter, requiring students to attend to the TweetChat that was being projected to the shared display. It was hoped that by requiring students to

attend to the shared display, they would be more aware of the tweets being made by other groups and perhaps engage in conversation with their classmates in different groups.

3.1.5 Implementation three

The final implementation of Twitter during discussion groups took place during the first week of classes after winter break. This class was focused on the role of teachers in supporting learning. The topic picked up on issues of assessment from the previous class and also examined the various roles of the teacher. The reading that was the focus of the discussion was a chapter by Bransford and colleagues (2005) that brought together learning theories and teaching.

During this third implementation, we used Twitter as the medium through which the teaching staff would ask questions of the students, rather than interrupting the discussions vocally. One reason for this was to provide a reason for the students to attend to the joint display during their discussion – looking for our questions, but also looking at the comments the other groups were making. We posted new questions when the room seemed to become quieter and the frequency of tweets from students was reduced. The goal of our questions was to pose the relevant questions, while also keeping the groups talking about the different ideas in the readings.

By this stage of the year, students were very comfortable with using Twitter and some greeted the activity with enthusiasm. While the discussion focused on teachers, students returned to their questions about assessment from the previous class and both classes focused somewhat on the role of the teacher as assessor. By orchestrating the conversation through Twitter, we also saw more responses to our tweets. There was also an increase in twitter conversations between groups as their focus was more on the shared display than within their group.

3.1.6 Teaching staff reflections

The primary reason we chose to use Twitter in this course, was that students expressed an eagerness to work in groups during class time, but appeared to struggle to stay on topic. Twitter provided a way for us to gain an insight into what was going on in the group, an audience for the students during their group discussions and a way of managing whole class discussion based on the tweets, rather than relying solely on a group spokesperson reporting back to the whole class.

From the beginning of this intervention, we were pleased to see that groups remained on-topic throughout the activity, rather than discussing their pending social activities. However, we did worry that the nature of activity restricted groups from engaging in deep discussion of the ideas. By requiring them to frequently create comments about their discussion, the discussion was interrupted and we were concerned that for some students, the goal of creating pithy comments overtook the goal of talking about the readings.

The ongoing audience changed the nature of group discussions, requiring them to remain on topic and engaged throughout the activity. The interaction between some groups and the questions they asked of each other's tweets, during the final implementation, also suggested that this awareness of the class as the wider audience for this discussion was motivating for some students.

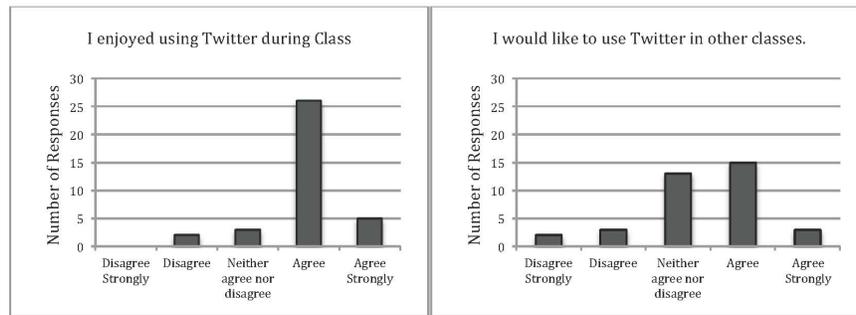
As instructors, being able to orchestrate the final discussion through the tweet-chat display provided a much welcome opportunity to direct the conversation to key questions and ideas. We could probe the groups who posted tweets that seemed to express incomplete ideas or questions, asking them to elaborate on their discussion around these ideas.

We also used the tweets to identify misconceptions and misunderstandings and address them with the whole class. This was one feature of the activity that differed from usual group discussions, where instructors rarely see or hear the issues that groups might be encountering, allowing us insight and the opportunity to intervene that might not have been present without the tool.

3.2 Results from student survey

Students responded on a five point Likert scale to ten items about the use of Twitter during the course. Two items assessed their overall response to using Twitter and while students were mostly positive about their enjoyment of using Twitter, they were slightly more mixed in their responses to whether they would like to use Twitter in other courses. See Figure 1 for descriptive statistics.

Figure 1 Students’ attitudes towards using twitter in classes



Four items on the scale assessed students’ thoughts about how the use of Twitter supported their group during the discussions. Students generally felt that Twitter helped their groups stay on topic and did not limit their ability to engage in a deep discussion of the topic. Students felt mostly that the tweets represented what their group was discussing, however, equal numbers of students agreed that it was difficult for everyone to contribute to the tweets as disagreed. The descriptive statistics are presented in Figure 2.

The final four items on the scale assessed students’ thoughts about how the use of Twitter supported whole class and between group interactions. Students were in complete agreement that they enjoyed watching the tweets from other groups and mostly agreed that the tweets were useful during whole class discussions. The responses to the item ‘Watching the tweets from the other groups were distracting’ were also mixed, with ten of the 35 students who responded to this item agreeing that it was a distraction. However, most students agreed that they got ideas from watching tweets from other groups, suggesting some benefit despite the potential for distraction. Descriptive statistics for these items are presented in Figure 3.

Figure 2 Students' thoughts of twitter to support group discussion

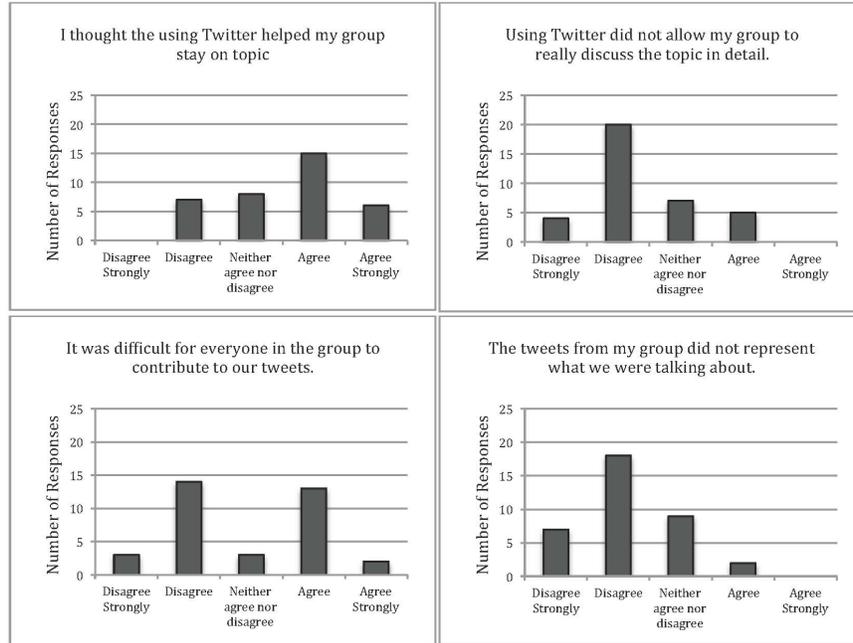
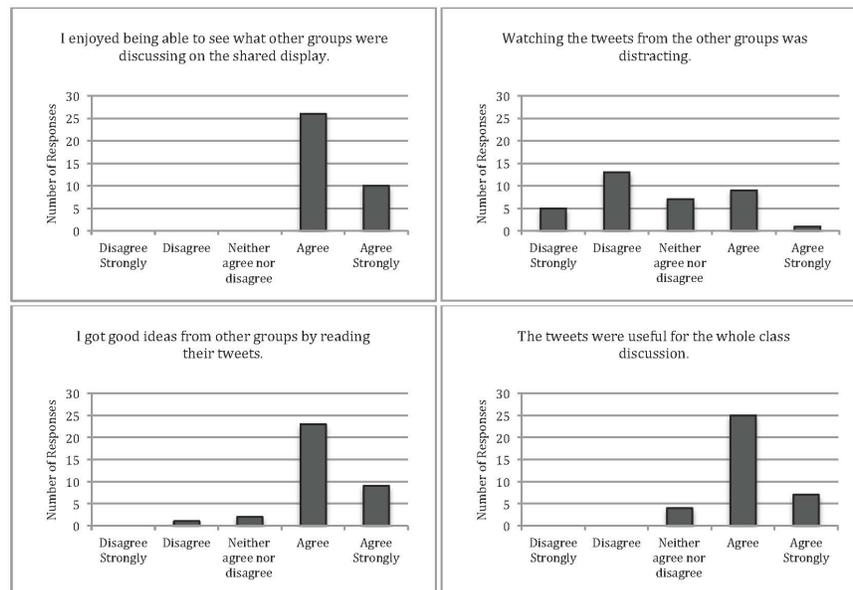


Figure 3 Students' responses to the joint display of tweets



3.3 *Qualitative data*

The final item on the survey was an open-ended item that allowed students to provide any other comments they had about the use of Twitter in the class. Sixteen students wrote responses to this item (44%). While some comments were short, many contained a number of different ideas. Categorising the tweets led to six primary categories of responses that are described in the sections below.

3.3.1 *General comments*

Six comments were positive responses to using Twitter, but did not include any specifics. These included comments such as:

- Very helpful and entertaining. Helped to make learning interesting.
- It was memorable and interactive.

3.3.2 *Other groups' ideas and whole class discussion*

Six comments referred to it being interesting to see what other groups were talking about and that it supported whole class discussion. One student complained that not all the ideas posted as tweets were picked up by the instructors during whole class discussion.

3.3.3 *Distraction*

Four students commented that they found using Twitter distracting, or reported that it was difficult to maintain focus on their groups' discussion while also following the live tweets on the shared display.

3.3.4 *Participation*

Three students commented on the uneven participation of their group members, or groups within the class, noting that not every group contributed tweets with the same frequency.

One student expressed the opinion that this tool allowed more shy students to have their voices heard within a class discussion, when they might typically remain quiet. However, a different student complained that he preferred to be able to talk in class, rather than being constrained to typing his contributions.

3.3.5 *More traditional teaching*

While most of the responses were explicitly positive, or had a positive tone about the structure of the activities, there were some responses that reported they would rather experience more traditional teaching in their classes. In addition to the student in the participation category, who commented that he would rather talk during class discussion, one student commented that it was a distraction that "took time away from discussion". Another suggested, "in future, the discussion should be more teacher-led", while a third noted that 'more guidance' might have helped the groups from becoming distracted.

3.3.6 Limitations of Twitter

One student commented that the use of Twitter limited what they could say, as they needed to condense their ideas to the length of a tweet. This constraint was seen as a positive by another student, who noted that it was useful to have to *boil down* the key points to share them in tweets.

Additionally, one student commented that it would have been better if more members of their group were able to tweet (the requirement was at least one group member had to be tweeting). While a different student pointed out that while this worked well as a group activity because students who were not familiar with Twitter could be supported by their team-mates, it would not be suitable as an individual activity unless everyone had prior experience with the tool.

4 Discussion

This design-experiment set out to understand whether Twitter could be used in a classroom setting to support small group discussion, inter-group awareness and whole class conversation. Through three iterations we refined our practice with Twitter and a final student survey provided an insight into students' experiences with the tool.

By only having one or two people per group tweet, we did not encounter Wi-Fi access issues, however, with more students tweeting, this could potentially be an issue. Fewer tweeters may have influenced what got tweeted and how representative it was of the groups' discussions. It also may have influenced students' reactions to the activity, as those who had less direct engagement may have had a different experience from those who tweeted throughout the classes.

Overall, the teaching team and students responded positively to using Twitter during small group discussions. From a teaching perspective, the increased on-task talk and ability to redirect discussions during the activity were important features in allowing us to continue using this type of pedagogic activity. The ability to direct the final conversation by addressing tweets, asking the groups who wrote a tweet to expand or explain it, or asking other groups to comment on the ideas contained in a tweet, allowed for more concrete discussion. It also allowed us to pick up on issues and misconceptions, which were particularly important during the second and third iteration, where the concepts of assessment and progressive education were particularly difficult for our students.

The students' response in the survey presents a positive view of the use of the tool and they were less concerned about the depth of discussion than the teaching team. The students reported that there were benefits of having to condense their ideas to short tweets, to providing a way for quieter students to contribute and to seeing the ideas coming out of other groups. However, one student did note that he preferred speaking aloud in class. This difference in preferred interaction styles reflects findings by Tiernan (2014), who described some students using Twitter to interact with the professor during a lecture, while other students asked questions aloud, in a more typical form of interaction. This indicates both forms of interaction may be important and providing a range of modes for students to share their ideas with their classmates and professors may be important in allowing the widest range of students to voice their opinions and receive support.

Some students did report that the activity was distracting and, during the final interaction, the teaching team were concerned that groups were focused on responding to tweets of other groups rather than engaging in discussion with their own group. Future experiments could alter the amount of time that the shared display was visible, perhaps allowing groups some time to work together, pausing to allow them to see the screen, before returning to small group discussion. Thus a more monitored version of the task might provide a richer experience for students.

The focus on more traditional teaching was a comment we encountered from a number of students each year when we taught the course in this manner, regardless of whether Twitter was involved. Recognising that this form of pedagogy was unusual for many students and likely the only course they were taking that was taught in this manner, further research with students who are more familiar with collaborative learning will be necessary to identify more aspects of the role of instructors during this type of activity.

As a teaching team, we were concerned that students did not have time to engage deeply with the ideas during the activity. While we believed the trade-off between lack of depth and constant on-task conversation in this class of first year students was acceptable, research with more senior undergraduates or graduate students will be important to understand more about this issue. In a class of students who are keen and able to engage in deeper discussion, Twitter might prove to be too distracting. However, a less frequent schedule of tweets, such as requiring one every ten minutes, might alleviate some of these issues.

Reflecting on the six uses of social media for education identified by Hsu et al. (2014), this use of Twitter to support collaborative learning in classrooms address the first three of their uses;

- 1 publishing and sharing learning progress
- 2 supporting and achieving collaborative tasks
- 3 making thinking, collaborative processes and products visible through tangible artifacts.

It also extends the use of the third feature, by allowing instructors to adapt their class discussion immediately in reaction to being able to see the thinking processes of their students. Instructors can intervene as soon as misconceptions appear in tweets, address them during whole class discussion, or use the content of tweets to alter the direction of discussions in other groups. This provides an important tool for teachers orchestrating collaborative learning and concerned for the types of conversation that are occurring in each group in their class.

This use of Twitter also disrupts the traditional teacher-student interaction pattern. Where previous uses of Twitter had focuses on interactions between the instructor as expert and student as novice (Dhir et al., 2013), the use of Twitter to support collaborative interactions within and between groups, provides a different model for classroom participation behaviours. In particular, the tweet-based interaction between students and between students and instructors seen during the third implementation of Twitter in our classes, suggests a more democratic form of knowledge construction can be made available through the use of such tools (Brookfield and Preskill, 1999).

This design research study has a number of limitations, including the relatively small size of the sample, the structure of the class and the fact that the survey data is from a sub-group of the class. Although we used Twitter in two sections of the same class, both

classes were quite small (less than 30 students) and so we cannot draw conclusions about how this would scale up to a larger class size. In addition, although the students were not familiar with collaborative learning activities before starting this class, they worked in the same groups throughout the year, so their within-group interactions were established before we introduced Twitter. The task may be more difficult for newly formed groups. Finally, the survey was conducted during the final review class of the year. Not all students attended this class and therefore we may have some level of selection bias in the sample as students who chose not to attend the final class may have differed in their opinion towards the course from those who did attend.

Research on the role of the teacher in supporting collaborative learning in the classroom has received limited attention (Webb, 2009) and the development of technology tools to help teachers orchestrate collaborative learning is in its infancy. Kaendler and colleagues (2014) proposed the Implementing Collaborative Learning in Classrooms (ICLC) framework, to identify the phases and types of activity that the teacher needs to engage in to support collaborative interactions in their classrooms. In the inter-active phase, they highlight the importance of monitoring, supporting and consolidating competencies. The use of Twitter provides a novel way for teachers to monitor what students are talking about during collaborative discussions and then consolidate the conversation happening within the groups by directly referring to their tweets during whole class conversation.

The study points towards the value of experimenting with easily available tools when conducting collaborative learning activities in classrooms. The ability to get a glimpse of the students' discussions, without having to stand over them, provided important insight into their understanding of the content. The ability to orchestrate discussions based on the shared representation of tweets, rather than relying solely on students reporting back, allowed us to have longer and more complex discussions in the classroom. This use of easily accessible tools on devices students themselves bring to the classroom and the movement between small group and whole class discussion through the networking and integration of small devices (phones, tablets, laptops) and large shared displays, suggests the possibility of using a range of technologies in changing the nature of small group collaborative learning in classrooms.

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