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Social media as a student response system: new evidence on learning impact

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The ubiquitousness of social media renders it a potentially powerful tool in higher education. This study explores the use of Twitter as a tool to enhance active learning and improve feedback during large-sized lectures. Students in a final-year undergraduate accounting course at an Australian university engaged in Twitter-based synchronous activities, including answering in-lecture quizzes and posting questions. This study explores two key questions: (1) 'what encourages students to actively utilise social media in their learning process?' and (2) 'what pedagogical advantages are offered by social media in enhancing students' learning experiences?' Results of a student survey administered at the end of the course show that (1) students are more likely to participate in in-lecture Twitter activities if they are familiar with the technology, (2) Twitter activities encourage students to participate in active learning, (3) Twitter provides a platform enabling two-way student–instructor communication and (4) students find Twitter activities helpful *regardless* of whether they attend the lecture in real time or view online lecture recordings. These findings deepen our understanding of the pedagogical benefits of using Twitter as a student response system, which will assist educators to better harness the power of social media in the learning–teaching process.

Keywords: Twitter; social media; large lectures; active learning; student response system; flipped classroom.

Introduction

The rapid rise of social media constitutes a significant phenomenon in modern society (Van Dijck 2013). Social media can influence public opinion (Ausserhofer and Maireder 2013; Metaxas and Mustafaraj 2012), destroy products via boycotts (Hoffman and Fodor 2010) and even sway election outcomes (Ampofo, Anstead, and O'Loughlin 2011; Bruns and Highfield 2013; Christensen 2013). As social media offers increasingly salient platforms for communication, the education sector is not impervious to these socio-technological changes. However, despite its ubiquitousness, the role of social media in education remains ambivalent (Carpenter and Krutka 2014). On the one hand, educators have utilised social media in constructive ways to improve teaching (see, e.g., Dyson *et al*. 2015; Lee and Gould 2014). On the other hand, social media is still widely regarded as a distraction in the classroom, often banned in schools (Richtel 2011) and discouraged at universities (Lee and Gould 2014). In addition, some educators remain wary of incorporating social media into teaching curriculums and practices because it can drastically alter the traditional

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classroom dynamic (Elavsky, Mislan, and Elavsky 2011; Young 2009). This study seeks to contribute to this growing literature on the educational use of social media by investigating the use of a Web 2.0 microblogging platform, Twitter, as a learning tool in higher education.

Twitter is one of the most well-known microblogs worldwide. From 2010 to 2015, the number of its active monthly users has multiplied tenfold, from 30 million to 307 million (Statista 2017). The explosive growth in its user base is mirrored by Twitter's increasing social impacts, as demonstrated by world events such as the Arab Spring revolution (Howard *et al*. 2015) and the 2016 U.S. Presidential Candidate Race (Gold 2016). In the political context, Twitter plays a vital role in enabling public discourse and setting media agendas (Jungherr 2015). It provides a platform for negotiating political issues (Ausserhofer and Maireder 2013), conducting election campaigns (Metaxas and Mustafaraj 2012) and furthering political activism (Bennett and Segerberg 2013). Similarly, in the commercial context, businesses around the world increasingly regard Twitter as an important avenue for conducting marketing campaigns (Hennig-Thurau, Wiertz, and Feldhaus 2015).

In the higher education sector, Twitter already plays a role in non-teaching activities at both institutional and individual levels. Universities utilise Twitter as a means of communicating with other universities (Shields 2016). Academic scholars increasingly use Twitter for purposes such as community engagement (Veletsianos 2012) and professional development (Carpenter and Krutka 2014).

Social media forms an integral component of the daily life of the current generation of university students (Kelleher and Sweetser 2012). Many young adults view Twitter as a part of their social identity (Boyd 2014; Murthy 2012). Given its significant social role, Twitter offers considerable potential to education if effectively utilised. Twitter's ready availability, ease of access and the instantaneousness of its communication all contribute to making it a potentially valuable tool in the modern classroom.

This article explores the use of Twitter in the context of teaching large-sized lectures, based on a project implemented in an undergraduate accounting course at an Australian university. Specifically, this study investigates the impacts of Twitter on students' learning process, and the relationship between student participation, their technology-savviness and the effects on their learning experience. This study provides evidence on the pedagogical benefits of Twitter in the context of higher education and formulates strategies to enable more students to derive greater benefits from the use of social media to assist their learning.

Prior literature

Social media and learning technologies

Prior literature has examined various social media applications in education. According to surveys conducted by Neier and Zayer (2015), undergraduate university students saw potential in using social media applications such as Facebook, Twitter, YouTube and Pinterest as learning tools. Buzzard *et al*. (2011) documented that both instructors and students perceived technology to be an important part of the learning–teaching process. These positive expectations, however, were not necessarily realised in practice, as evidenced by mixed empirical findings regarding learning outcomes.

For example, Dyson *et al*. (2015) used Facebook as a platform to engage students in an undergraduate first-year psychology course, but observed no significant impacts on the students' self-reported level of engagement and understanding. In contrast, Bal *et al*. (2015) required marketing students to complete a project on 'social media marketing strategy' using Facebook. As Facebook not only served as a learning tool but also constituted the subject studied in that course, its usage was associated with better learning outcomes.

Contrasting social media, learning technologies such as student response systems are specifically designed for the purpose of enhancing the learning–teaching experience. Clicker, a well-known student response system, provides a platform for students in a classroom to give feedback during the teaching process by streaming answers back to the instructor. Heaslip, Donovan, and Cullen (2014) and Rana and Dwivedi (2015) investigated the use of clicker in business courses with over 100 students, reporting increased student participation (Heaslip, Donovan, and Cullen 2014) and satisfaction (Rana and Dwivedi 2015).

Compared with other social media platforms and learning technologies, Twitter offers some distinctive advantages. Firstly, as a microblogging tool, Twitter limits the length of each post to 140 characters (now increased to 280). The succinctness renders Twitter particularly suitable for contemporaneous communication and instantaneous feedback in the classroom (e.g. Dunlap and Lowenthal 2009). Secondly, Twitter is more accessible and readily available to students compared with other student response systems such as Clicker, which requires individual students to each obtain a handheld voting device to use the technology (Heaslip, Donovan, and Cullen 2014). In contrast, students may be already using Twitter for non-education purposes and, unlike Clicker, Twitter is accessible via any smartphone, laptop or other smart devices (Ebner 2009). Therefore, there is a lower administrative barrier to using Twitter.

However, the instant nature of Twitter and its established role as a social media platform could serve as a double-edged sword. Students may be reluctant to include instructors in their Twitter social networks (and vice versa) (Dunlap and Lowenthal 2009; Hodges 2010). For instructors, this problem can be more easily resolved by creating a separate account exclusively for teaching purposes (Chen and Chen 2012). Furthermore, excessive usage of Twitter for out-of-class communications can be extremely time-consuming and intrusive, rendering the instructors 'on-call' 24/7 to deal with student queries (Grosseck and Holotescu 2008).

Twitter in education

Prior literature that examines the role of Twitter as an educational tool has explored the use of Twitter for two main purposes: enhancing student engagement and facilitating communication. The use of Twitter is found to be linked to increased student engagement (Domizi 2013; Ebner *et al*. 2010), particularly for shy or introvert students (Tiernan 2014; Voorn and Kommers 2013), and more effective communication (Lee and Gould 2014). Whilst some studies document increased student satisfaction (Elavsky, Mislan, and Elavsky 2011), there is mixed evidence on whether the use of Twitter is associated with improved learning outcomes (Junco, Elavsky, and Heiberger 2013; Krutka and Milton 2013; Lee and Gould 2014; West, Moore, and Barry 2015).

Enhancing student engagement

Numerous researchers have explored using Twitter for teaching activities designed to engage students during or outside lesson times. These Twitter-based learning activities can be divided into two broad categories: synchronous and asynchronous.

Synchronous activities take place during class and usually involve real-time interactions and instant responses. A common type of synchronous activity facilitated by Twitter is live discussion feeds using a common hashtag (i.e. 'live-tweeting') (Matteson 2010). In a study by Krutka and Milton (2013), students of a secondary social studies class utilised Twitter as a platform to engage in role-playing debates and discussions during class. Elavsky, Mislan, and Elavsky (2011) and Tiernan (2014) used Twitter during lectures as a parallel platform for class discussions. The content of the Twitter discussions was regularly projected onto the overhead screen and incorporated into the content delivery by the instructors (Elavsky, Mislan, and Elavsky 2011; Tiernan 2014). However, using Twitter in such a way can shift significant power from the instructor to the students. Educators may be reluctant to relinquish control over the discussion content, with the risk of discussions proceeding 'offcourse' or being 'hijacked' by students (Young 2009). For example, Elavsky, Mislan, and Elavsky (2011) reported that in-lecture discussions can digress as students became distracted by tangential issues that were socially or politically sensitive, rather than focusing on materials relevant to the course content.

In contrast, asynchronous activities take place over an unspecified time frame (usually outside the classroom), where students can participate at any time. A wide range of asynchronous activities have been documented, including course-level discussions that are structured (Kassens-Noor 2012; Scheg 2015) or unstructured (Rinaldo *et al*. 2011; Wright 2010), and more novel activities such as historical re-enactments (Lee *et al*. 2012) and collaborative creative writing (Matteson 2010). Twitter is found to encourage collaborative learning outside the classroom (Domizi 2013; Kassens-Noor 2012) and foster a sense of community amongst student participants (Wright 2010). For example, Domizi (2013) incorporated the use of Twitter in teaching a multidisciplinary graduate seminar course, in which students were required to post out-of-classroom discussions on Twitter and view others' posts at least 2–3 times a week. Domizi documented evidence of peer-assisted learning, as well as a positive shift in student attitude towards Twitter over the duration of the course (as many were resistant at first). In contrast, Chen and Chen (2012) reported a lack of commitment to peer-assisted learning exhibited by students in a training course, especially when no instructor was present to guide the discussions. In light of the reluctance on the part of the students, some studies proposed mandatory Twitter participation linked to course grades (Junco, Elavsky, and Heiberger 2013; West, Moore, and Barry 2015).

Facilitating communication

As a microblogging platform, Twitter's original and primary purpose is to enable communication. Not surprisingly, one of the key ways in which educators utilise Twitter is to improve communication amongst participants of the learning process. Twitter provides a timely channel for communications from instructors to students (Dunlap and Lowenthal 2009), such as in the form of administrative announcements (Badge *et al*. 2011; Rinaldo *et al*. 2011) and deadline reminders (Domizi 2013). For example, in the study by Rinaldo *et al*. (2011), students in an undergraduate marketing course were

asked to 'follow' the Twitter account of the instructor, who regularly posted course-related communications. Twitter can also be employed to disseminate learning materials on a regular basis. For example, Lee and Gould (2014) documented enhanced learning outcomes after instructors regularly tweeted multiple-choice quizzes to the students, with answers tweeted on the following day. Furthermore, the communication channel can also facilitate teachers' communication with other stakeholder groups and communities (Porterfield and Carnes 2011). For example, Kurtz (2009) used Twitter to share the work of his first and second graders with their parents.

Apart from instructor–student communication, other studies explored the use of Twitter to enhance peer-to-peer communication amongst student cohorts (Carpenter and Krutka 2014; Kassens-Noor 2012). In addition to facilitating academic discourse, Twitter can foster a sense of community amongst students (Rinaldo *et al*. 2011) by providing a platform for social bonding and support (Badge *et al*. 2011).

A less explored avenue of communication is student-to-instructor communications using Twitter, commonly in the form of questions (Chen and Chen 2012; Domizi 2013). Such communications are usually asynchronous, involving students posting questions to the instructors outside face-to-face lectures. According to Chen and Chen (2012), Twitter allows students a 'heightened degree of self-expression' by eliminating the inhibition present in face-to-face communication, thus encouraging students to ask questions more freely.

Gap in the literature and contribution

Whilst extant research has explored the use of Twitter in education, few researchers have examined the potential factors determining students' willingness to participate, or the interaction between participation and perceived usefulness of the technology. In particular, Rinaldo *et al*. (2011) has identified this gap in the literature suggesting that '[f]uture research in this area should address methods and strategies for increasing student use of Twitter'. In addition, little academic attention has been directed towards investigating the use of Twitter as a tool for synchronous, instant communication from students to instructor, to enable the instructor to gauge student understanding in a timely manner and accordingly adapt the lecture content.

This study seeks to address these gaps in the literature by developing a two-stage model to predict the interaction between (1) students' inclination to actively participate in Twitter activities and (2) the usefulness of Twitter in their learning experience, as illustrated in Figure 1. Based on the evidence from the analyses, this study proposes strategies aimed at increasing student participation in social media-based lecture activities. Furthermore, this study examines not only *whether* Twitter serves as a useful educational tool but also specifically *how* it can enhance and facilitate student learning by exploring the various avenues through which Twitter activities can improve students' in-lecture learning experience.

Method

Study setting

This article reports on a case study involving the use of Twitter for synchronous activities and communication in the context of an accounting course delivered to over 150 third-year undergraduate students at an Australian university. At the start of the course, a Twitter account and a hashtag were created. Students were provided
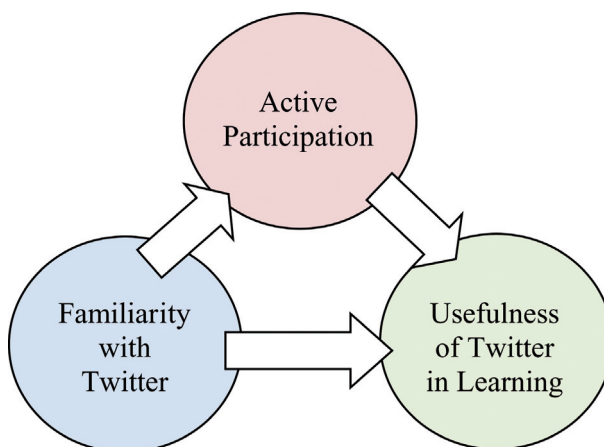
Figure 1.   Interactions amongst familiarity, participation, and usefulness.

with a 'Guide to Using Twitter for In-Lecture Activities' for the purpose of this course, which detailed the nature of the in-lecture activities and other relevant information.[1]

The Twitter activities consisted of two components. Firstly, a series of Twitter-based in-class quizzes were designed for each lecture, comprising three to four questions provided on screen at strategic intervals, to examine students on recently delivered lecture materials during the previous 15–30 minute intervals. Students were invited to participate in the quizzes by posting on Twitter (or 'tweeting') their answers using the course hashtag. It was not necessary for students to join any group or to 'follow' the instructor account. At the end of each quiz, which typically lasted for 2–3 min, the solution to the quiz was provided in the lecture presentation along with additional explanations. Furthermore, students were encouraged to live-tweet any questions or comments using the course hashtag during the lectures. The instructor provided synchronous verbal responses to these questions as a part of the lecture delivery. However, students appeared reluctant to use this latter feature and only a small number of tweets were posted outside the scope of quiz answers. All tweets were sent by students who were physically present in the lecture theatre, from their cell phones, laptops or other smart devices (e.g. iPads).

The objectives of the Twitter activities are twofold: (1) to encourage students to stay engaged and attentive during lectures by providing them with the opportunity to become active participants in the learning process and (2) to enable students to receive instantaneous and targeted feedback, simultaneously allowing the instructor to gauge student understanding of the course materials and to identify common weaknesses or misconceptions.

Survey data collection

At the end of the semester, all students in the course were invited to provide feedback in a survey designed to explore their experience of using Twitter and to gauge the usefulness of Twitter to their learning process. The survey was administered through

the Blackboard course website. A total of 58 valid responses were received. The survey consisted of two parts: Likert scale questions and free response questions. The Likert scale questions were designed to gauge three aspects of student experience with Twitter, including (1) a student's familiarity with Twitter prior to the course, (2) a student's experience with Twitter activities in this course and (3) specific ways in which Twitter activities affected their learning experience. The free response part of the survey included the three following questions: (1) 'What are the best aspects of the Twitter activities during lectures?', (2) 'How could the Twitter activities during lectures be improved?' and (3) 'What would encourage you to participate more actively in the Twitter activities during lectures?'. The survey questions are detailed in Appendix A.

Empirical models

This article posits that the usefulness of Twitter-based learning activities to students depends significantly on active student participation. Tiernan (2014) found that hardware-related technological constraints (e.g. the lack of a smartphone or smart device) constituted one of the reasons why students chose not to use the Twitter platform for education purposes. Whilst few students nowadays are deterred by the lack of access to the Twitter application, their previous experience with the microblogging platform can have a salient effect on their inclination to use it.

   This study proposes that a number of factors, such as having an existing Twitter account (Lee and Gould 2014), familiarity with the technology and lecture attendance patterns, may affect students' inclination to actively participate in the Twitter-based lecture activities. Through influencing the students' decision to participate, these factors may also potentially impact their learning experience and the usefulness of Twitter to their learning process.

   To examine these *a priori* expectations, a two-stage regression model is employed in this study. As specified in Equation (1), in the first stage, an ordinary least square (OLS) model is estimated to predict a student's inclination to actively participate in Twitter activities during lectures. Four independent variables are included to capture factors that are likely to affect a student's level of participation: $EXISTACC_j$ is a dummy variable assigned a value of one if the student already had a Twitter account prior to starting the course, and zero otherwise. $EASE_j$ and $FAMILIAR_j$ capture the student's Likert scale response to the questions 'I am familiar with the use of Twitter' and 'I find it easy to use Twitter for the in-lecture activities', respectively. Finally, $LECATTEND_j$ captures a student's self-reported regularity of attending lectures. In an alternative re-estimation of this regression model, in lieu of $LECATTEND_j$, $LECONLINE_j$ is employed to capture the student's self-reported regularity of listening to lecture recordings online. Using the results from the first-stage regression model in Equation (1), a predicted level of student participation ($ACTIVE\_P_j$) is calculated, which is employed as an independent variable in the second-stage regression model.

First-stage regression specification:

$$ACTIVE_j = \alpha + \beta_1 EXISTACC_j + \beta_2 EASE_j + \beta_3 FAMILIAR_j + \beta_4 LECATTEND_j + \varepsilon \quad (1)$$

Second-stage regression specification:

$$USEFUL_j = \alpha + \beta_1 ACTIVE\_P_j + \beta_2 INTERACT_j + \beta_3 INVOLVE_j + \beta_4 INTEREST_j$$
$$+ \beta_5 FOCUS_j + \beta_6 OPINION_j + \beta_7 PARTICIPATE_j + \beta_8 FEEDBACK_j$$
$$+ \beta_9 FEEDBACKLEC_j + \beta_{10} ASSESS_j + \beta_{11} COMPARE_j$$
$$+ \beta_{12} LECONLINE_j + \varepsilon \tag{2}$$

In the second stage, the OLS model specified in Equation (2) predicts the reported usefulness of Twitter in the student learning process ($USEFUL_j$). A student's active participation in the Twitter activities is *a priori* expected to significantly affect the student's perceived usefulness of Twitter as an educational tool. Apart from $ACTIVE\_P_j$, the model employs a series of independent variables that capture various aspects of the learning experience, which are computed based on student survey responses. These variables are designed to isolate specific aspects of the learning experience which may be enhanced (or hindered) by the use of Twitter (all variable definitions are provided in Appendix B). Finally, $LECONLINE_j$ is also included in the model to investigate the usefulness of Twitter for students who view lecture recordings online rather than attend lectures in person.

Empirical results

In this section, I discuss and analyse the results from the student survey on Twitter activities. I first describe the responses to the Likert scale questions concerning the students' existing familiarity with Twitter, their inclination to participate in in-lecture activities and the impacts of Twitter activities on their learning. I then present the empirical results from the regression analyses to explain the avenues through which Twitter activities can improve students' learning experiences. Finally, I discuss numerous free response comments from students to provide further insights into their experience with using Twitter as a learning tool.

Survey results: Likert scale questions

Table 1 reports the results from the first part of the survey containing Likert scale questions. A total of 58 responses were received. The results from these questions are also presented in a series of histograms in Figure 2 in Appendix C.

Existing familiarity

Firstly, the survey results provide an overview of students' existing familiarity with Twitter. As reported in Table 1, approximately half of the students had pre-existing familiarity with using Twitter. About 53% of the students reported that they already had a Twitter account prior to the start of the course and 47% did not have existing accounts. Consistently, 53% of students reported that they were familiar or very familiar with using Twitter, whilst the remaining 47% were undecided, unfamiliar or very unfamiliar with using Twitter.

Table 1. Survey results (Likert Scale).

	Survey Question	Valid Responses	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree		NA
1	I am familiar with the use of Twitter	57	6	11%	15	26%	6	11%	22	39%	8	14%	1
2	I already had a Twitter account prior to starting this course	58	No: 27	47%	–	–	–	–	–	–	Yes: 31	53%	0
3	I find it easy to use Twitter for the in-lecture activities	57	1	2%	6	11%	14	25%	22	39%	14	25%	1
4	I actively participate in the in-lecture activities using Twitter	58	12	21%	5	9%	15	26%	19	33%	7	12%	0
5	I find the use of Twitter during lectures useful to my learning	56	5	9%	6	11%	14	25%	20	36%	11	20%	2
6	Twitter enables me to interact with the lecturer during lectures	55	4	7%	2	4%	12	22%	32	58%	5	9%	3
7	Twitter activities enable me to be involved in learning during lectures	56	5	9%	1	2%	10	18%	32	57%	8	14%	2
8	Twitter activities make lectures more interesting	53	5	9%	3	6%	5	9%	31	58%	9	17%	5
9	Twitter activities help me stay focused during lectures	56	6	11%	6	11%	7	13%	29	52%	8	14%	2
10	Twitter activities enable me to voice my opinion in class discussions	53	5	9%	0	0%	12	23%	27	51%	9	17%	5
11	Twitter activities enable me to participate in class discussions	55	6	11%	1	2%	9	16%	31	56%	8	15%	3
12	I receive feedback from the lecturer during class based on my Twitter responses	54	6	11%	4	7%	20	37%	15	28%	9	17%	4

Table 1. (*Continued*)

Survey Question	Valid Responses	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree		NA
13 I receive feedback on my understanding of the course materials through Twitter activities	56	6	11%	1	2%	15	27%	26	46%	8	14%	2
14 I can assess how well I understand the course materials through Twitter activities	55	5	9%	5	9%	10	18%	28	51%	7	13%	3
15 I can compare my understanding with other students through Twitter activities	56	5	9%	5	9%	18	32%	22	39%	6	11%	2
16 I find the lectures in this course useful to my learning	55	1	2%	0	0%	1	2%	28	51%	25	45%	3
17 I regularly attend lectures in person	54	11	20%	3	6%	8	15%	19	35%	13	24%	4
18 I regularly listen to online lecture recordings	54	1	2%	3	6%	4	7%	25	46%	21	39%	4

		0–2		3–5		6–7		8–10		11–12		NA
19 I have attended approximately _____ number of lectures in this course	56	12	21%	9	16%	12	21%	19	34%	4	7%	2
20 I have listened to the online recording(s) of approximately _____ number of lectures in this course	56	4	7%	11	20%	9	16%	12	21%	20	36%	2

Active participation and usefulness

Secondly, the survey responses indicate that a majority of students have participated in the Twitter-based lecture activities and found them useful to their learning. Specifically, 45% of students participated actively or very actively in Twitter in-lecture activities and 26% participated somewhat, whereas 29% did not actively participate. A majority of the students found Twitter activities useful or very useful to their learning (56%), whilst 25% were undecided and 20% did not find them useful. It is noteworthy that a higher percentage of students found Twitter activities useful compared with the percentage of students who reported to be active participants. This suggests that students who did not actively participate in the in-lecture activities may nevertheless find them helpful to their learning process. Finally, students, on average, viewed lecture recordings online more often than attending lectures in person, with 62% reported having attended more than half of the lectures in the semester and 73% reported having viewed more than half of the recordings.

Twitter and specific aspects of learning

Thirdly, the survey further allowed students to identify specific aspects of the learning process which are improved by using Twitter in lectures. Student responses indicate that Twitter-related activities make lectures more interesting, help students stay focused and facilitate student participation. For example, 75% of students either strongly agreed or agreed with the statement that 'Twitter activities make lectures more interesting'.

Regression analysis

In order to explain the usefulness of Twitter to student learning, I compile a number of variables based on the responses from the survey, which are analysed using a two-stage regression model as specified in Equations (1) and (2) in the 'Empirical models' section (all variables are defined in Appendix B). In the first stage of the analysis, I run an OLS regression model which employs as explanatory variables (1) students' prior experience with Twitter and (2) their lecture attendance patterns, to predict their levels of participation in Twitter activities during class. In the second-stage analysis, I run an OLS model with explanatory variables including (1) the students' *predicted* inclination to engage in active participation from the first-stage analysis and (2) student ratings on specific roles of Twitter in assisting various aspects of their learning. The dependent variable in the second-stage model represents the degree of usefulness of Twitter to students' learning process as reported in the survey.

What drives active student participation?

Table 2 reports the results from the OLS regression analysis as specified in Equation (1). In Model (1) of Table 2, the coefficient of the variable $EASE_j$, which measures how easy students find Twitter to use, is positive and significant in predicting students' active participation in Twitter activities ($p < 0.01$). In contrast, neither having an existing Twitter account ($EXISTACC_j$) nor students' previous familiarity with Twitter ($FAMILIAR_j$) is significant in predicting their willingness to take part in the activities.

Table 2. Active participation in Twitter learning activities.

	ACTIVE (1)	ACTIVE (2)
EXISTACC	0.293	0.208
	(0.345)	(0.446)
EASE	0.636***	0.704***
	(0.000)	(0.000)
FAMILIAR	0.179	0.202*
	(0.159)	(0.074)
LECATTEND	0.254**	
	(0.024)	
LECONLINE		−0.101
		(0.499)
constant	−0.835	0.161
	(0.141)	(0.842)
n	52.000	52.000
Adj. R^2	0.476	0.470
F-stat	16.721	10.045

Note: *p*-values in parentheses.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

In addition, consistent with expectation, the coefficient of $LECATTEND_j$ is positive and significant in predicting $ACTIVE_j$ ($p < 0.05$), indicating that students who attend lectures in person are more likely to participate. These results show that students are more willing to engage with in-class Twitter activities if they find the technology easy to use, regardless of whether they have used Twitter before or their existing familiarity with the platform. These findings have significant practical implications for educators. Specifically, given that the main barrier to students' participation in Twitter lecture activities is the difficulty in using the app, instructors can encourage student participation by providing basic instructions on account set-up and navigating Twitter.

As a robustness test, the regression is re-estimated in Model (2) of Table 2 by replacing $LECATTEND_j$ (lecture attendance) with $LECONLINE_j$ (online lecture viewing). The estimated coefficient of $LECONLINE_j$ is negative but not significant. This shows that whilst regular lecture attendance is associated with more active participation in Twitter activities, viewing online lecture recordings does not necessarily preclude students from participating in or deriving benefits from the Twitter in-lecture activities. Finally, I calculate a new variable, $ACTIVE\_P_j$, which captures the predicted value of $ACTIVE_j$ (active participation) using the estimated coefficients from Model (1). $ACTIVE\_P_j$ is employed as an explanatory variable in the second-stage regression to predict the reported usefulness of Twitter to student learning.

Why is Twitter useful as a learning tool?

The second-stage regression seeks to explain the usefulness of Twitter as a learning tool by examining various aspects of the students' in-lecture experiences. Firstly, as reported in Model (1) of Table 3, $ACTIVE\_P_j$ is positive and is significantly associated with $USEFUL_j$ ($p < 0.01$), indicating that the more actively students participate

Table 3. Usefulness of Twitter as a learning tool.

	USEFUL (1)	USEFUL (2)	USEFUL (3)	USEFUL (4)
ACTIVE_P	0.675***	0.747***	0.522***	0.551***
	(0.000)	(0.000)	(0.002)	(0.001)
INTERACT	0.579***	0.647***	0.373**	0.418***
	(0.006)	(0.001)	(0.018)	(0.002)
INVOLVE	0.425**	0.509***	0.474**	0.515***
	(0.044)	(0.005)	(0.022)	(0.005)
INTEREST	0.226	0.406*		
	(0.379)	(0.084)		
FOCUS	0.297**	−0.124	0.363**	0.189
	(0.046)	(0.554)	(0.010)	(0.274)
OPINION	−0.279	−0.386		
	(0.227)	(0.101)		
PARTICIPATE	−0.275	−0.308*	−0.326	−0.336**
	(0.141)	(0.099)	(0.101)	(0.035)
FEEDBACK	0.008	0.096	0.016	0.095
	(0.952)	(0.523)	(0.892)	(0.404)
FEEDBACKLEC	−0.286*	−0.345***		
	(0.062)	(0.006)		
ASSESS	0.082	0.210		
	(0.459)	(0.168)		
COMPARE	−0.275***	−0.188**	−0.369***	−0.348***
	(0.005)	(0.028)	(0.000)	(0.000)
LECONLINE		0.403***		0.264**
		(0.002)		(0.048)
constant	−0.556	−2.569***	−0.135	−1.325**
	(0.129)	(0.000)	(0.596)	(0.039)
n	45.000	43.000	49.000	47.000
Adj. R^2	0.773	0.862	0.784	0.837
F-stat	51.352	62.254	91.966	73.070

Note: *p*-values in parentheses.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

in Twitter activities, the more likely they would find Twitter useful to their learning. This finding offers important insights to educators. Whilst prior researchers have focused on selecting the appropriate social medial platform and designing the optimal activities (Dyson *et al.* 2015; Heaslip, Donovan, and Cullen 2014; Zaina, Ameida, and Torres 2014), the evidence from this study shows that encouraging active student participation is an important element for improving students' learning experience. Combined with the results from the first-stage regressions, the empirical findings suggest that the key to implementing Twitter-based learning activities is by improving the ease with which students can use the technology. This can be achieved through several practical measures, such as (1) providing basic instructions to students who are new Twitter users and (2) ensuring that information relating to course-related Twitter activities (including the course hashtag) is available and accessible to students.

Secondly, Twitter's overall usefulness to students can be explained by its impacts on several specific aspects of the learning experience. $INTERACT_j$, $INVOLVE_j$ and

$FOCUS_j$ are positively and significantly associated with the usefulness of Twitter ($p < 0.05$ or better). These results show that students find that Twitter-based activities assist their learning through the following avenues: (1) facilitating interaction with the instructor during lectures, (2) enabling students to feel more involved in the learning process and (3) helping students stay focused during lectures. These statistical findings are further corroborated by anecdotal comments from the 'free response' section of the survey (discussed in the next section). In addition, it is noteworthy that $COMPARE_j$ is negatively and significantly associated with the usefulness of Twitter ($p < 0.05$). This indicates that students, on average, find it less useful to compare their answers with those of their peers.

Whilst prior literature documents that social media tools can facilitate the learning process (Dyson *et al*. 2015; Heaslip, Donovan, and Cullen 2014), the results of this study identify *specific* ways in which Twitter enhances students' in-lecture learning experiences. Lectures are traditionally regarded as a one-way learning method, where students assume a passive recipient role (Dyson *et al*. 2015; Tiernan 2014). Given the large class size of lectures in Australian universities, attending lectures can be rendered an impersonal and passive experience. However, the use of Twitter significantly improves this aspect of the lecture experience by involving students and providing them a more active role in the learning process. As one student remarks in the survey, Twitter activities 'get the students to pay attention, otherwise we won't have any answer to tweet'. In doing so, Twitter activities help students stay focused by providing motivation, incentives and positive reinforcement.

Thirdly, I examine the relationship between the usefulness of Twitter and viewing lecture recordings online. In Model (2) of Table 3, I re-estimate the regression by including an additional variable $LECONLINE_j$, which captures how regularly a student views online lecture recordings. $LECONLINE_j$ is positively and significantly associated with $USEFUL_j$ ($p < 0.01$), indicating that students who view online lecture recordings also gain value from the Twitter activities. Additionally, when $LECONLINE_j$ is added to the model, $FOCUS_j$ is no longer statistically significant; however, $INTEREST_j$ becomes significant ($p < 0.10$).

Contrary to the *a priori* expectations that Twitter-based activities primarily benefit students physically attending lectures, these results show that students who regularly view online lecture recordings also benefit from the Twitter activities. As a robustness check, I re-estimate the regressions in Models (1) and (2) by using a more parsimonious model, after excluding independent variables which may be highly correlated. The results are reported in Models (3) and (4) of Table 3. The estimated coefficients and statistical significance of the key variables are not materially different from the baseline results discussed above.

Does Twitter encourage lecture attendance?

To further investigate the relationship between lecture attendance and in-lecture use of Twitter, I estimated two additional OLS regression models as specified in Equations (3) and (4) (all variables are defined in Appendix B). The results are reported in Table 4.

$$LECATTEND_j = \alpha + \beta_1 EXISTACC_j + \beta_2 EASE_j + \beta_3 FAMILIAR_j + \beta_4 USEFUL_j$$
$$+ \beta_4 NLECONLINE_j + \varepsilon \tag{3}$$

Table 4. Use of Twitter and lecture attendance.

	LECATTEND (1)	LECONLINE (2)
EXISTACC	0.022	0.117
	(0.957)	(0.679)
EASE	0.187	−0.096
	(0.597)	(0.701)
FAMILIAR	−0.070	−0.100
	(0.647)	(0.387)
USEFUL	−0.103	0.318*
	(0.736)	(0.096)
NLECONLINE	−0.424***	
	(0.003)	
NLECATTEND		−0.204*
		(0.055)
constant	4.800***	4.212***
	(0.000)	(0.000)
n	50.000	50.000
Adj. R^2	0.197	0.159
F-stat	2.937	1.375

Note: *p*-values in parentheses.
*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

$$LECONLINE_j = \alpha + \beta_1 EXISTACC_j + \beta_2 EASE_j + \beta_3 FAMILIAR_j + \beta_4 USEFUL_j$$
$$+ \beta_4 NLECATTEND_j + \varepsilon \qquad (4)$$

As reported in Model (1), $USEFUL_j$ is not significant in predicting *LECAT-TEND*$_j$, meaning that the perceived usefulness of Twitter-based lecture activities does not influence students' lecture attendance rates. However, $USEFUL_j$ is significant and positive ($p < 0.10$) in predicting $LECONLINE_j$ in Model (2). This shows that the more useful students find Twitter activities, the more likely they would view lecture recordings online. Finally, attending physical lectures and viewing online lectures are substitutes and thus inversely correlated. More viewing of lecture recordings is associated with less physical lecture attendance [$p < 0.01$ of $NLECONLINE_j$, Model (1)] and vice versa [$p < 0.10$ of $NLECATTEND_j$, Model (2)].

Overall, these regression results provide numerous insights. Firstly, students are more likely to actively participate in and derive value from Twitter-based lecture activities if they find the technology easy to use. Secondly, the use of Twitter during lectures improves the student's learning experience by facilitating interactions with the instructor, encouraging active learning and helping students stay focused. Finally, Twitter activities not only benefit students who attend lectures in person, but also those who view lecture recordings online.

Survey results: free response questions

In this section, I discuss the student comments from the free response questions. contained in the second part of the survey. Amongst the 28 responses, 25 students

answered the question 'What are the best aspects of the Twitter activities during lectures?', 20 students responded to the question 'How could the Twitter activities during lectures be improved?' and 18 provided answers to the question 'What would encourage you to participate more actively in the Twitter activities during lectures?'. All responses are reported in Appendix D. A number of common themes are identified from these free responses, which further supplement and corroborate the regression results reported in the previous section.

Firstly, in relation to student engagement, students provide insights into *how* Twitter activities enable them to become more involved in the lecture learning process. During the lectures, Twitter activities 'provoke [students] to think about what [they] have just learnt' (Students 8 and 18), allowing them to 'put learning into practice' (Student 9), and offering opportunities to 'gather their thoughts' (Student 9), 'assess where [they] 're at in the lecture' (Student 10) and reflect on recent content 'prior to continuing to the next' (Student 12). Providing assessment and feedback is also an important aspect of Twitter activities. Students value the opportunity to 'test' their knowledge (Student 2) and receive 'instant feedback on [their] understanding of course concepts' (Student 19). The results enable students to 'pinpoint' weaknesses in their understanding (Student 4), thus informing them on 'which part [they] need to focus more' attention (Student 22). Consequently, incorporating Twitter activities in lectures encourages students to 'pay attention' (Student 13) and 'focus on the topic' (Student 6) by providing motivation and positive reinforcement for doing so. As articulated by one student, 'otherwise we won't have any answer to tweet' (Student 13).

Secondly, the results demonstrate that the adoption of the Twitter platform facilitates students' interactions with the instructor. This serves to turn lectures into a two-way reciprocal experience by providing students with a parallel avenue of interacting with the instructor during lecture time. Some students comment on the value offered by Twitter as an alternative means of communication during lectures, enabling students to 'get feedback *without having to talk*' as a benefit of using Twitter in lectures. However, despite students being encouraged to live-tweet their questions and comments during lectures, few have done so throughout the semester, with students preferring to ask questions in person during lecture breaks or after the lectures. These observations are inconsistent with the findings of Chen and Chen (2012), who found that using Twitter encouraged students to communicate more freely with the instructor. This discrepancy is potentially attributable to cultural differences. Chen and Chen (2012)'s study was conducted in Confucius-influenced Taiwan, where students may feel 'inhibited' from asking questions during lectures (Chen and Chen 2012), potentially due to a greater power distance between students and instructors and a stronger emphasis on collectivism in a group setting (Gelfand *et al*. 2011; Hofstede 2001; Hofstede, Hofstede, and Minkov 2010). As documented by Chen and Chen (2012), Twitter provides an alternative avenue for those students to raise queries in a more socially acceptable manner, without appearing to 'interrupt' the instructors. In contrast, in the Australian setting where this study is conducted, students may not experience the same cultural inhibition discouraging them from asking questions, and thus no increase in the volume of questions is observed by students using Twitter.

Thirdly, students specifically mention that they have found Twitter activities useful despite not regularly attending lectures for a variety of reasons such as 'part-time work commitment' (Student 8). Student 4 states that 'I don't attend lectures in person, but I [...] enjoy doing the multiple choice questions during the lecture (even though

I participate from home), it really helps me quickly identify whether or not I understand the concepts. If I don't, then I have the opportunity to […] go back and re-listen or read up on it'. Even though Student 14 prefers the activities to be more 'accommodating to those who are watching online', Student 18 states that 'even when you're not in the lecture theatre but listening to the recordings at home, you can still make good use of the quizzes'.

These anecdotal observations strongly corroborate the results from the regression analysis in the previous section, which show that students derive benefits from Twitter activities *regardless* of whether they attend lectures in person. This finding is of particular significance and interest to modern educators, given the now common practice of recording lectures, and students' tendency to view them online rather than attending lectures in person. These results suggest that Twitter-based in-lecture activities can be utilised as a means of reaching out to the cohort of students viewing lectures online, providing them with the same opportunities (albeit not synchronous) to be involved in the learning process, assess and consolidate their knowledge, and receive feedback on their understanding.

Conclusion

Key findings and implications

This study explores the use of Twitter in higher education, specifically, as a means of enhancing active learning, providing feedback and increasing student engagement during large university lectures. Prior studies have only examined the relationship between the use of technology and the resulting learning experience. This study investigates the interaction between students' existing familiarity with the technology, the likelihood of active participation in its usage and the eventual impacts on the learning process.

Findings of this study show that students are more likely to find Twitter useful when they actively participate in the in-lecture activities. Active participation is in turn determined by how easy students find using Twitter, but not necessarily by their prior experience with this social media tool. In addition, Twitter's usefulness as a learning tool is specifically related to enabling students to be involved during lectures, facilitating student–instructor interactions and helping students remain focused throughout the lecture process. Students find Twitter activities useful irrespective of whether they regularly attend lectures in person or watch recordings online. These novel findings have a number of practical implications.

Firstly, the evidence suggests that the usefulness of social media-based (or other technology-based) learning activities depends not only on their pedagogical design, but also on the practical inclination of students to actively utilise them. Educators can encourage students to participate in these activities by helping students become more familiar with the technology and making it easier for students to navigate (e.g. by providing instruction manuals or training).

Secondly, Twitter-based activities enhance students' lecture experience by improving specific aspects of the learning process, in particular, by enabling students to become involved in active learning, by providing incentives to stay focused on lecture materials and by allowing students opportunities for feedback and reflection. Such social media-based activities are, therefore, particularly useful for instructors teaching large-sized lectures, where students may otherwise lack a sense of active involvement

during lectures. These activities can also be useful in courses with technically complex content, where timely feedback may be particularly helpful to students in solidifying their knowledge.

Thirdly, as technological advances enable educators to record and deliver content online, the current generation of students increasingly expect readily available, self-paced lecture recordings, in lieu of the traditional model of face-to-face delivery. This inevitable trend renders it more imperative for educators to seek ways to engage students online. The findings of this study show that Twitter-based in-lecture activities benefit not only students who attend lectures in person, but also those who view lecture recordings online. These findings inform educators of the usefulness and significant potential of social media tools in enhancing the learning experience of students in this modern digital era.

Limitations and directions of further research

This study also reveals potential 'pitfalls' when using social media technology in the classroom. Firstly, social media may create distractions. For example, as Student 5 candidly states in the free response part of the survey, 'after [using] Twitter, sometimes I opened the other apps and missed [the] following content'. Secondly, time constraint is a challenge commonly encountered when adopting interactive activities as a part of lecture delivery. Thirdly, one of the primary concerns *ex ante* has been the potential of out-of-control student behaviours (such as inappropriate language) on Twitter. The instructors' institutions have no control over social media platforms, unlike other avenues of course-related communications (such as discussion boards). Elavsky, Mislan, and Elavsky (2011) required students to submit their student IDs and Twitter account name as a precautionary step of holding students accountable for their Twitter comments. In this study, students were provided with guidelines to using Twitter for in-lecture activities at the start of the course, detailing the relevant university rules pertaining to IT usage and student misconduct. This approach appears sufficient to pre-empt inappropriate online conduct, as no incident arose during the course of this study.

There are several limitations of this study. Firstly, this study only investigates the use of Twitter in the education context without considering other social media tools or technologies. Secondly, the generalisability of the findings is constrained by the setting in which this study is conducted. The reported experience of third-year undergraduate students at an Australian university might not be extrapolated to other cohorts of students or those in other countries with different cultural backgrounds. Finally, further research is needed to determine the effectiveness of the measures proposed in this study of increasing student participation in the in-lecture activities by increasing students' social media technology literacy.

Note

1. In order to prevent 'trolling' or other inappropriate language and/or behaviour involving the course Twitter account or hashtag, the 'Guide to Using Twitter' distributed to students set out guidelines of acceptable/unacceptable behaviours, including an extract of the University's Policy on 'IT acceptable use and security' and Student behavior and conduct policy.

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Appendix A. Survey instrument.

No.	Questions	Likert/Other Format
1	I am familiar with the use of Twitter	1 2 3 4 5
2	I already had a Twitter account prior to starting this course	Yes No
3	I find it easy to use Twitter for the in-lecture activities	1 2 3 4 5
4	I actively participate in the in-lecture activities using Twitter	1 2 3 4 5
5	I find the use of Twitter during lectures useful to my learning	1 2 3 4 5
6	Twitter enables me to interact with the lecturer during lectures	1 2 3 4 5
7	Twitter activities enable me to be involved in learning during lectures	1 2 3 4 5
8	Twitter activities make lectures more interesting	1 2 3 4 5
9	Twitter activities help me stay focused during lectures	1 2 3 4 5
10	Twitter activities enable me to voice my opinion in class discussions	1 2 3 4 5
11	Twitter activities enable me to participate in class discussions	1 2 3 4 5
12	I receive feedback from the lecturer during class based on my Twitter responses	1 2 3 4 5
13	I receive feedback on my understanding of the course materials through Twitter activities	1 2 3 4 5
14	I can assess how well I understand the course materials through Twitter activities	1 2 3 4 5
15	I can compare my understanding with other students through Twitter activities	1 2 3 4 5
16	I find the lectures in this course useful to my learning	1 2 3 4 5
17	I regularly attend lectures in person	1 2 3 4 5
18	I regularly listen to lecture recordings	1 2 3 4 5
19	I have attended approximately _____ number of lectures in this course	0–2 3–5 6–7 8–10 11–12
20	I have listened to the recording(s) of approximately _____ number of lectures in this course	0–2 3–5 6–7 8–10 11–12
21	What are the best aspects of the Twitter activities during lectures?	Free response
22	How could the Twitter activities during lectures be improved?	Free response
23	What would encourage you to participate more actively in the Twitter activities during lectures?	Free response

Likert Scale	1	2	3	4	5
	Strongly disagree	Disagree	Undecided	Agree	Strongly Agree

Appendix B. Variable definitions.

Variable name	Variable definition
$ACTIVE_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I actively participate in the in-lecture activities using Twitter' (1 = strongly disagree, 5 = strongly agree).
$EXISTACC_j$	Dummy variable that is assigned a value of 1 if the student already had Twitter account prior to starting this course, and a value of 0 otherwise.
$EASE_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I find it easy to use Twitter for the in-lecture activities' (1 = strongly disagree, 5 = strongly agree).
$FAMILIAR_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I am familiar with the use of Twitter' (1 = strongly disagree, 5 = strongly agree).
$LECATTEND_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I regularly attend lectures in person' (1 = strongly disagree, 5 = strongly agree).
$LECONLINE_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I regularly listen to lecture recordings' (1 = strongly disagree, 5 = strongly agree).
$USEFUL_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I find the use of Twitter during lectures useful to my learning' (1 = strongly disagree, 5 = strongly agree).
$ACTIVE\_P_j$	Predicted value of $ACTIVE_j$ using the results from the ordinary least squares regression specified as follows: $$ACTIVE_j = \alpha + \beta_1 EXISTACC_j + \beta_2 EASE_j + \beta_3 FAMILIAR_j + \beta_4 LECATTEND + \varepsilon$$
$INTERECT_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter enables me to interact with the lecturer during lectures' (1 = strongly disagree, 5 = strongly agree).
$INVOLVE_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter activities enable me to be involved in learning during lectures' (1 = strongly disagree, 5 = strongly agree).
$INTEREST_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter activities make lectures more interesting' (1 = strongly disagree, 5 = strongly agree).
$FOCUS_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter activities help me stay focused during lectures' (1 = strongly disagree, 5 = strongly agree).
$OPINION_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter activities enable me to voice my opinion in class discussions' (1 = strongly disagree, 5 = strongly agree).
$PARTICIPATE_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'Twitter activities enable me to participate in class discussions' (1 = strongly disagree, 5 = strongly agree).
$FEEDBACK_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I receive feedback on my understanding of the course materials through Twitter activities' (1 = strongly disagree, 5 = strongly agree).
$FEEDBACKLEC_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I receive feedback from the lecturer during class based on my Twitter responses' (1 = strongly disagree, 5 = strongly agree).
$ASSESS_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I can assess how well I understand the course materials through Twitter activities' (1 = strongly disagree, 5 = strongly agree).

Appendix B. (*Continued*)

Variable name	Variable definition
COMPARE$_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I can compare my understanding with other students through Twitter activities' (1 = strongly disagree, 5 = strongly agree).
NLECATTEND$_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I have attended approximately _____ number of lectures in this course' (1 = 0–2, 2 = 3–5, 3 = 6–7, 4 = 8–10, 5 = 11–12).
NLECONLINE$_j$	Scalar variable (with a value of 1 to 5) based on the Likert scale response to the question: 'I have listened to the recording(s) of approximately _____ number of lectures in this course' (1 = 0–2, 2 = 3–5, 3 = 6–7, 4 = 8–10, 5 = 11–12).

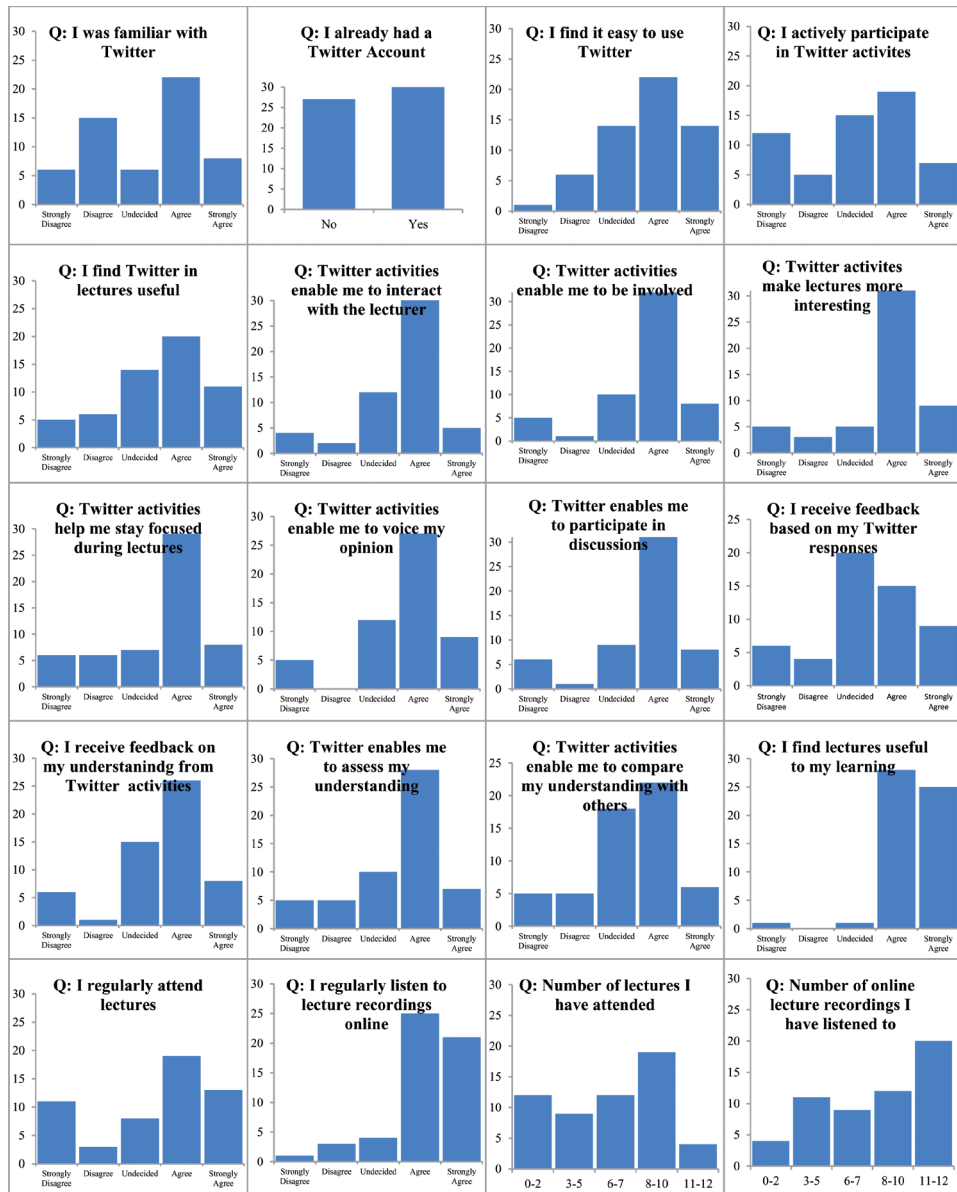Appendix C. Survey results (histograms of Likert responses).

Figure 2.   Histograms.

Appendix D. Survey results (free-response questions).

Student	Q: What are the best aspects of the Twitter activities during lectures?	Q: How could the Twitter activities during lectures be improved?	Q: What would encourage you to participate more actively in the Twitter activities during lectures?
1	Engaging, tests your understanding whether you really follow the lecture and understand it.	More questions.	Make it more fun, e.g. encourage, and give treats.
2	Ability to test knowledge of concepts covered in lectures and get feedback without having to talk	N/A, I think the twitter activities are structured really well	Nothing in particular as I don't attend many lectures, however in the lectures I did attend I found participating in the twitter activities fun and easy.
3	You get to test your knowledge by figuring out your answer and getting immediate feedback.	Using something other than Twitter.	If the answers could be anonymous.
4	I don't attend lectures in person, but I wish I could. The Twitter activates seem to be a really cool concept. I enjoy doing the multiple choice questions during the lecture (even though I participate from home) it really helps me quickly identify whether or not I understand the concepts. If I don't, then I have the opportunity to pinpoint what I don't understand so I could go back and re-listen or read up on it. Overall, I had a great experience with all lectures this semester.	I'm not sure	If I were to attend lectures in person I would participate on Twitter.
5	It is relevant to the topic content. HOWEVER, when I after use the twitter, sometimes I opened the other APPs. And missed following content.	Could you add the questions in the lecture slides, because some questions could be a good exercise or example that we reviewed.	Enjoy the relax time.
6	Speak my words and get responses. Help to focus on the topic and know the process.	Let students get ready before the course stated.	More questions or communicate after the class using twitter.
7	The best aspects that we can choose the answer and [not be] afraid that is wrong	Hope more people to join the twitter	We only need twitter the answer to internet

Appendix D. (*Continued*)

Student	Q: What are the best aspects of the Twitter activities during lectures?	Q: How could the Twitter activities during lectures be improved?	Q: What would encourage you to participate more actively in the Twitter activities during lectures?
8	The best aspects would have to be the questions asked – they are clearly thought out and also completely related to what was just learnt. I also enjoy how the twitter questions provoke me to think about what I have just learnt in the lecture. Another positive is the amount of time that is given after the question is asked.	I don't think they could really be improved – maybe more if anything?	As I work part time I unfortunately am not able to attend the lectures. An encouragement would definitely be to gain overall grade points relevant to how many quiz questions you respond to (however this wouldn't benefit people who can't make it to lectures)
9	They allow me to put learning into practice straight away and allow my brain to put what theory I have just learnt into a question/answer setting immediately which helps to further my learning. It also is a good break in the lectures to gather my thoughts on such heavy theory – definitely a great idea!	I don't think there are any areas of improvement.	I already participate actively.
10	Twitter allows me to take a break and assess where we're at in the lecture. It breaks up the lecture in a good way and stops it from getting a bit too much. It also reinforces what we've learnt.	I think a few more twitter breaks would be good, but only if other students would participate. This course is very heavy and any opportunity to break up the lecture and reinforce things we've done are good. Also it's good to get some feedback.	If it was marked, or if there were bonus marks. But that kind of defeats the purpose. I can't think of a way to engage others.
11	Useful tool to compare quiz answers to other students – instant feedback on understanding of course concepts.	Perhaps showing a brief view of the twitter feed on the projector so those who watch recordings can see how their understanding compares to others.	Unsure, I think it encourages participation as it is.

Appendix D. (*Continued*)

Student	Q: What are the best aspects of the Twitter activities during lectures?	Q: How could the Twitter activities during lectures be improved?	Q: What would encourage you to participate more actively in the Twitter activities during lectures?
12	We can refresh back the content that we learn from the lecture prior to continuing to the next lecture content and able to gain more understanding of the overall content.	none	if there are more students participate together in the twitter activities, thus we can compare answers among other students
13	Get the students to pay attention, otherwise we won't have any answer to tweet.	\<Unanswered\>	To participate in class and share my answer
14	Gives a chance to recapture what we have just learnt	Not sure.	Already having an understanding of twitter.
15	I can ask a question or query as it arises without interrupting anyone.	Not sure.	May be bonus marks for participation.
16	quiz	no idea	no idea
17	I can know how other students think about the question, and I can have a discussion with my friends.	It is little waste time when enter tags, and answers of every questions are listed.	\<Unanswered\>
18	It gives you a chance to stop and think about what you've just learnt. It is great that there's always a chance to pause and work out the answers for yourself – I don't like it when the lecturer tells you the answer before you've had time to figure it out. Even when you're not in the lecture theatre but listening to the recordings at home, you can still make good use of the quizzes.	\<Unanswered\>	\<Unanswered\>
19	I like the quizzes in lecture, especially the lecturer's analysis. That's really helpful.	\<Unanswered\>	Don't know how to handle Twitter very well

Appendix D. (*Continued*)

Student	Q: What are the best aspects of the Twitter activities during lectures?	Q: How could the Twitter activities during lectures be improved?	Q: What would encourage you to participate more actively in the Twitter activities during lectures?
20	When I attended in the lecture, Twitter activity makes me have to focus studying.	<Unanswered>	<Unanswered>
21	It keeps focus during the lecture, lecture quiz helps me get a better understanding of the topic.	<Unanswered>	<Unanswered>
22	Lecture emphasises on the principle of each topic in the lecture quizzes which make me know which part I need to focus more.	<Unanswered>	<Unanswered>
23	interesting	motivation	<Unanswered>
24	<Unanswered>	Accommodate those who are watching online	<Unanswered>
25	<Unanswered>	Don't spent too much time on it.	when looking for answer
26	<Unanswered>	No Twitter	<Unanswered>
27	Quiz	<Unanswered>	<Unanswered>
28	I didn't use Twitter to study this subject.	<Unanswered>	<Unanswered>