

The effect of Twitter on college student engagement and grades

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Abstract

Despite the widespread use of social media by students and its increased use by instructors, very little empirical evidence is available concerning the impact of social media use on student learning and engagement. This paper describes our semester-long experimental study to determine if using Twitter – the microblogging and social networking platform most amenable to ongoing, public dialogue – for educationally relevant purposes can impact college student engagement and grades. A total of 125 students taking a first year seminar course for pre-health professional majors participated in this study (70 in the experimental group and 55 in the control group). With the experimental group, Twitter was used for various types of academic and co-curricular discussions. Engagement was quantified by using a 19-item scale based on the National Survey of Student Engagement. To assess differences in engagement and grades, we used mixed effects analysis of variance (ANOVA) models, with class sections nested within treatment groups. We also conducted content analyses of samples of Twitter exchanges. The ANOVA results showed that the experimental group had a significantly greater increase in engagement than the control group, as well as higher semester grade point averages. Analyses of Twitter communications showed that students and faculty were both highly engaged in the learning process in ways that transcended traditional classroom activities. This study provides experimental evidence that Twitter can be used as an educational tool to help engage students and to mobilize faculty into a more active and participatory role.

Keywords

cooperative/collaborative learning, learning communities, media in education, post-secondary education, social media, teaching/learning strategies.

Introduction

Social media in higher education

Social media are a collection of Internet websites, services, and practices that support collaboration, community building, participation, and sharing. These technologies have attracted the interest of higher education faculty members looking for ways to engage and

motivate their students to be more active learners (Hughes 2009). There has been interest in integrating various social media tools (such as blogs, microblogs, video-sharing sites, and social networking) into the learning process (Grosbeck & Holotescu 2009; Rankin 2009; Ebner *et al.* 2010; Schroeder *et al.* 2010), especially by faculty members with a disposition towards the use of newer technology in education (Crook 2008).

A major category of social media activity is social networking. Social networking websites, such as Facebook, Myspace, and Twitter, have become an integral

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part of U.S. college students' lives (Junco & Mastrodicasa 2007; New Media Consortium 2007; Cotten 2008). The Higher Education Research Institute (HERI 2007) reported that 94% of first year college students use social networking websites, and data from a survey by Mastrodicasa and Kepic (2005) showed that 85% of students at a large research university had accounts on Facebook, the most popular social networking site. These data are congruent with more recent statistics on social networking website use and reinforce the fact that social networking is an important part of college students' lives (Jones & Fox 2009; Matney & Borland 2009).

While Facebook has been the most popular social networking site for American college students to date, educators have been more willing to try to integrate Twitter as part of the learning process (Grosbeck & Holotescu 2009; Rankin 2009; Ebner *et al.* 2010; Schroeder *et al.* 2010). Twitter is more amenable to an ongoing, public dialogue than Facebook because Twitter is primarily a microblogging platform (Ebner, *et al.* 2010). Indeed, some have described Twitter as a blog that is restricted to 140 characters per post but that also includes the functionality of social networking (McFedries 2007).

Student engagement

In 1984, Alexander Astin proposed a developmental theory for college students that focused on the concept of involvement, which he later renamed engagement. Astin defined engagement as 'the amount of physical and psychological energy that the student devotes to the academic experience' (Astin 1984, p. 297). Today, engagement is conceptualized as the time and effort students invest in educational activities that are empirically linked to desired college outcomes (Kuh 2009). Engagement encompasses various factors, including investment in the academic experience of college, interactions with faculty, involvement in co-curricular activities, and interaction with peers (Pascarella & Terenzini 2005; Kuh 2009). Kuh (2009) emphasizes two major facets: in-class (or academic) engagement and out-of-class engagement in educationally relevant (or co-curricular) activities, both of which are important to student success.

Chickering and Gamson (1987) proposed seven principles for good practice in undergraduate education, all

of which are related to student engagement. They are: (1) student/faculty contact; (2) cooperation among students; (3) active learning; (4) prompt feedback; (5) emphasizing time on task; (6) communicating high expectations; and (7) respecting diversity. Later, Chickering and Ehrmann (1996) gave examples of how technology can be used to help implement the seven principles. Kuh (2009) reported that institutions of higher education can directly influence engagement by implementing these seven principles.

Since 1984, the construct of engagement has been extensively researched. As Kuh (2009) states: 'student engagement and its historical antecedents . . . are supported by decades of research showing positive associations with a range of desired outcomes of college' (p. 698).

We know that academic and co-curricular engagement are powerful forces in both student psychosocial development and academic success. Improvement in grades and persistence has been noted across a variety of populations, including minority students, first generation students, and students who are not adequately prepared for college academic work with increased engagement (Pascarella & Terenzini 2005; Kuh *et al.* 2008). Institutions can create programmes that help increase student engagement, and thereby increase the chances that students will reach the desired outcomes of a college education (Kuh 2009).

Social media and student engagement

While there is little research focusing on the relationship between social media and student engagement in higher education, a number of studies have found relationships between technology use and engagement. For instance, King and Robinson (2009) found that college students who used electronic voting systems reported they were more likely to answer questions in their math course. Annetta *et al.* (2009) observed that students who played an educational game designed to teach genetics concepts were more engaged in their work than a control group. In a study using data from the National Survey of Student Engagement (NSSE), Chen *et al.* (2010) found significant correlations between the use of educational technology and student engagement. While these studies have been important contributions to the research on technology engagement,

they have been limited by either their measurement of engagement (single variables) or their scope (cross-sectional).

Two recent studies have focused specifically on social media and engagement and have found relationships between time spent on social media and student engagement as described by Astin (1984), and measured through single survey items. Heiberger and Harper (2008) conducted a study of 377 undergraduate students at a Midwestern institution, while the HERI (HERI 2007) used the Your First College Year survey to collect data from over 31 000 students at 114 colleges and universities. Both the Heiberger and Harper (2008) and HERI (2007) studies found a positive correlation between social networking website use and college student engagement. For instance, a higher percentage of high users of social networking websites participated in and spent more time in campus organizations than low users. Additionally, more of the high users reported that they interacted daily (in the real world) with close friends and felt strong connections to them (HERI 2007).

Purpose of the study and research questions

Although some research has been conducted on the effects of social media on student engagement (HERI 2007; Heiberger & Harper 2008), studies up to this point have been cross-sectional and correlational in nature, and therefore it has been difficult to make causal inferences. More specifically, no studies have examined the effect of using Twitter as part of an educational intervention on student engagement. Therefore, the current study serves to extend previous research by using an experimental design to examine the causal link between educationally relevant social media use and student engagement in a sample of American university students. Because of the strong links between engagement and student success (Pascarella & Terenzini 2005; Kuh 2009), this study will also examine student grades as an outcome variable. Additionally, we will conduct a qualitative analysis of tweets to provide examples of how students engaged via Twitter. The research questions examined were:

- What effect does encouraging the use of Twitter for educationally relevant purposes have on student engagement?

- What effect does encouraging the use of Twitter for educationally relevant purposes have on semester grades?

Methods

Sample

Seven sections of a one-credit first-year seminar course for pre-health professional majors (students planning to apply to dental, chiropractic, medical, physical therapy, etc. schools) were used for the study. Four of the sections were randomly assigned to the experimental group and three to the control group. The experimental group used Twitter as part of the class while the control group did not (complete procedures described next). None of the students used Twitter before participating in this study. Both groups used Ning (<http://www.ning.com>; a service that allows users to create their own social networking site) instead of a learning management system as a regular part of the course. Students were asked to participate in the study by taking a pre- and post-test (the survey containing the engagement instrument). Although participation was voluntary, participants could enter to win drawings of cash deposits to their university flex accounts throughout the semester. The drawings were announced via Twitter for the experimental group and via Ning for the control group.

Of the 132 students in the seven sections, 125 took the pre-test survey for an overall 95% participation rate. In the experimental group, 70 out of 74 (95%) students participated while 55 out of 58 (95%) participated in the control group. There was no significant difference between groups in participation rate. Sixty per cent of those who took the pre-test were female and 40% were male. The mean age of our sample was 18.2, with a standard deviation of 0.445. The age of our participants ranged from 17 to 20, although over 98% were between 18 and 19 years old. Twenty-eight per cent of the sample reported that neither parent had a college degree. In terms of race and ethnicity, our sample was overwhelmingly Caucasian, with 91% of students listing that as their race. Additionally, 6% of our sample was Latino, 3% Native American and 1% Asian American. We had no African Americans in our sample. The race and ethnic breakdown of our sample was similar to that of the overall university population,

with the exception of a slight overrepresentation of Latinos and a slight underrepresentation of Asian Americans in our sample.

The study ran for 14 weeks. During those 14 weeks, there were seven dropouts from the study, five (7%) from the experimental group and two (4%) from the control group. We followed up with the seven students who dropped out of the study. Five of the students dropped the class with the most frequent reason being change of major, while two reported they were transferring to universities closer to home. Final sample sizes were 65 students in the experimental group and 53 in the control group. The final sample was 92% Caucasian, 5% Latino and 3% Native American.

Twitter procedure

During the second week of the semester, the sections in the experimental group received an hour-long training on how to use Twitter. This training was supplemented by question-and-answer periods over the next few class meetings. Students were taught the basics of Twitter [how to sign up for an account, how to send tweets (Twitter messages), how to use hashtags (clickable keywords within tweets) and @ replies (replies to other users)], and were shown how to enable privacy settings. All students were asked to send an introductory tweet during the training session. Students from experimental group sections were asked to follow a single Twitter account created for this study as well as follow each other so that they could interact across sections. Right after the Twitter training sessions, both the experimental and control groups were sent links to the online engagement instrument. The post-test instrument was sent during the last week of the study.

The Twitter class account was administered by two of the authors. Based on previous research on engagement (Chickering & Ehrmann 1996; Pascarella & Terenzini 2005; Kuh 2009), engagement in social media (HERI 2007; Heiberger & Harper 2008), and case studies of Twitter use, we used Twitter for the following educationally relevant activities:

- Continuity for class discussions: Because the first-year seminar met only once a week for an hour, Twitter was used to continue conversations begun in

class. For instance, students were asked to discuss the role of altruism in the helping professions.

- Giving students a low-stress way to ask questions: Oftentimes, first-year and/or introverted students are less comfortable asking questions in class. The dynamics of Twitter allow students to feel more comfortable asking questions given the psychological barriers inherent in online communication (Kruger *et al.* 2005).
- Book discussion: All first-year students read the same book as part of their first-year reading programme. The book, *Mountains Beyond Mountains* (Kidder 2004), focuses on Dr Paul Farmer's medical relief work in Haiti and was used to stimulate discussion about altruism and the helping professions.
- Class reminders: As students all took a similar sequence of courses, we were able to remind them of due dates for assignments and dates for exams in multiple classes via one Twitter feed.
- Campus event reminders: At the beginning of the semester, we used SocialOomph (formerly Tweetlater) to schedule tweet reminders for the entire semester. These reminders included campus events, speakers, concerts and volunteer opportunities.
- Providing academic and personal support: We regularly posted information about academic enrichment opportunities on campus (for instance, the location and hours for the tutoring centre), both periodically and in response to student requests for help. Additionally, we provided encouragement and support when students reported things such as feeling 'stressed out' or being worried about exams.
- Helping students connect with each other and with instructors: The 'cohort effect' or the intentional creation of learning communities is an important concept in ensuring student persistence (Keup 2005–2006). Additionally, student/faculty interaction is an NSSE factor shown to be related to student success (Kuh 2002).
- Organizing service learning projects: As part of this course, students needed to participate in a service learning volunteer opportunity. Students used the Twitter feed to coordinate volunteer times with each other.
- Organizing study groups: With only a little encouragement from the authors via the Twitter feed, students organized study groups for two of their more difficult courses, Chemistry and Biology.

- Optional assignments: Students had the option of completing two assignments via Twitter. The two assignments were:
 1. Attend an upper-class student panel and tweet two questions they had for panelists.
 2. Tweet reactions to their shadowing experience (where they shadowed a healthcare professional in the community for a day).
- Required assignments: Students in all experimental group sections had four required Twitter assignments during the final 4 weeks of the semester. They were:
 1. Students were required to post two tweets and two replies to other students, discussing how reading *Mountains Beyond Mountains* has changed their ideas about people who are less fortunate than they are.
 2. Students were asked to watch a video of the Hurst family's medical volunteer work at the Pine Ridge Indian Reservation, read an online article about the Hursts, read the article *100 People: A World Portrait*, and discuss their reactions by posting two tweets and tweeting two responses to other students' reactions.
 3. Students were asked to react to the statement that what Paul Farmer was doing in *Mountains Beyond Mountains* was only a band-aid for the problem by posting two tweets and sending two tweet responses to other students' posts.
 4. Students were asked to discuss their service project in the context of their future career. They were also asked to compare and contrast their experience to that of Paul Farmer and to use examples from their assigned readings.

By the end of the semester, we had sent 301 tweets via the Twitter account. Of those 301, 89 were replies (@ replies) to students while 18 were retweets (forwarding tweets from another user). Our goal was to select activities that were reflective of all of Chickering and Gamson's (1987) and Chickering and Ehrmann's (1996) seven principles for good practice in higher education and to maximize active learning. The control group was provided all of the same information that was posted to the Twitter group; however, this information was posted through the comment wall of the Ning social network. Our analyses of the Ning

activity show that the control group engaged with faculty in all of the educationally relevant activities listed previously, with the exception of forming study groups.

Instrument and measures

The NSSE is an established instrument that was developed to measure engagement in educationally relevant activities and the desired outcomes of college (Pascarella & Terenzini 2005; Kuh 2009). The NSSE exhibits acceptable psychometric properties (see Kuh 2002) and items focusing on good practices in undergraduate education consistently predict development during the first year of college based on multiple objective measures (Pascarella *et al.* 2009). Items from the larger NSSE have been used to develop shorter scales to measure engagement in educationally relevant practices and engagement in online courses (Kuh *et al.* 2008; Chen *et al.* 2010).

We selected 19 items from the NSSE to use in our engagement scale (Appendix S1). The 19-item engagement scale was administered as part of a survey that also included demographic items, items inquiring about student's technology use, and items that were included for forthcoming analyses. Engagement scale items 1–14 were coded using a four-point Likert scale ranging from 'Very often' to 'Never'. For our analyses, 'Never' was coded as 1, 'Sometimes' as 2, 'Often' as 3, and 'Very often' as 4. Question 15–17 were presented as a seven-point Likert scale and were coded with responses 1 or 2 as '1,' responses 3 or 4 as '2,' responses 5 or 6 as '3,' and response 7 as '4'. Responses for question 18 were coded 1 for 'Very little', 2 for 'Some', 3 for 'Quite a bit', and 4 for 'Very much'. Lastly, responses for question 19 were coded 1 for 'Poor', 2 for 'Fair', 3 for 'Good', and 4 for 'Excellent'. Given the instrument's demonstrated reliability (discussed next), an aggregate engagement score was created using the sum of the individual items. The minimum score possible on the instrument was 19 and the maximum was 76.

Students gave the researchers permission to access their academic record to obtain their semester grade point averages (GPAs), as well as their high school GPAs to examine the differences in grades between the experimental and control group. Grades were measured on a 4.0 scale ranging from 0 for 'F' to 4.0 for 'A'.

Engagement instrument reliability and validity

Reliability analyses found that the data from both administrations of the survey were internally consistent. Cronbach's α for the pre-test administration was 0.75, and for the post-test administration it was 0.81. Our instrument's reliability was similar to the α of 0.82 reported by Kuh *et al.* (2008) and the α of 0.85 reported by Hytten (2010) using a different 19-item scale from the NSSE. Also, our instrument's reliability was similar to the α of 0.85 obtained by examining the data on the 22 college activity items (Kuh 2002). Our Cronbach's α of 0.75 and 0.81 indicate that the items measure a single latent construct, which in this case is engagement.

Because the engagement instrument was created for this study, no validity data existed on this grouping of 19 items. However, the NSSE has a long history supported by research, of being used as a measure of college student engagement. Additionally, we collected some evidence for the construct validity of the instrument by correlating the total score on the engagement scale to the number of hours students reported that they spent in a typical week participating in co-curricular activities (such as involvement in campus organizations, campus publications, student government, fraternity or sorority, intercollegiate or intramural sports, etc.) on campus. Because, theoretically, students who are more engaged in general spend more time in co-curricular activities, one way to show evidence of construct validity of the engagement instrument would be if the scores on the engagement instrument correlated with the amount of time students spent in co-curricular activities. Indeed, we found that scores on the engagement instrument, both at the pre-test and the post-test, correlated significantly with the hours per week students reported spending in co-curricular activities (Pearson's $r = 0.26$, $P = 0.005$ at the pre-test, and Pearson's $r = 0.33$, $P = 0.001$ at the post-test). Although the correlations were significant, the correlation coefficients were modest, indicating that our instrument measures more than just co-curricular engagement – a finding supported by the theoretical background of our instrument as an omnibus measure of student engagement.

Statistics

To assess differences in engagement and grades, we used mixed effects analysis of variance (ANOVA)

models, with class sections nested within treatment groups. In order to assess changes between the pre- and post- test measurement of engagement, we used difference scores as the dependent variable. To calculate difference scores we subtracted the total pre-test score on the engagement instrument from the total post-test score. Using difference scores is equivalent to a repeated measures design with two time points (Bonate 2000). We used PASW (SPSS; IBM Corporation, Somers, NY, USA) Statistics Version 17.0 for all analyses.

Results

Twitter usage

We collected data on the percentage of students sending tweets and the number of tweets sent by using the Twitter Application Programming Interface. As can be seen in Fig 1, students participated in Twitter throughout the semester. The spike in Twitter activity at week 12 was because of the start of the required Twitter assignments. The average number of student tweets sent over the entire study was 48.20, with a standard deviation of 52.87 and a median of 30. No students in the control group reported using Twitter during the study period.

Research question 1

Question 1: What effect does encouraging the use of Twitter for educationally relevant purposes have on student engagement?

To examine the effect of Twitter on student engagement, we used a mixed effects ANOVA model, with sections nested within treatment groups. The dependent variable was the difference score between the post-test administration of the engagement instrument and the pre-test administration. Table 1 shows the descriptive data for engagement score difference by group and nested sections. The experimental group had significantly higher difference scores, with $F(1, 4.9) = 12.12$, $P = 0.018$. We also conducted a mixed effects ANOVA model with pre-test engagement scores as the dependent variable and found that there were no pre-existing differences in engagement by group and nested sections [$F(1, 4.9) = 2.80$, $P = 0.156$].

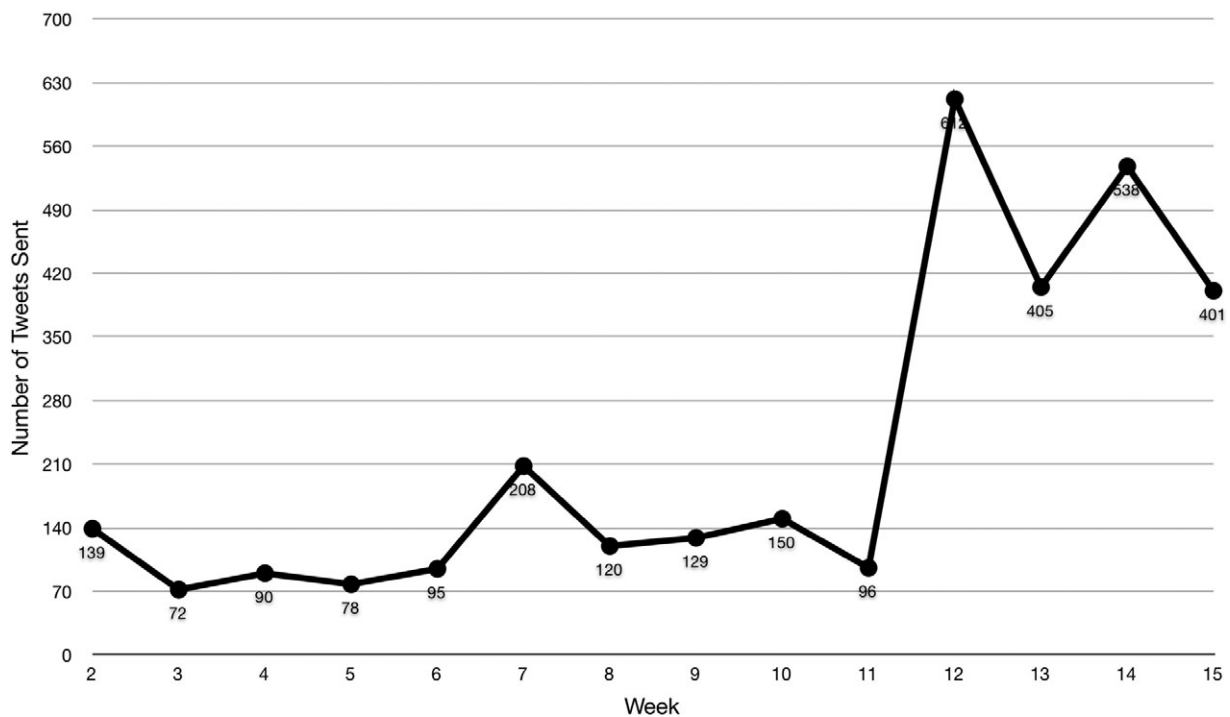


Fig 1 Number of tweets sent each week of the semester. Note: Twitter use began on the second week.

Research question 2

Question 2: What effect does encouraging the use of Twitter for educationally relevant purposes have on grades?

For these analyses, we also used a mixed effects ANOVA model, with sections nested within treatment

groups. The dependent variable was overall first semester GPA. Table 1 shows the descriptive data for GPA by group and nested sections. The semester GPAs of the experimental group were significantly higher than those of the control group with, $F(1, 4.9) = 8.01$, $P = 0.037$. We also conducted a mixed effects ANOVA model with high school GPA as the

Table 1. Means, standard deviations, and sample sizes by treatment group and nested sections for engagement difference scores and semester grade point averages (GPAs).

Group	Section	Engagement score difference		Semester GPA		N
		Mean	SD	Mean	SD	
Experimental	1	4.94	4.92	2.48	0.91	16
	2	6.93	7.77	3.05	0.82	15
	3	5.20	5.99	2.66	0.83	15
	4	3.79	7.70	2.94	0.81	19
	Overall	5.12 ¹	6.69	2.79 ²	0.85	65
Control	1	1.79	7.37	2.36	1.18	14
	2	3.11	8.48	2.09	1.08	20
	3	1.84	7.38	2.41	1.03	19
	Overall	2.29 ¹	7.67	2.28 ²	1.08	53

¹Experimental group had significantly higher difference scores on engagement ($P < 0.05$).

²Experimental group had significantly higher semester GPAs ($P < 0.05$).

dependent variable and found no pre-existing differences between groups [$F(1, 4.9) = 1.24, P = 0.316$].

Analysis of Twitter activity

While an exhaustive review of the qualitative data generated during this study is impractical given the scope of this paper, we selected three examples to illustrate student engagement. An examination of the content of the tweets suggests that students engaged with faculty and each other in a vibrant and connected virtual learning community.

Book discussion

Students were required to participate in discussing the *Mountains Beyond Mountains* book (Kidder 2004). The following is a sample of a conversation that is representative of the type of academic engagement we observed during book discussions.

Faculty: How has reading MBM changed your ideas about responsibility or obligations toward people who are poorer than you are?

Student01: @Faculty Reading mbm has made me less self centered. I realized alot of ppl need help and you can help them by doing simple things:)

Student02: @Faculty It made me realize how selfless I need to be, just like how Farmer put his dedication toward helping others before his own needs.

Student03: I've realized that helping the less fortunate is a social and moral responsibility that nobody is exempt from to help make the world better.

Student04: @Faculty it helped me to see that one person really can make a difference if the effort is put forth

Student02: @Student03 I definitely agree. It's not up to just one person. Farmer had lots of others help him, like the MacArthur Foundation.

Student02: @Student04 Do you think that just one person can make a difference, or that one person inspires many people to help make a difference?

Student04: @Student02 i think in a way its the same thing because that one person inspiring others is still making it all happen by involving others

Student02: @Student04 That's a good point. Farmer made a difference in people's lives while inspiring others, like us, at the same time!

Student05: Simply volunteering throughout the community like at the Harvest Table is a small step towards bettering the world.

Student06: This book showed how selfish people are and makes me want to learn to be more selfless so I can serve those in need for the rest of my life

Student07: @Faculty I enjoying volunteering, and look forward to doing more in the future. Its an awesome feeling!

Student06: @Student07 Volunteering really is great in the fact that it is doing good for someone else and by doing so you actually feel good!

Student08: @Faculty I believe that it has showed me how my life is a blessing and others should realize it do, we are privileged kids in every way

Student09: @Student08 we don't realize how good we have it until we actually see how the other half lives . . . and its a rude awakening.

Using Twitter produced a more rich discussion of student's relationship to themes covered in the book than would have been possible during the limited class time. Twitter allowed us to extend conversations in ways that would not have been practical during the hour-long class sessions. The first-year seminar was only 1 h each week, and while it would take students some time to 'warm up' to talk about personally impactful themes from the book, they did this readily via the electronic format. Students were also surprisingly comfortable with candid expressions of their feelings and their shortcomings as evidenced by this sample of tweets. They also engaged in a great deal more cross-communication about the book than first-year students typically do during class sessions.

Some students who were engaged in academic discussions via Twitter also forged interpersonal relationships. While they discussed the reading, students made connections when realizing they had shared values and interests. For instance, the conversation between Student02 and Student04 led them to realize that they have a mutual friend and a shared extra-curricular interest. While these connections may have happened eventually in class, they happened quickly over Twitter as traditional classroom discussion boundaries did not exist (i.e. 'don't talk about personal things during academic discussions'). Indeed, one of the striking effects of having students communicate on Twitter is how they built strong relationships across diverse groups – something that rarely happens with first-year students at this institution. One particularly noteworthy example was an extroverted student who is a popular athlete who became good friends with a more introverted student who is interested in comic books – a connection that may have never happened in the real world.

Upper class panel

One of the optional assignments was for students to attend a panel of upper-class pre-health professional students and to tweet questions they had for the

panelists. Students in both groups had the option to submit a short paper with their questions in lieu of tweeting or posting them on Ning. The following are example tweets from this thread.

Faculty: Class canceled next week (10/21). Instead you are req'd to attend the upper-class student panel on Wed. (21st) at 12pm in SNP 103

Faculty: 3 min paper option for the 21st is to tweet questions you have for upper-class pre-health professional students. Due 12pm 10/21.

Student01: @Faculty I have a psych class at noon. How am I supposed to attend?

Faculty: @Student01 If you can't attend because of scheduling conflict, please complete 3 min paper about last class.

Student02: @Faculty Why are you training to become a health professional? is what I would ask them, could I go to the discussion. Alas, Bio lab.

Student03: @Faculty My question is, How many of you are planning to go into radiology and why?

Student04: @Faculty My question is – What made you decide the specific career in the health field you want to pursue?

Student05: @Faculty My question is: How many Medical schools did you apply to and how did you choose which ones to apply to?

Student06: What is the hardest part of the application process for PT school and do you have any advice on how to make it easier?

Student07: Where is SNP? My question is. How many of you have changed your majors and how many times?

Student08: @Faculty What inspires you to complete all the schooling for your profession? How do you manage your time so you are not always stressed?

An examination of these tweets reveals some of the ways that students were engaging via Twitter. First, a review of the number of questions proposed (over 75) and the number of students involved in the discussion (55) shows that students took advantage of having Twitter as a forum to ask questions. Indeed, student use of Twitter generated more and different types of questions than would have been generated in typical class discussions on the same topic. For instance, the statement and question by Student01 was uncharacteristically candid for a first-year student and lends support to the idea that Twitter helped students feel more comfortable asking questions they may not be comfortable with asking in class. Second, the questions proposed by students reflected many of the typical issues faced by first-year pre-health professional students – i.e. 'am I on the right track?', 'what do I need to do to get into graduate school?', 'what should I look forward to as I progress

in the major?' Third, much in the same way that professionals can attend conferences virtually via Twitter, students were able to ask questions of the panel, even though they had scheduling conflicts and were not able to attend (as evidenced by Student02's response).

Study groups

Pre-health professional students take a similar sequence of courses which includes introductory Biology and Chemistry courses. We used Twitter to encourage students to arrange study groups for their more difficult courses, Chemistry and Biology. The following tweets are examples of a discussion about study groups that arose after students were tweeting about being anxious about their upcoming Chemistry exam.

Faculty: Anyone interested in forming a study group?

Student01: @Faculty for what class

Student02: @Faculty For what class?

Student03: @Faculty study group for what?

Student04: for?

Faculty: @Student01 @Student02 @Student03 @Student04 What class would you like to form a study group for? Chem?

Student05: Both Chemistry and Biology would be nice-OK how about a Chem and Bio study group? Who is in?

Student06: Anyone that wants to have a study group for Bio or Chem. Let me know and I'm in!

Faculty: @Student01 @Student02 @Student03 @Student04 Both @Student05 and @Student06 suggest both Chem and Bio. What is a good time for you to meet?

Faculty: How about a study group for Chem tonight starting at 7pm 2nd floor of the library – at the blue couches. Who will be there? Please RSVP

Student05: I'm planning on coming to the study group

Student06: Sounds good

Student01: I'm in

Faculty: So it looks like @Student05 @Student06 and @Student01 will be at the study group. Any others planning to attend?

Student07: Count me in

Student03: I'll be there

A review of these tweets shows that it took little effort on the part of the faculty member to help students create and attend a study group. Interestingly, after the first meeting of five students, they continued to set up study groups (without faculty intervention) that saw increased attendance as the semester progressed. Two issues are particularly noteworthy about student engagement in creating a study group: First, it was relatively easy to help students create a study group on short notice. Within hours, students went from chatting about their

concerns about an upcoming exam to holding a study group meeting in the library. Second, the public nature of Twitter helped students be more comfortable asking each other for help. In our experience, pre-health professional students at this institution rarely develop study groups in their first semester. Their eagerness to form study groups could be partly because of the fact that their anxieties about the exam were being expressed in a public forum and therefore, they discovered that others felt the same way. When students made such a discovery, it may have been easier to then realize that they could benefit from studying with others in the same situation.

Discussion

Research question 1

Question 1: What effect does encouraging the use of Twitter for educationally relevant purposes have on student engagement?

The analyses of difference scores show that there was a greater increase in engagement scores for the experimental group than the control group. From this we can conclude that using Twitter in educationally relevant ways had a positive effect on student engagement as measured by our instrument. Because we conducted analyses on difference scores, we took into account pre-existing differences in engagement level.

Research question 2

Question 2: What effect does encouraging the use of Twitter for educationally relevant purposes have on grades?

Our analyses show that encouraging the use of Twitter for educationally relevant purposes has a positive effect on grades. We found no pre-existing differences between the groups on high school GPA, indicating that the groups were equivalent in terms of academic ability.

Analysis of Twitter activity

The examination of tweet content shows that students were motivated and engaged with each other. In ways that rarely happen with pre-health professional first-year students at this institution, students were actively

engaged in thoughtful and personally meaningful conversation about themes addressed in the *Mountains Beyond Mountains* book. These conversations extended over hours and sometimes days as students would log off Twitter, then back on to find a response to a previous statement and continue the conversation. An examination of tweets about the upper-class student panel showed that students were engaged in asking questions of their peers about academic milestones they expected to need help with.

Our examination of the tweets related to setting up study groups for Chemistry and Biology showed that a group of students were enthusiastic about collaborative learning through study groups. With our encouragement and help, these students set up their first study group for Chemistry. After the first meeting, students independently organized additional study groups. Study group participation grew throughout the semester and expanded beyond Chemistry to other courses.

Implications

Our results suggest that Twitter can be used to engage students in ways that are important for their academic and psychosocial development. We were able to leverage Twitter to support Chickering and Gamson's (1987) seven principles for good practice in undergraduate education:

- We improved contact between students and faculty (principle 1) by providing an avenue for contact congruent with their digital lifestyles.
- The use of our Twitter protocol also encouraged cooperation among students (principle 2) – students used Twitter to ask each other questions, not only about the material in the first-year seminar course, but also about material in other courses. Students also collaborated on their service learning projects via the Twitter feed, provided emotional support to each other, and created and scheduled real-world study groups via Twitter.
- The Twitter assignments promoted active learning (principle 3) by helping students relate the course material to their own experiences both inside and outside of the classroom.
- Twitter allowed us to provide prompt feedback (principle 4) to students, not only for their assignments, but

also for a wide variety of questions and issues they faced. For example, a few students tweeted about having trouble viewing an online video that was required for the course, and within 10 min we provided feedback as to how they could solve the problem.

- One of the great benefits of using Twitter in this way with our first-year experience courses was that we were able to maximize time on task (principle 5). The course only met for an hour each week; however, thanks to the Twitter stream, we were able to continue discussion and build a strong learning community among students.
- We used Twitter to communicate high expectations (principle 6) in student's academic work, service learning projects, and out-of class activities.
- Lastly, using Twitter showed a respect for diversity (principle 7) because, in addition to discussing diversity issues via the Twitter feed, we encouraged students who otherwise may not be active participants in class to participate online.

Even though our results were positive, it is important to note that these results may not be solely attributable to the technology. While Twitter facilitated communication, engagement, and the democratization of roles and relationships in ways that may not have happened in the real world, the introduction of Twitter into the learning process mobilized faculty into a more active role with students that was different than when using Ning. Students in both the Twitter and the Ning groups received the same information and performed the same activities; however, Twitter lent itself more to a conversation between students and faculty. While Ning announcements took the form of static bulletin board postings, Twitter announcements were met with active responses by students which were met by even more interaction by faculty. Indeed, 30% of tweets from the faculty account were responses to students, whereby less than 1% of posts on Ning were responses to students – students on Ning did not ask as many questions or engage faculty in the same way as they did on Twitter.

The use of Twitter also demanded that two of the faculty members involved in this study regularly monitor and participate in the Twitter feed. This helped increase students' sense of connection with faculty and the institution, one facet of engagement. It also helped

increase student's academic engagement. The frequency and intensity of faculty queries about both academic and co-curricular issues was much more than what is typically experienced by first-year students. Students in the Twitter group had the benefit of almost-always-on support for academic, co-curricular, and personal issues. For instance, when a student tweeted 'Procrastinators unite! . . . Tomorrow. It's a bad habit I developed in high school that's hard to break,' we immediately asked 'what helps your procrastination?' which led to a conversation with the student about what motivates her. Later in the conversation, we discovered that the student has trouble 'clearing [her] head' and we provide links to resources to learn diaphragmatic breathing (which helps in anxiety reduction). Responses by faculty members generated even more tweets from students. This positive feedback loop of interaction kept the Twitter feed very busy (as can be seen in Table 1) and highly interactive.

In addition to engendering motivation to engage students on the part of the faculty, the use of Twitter created a culture of engagement between students. As was reported in the results, students interacted with each other a great deal around academic and co-curricular issues, which led to deepening of their interpersonal connections. It was common to see students support one another when someone would tweet about their stress or workload. One striking example was when a student tweeted about wanting to harm himself. Quickly, another student tweeted 'are you ok? Not that I know you or anything but your status sounds not so good.' They engaged in a conversation that helped the original tweeter feel like he did not want to hurt himself until a faculty member could intervene and have a face-to-face meeting with him.

Limitations

There are a number of limitations to the current study. The first and most important limitation is that the study was conducted on a narrow sample of the overall student population at an institution that is not necessarily representative (with respect to racial, ethnic, and income factors) of all institutions in the United States, let alone internationally. Furthermore, students who choose to be pre-health professional majors are a specific population unto themselves, with characteristics that may not

match the characteristics of most students in higher education. It will be important to replicate this study with more diverse samples in terms of race, ethnicity, income, and academic majors and settings. It will also be important to specifically determine whether using Twitter can help engage students who are historically less engaged to begin with, such as those who may not be adequately prepared for college, those from minority backgrounds, and those who are first-generation students (Kuh 2009).

Another limitation is the engagement instrument. It is important to note that we measured the construct of engagement through self-report and not actual student engagement. The engagement instrument appeared to measure engagement adequately, and we found a correlation with scores on the instrument and time spent in campus activities. However, we would like to further investigate evidence of the instrument's relationship to actual indices of engagement. Moreover, the real-world implications of a difference of almost three points in engagement scale score means are unclear. Further research should be conducted to see if the engagement instrument correlates with indices such as observed participation in class discussion, campus activities, and interactions with students and faculty. Additionally, future research should measure indices of actual engagement (such as observation of classroom behaviour) as dependent variables to attempt to determine the best way to measure engagement.

One further limitation was the fact that we are unable to tease out how much of the variance in increased student engagement and improved grades is as a result of Twitter and how much is because of a possible orientation of faculty to be more engaged. Crook (2008) notes that the integration of social media depends on 'considerable creative involvement from teachers' (p. 35) and that adoption of these technologies may be more reflective of a disposition that is adopted by these faculty. In this sense, it is important to focus more on a 'Web 2.0 mentality' than on the technology (Crook 2008). In other words, the increases in engagement and grades may be able to be explained more by an overarching attitude about teaching and learning than about the technology itself. The disposition described by Crook (2008) may very well be related to an increased faculty interest and ability to engage students. While there is no way to tease out this variance, future studies may want to examine possible dispositional variables

that may lead to educationally relevant adoption of technology.

A final limitation was the structure of the study. We had a modest sample size and because the study was structured across just seven sections as the units of randomization, the design was somewhat limited. In this case, the limited number of sections required us to run conservative statistical tests using section as a nested, random effect, and thus had few degrees of freedom for error. Future research should try to randomize across more classes and include a larger sample.

Conclusion

This study provides the first piece of controlled experimental evidence that using Twitter in educationally relevant ways can increase student engagement and improve grades, and thus, that social media can be used as an educational tool to help students reach desired college outcomes. We provided evidence to suggest that students and faculty were both highly engaged in the learning process through communication and connections on Twitter. As there is continuing growth in the use of social media by college students and faculty, it is hoped that this study will motivate further controlled studies of Twitter and other social media to evaluate how emerging technologies can be best used in educational settings and to tease out the variance between the effects of the actual technology and of the 'Web 2.0 mentality.'

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Engagement instrument.

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