

Scholars in An Increasingly Open and Digital World:
How do Education Professors and Students use Twitter?

Abstract

There has been a lack of large-scale research examining education scholars' (professors' and doctoral students') social media participation. We address this weakness in the literature by using data mining methods to capture a large data set of scholars' participation on Twitter (232 students, 237 professors, 74,814 unique hashtags, and 645,579 tweets). We report how education scholars use Twitter, which hashtags they contribute to, and what factors predict Twitter follower counts. We also examine differences between professors and graduate students. Results (a) reveal significant variation in how education scholars participate on Twitter, (b) question purported egalitarian structures of social media use for scholarship, and (c) suggest that by focusing on the use of social media *for* scholarship researchers have only examined a narrow sliver of scholars' online activities, possibly ignoring other areas of online presence. Implications of this study lead us to consider (a) the meaningfulness of alternative metrics for determining scholarly impact, (b) the impact that power structures have upon role-based differences in use (e.g. professor vs. student), and (c) the richness of scholarly identity as a construct that extends beyond formal research agendas.

Veletsianos, G., & Kimmons, R. (in press). Scholars in an Increasingly Digital and Open World: How do Education Professors and Students use Twitter? *The Internet and Higher Education*.

Scholars in An Increasingly Open and Digital World:

How do Education Professors and Students use Twitter?

Research on emergent forms of technology-infused scholarship and social media use by scholars has explored the relationship between technology and scholarly practice and the impact and implications of technology in the work and life of scholars. Such research, however, has rarely focused on scholars in the field of education or differentiated between faculty members and doctoral students and typically has depended on surveys, interviews, or small-scale naturalistic observations of social media practices. In other words, while existing empirical research from a variety of disciplines may yield some insights into education scholars' activities online, there has been a lack of large-scale research examining social media participation. Research in this area is necessary because many researchers have claimed that digital practices in general, and social media activities in particular, have the potential to transform the ways in which education scholarship is conducted and disseminated (Burbules & Bruce, 1995; Fetterman, 1998; Greenhow, Robelia, & Hughes, 2009; Yettick, 2015). For instance, social media may foster participatory learning and expand the reach of research. Yet, such advocacy often rests on claims rather than empirical evidence (Kimmons, 2014) and uses of social media have led to tensions and conundrums in scholars' professional lives (Veletsianos & Kimmons, 2013; Veletsianos, 2016). This dichotomy suggests that we need to better understand how social media are being used in scholarship as well as the implications of their use. To help fill that gap, this study analyzes a large data set of education scholars' activities on Twitter, one of the most popular social media platforms among academics (Lupton, 2014). Using these data, we examine the ways in which doctoral students and professors in education use Twitter, the hashtags that

they contribute to, and the factors that predict their follower counts. By doing so, we hope to provide greater insight into education scholars' online participation.

Literature Review

Proponents of open, digital, and social scholarship have argued that scholarly use of social media can “enhance the impact and reach of scholarship” and “foster the development of more equitable, effective, efficient, and transparent scholarly and educational processes” (Veletsianos & Kimmons, 2012, pp. 166). As a result, universities are increasingly encouraging researchers and educators to expand their online presence (Mewburn & Thompson, 2013). Advocates for greater incorporation of digital technology into scholarly practice have focused on the societal benefits of these emergent forms (e.g., broadening access to education and scholarship for the common good), but Scheliga and Friesike (2014) have found that scholars face both individual and systemic barriers that may prevent them from engaging in these practices despite understanding their potential at a systemic level. Similarly, Esposito (2013) found that scholars' use of digital and open practices may largely serve functional purposes and be driven by a desire to achieve efficiencies instead of an aspiration to re-imagine scholarly practices.

Twitter is a popular social media platform for scholars (Lupton, 2014; Van Noorden, 2014), and prior research on Twitter has found that scholars use it to share information, resources, and media pertaining to their teaching and research practice. For instance, scholars have been shown to use Twitter to request and offer assistance to others (Veletsianos, 2012), critique the work of other scholars (Mandavilli, 2011), contribute to conferences via hashtags (Li & Greenhow, 2015; Mahrt, Weller, & Peters, 2014; Ross, Terras, Warwick, & Welsh, 2011), implement engaging pedagogies (Junco, Heiberger, & Loken, 2011), and share and comment

upon preprint and published articles (Eysenbach, 2011). Although several studies have examined disciplinary differences in the use of Twitter (Holmberg & Thelwall, 2014; Rowlands, Nicholas, Russell, Canty, & Watkinson, 2011), other than the research reported by Li and Greenhow, we were unable to identify studies that specifically examined its use by education scholars.

Researchers have also argued that attending to alternative metrics, such as examining references to the scholarly literature in tweets, can extend scholars' impact beyond citations in peer-reviewed journals (Priem & Hemminger, 2010). For instance, some have found that the frequency of article mentions via Twitter appears to correlate with subsequent downloads and citations (Shuai, Pepe, & Bollen, 2012; Thelwall, Haustein, Larivière, & Sugimoto, 2013), although the correlation between tweets and citations in all fields is unclear (Haustein, Peters, Sugimoto, Thelwall, & Larivière, 2013) and in some cases appears to be weakly associated (de Winter, 2014). On the other hand, Hall (2014) warns that researchers may lose sight of valuable scholarly metrics (e.g., citation indices) in favor of popularity metrics like Twitter followers. By examining a large sample of education scholars' online practices, we can begin to better understand social media metrics and thus contribute to the conversation of whether social media metrics can be used to better understand a scholar's impact.

While researchers are able to say with increasing confidence *what* scholars do on social media, it is somewhat unclear how scholars participate on Twitter and how online activities relate to academic identity. Greenhow, Robelia, and Hughes (2009) argued that social media support the development of scholars' digital identities, and others found that both professors (Veletsianos & Kimmons, 2013) and students (Kimmons & Veletsianos, 2014) intentionally refine or limit their online participation so that it can be scrutinized by others. One study examined education scholars' Twitter participation during the American Educational Research

Association (AERA) 2014 conference and described commonalities and differences between faculty members and students (Li & Greenhow, 2015). In that study, faculty members reported that Twitter supported their professional digital identity, while students reported that Twitter served other purposes for them that were unrelated to identity (e.g., access to the research community). Li and Greenhow's study supports findings from other literature that showed that faculty and student perceptions of popular social media deviate (e.g., Roblyer et al., 2010).

The existing research suffers from three weaknesses that this study attempts to remedy. First, very little research has examined education scholars' activities on social media, and even less has compared education professors' activities with students' activities. Second, while education student and faculty use of social media has been examined via self-reported means (e.g., Kimmons & Veletsianos, 2015; Li & Greenhow, 2015), no research has examined such differences by examining naturalistic data trails at any scale. Third, current research on what mediates education scholars' participation on social media has been mostly exploratory, thus preventing scholars from developing inferential models. This study addresses all these weaknesses by using data mining methods to capture and analyze a large data set to illuminate scholars' participation on Twitter.

Theoretical Framework

This study is situated in the digital networked practices of scholars, and in particular on *Networked Participatory Scholarship* (NPS). NPS refers to scholars' use of "online social networks to share, reflect upon, critique, improve, validate, and otherwise develop their scholarship" (Veletsianos & Kimmons, 2012, p. 768). The networked spaces that scholars use (e.g., Twitter, blogs) can be described as fluid organizational structures that impose little restrictions on membership and enable loosely-connected and tightly-knit distributed individuals

to connect with one another (Dron & Anderson, 2009). Social learning theory underpins networked participation on social media. In this perspective, learning and knowledge in networked spaces are facilitated, negotiated, and co-constructed individually as well as socially (cf. Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Wenger, 1998). Thus, learning in online networks becomes a situated activity that takes the form of participation in the socio-cultural practice of scholarship, and as Veletsianos (2012, p. 337) argues, online social networks serve as “emerging and evolving network[s] of scholar–learners where scholarly practices may be created, refined, performed, shared, discussed, and negotiated.”

Methods

The research focuses on Twitter as a platform for scholarly purposes, because it is widely used for scholarship (Lupton, 2014). Twitter is a free microblogging platform that allows users to post content in the form of “tweets” that may also contain links to online content. Tweets are limited to 140 characters of text and may be hashtagged with keywords (e.g., #education) or may mention other users by username (e.g., @BarackObama). A hashtag refers to a “#” symbol followed by a short phrase. Through hashtags and mentions, users can find others that are tweeting on similar topics, share information in an organized manner, and form networks around shared interests. About one-third of tweets include mentions (boyd, Golder, & Lotan, 2010), most of which may be conversational in nature (Honeycutt & Herring, 2009). Users can also retweet a tweet to share content posted by someone else with all of their followers. By default, all sharing on Twitter is publicly visible, meaning each user can go to another user’s profile page, see all of that user’s tweets, and “follow” that user to have new tweets provided directly to them. Each user’s profile page also provides some general metrics about use and popularity, including that user’s number of tweets and followers.

This study collected the most recent 3,500 tweets for each user who used the official hashtag of the 2014 American Educational Research Association conference (#aera14). Contributors to the hashtag were a subsection of education scholars, and by gathering a list of contributors we were able to examine education scholars' Twitter participation. We selected this particular hashtag as a way to identify education scholars because the AERA annual meeting is one of the largest gatherings of education scholars worldwide, includes a broad array of education researchers (as opposed to a content- or methods-focused conference), and the 2014 conference was the latest AERA conference at the time of writing. Thus, the #aera14 hashtag served as a *vehicle* to locate a large and diverse sample of education scholars. In other words, the data in our sample are not limited to the AERA conference – the conference only served as a way to identify education scholars. While some users may have used other hashtags in relation to this conference (e.g., #aera2014), we limited our identification of scholars by examining the profiles of those who posted using the official hashtag. As a result, our sample excludes scholars who did not use the official hashtag.

Research Questions

To better understand education scholars' uses of Twitter, we asked the following three research questions:

RQ1: How do scholars in the education field use Twitter?

RQ2: Which hashtags do education scholars contribute to?

RQ3: What factors predict participants' follower counts?

For each of these questions, we also examined possible differences between professors and graduate students because prior research suggests that students and faculty hold different perceptions about the use of social media in education. One study found that students believed

social media could be more convenient than did faculty, while faculty were more likely to believe that such media were not appropriate for classwork (Roblyer et al., 2010). In interviews of education scholars contributing to #aera14, Li and Greenhow (2015) similarly reported that these groups differed in how they viewed Twitter. Based on these findings we anticipated observable participation differences between graduate students and professors.

The first question addressed the scholarly uses of Twitter specifically among education scholars to better understand how this technology is used. The second was intended to uncover what intellectual and social online communities education scholars participate in and how diverse or homogenous those communities happen to be to better understand the scope or multifacetedness of scholarly online identities. The third was intended to examine the factors that may predict scholars' follower numbers and shed light on the claim that social media metrics can enrich our understanding of scholars' impact.

Data Collection

Twitter's application program interface (API) allows researchers to systematically retrieve large amounts of public user data. We used the #aera14 Twitter feed and the Twitter API to collect data. First, we developed a series of PHP/REST/JSON scripts to use the Twitter API to extract information for all of the identified #aera14 tweets, including tweet text, metadata (e.g., creation date, retweet count), and author information (e.g., ID, name, tweet count, description). Tweet, user, hashtag, and mention data were also stored in the database and identifiers were included to maintain relationships between objects (e.g., tweets and their authors, hashtags and their tweets).

Second, we developed another series of web scripts for the Twitter API to extract the most recent tweets from each user identified in the previous step, which allowed us to collect

user tweets that were not labeled with the #aera14 hashtag. A Twitter API restriction though, limited our access to only the most recent 3,500 tweets for each user. Tweet data began being collected six months following the AERA 2014 conference and continued for several months. Thus, collected tweets include tweets prior to, during, and after the conference.

Third, we programmatically generated basic descriptives for each tweet (e.g., number of hashtags, number of mentions), user (e.g., lifespan), and hashtag (e.g., unique uses), and generated binary descriptive variables (e.g., hashtagged, mentioned).

Data Analysis

We identified 1,629 users. Next, we read each user's profile information (bio, location, username) and using this information we coded the collected users as *graduate students*, *professors*, or *other*. Accounts that could not be readily identified from this information as either graduate student or professor accounts (e.g., unclear, corporate, multiauthor, or anonymous accounts) were excluded from analysis, and the final data set included an almost equal number of graduate students (232) and professors (237) for a total number of 469. By identifying accounts in this way, it is possible that student or professor accounts might have been excluded from analysis if they did not self-identify as such. This, however, is an intentional delimitation of the study, as we did not feel it to be appropriate to label accounts in a manner that was not reflective of self-descriptions. Furthermore, if the goal of this study is to understand scholars' participation in social media, then it seems to make sense to focus our attention on social media use which users connect to their identities as scholars.

All data were then exported from the database and imported to SPSS for statistical analysis. Separate variables were analyzed for three data sets.

Tweet data set. This dataset included *unique identifiers*, *retweets* (the number of times the tweet had been retweeted), and *retweet* (a binary variable reflecting whether the tweet was original or a retweet).

Hashtag data set. This dataset included unique hashtags and the number of times each was used. Hashtag counts were calculated to determine communities (e.g., phdchat), conferences (e.g., aera13), and topics (e.g., immigration) that were identified in tweets. Hashtag use varied by user, and some hashtags were widely used while others were used by only one or two users. Hashtags that were used by more than 50 unique users in the data set (roughly 10% of users) were marked as viral. We used 50 users to demarcate viral and non-viral hashtags because the number of users using a hashtag fell dramatically from that point onwards, indicating low uptake.

User data set. This dataset included raw and percentage participation factors. Percentage factors were used to represent each user's overall twitter activities, counteracting skewing that would have resulted from highly differential numbers of tweets. Participation factors were:

- *professor* - Whether the participant self-identified as a professor (non-exclusive to *student*).
- *student* - Whether the participant self-identified as a student (non-exclusive to *professor*).
- *followers* (dependent) - The number of other Twitter users who “follow” the user.
- *following* (independent) - The number of other Twitter users whom the user “follows.”
- *listed* (correlate/independent) - The number of Twitter lists on which the user appears.
- *tweets* (independent) - The number of tweets the user has posted.
- *lifespan* (independent) - The number of years (in decimal form) since the Twitter user account was first created, calculated as $lifespan = current\ date - creation\ date$.

- *frequency* (independent) - The number of tweets the user posts in a day, calculated as $\text{number of tweets} \div (\text{last tweet date} - \text{first tweet date})$.
- *mentioning* (independent) - The percentage of tweets in which the user mentions another user, calculated as $\text{user tweets with mentions} \div \text{tweets}$.
- *hashtagging* (independent) - The percentage of tweets in which the user includes a hashtag, calculated as $\text{user tweets with hashtags} \div \text{tweets}$.
- *linking* (independent) - The percentage of tweets in which the user includes a URL, as calculated by $\text{user tweets with links} \div \text{tweets}$.
- *retweeting* (independent) - The percentage of tweets that are retweets (i.e., non-original), calculated as $\text{user retweets} \div \text{tweets}$.
- *replying* (independent) - The percentage of tweets that are replies to other Twitter users or tweets, calculated as $\text{user replies} \div \text{tweets}$.

Results

After data cleaning, identification of users by role, and exclusion of participants who could not be identified as students or professors, the user data set included 469 users (232 students and 237 professors), the hashtag data set included 74,814 unique hashtags that were used 427,930 times, and the tweet data set included 645,579 tweets (48% from students and 52% from professors).

RQ1: How do graduate students and professors in the education field use Twitter?

The descriptive statistics of student and professor use of Twitter revealed that more than half of the tweets (55.2%) mentioned other users, while only about a quarter (22.8%) were replies to others. Further, more than 30% of tweets were retweets, 37% included a hashtag, and more than 31% included a hyperlink. Results also showed considerable variance between

individual users with a positive skew on most non-normalized factors. For instance, the standard deviation of *followers*, *following*, *listed*, and *tweets* exceeded each factor's mean, and the median was far below the mean. Those participants who were more active (i.e., posted more tweets) or more popular (i.e., gained more followers) exponentially exceeded their counterparts (Table 1).

Table 1. Descriptive Results of Students' and Professors' Twitter Use

	Mean	SD	Median	Min	Max
followers	756.8	1,913.2	298	4	24,611
following	564.2	674.7	362	7	8,404
listed	31.8	86.2	10	0	1,201
tweets	3,676	8,752	1,010	4	82,690
lifespan	3.9	1.8	3.8	0.84	7.9
frequency	2.4	4.8	0.76	0	41.3
mentioning	55.2	22.6	0.59	0.47	94.8
hashtagging	37.01	20.1	0.36	0.15	1
linking	31.3	19.9	0.29	0	88.9
retweeting	30.5	17.6	0.28	0	92.9
replying	22.8	13.7	0.15	0	81.9

Table 2 provides an overview of activity and popularity by percentile groups. Comparing the popularity of the top 50% with that of the bottom 50% of scholars suggests that popularity is roughly equivalent to activity or the efforts of the individual in terms of tweet counts. However, this view breaks down as we consider the top percentile groups: the top 5% garner 43% of all followers (though they provide 29% of all tweets) and the top 1% command 21% of all followers (though they only provide 7% of all tweets). These differences become starker when we consider that the most popular 1% scholars have an average follower base nearly 100 times that of scholars in the lower 99% and 700 times those in the bottom 50%.

Table 2. Followers (Popularity) and Tweets (Activity) of Scholars by Percentile Groups

Percentile Group	Followers	Tweets	Avg. followers
top 1%	21%	7%	15,059
top 5%	43%	29%	4,385
top 10%	57%	45%	1,389
top 50%	91%	90%	140
bottom 99%	79%	93%	164
bottom 50%	9%	10%	22

To determine if any factors were attributable to participant roles as either student or professor, a multivariate analysis of variance (MANOVA) with user descriptives as the dependent variables and role as the independent variable yielded significant overall effects (Wilks' $\lambda = .92$, $p < .001$, partial eta squared = .08, observed power = 1). Given the significance of the overall test, univariate main effects were examined, and significant effects were detected for *followers*, $F(1) = 10.14$, $p < .01$, partial eta squared = .02, observed power = .89; *listed*, $F(1) = 11.64$, $p < .01$, partial eta squared = .02, observed power = .93; and *linking*, $F(1) = 4.71$, $p < .05$, partial eta squared = .01, observed power = .58. Estimated marginal means for each dependent variable by role (table 3) revealed that:

1. Professors had more followers than students (MD = 557).
2. Professors were listed more often than students (MD = 36).
3. Professors included links in their tweets more often than did students (MD = 4%).

Table 3. Estimated Marginal Means and Medians of Role-based Twitter Differences

	Professors	Graduate Students

	E.M. Mean	Std. Error	Median	E.M. Mean	Std. Error	Median
Followers	1,032.4	123.1	367	475.2	124.4	219
Listed	45.1	5.5	14	18.3	5.6	7
Linking	.33	.01	.31	.29	.01	.28

RQ2: Which hashtags do education scholars contribute to?

Other than #aera14, which was the hashtag that all these scholars contributed to, what hashtags did they use? Our analysis revealed that both graduate students and professors hashtagged 37% of their tweets. In total, 74,814 unique hashtags were used, with around 25 unique hashtags used per user, but just 136 unique hashtags (0.18%) were considered viral. The average hashtag was used by only 1.95 users an average of 2.39 times, suggesting high variability. Though non-viral hashtags accounted for 99.82% of all hashtags, they were present in about half (51.81%) of all tweets.

The 136 viral hashtags were present in 14.48% of all tweets, reflecting that some hashtags were important to a large number of participants. As shown in Table 4, these hashtags were related to education (e.g., *edchat*, *highered*, *edreform*), civil rights or advocacy (e.g., *Ferguson*, *BlackLivesMatter*), or general Internet culture (e.g., *FF* for Follow Friday, *TBT* for Throwback Thursday).

Table 4. Top Hashtags by User Role

Professor			Student		
Hashtag	% of users	tweets per user	Hashtag	% of users	tweets per user
education	66.7	9.2	education	64.2	7.3

highered	62.5	30.2	edchat	59.9	20.9
edchat	62.0	32.3	highered	54.7	32.6
edtech	48.1	40.2	Ferguson	46.6	20.8
Ferguson	41.8	18.3	edtech	45.7	19.4
FF	38.8	4.5	research	33.2	3.8
research	38.0	3.3	phdchat	32.8	11.4
AERA13	35.4	17.9	teachers	32.0	3.6
STEM	34.6	7.9	edreform	32.0	5.5
teachers	34.2	4.6	FF	32.0	4.5

We created viral hashtag scatter plots of participation and use frequencies to better understand differences between groups and detected a strong, positive linear relationship for participation between groups ($R^2 = .79$) as expressed in the following equation: $student\ participation = .03 + (.81 \times professor\ participation)$ (figure 1), and a moderate, positive power law relationship for hashtag frequency between groups ($R^2 = .51$), as expressed in the following equation: $student\ frequency = 1.49 \times professor\ frequency^{.68}$ (Figure 2). These relationships reveal that students were somewhat less likely to participate in each viral hashtag than professors and that the frequency in which professors participate in these hashtags is exponentially greater than that of students.

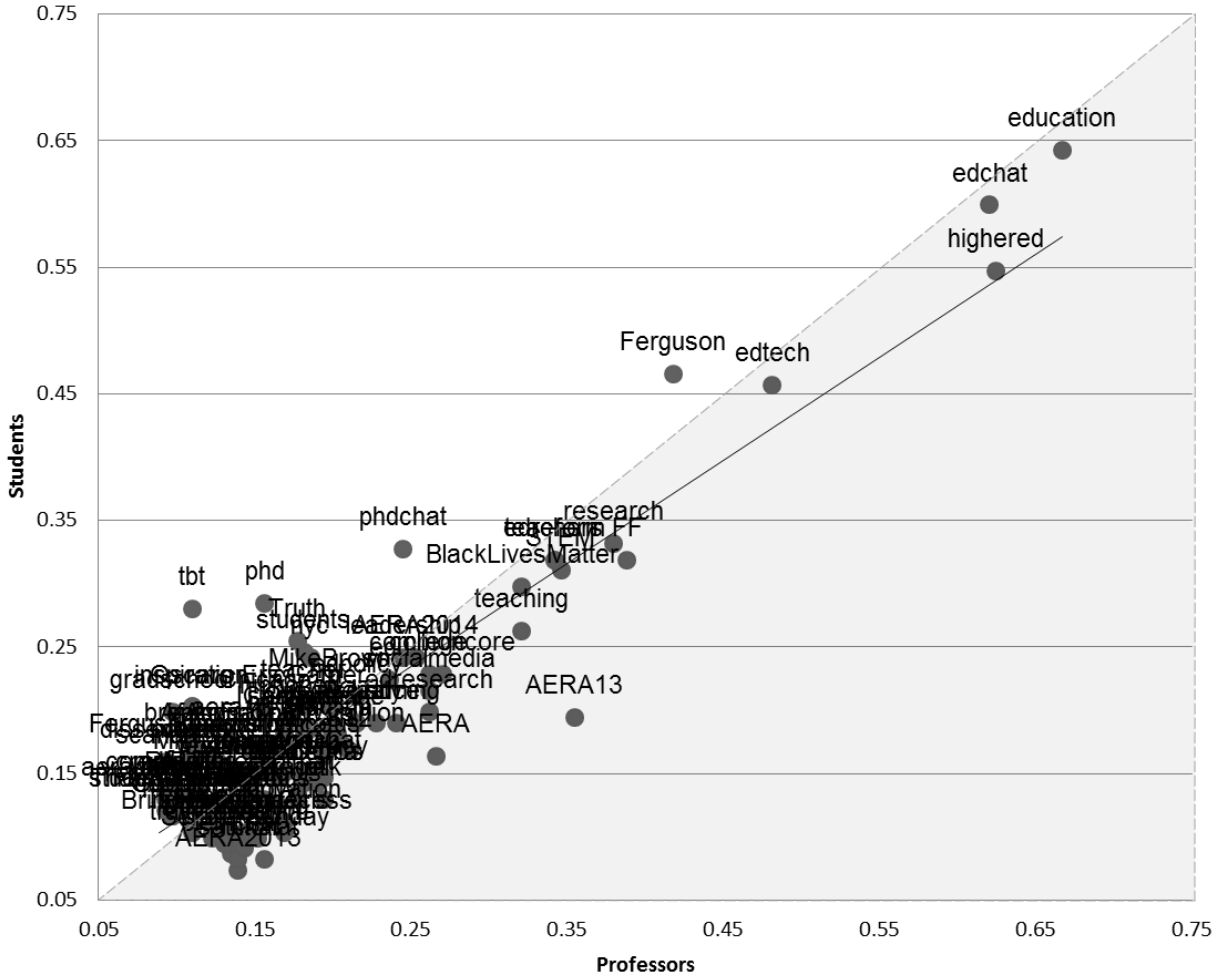


Figure 1. Plot of linear relationship between hashtag participation of students and professors.

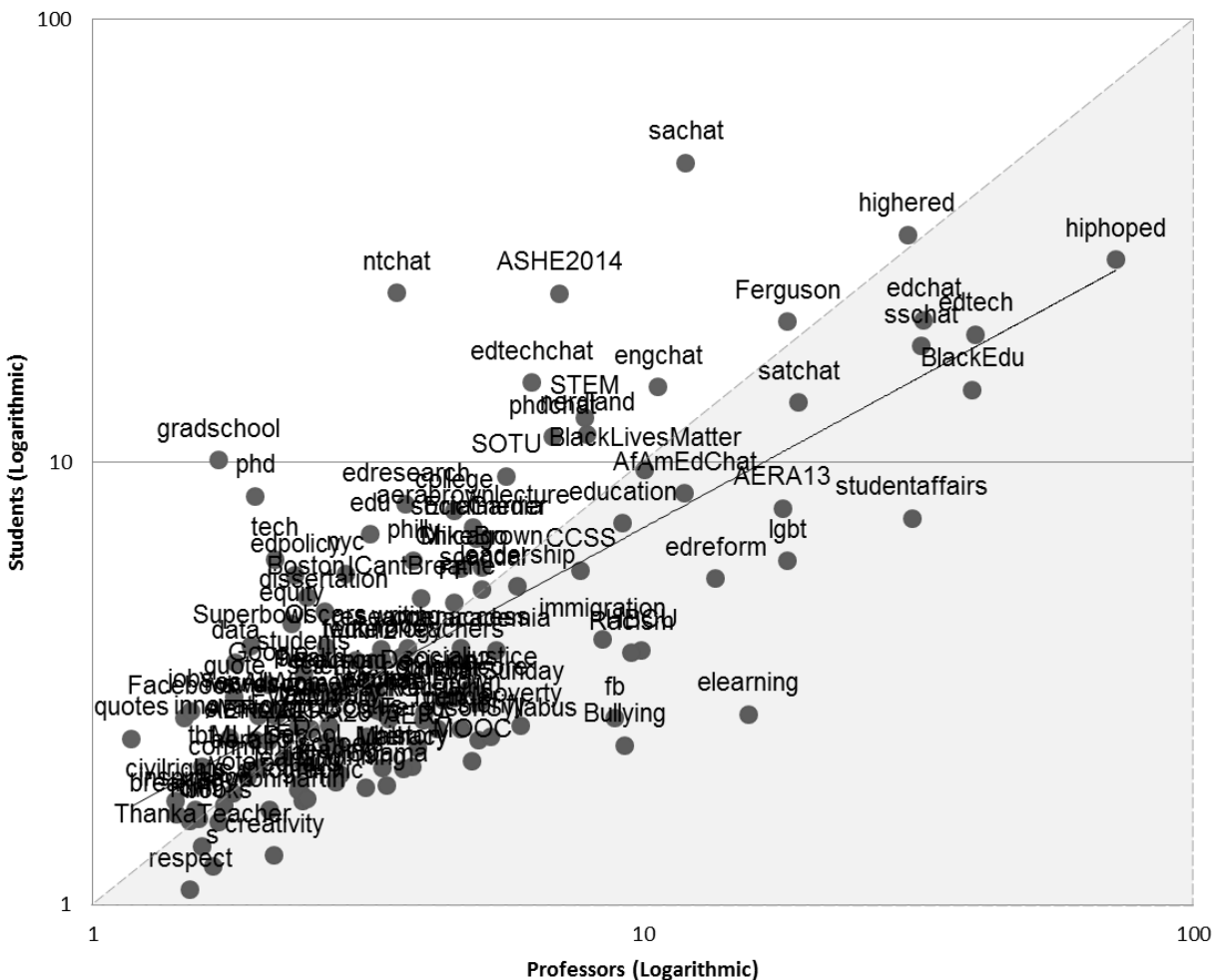


Figure 2. Plot of power law relationship between hashtag frequency of students and professors. RQ3: What factors predict participants' follower counts?

We had anticipated that several measurable participation factors might influence follower counts, including *tweets*, *following*, *role*, and *lifespan*. Visual inspection of initial scatterplots and curve estimation tests revealed potential power law relationships between most factors, so values of scale variables were recoded logarithmically to allow for further analysis that assumed linearity. Visual inspection of logarithmic scatterplots revealed linearity, and bivariate correlation results of raw values were compared to results of logarithmic values to ensure that data recoding improved correlations in data. In all cases, correlations in the data were improved as a result of the logarithmic recoding of scale variables (table 5).

Table 5. Bivariate correlations of factors with raw values vs. logarithmic values

	tweets	following	lifespan	role
followers	.43 **	.42 **	.24 **	.15 **
	lg(tweets)	lg(following)	lg(lifespan)	role
lg(followers)	.82 **	.79 **	.41 **	.22 **

** Denotes significance at the $p < .01$ level.

First, a logarithmic scatter plot of *followers* to *following* (figure 3) revealed a strong, positive linear relationship between the two variables ($R^2 = .62$), as expressed in the following equation: $lg(followers) = .98 \times lg(following)$. This reveals that by following more people, participants will receive more followers but that this rate decreases. For example, if one user follows 10 people, another follows 100, and a third follows 1,000, the first will receive a number of followers representing 95% of those followed, the second would receive 91%, the third 87%, and so forth. The scatterplot also revealed the possibility of outliers, which needed to be considered in later analysis.

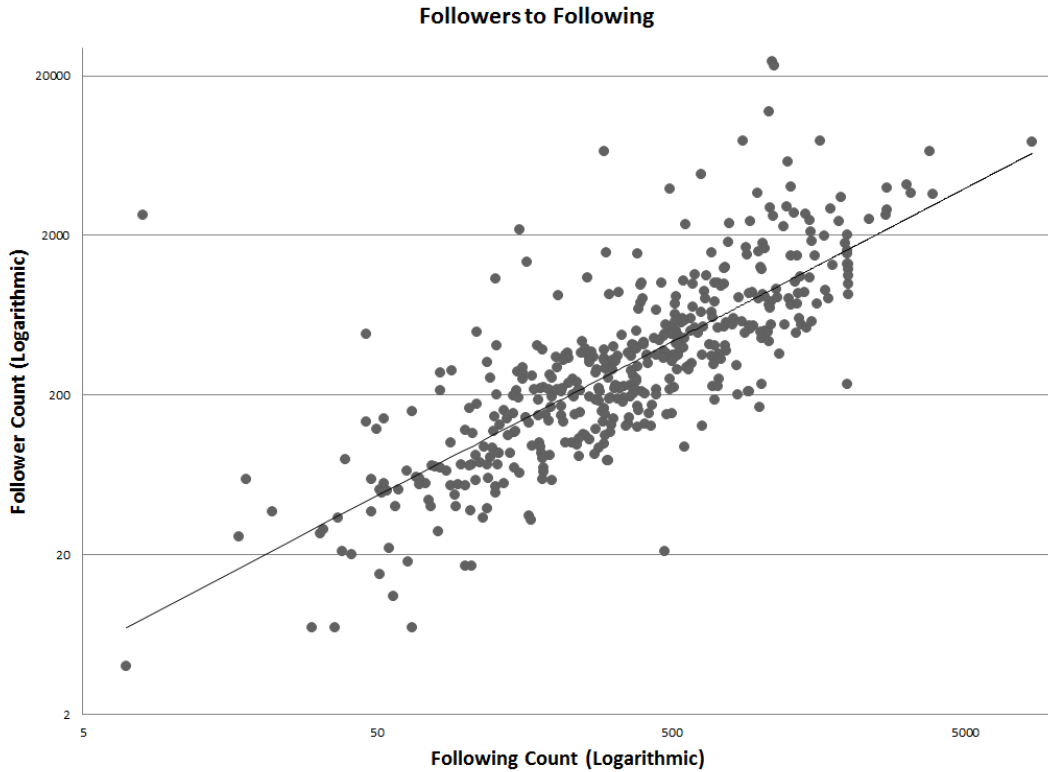


Figure 3. Plot of users' linear relationship between logarithmic follower and following counts.

Next, a logarithmic scatter plot of *followers* to *tweets* (figure 4) revealed a strong, positive linear relationship between the two variables ($R^2 = .67$), as expressed in the following equation: $lg(followers) = .63 + (.62 \times lg(tweets))$. This reveals that by tweeting more, participants will receive more followers but that this rate decreases. For example, if one user posts 10 tweets, another posts 100, and a third posts 1,000, the first would gain 1.78 followers per tweet, the second would gain .74, the third .31, and so forth.

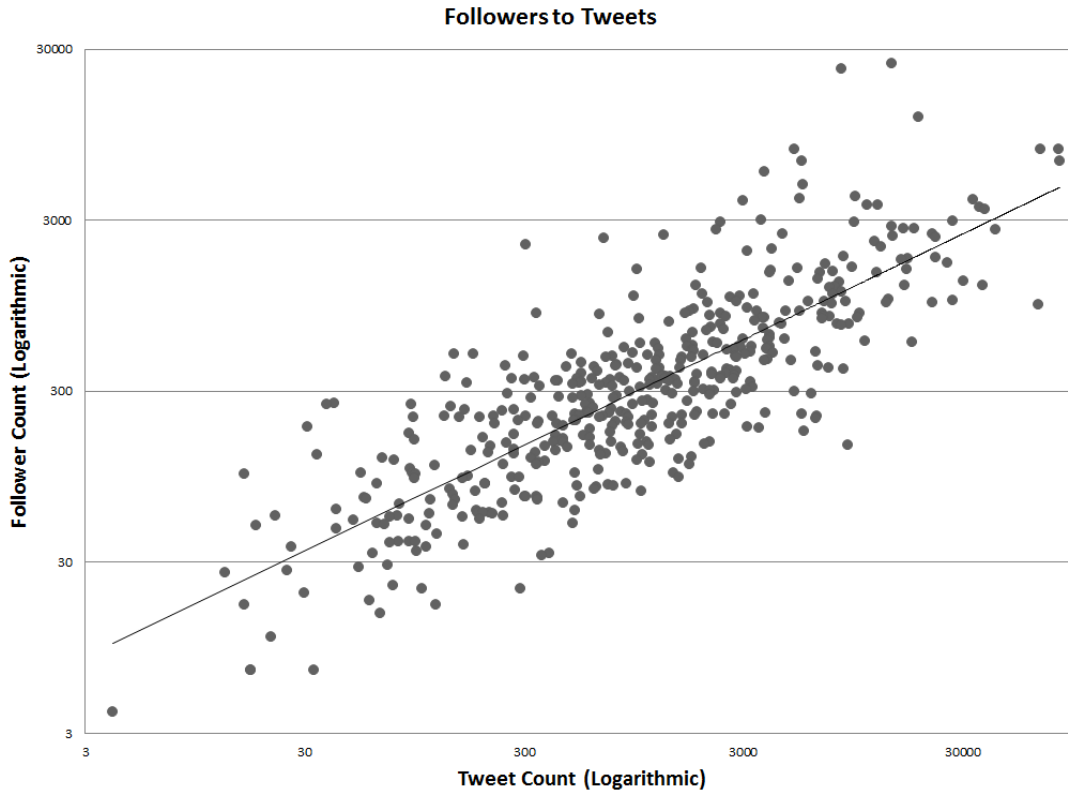


Figure 4. Plot of users' linear relationship between logarithmic follower and tweet counts.

And third, a logarithmic scatter plot of *followers* to *lifespan* (figure 5) revealed a weak, positive linear relationship between the two variables ($R^2 = .17$) as expressed in the following equation: $lg(\text{followers}) = 1.94 + (.98 \times lg(\text{lifespan}))$. This reveals that mere time in the medium produces followers but that the rate of return on followers per time interval decreases. For example, a user's first year would garner 87.1 followers, first four years would garner 84.7 followers per year, first eight years would garner 83.6 per year, and so forth.

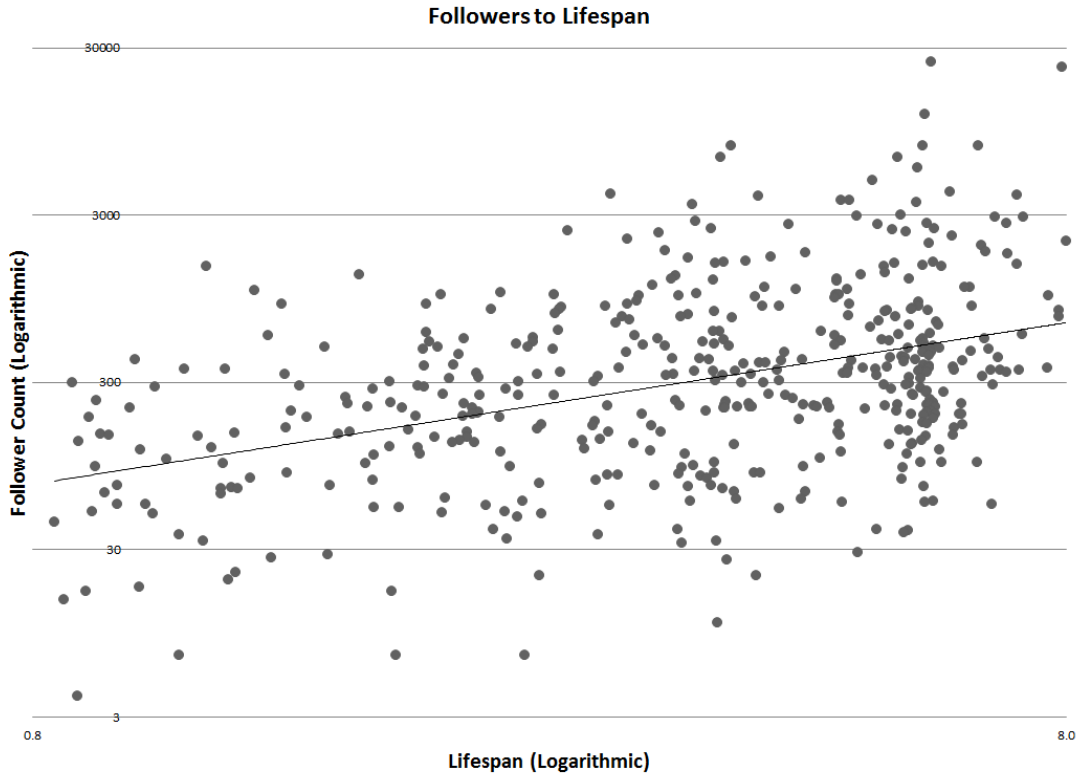


Figure 5. Plot of users' linear relationship between logarithmic follower counts and lifespan.

Multiple linear regression was utilized to test whether any of the participation factors significantly predicted users' follower counts. The results of the stepwise linear regression indicated that a model of four predictors explained 78% of the user variance ($R^2 = .78$, $F [4,468] = 411.04$, $p < .001$), but casewise diagnostics identified nine outliers exceeding three standard deviations from predicted values. Of these, seven identified themselves in their profiles as belonging to elite universities, including Harvard, Princeton, University of Pennsylvania, and University of Toronto. This suggested that outlier status may be influenced by self-identifying factors as either elite or otherwise. To test this, participant data was coded with two new variables based upon whether the user identified a university in their profile and if so, whether this was an elite university, where elite university was considered to be any university that the Carnegie classification system was described as “very high research university.” ANOVA

comparisons of followers based on these new factors did not reveal significant results. Outliers were therefore excluded from the analysis.

Upon exclusion of these nine cases, the strength of the predictive model increased to 83% ($R^2 = .83$, $F[4,459] = 571.42$, $p < .001$). It was found that *following* ($B = .58$, $p < .001$), *tweets* ($B = .32$, $p < .001$), *role* ($B = .16$, $p < .01$), and *lifespan* ($B = .12$, $p < .01$) significantly predicted *followers*. Those scholars who follow more users, have tweeted more, signal themselves as professors, and have been on Twitter longer will have more followers (Table 6). This relationship may be expressed in the following equation:

$$\lg(\text{followers}) = (.58 \times \lg(\text{following})) + (.32 \times \lg(\text{tweets})) + (.16 \times \text{role}) + (.12 \times \lg(\text{lifespan})) - .27.$$

Table 6. Regression Coefficients of Factors as Predictors of Followers

	B	Std. Error	t
(Constant)	-.27	.07	-4.2 ***
<i>lg(following)</i>	.58	.03	17.2 ***
<i>lg(tweets)</i>	.32	.02	15.4 ***
<i>role</i>	.16	.02	7.7 ***
<i>lg(lifespan)</i>	.12	.05	2.6 **

** Indicates significance at the $p < .01$ value.

*** Indicates significance at the $p < .001$ value.

Discussion and Implications

The results presented in this study reaffirm a number of previous research findings and contribute new insights to current knowledge regarding four aspects of the research questions: participation equity, role differences, scholars' online participation, and scholarly influence.

Participation Equity

Findings for RQ1 reveal significant variation in how education scholars participate on Twitter and the benefits received from participation. As scholars became more active (i.e., increase their number of tweets) and popular (i.e., increase their number of followers) on Twitter, they did so exponentially. For instance, the most followed 1% garnered 21% of all followers and had an average follower base nearly 100 times larger than that of other scholars, while providing only 7% of all tweets. This leads us to ask whether the use of social media for scholarly work necessarily leads to new and more egalitarian structures for scholarly dissemination or if it reflects existing, or fosters new, non-egalitarian structures of scholarly practice. Results for RQ3 show that being widely followed on social media is impacted by many factors that may have little to do with the actual quality of scholarly work (i.e. following count, tweet count, role, lifespan) and suggests that participation and popularity may be impacted by a number of additional factors unrelated to scholarly merit (e.g., wit, controversy, longevity).

Results for RQ3 should lead us to question whether social media metrics can and should be used as proxies for scholarly value, as has been argued by proponents of alternative metrics (e.g., Priem & Hemminger, 2010) and to recognize that a scholar's power to disseminate meaningful work in a digitally connected culture is mediated (and therefore can be manipulated) by effective social media strategies. Exponential increases in activity and popularity lend empirical support to earlier claims that some individuals may be more capable of exploiting the commons than others (Veletsianos & Kimmons, 2012) and suggests that Twitter and similar technologies may not be the equalizing forces they are sometimes portrayed to be.

Therefore, we recommend future research comparing traditional measures of scholarly outputs (e.g., number of journal articles or citations) to Twitter impact metrics to determine to

what extent they may or may not be connected. Similar research has been conducted in other disciplines (Eysenbach, 2011; Shuai, Pepe, & Bollen, 2012; Thelwall, Haustein, Larivière, & Sugimoto, 2013), but none has heretofore been done in the field of education. Although it may be that measuring social media activity may help determine impact in a manner more relevant to today's society, the fact that participation patterns predict follower counts (as shown in this paper) should elicit questions as to what follower counts actually mean in these contexts. This should lead us to consider what other factors may influence scholars' abilities to share their work in a meaningful manner and to examine what metrics may be meaningful to inspect.

Role Differences

Results for RQ3 also revealed that although participant role impacted follower counts, listed counts, and linking, this distinction accounted for only a very small percent of variation (2% or less) in each of those factors, suggesting that the social capital traditionally associated with professorial status may not provide much influence on Twitter. Yet, results for RQ2 reveal that viral hashtag use did skew toward professors, and our analysis also indicates that there may be some qualitative differences between hashtags based on role. Based on our scatter plots (figures 1 and 2), professors may be more likely to post on some civil rights issues like gender, sexual orientation, race, and violence and on content-related topics such as history, math, and literacy. Students, on the other hand, appeared to be more likely to post on topics specifically related to the graduate student experience, such as dissertations, jobs, and data, and on topics of wider cultural interest, such as events and scandals. It seems that students also tended to refer to technology in generalities (e.g., tech), while professors were more likely to refer to specific technologies and initiatives (e.g., MOOCs, open access, elearning).

These results extend earlier findings in the literature. Li and Greenhow (2015) suggested that differences in motivations may reflect different roles within conferences, and our research showed that participation patterns vary by roles. Future research in this area should explore the following: 1) role differences within the community of educational scholars to determine if statistically significant differences exist in the hashtag use of students and professors; 2) differences based upon other demographic factors, such as gender, race, and age; and 3) contextualized, qualitative use of hashtags.

Scholarly Online Participation

The results of RQ2 also suggest that scholars' participation in and contributions to hashtags is diverse and may extend well beyond traditional notions of scholarship. Other researchers have reported that scholars often use Twitter in both personal and professional ways (e.g., Bowman, 2015; Holmberg & Thelwall, 2014; Veletsianos, 2012) and that events external to conferences can impact the conference hashtag activity (Mahrt, Weller, & Peters, 2014). Our research contributes to the current understanding by demonstrating that scholars' online participation is influenced by temporal events other than conferences, such as the Ferguson events (revealed by the viral presence of the hashtags #Ferguson and #BlackLivesMatter). Our research also shows that peaks in activity (as shown by viral hashtags) can be produced by events of broad societal significance related to the scholarly interests of various subcultures within the community (e.g., critical educators, culture and race researchers) that may not be relevant to all subcultures within the community (e.g., international scholars). Furthermore, although some individuals within the sample may have used the Ferguson hashtag because it relates to their area of expertise, the sheer volume of tweets pertaining to this topic and the number of individuals

contributing to it suggests that at least some of those scholars may not necessarily have had a research connection to the topic.

This last finding also suggests that by focusing on the use of social media *for* scholarship most of the current frameworks used to investigate emergent forms of technology-infused scholarship (i.e., social scholarship, digital scholarship, open scholarship) have focused on a narrow sliver of scholars' online activities (Kimmons, 2014) and have ignored other aspects of online presence (e.g., scholars' expression of identity). This research shows that scholars enact an eclectic range of activities online and suggests that researchers need to explore a wider range of scholars' activities to fully understand their online lives and participation. At present, the scholarly community lacks frameworks to make sense of the diversity of scholars' online and networked participation. While understanding *scholarly participation online* is significant, the research community would benefit from further development and adoption of frameworks to understand *scholars' online participation* beyond scholarship. Future research in this area, for example, might explore the reasons that scholars participate online in the ways that they do and investigate such topics as scholars' online activism, use of humor, and discourse surrounding academic life. In summary, future research should examine the substance of education scholars' tweets qualitatively in order to gain a more in-depth look at how scholars are using Twitter.

Scholarly Influence

Given that many scholars use Twitter to share their work with a broader audience, it has been suggested that follower counts might be a useful metric of success in this regard (cf. Marwick & boyd, 2011). Regardless of whether Twitter and similar technologies are equalizing forces, our findings for RQ3 offer several practical suggestions for scholars who would like to increase their followership: (a) tweet often, (b) follow many other users, (c) self-identify as a

professor if accurate, and (d) continue using Twitter over an extended period. Whether one views this advice as gaming the system or legitimate participation in the community may depend on one's own assumptions about the medium. However, if follower counts are considered a metric of impact, one has to question it further, as our results show that education scholars' followership is most strongly predicted by the number of tweets posted and number of people followed. A wide range of variables might mediate the number of tweets posted: Extroverts might tweet more than introverts and scholars with family responsibilities might have less time to tweet than those without.

Limitations and Future Research

One major limitation of this study is that results will not necessarily transfer to other online social networks used by scholars like ResearchGate, Facebook or Academia.edu (Tufecki, 2014). Another is that participants were selected based upon their use of the #aera14 hashtag and this decision led to the exclusion of education scholars who did not use the hashtag. As a result of this choice, we may be missing nuanced scholarly social media use that might lead education scholars to elect not to participate in popular conference hashtags even though they might have a Twitter account. Future research can address these two limitations by examining scholars' participation on other social media platforms, and by conducting analyses similar to the ones reported here using additional hashtags as vehicles to identify education scholars. The latter approach, would enable researchers to broaden the data source to include professors and students who participated in other education-focused conferences/communities. Additionally, other areas of future research mentioned previously include:

- The comparison of traditional scholarly output measures to Twitter impact metrics;
- The analysis of role, gender, race, and age differences regarding hashtag use;

- And the qualitative analysis of scholars' tweets to determine more substantial meanings of use.

Conclusion

This research used a large-scale data set to examine education scholars' participation on Twitter. It examined the ways in which doctoral students and professors used Twitter, the hashtags that they contributed to, and what factors predicted their follower counts. Expanding opportunities to interact with diverse audiences in online settings and the potential of online networks to increase citations, reach, and impact have led many scholars to use social media and online social networks as part of their scholarly activities.

Yet, the results of this study indicate that significant variation exists in education scholars' networked participation. While one of the anticipated outcomes of social media use is the democratization of knowledge sharing and participation, the results of this research question such purported egalitarian structures of social media use. Significantly, the results reported herein caution researchers and practitioners that theoretical frameworks that focus exclusively on scholarship and overlook the diverse activities that scholars enact online, ignore significant aspects of who scholars are when they are online. The richness and complexity of networked scholarship, coupled with the findings reported here, provides a fertile ground for further research on the topic.

Acknowledgements

This study was partially funded by a grant from the Canada Research Chairs program.

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