TechTrends (2017) 61:273–281
DOI 10.1007/s11528-016-0142-4

ORIGINAL PAPER

28 Days Later: Twitter Hashtags as "Just in Time" Teacher Professional Development

Spencer P. Greenhalgh[1] · **Matthew J. Koehler**[2]

Published online: 19 December 2016

Abstract Researchers have argued that Twitter has potential to support high-quality professional development (PD) that can respond to teachers' questions and concerns just in time and "on the spot." Yet, very little attention has been paid to instances where Twitter has made just-in-time learning possible. In this paper, we examine one instance of timely professional development on Twitter, in which 3,598 users used an educational hashtag—#educattentats—to create a temporary affinity space supporting French teachers preparing to discuss recent terrorist attacks with their students. We describe this just-in-time PD by focusing on participants and modes of participation, the spread of the hashtag in its first hours and the growth and eventual decline of the hashtag over the course of 28 days. The results of this study suggest that #educattentats served effectively as just-in-time professional development for teachers. Implications for research and practice are discussed.

Keywords Affinity spaces · Professional development · Social learning · Social media · Social networking sites · Teacher learning · Twitter

✉ Spencer P. Greenhalgh
greenha6@msu.edu

Matthew J. Koehler
mkoehler@msu.edu

[1] Department of Counseling, Educational Psychology and Special Education, Michigan State University, 447 Erickson Hall, 620 Farm Lane, East Lansing, MI 48824, USA

[2] Department of Counseling, Educational Psychology and Special Education, Michigan State University, 509E Erickson Hall, 620 Farm Lane, East Lansing, MI 48824, USA

Changes in the teaching profession (Darling-Hammond and McLaughlin 1995) and the rapid evolution of resources and technologies (Jones and Dexter 2014) create a need for professional development (PD) that can respond to teachers' questions and concerns just in time and "on the spot" (Plair 2008, p. 73). In short, supporting teacher learning requires creating flexible environments that allow teachers to connect with colleagues and experts who can help them with their current questions. Some scholars have argued that this "real-time" and "on-demand" support can be provided by Twitter (Carpenter and Krutka 2015, p. 716).

Researchers describe Twitter-based professional development as taking place within *affinity spaces* (Carpenter and Krutka 2015) or *learning communities* (Gao and Li 2016). Research on Twitter-based professional development has emphasized its size and scope (Rosenberg et al. 2016), its openness and interconnectedness (Carpenter 2015) and its self-directed nature (Visser et al. 2014). However, despite calls to examine the use of Twitter to provide just-in-time training (Gao et al. 2012), little research has explored this type of professional development.

We respond to this gap by examining one instance of targeted and timely professional development on Twitter. After terrorist attacks in Paris in November 2015, the hashtag #educattentats served as a temporary *affinity space* to provide support for teachers preparing to address the incident with their students. We describe this affinity space from its creation to its virtual disappearance 28 days later.

Conceptual Framework

In this section, we introduce Twitter-based professional development as a kind of social learning that happens through affinity spaces.

Social Nature of Learning

The recognition of the social nature of learning is a recent "major advance" (Greeno et al. 1996, p. 15) in the field of educational psychology. One common way of conceiving of social learning is the *community of practice* (Lave and Wenger 1991), a perspective purporting that people learn in and from groups sharing the same professional (or other) practices. Gee (2004) suggested the alternative perspective of a *social semiotic space* dedicated to particular *content*, characterized by *interactions* within the space and accessed through a specific *portal. Affinity spaces* are social semiotic spaces that are further characterized by features such as diverse forms of participation and dispersed networks of knowledge (Gee 2004).

Teacher Learning in Social Spaces

Social conceptions of learning can describe—and inform—teachers' learning. Professional development (PD) is a key resource for education reform (Darling-Hammond and McLaughlin 1995), and a number of scholars have highlighted perceived shortcomings of existing PD (Jones and Dexter 2014; Lawless and Pellegrino 2007; Lock 2006; Visser et al. 2014). Suggestions for improvement often focus on the social nature of learning and sometimes even use the language of communities (Darling-Hammond and McLaughlin 1995; Jones and Dexter 2014).

Social Learning and Just-in-Time Professional Development

The phrase "just-in-time" describes PD that is responsive, timely and effective (e.g., Lock 2006; Mouza 2002). Although just-in-time PD is not a formalized concept built on a foundation of empirical evidence, it is a useful metaphor for PD organized around flexible structures that emerge when necessary and disappear when no longer needed (Darling-Hammond and McLaughlin 1995; Jones and Dexter 2014). As opposed to typical PD—in which facilitators organize the curriculum and use a predetermined structure to guide the training—learning in just-in-time PD is driven by teachers who use flexible structures to find "knowledge brokers" (Plair 2008, p. 70) who help them focus on their specific needs (Darling-Hammond and McLaughlin 1995; Easton 2008). Teachers' interactions with experts and colleagues who already have the knowledge they are trying to obtain are compelling examples of the social nature of learning.

Twitter as a Social Space

Technology facilitates social, just-in-time PD (Jones and Dexter 2014; Lock 2006), and Twitter has received particular attention. Researchers describe synchronous "chats" and asynchronous activities on Twitter in terms of social learning constructs such as communities of practice and affinity spaces (Carpenter and Krutka 2015; Gao and Li 2016; Visser et al. 2014). Much Twitter-based PD follows a traditional model, with coordinators for a particular chat deciding on a set topic that may be more helpful for some participants than others. Nonetheless, Carpenter and Krutka (2014, 2015) reported that teachers recognized and appreciated Twitter's potential to provide just-in-time PD, commenting on their ability to obtain PD tailored to their needs and their schedule. However, there remains little research on what this process looks like.

Purpose and Research Questions

We examine how Twitter users interested in education responded to terrorist attacks carried out in Paris on November 13, 2015. Early on November 14, Arnaud Lecuyer (aka @padagogie), a social studies teacher in Versailles, posted the following tweet (Fig. 1):

With this tweet, Lecuyer created the hashtag "#educattentats," a portmanteau of the French words *éducation* (education) and *attentat* (terrorist attack). The tweet indicates Lecuyer's purpose for creating the hashtag: facilitating the collection, organization and dissemination of ideas and resources for teachers as they prepared to discuss the attacks with their students. The hashtag thus became a portal to an affinity space dedicated to interactions around this content. Furthermore, the context surrounding Lecuyer's tweet suggests that the hashtag was meant as just-in-time PD: The hashtag was created the day after the attacks to ask how teachers would respond on Monday, just 2 days later. Indeed, over the days and weeks that followed, a number of people accessed this affinity space to discuss Twitter, teachers and terrorism.

The purpose of this paper is to explore how the #educattentats affinity space served as a space for teacher learning and an example of the broader phenomenon of just-in-time PD. Because this space emerged from a setting where a large group of teachers were seeking just-in-time PD, we were able to analyze a large-scale but specific instance of this phenomenon. This exploration is guided by a descriptive approach that addressed the following research questions:

1) Who participated in the #educattentats affinity space and how?
2) How did the #educattentats affinity space spread?
3) How long did the #educattentats affinity space last?

Fig. 1 Screenshot of the first tweet using the #educattentats hashtag. The text translates to "#teachers! How will you respond in your classes? Need to reflect and share #educattentats"

Method

We present a case study that employs digital methods—the use of "online and digital technologies to collect and analyze" data (Snee et al. 2016, p. 1). We use automated computational methods—which emphasize "reliability, reproducibility, [and] time-efficiency" (Munzert et al. 2015, p. xi)—to aggregate and analyze large numbers of "digital traces" (Welser et al. 2008). That is, we used a descriptive research design by employing digital methods that summarize and describe the raw data and metadata associated with this affinity space. We use interpretive analyses to add nuance and understanding to these descriptive accounts.

Sampling

For this study, we chose #educattentats as a *purposive sample* (Remler and Van Ryzin 2011) of an affinity space dedicated to just-in-time phenomenon. While we could have chosen other hashtags for this purpose (e.g., #FergusonSyllabus and #CharlestonSyllabus), #educattentats had two qualities that made it particularly compelling. First, we began collecting #educattentats data immediately after the hashtag was created, allowing us to build a thorough data set and maximize the utility of our digital methods approach. Second, using #educattentats allows us to explore an international perspective, thereby expanding previous research focused on the United States.

Data Collection

We collected data using a Twitter Archiving Google Sheet (TAGS; Hawksey 2014). The TAGS collected tweets and retweets using the #educattentats hashtag along with metadata such as usernames and timestamps. An initial examination of these data suggested that most of the activity in this affinity space occurred during the first 28 days of its existence, so we focused on data from November 14, 2015 through December 11, 2015. After we excluded data from private Twitter accounts, banned Twitter accounts and accounts whose #educattentats tweets had since been removed, the final data set consisted of 1,208 original tweets and 4,333 retweets.

To supplement these data, we collected additional information using *web scraping*, the use of digital methods to automatically collect information from websites (Munzert et al. 2015). This included:

1) the profile description and listed geographic location of Twitter users in the original data set, and
2) additional participants who had not composed any tweets but had interacted with the #educattentats affinity space by clicking the "like" button for one or more tweets (however, due to limits imposed by Twitter, we were unable to identify all such users).

Data Analysis

We then took steps to analyze these data in terms of our research questions.

RQ1: Who Participated in the #educattentats Affinity Space and How? In asking who participated in the #educattentats affinity space, we were first interested in the number of people involved and who these people were. We first calculated the total number of *unique users* (unique Twitter accounts) who had tweeted, retweeted or "liked" posts in our dataset. We also examined the *user role* represented by each account. Two coders used iterative in vivo coding (Saldaña 2015) to develop mutually-exclusive codes describing the roles participants played in the educational or broader community as indicated in their Twitter profile. This approach resulted in *substantial* inter-rater reliability ($\kappa = .65$; Landis and Koch 1977).

We took a similar approach to explore how Twitter users participated in this affinity space. We determined the percentage of *unique users* who: a) posted to Twitter (in any form), b) composed original posts, c) retweeted original posts and (d) "liked" posts. To better understand these tweets, two coders measured *tweet purpose* by using the coding methods described above to develop a second set of mutually-exclusive codes that described the purposes tweets appeared to serve; the coders reached *substantial* levels of reliability ($\kappa = .78$; Landis and Koch 1977).

RQ2: How Did the #educattentats Affinity Space Spread? Because not every new hashtag becomes an affinity space, we set out to learn how this space grew over time, both in terms of physical geography and interpersonal networks. We developed a list of *user connections* by capturing every mention or retweet of one participant by another. Cross-referencing this measure with lists of people who had participated within

certain time intervals allowed us to see how the affinity space expanded over time within virtual space.

We also estimated the *user location* for each participant who tweeted or retweeted using the #educattentats hashtag by retrieving the locations listed in their profiles and using the Google Maps API to convert those locations into latitude and longitude coordinates. By cross-referencing this measure with the lists of participation over time, we were able to see how awareness of and participation in this affinity space spread throughout physical space.

RQ3: How Long Did the #educattentats Affinity Space Last? To explore the nature of the #educattentats affinity space as just-in-time PD, we measured the number of: a) original *tweets per day*, b) *retweets per day*, c) *users per day* and d) *new users per day* (i.e., *users per day* who had not previously tweeted) and determined how these numbers changed over time.

Results

In this section, we present and comment on the answers to our three research questions.

RQ1: Who Participated in the #educattentats Affinity Space and How?

This affinity space consisted of 3,598 *unique users* representing a variety of *username roles* (see Table 1). The largest group consists of people and institutions affiliated with primary and secondary education, representing over 22% of the coded sample. Other groups explicitly connected to education (i.e., *administration and government; research, higher education and libraries*; and *other education*) collectively represent 24% of the sample, and another 14% of the sample consists of groups whose members were often—but not always—connected to children and schools (i.e., *organizations and associations* and *journalism and media*). The remaining codes demonstrate that the #educattentats affinity space was open to a range of other roles and that it is not always possible to determine who is participating in an affinity space such as #educattentats.

Twitter users participated in this affinity space in a variety of ways. Table 2 shows that nearly a quarter of participants posted no tweets at all (only "liking" others tweets) and that less than 11% of participants actually posted original tweets. Moreover, the data presented in Table 3 suggests high levels of concentration: Over 15% of the total activity—and over half of the original tweets—can be traced back to the most active 1% of participants. These data suggest that #educattentats was characterized by a core group of people who generated content and a larger group of auxiliary participants who only participated by distributing the content, possibly with no knowledge of the larger affinity space.

The analysis of our *tweet purpose* measure demonstrates the professional development aims of the #educattentats affinity space, putting particular focus on teachers' needs. As seen in Table 4, over half of the tweets were dedicated to calling attention to resources that participants in the affinity space could use, including advice for teachers and materials for students. However, while the *pedagogical support* and *resources for learners* tweets shared this focus on resources, there was an important difference between them. Tweets pointing to resources for learners were simple recommendations for web sites, articles and lesson plans that teachers (or parents) could integrate into a learning experience; while the words "Paris attacks" in our sample tweet for this code make clear its connection to a very specific educational context, the remaining words would not look out of place in any other PD-focused setting. However, tweets providing pedagogical support directly acknowledged teachers' (and not just students') needs for support and assistance and were thus more closely tied to this context. For example, the corresponding tweet in Table 4 acknowledges that teachers are being forced by circumstances to have conversations that they may have never expected (much less wanted) to have with their students.

Although they represent a smaller proportion of our sample, the other codes also highlight this focus on teachers' needs and experiences in a difficult educational context. Tweets that *described classroom experiences* explicitly promoted and implicitly validated the work that teachers did with their students in the days following the Paris attacks. Likewise, tweets that *invited collaboration and built community* served to recognize the value of the teaching profession or encourage cooperation between its members; the sample tweet in Table 4 even goes so far as to endorse the work happening within the #educattentats space, presumably inviting yet more followers to join in the conversation.

RQ2: How Did the #educattentats Affinity Space Spread?

We examined the spread of the #educattentats hashtag in terms of both relationships between participants and geographical location. Figure 2 is a network visualization of these relationships. Each dot represents a participant, and arrows point from a participant making a reference (through a mention or retweet) to the participant being referenced. Once added, dots remain in the same position. In hour one, most of the interaction is clustered in two groups focused on single participants, either through others' mentions of them or their mention of others; there is also one independent user. By hour two, some new, smaller clusters have appeared, the original clusters have grown and there is now a connection between the core participants in each major cluster. Hours three and four see the addition of new auxiliary participants clustering around (and

Table 1 Description and distribution of codes for username roles

Code	Description of accounts	Percentage
Primary and secondary education	Associated with teachers, institutions and students in primary and secondary education systems	22.67% (68)
Administration and government	Associated with officials and institutions connected with the French education ministry, school administrators and politicians	7.00% (21)
Research, higher education and libraries	Associated with professors, institutions, students and employees of research, higher education or library institutions	10.33% (31)
Other education	Associated with people who expressed interest in education but whose exact role was either unclear or did not fit into any of the above categories	6.67% (20)
Organizations and associations	Associated with private or non-profit organizations, many of which had educational interests, including parents' organizations, advocacy groups and teachers' unions	8.33% (25)
Journalism and media	Associated with media outlets and their employees; many were focused specifically on educational or children's issues	5.67% (17)
Other	Associated with people expressing a clear identity that did not fit any of the above categories	18.00% (54)
Unclear	Did not clearly state a role or identity for the associated user	7.00% (21)
Blank	Contained no information in the profile	14.33% (43)

$N = 300$

presumably retweeting) a small set of core participants, which is slowly growing.

These networks were not limited by geographical space. Figure 3 demonstrates how #educattentats spread over the first 12 hours of its existence. Each dot represents the *user location* of one participant in the space, and the visualization for each hour includes everyone who has participated up to that point. In the first hour, participants in this affinity space had already spread to several parts of France and to Brussels. By hour twelve, people throughout France and several other Western European countries had participated in the hashtag. Given the nature of #educattentats, it is not surprising that most of the activity occurred in France and its neighbors; however, this space saw also participation from throughout the world. Figure 4 shows on a world map every valid *user location* measure associated with the 28 days we have examined in this paper, demonstrating that people from every inhabited continent participated in the space.

Table 2 Participation levels in the #educattentats affinity space

Type of participation	Percentage of users engaging
Posting to Twitter	77.24% (2,779)
Composing original posts	11.09% (399)
Retweeting original posts	70.54% (2,538)
"Liking" posts	39.55% (1,423)

$N = 3{,}598$

RQ3: How Long Did the #educattentats Affinity Space Last?

This affinity space was characterized by rapid growth early in its existence and by steady decline thereafter. Figure 5 shows how *tweets per day*, *retweets per day*, *users per day* and *new users per day* increased steadily over the first three days (although *tweets per day* saw a small dip on day two). However, after peaking on day three, these measures decrease abruptly through days four and five and then begin steadily decreasing. There is little activity after day ten and virtually none by day 28.

Given the context of #educattentats, this pattern is not surprising. The hashtag was first used on the Saturday following the Paris attacks to help teachers prepare for class the following Monday. That Monday is represented by day three in Fig. 5—precisely the day that these measures peaked.

Table 3 Concentration levels of activity in the #educattentats affinity space

Percentage of users	Original tweets	Retweets	Likes	Total activity
1%	51.97%	13.46%	16.45%	15.74%
2%	64.88%	19.86%	24.15%	21.56%
2.5%	69.16%	22.27%	27.32%	23.92%
5%	81.00%	31.34%	38.63%	32.46%
10%	95.81%	43.05%	53.23%	43.49%

Table 4 Description and distribution of codes for purposes of tweets

Code	Description of tweets	Translated example	Percentage
Invite collaboration and build community	Publicized the affinity space, invited collaboration, reflected on the civic role of teachers, or expressed appreciation for the teaching community	A hashtag to help teachers and education personnel to prepare for the difficult Monday that's waiting for us #educattentats	18.00% (54)
Provide pedagogical support	Included or linked to information or resources that helped teachers prepare themselves emotionally or provided advice for how to teach sensitive subjects; many referenced resources for learners but in the overall context of providing support for teachers	Saying the unspeakable. How to talk about the attacks with your students. #educattentats. [link to web page] [embedded picture]	38.67% (116)
Share resources for learners	Linked to resources meant to support students' and children's understanding of the November attacks; these included lesson plans, slideshows, drawings and articles from children's media	Paris attacks: Online resources for children for understanding [link to web page] #educattentats	26.33% (79)
Describe classroom experiences	Included or linked to reported experiences talking in class about the November attacks; these included pictures of student work, links to student videos and teacher testimonies	#SchoolsForPeace, When children draw pictures about the attacks [link to web page] #educattentats [embedded picture]	13.33% (40)
Other/unclear	Purpose did not fall into one of the above categories or could not be determined	As long as there's humor, fundamentalism isn't winning … #educattentats [quoted tweet]	3.67% (11)

$N = 300$

Indeed, the figure suggests that the affinity space continued to see regular activity throughout the rest of the school week but that by the following Monday (i.e., day ten), teachers may have been returning to their regular classroom routines, minimizing the need for participation in this affinity space.

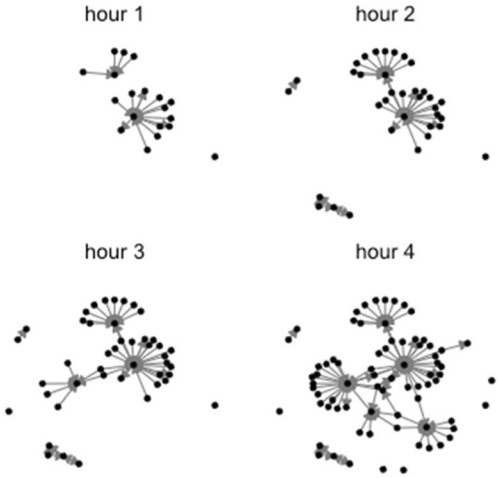

Fig. 2 User connections between #educattentats participants from hour 1 through hour 4

Discussion

The results to our study paint the #educattentats hashtag as an affinity space that delivered just-in-time professional development. As previously described, just-in-time PD is characterized by learning that is driven by teachers, supported by *knowledge brokers* and framed by flexible structures. In this section, we highlight how each of these three elements can be seen in our data.

In just-in-time professional development, teachers drive their own learning by pursuing the knowledge and resources that meet their needs. Our analysis shows that this space was largely driven by education stakeholders: *Username roles* with direct or indirect connections to education constituted the majority of Twitter profiles that we analyzed, and many of the tweets we coded were dedicated to either reflecting on, paying homage to, or providing support and resources for the teaching profession. Although the extent to which these resources met teachers' needs cannot be determined from our analysis, it seems clear that this affinity space was intended for that purpose.

Teacher-driven learning is made possible by *knowledge brokers* who can respond to teachers' needs in a timely fashion. According to Plair (2008), *knowledge brokers* help *knowledge integrators*, those putting knowledge into practice, connect with *knowledge creators* creating or providing knowledge. The high ratio of retweets to original tweets suggests that most #educattentats participants played the role of *knowledge brokers* by retweeting information from a small number

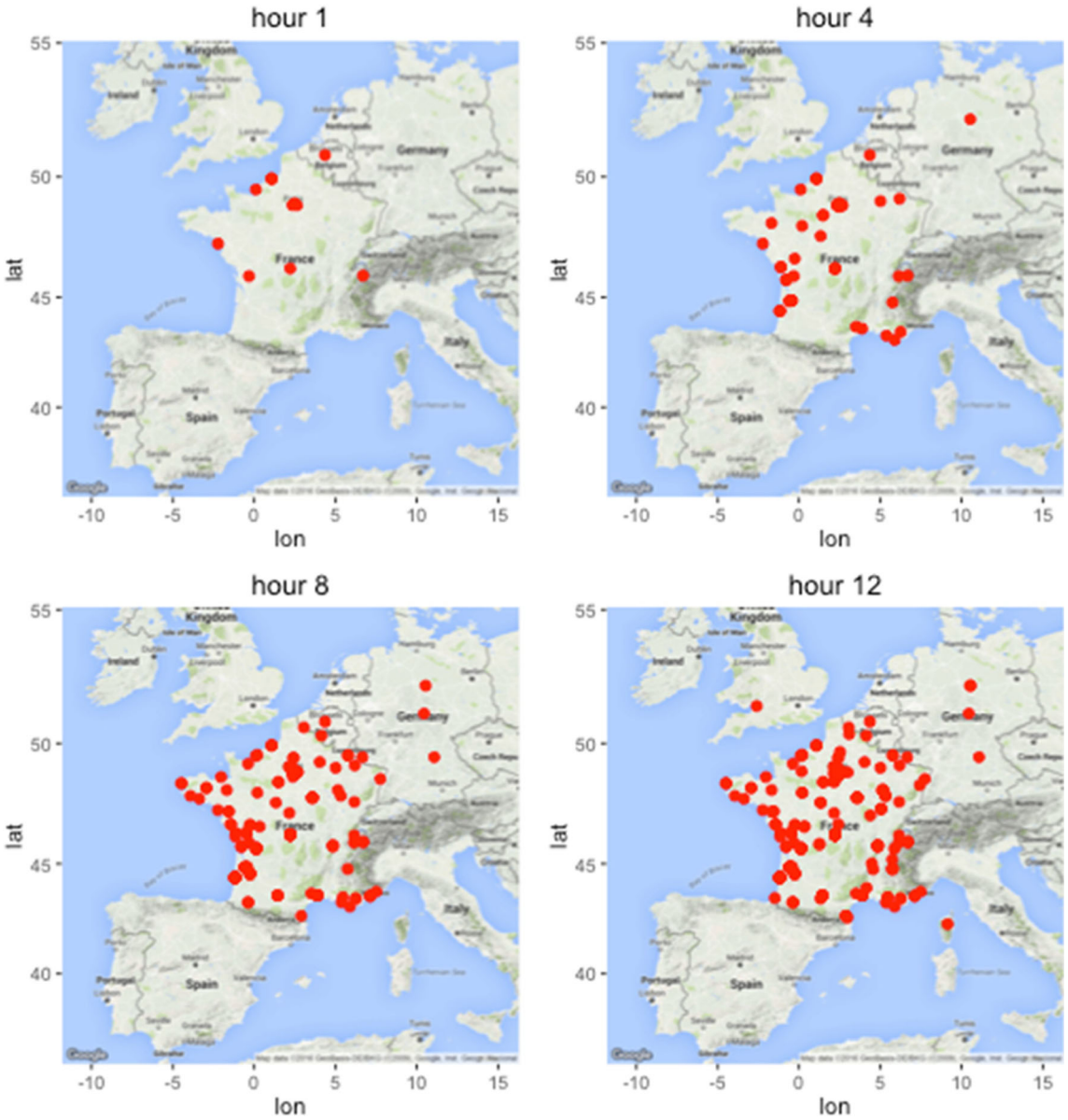

Fig. 3 User location of #educattentats participants in France and neighboring countries from hour 1 through hour 12

of *knowledge creators* posting original tweets. This relationship can be further seen in network visualizations of this space, which show a large group of auxiliary participants clustered around a small core and presumably retweeting their original posts.

Perhaps the most distinctive feature of the #educattentats affinity space was its flexibility: It emerged when needed and disappeared after it had served its purpose. Many hashtag-based affinity spaces dedicated to teacher PD are known—and valued—for their longevity; for example, #edchat has existed since 2009 (Anderson 2012). In contrast, #educattentats saw peak activity within 3 days and virtually disappeared in less than a month. However, Darling-Hammond and McLaughlin (1995) suggest that such disappearances should be seen not necessarily as failure but rather as a natural part of the process. Indeed, the peak of the #educattentats affinity space coincided with the day that teachers and students returned to school after the terrorist attacks. The decline in activity after this day therefore represents the decreasing importance and utility of the space and its flexibility in responding to teachers' time-sensitive needs.

Limitations and Future Research

Although our findings suggest that the #educattentats affinity space was successful in delivering "just in time" professional development, there remain a number of issues worthy of

Fig. 4 User location of #educattentats participants through day 28

further consideration. For example, our examination of this space is complicated by our inability to study some of its participants in detail. The limited availability of Twitter data makes it difficult to determine who "liked" tweets and impossible to identify all such participants. Similarly, other people may have read #educattentats tweets without leaving any digital traces of their interaction (Carpenter 2015).

Furthermore, the data we did collect were largely insufficient for determining what teachers' needs were and what they learned from participation in this space. The metadata of a tweet has nothing to contribute to these questions, and our coding was not focused on these subjects. Similarly, although the high concentration of activity in a small number of participants may be typical of hashtag-based affinity spaces (e.g., Gao and Li 2016), it also raises questions about whether all participants are learning the same amount. The large number

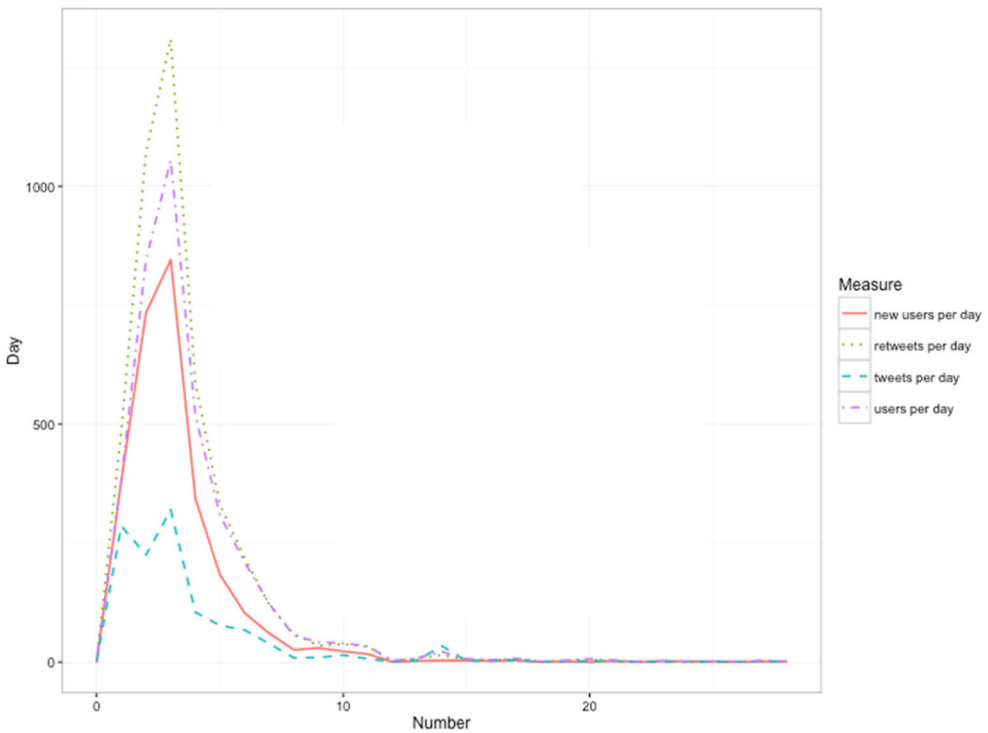

Fig. 5 New users per day, retweets per day, tweets per day, from tweet day 1 through tweet day 28

of participants coded as *Other* also invites questions as to how many of the participants actually benefited professionally from the information being shared.

These issues are primarily related to the nature of Twitter data and the digital methods that we used. Although these methods were effective for our purpose of developing a comprehensive description of the #educattentats affinity space, they are not as well-suited for providing a deeper look at participants' actions and experiences within this space. Future research should employ interviews and other qualitative methods to provide a richer description of affinity spaces dedicated to just-in-time PD.

Conclusion

Teachers can play a key role in informing students about important current affairs, and the November 2015 Paris attacks were no exception. However, teachers do not typically expect to—and may not be trained to—adjust their teaching to include such lessons. The concept of "just in time" professional development explains the importance of providing targeted and timely support to teachers in contexts such as these, and the #educattentats affinity space demonstrates how people were able to use Twitter to provide PD that was flexible, driven by education stakeholders and mediated by knowledge brokers. Fortunately, the utility of Twitter in providing this kind of support is not limited to these situations. Indeed, while #educattentats provides a large-scale look at how Twitter supports teacher learning in the moment it needs to happen, it is likely that practitioners and researchers have much to learn from many other such instances happening constantly at different scales and in different spaces throughout the Web.

Acknowledgements We would like to thank Josh Rosenberg and Sarah Gretter for their contributions to and advice for our analysis.

References

Anderson, S. (2012). A brief history of #edchat [Blog post]. Retrieved from http://blog.web20classroom.org/2012/03/brief-history-of-edchat.html.

Carpenter, J. (2015). Preservice teachers' microblogging: professional development via Twitter. *Contemporary Issues in Technology and Teacher Education, 15*, 209–234.

Carpenter, J. P., & Krutka, D. G. (2014). How and why educators use Twitter: a survey of the field. *Journal of Research on Technology in Education, 46*, 414–434. doi:10.1080/15391523.2014.925701.

Carpenter, J. P., & Krutka, D. G. (2015). Engagement through microblogging: educator professional development via Twitter. *Professional Development in Education, 41*, 707–728. doi:10.1080/19415257.2014.939294.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan, 76*, 597–604.

Easton, L. B. (2008). From professional development to professional learning. *Phi Delta Kappan, 89*, 755–759.

Gao, F., & Li, L. (2016). Examining a one-hour synchronous chat in a microblogging-based professional development community. *British Journal of Educational Technology*. doi:10.1111/bjet.12384.

Gao, F., Luo, T., & Zhang, K. (2012). Tweeting for learning: a critical analysis of research on microblogging in education published in 2008–2011. *British Journal of Educational Technology, 43*, 783–801. doi:10.1111/j.1467-8535.2012.01357.x.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. New York: Routledge.

Greeno, J., Collins, A., & Resnick, L. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–46). New York: Macmillan.

Hawksey, M. (2014). Need a better Twitter Archiving Google Sheet? TAGS v6.0 is here! [Blog post]. Retrieved from https://mashe.hawksey.info/2014/10/need-a-better-twitter-archiving-google-sheet-tags-v6-0-is-here/ .

Jones, W. M., & Dexter, S. (2014). How teachers learn: the roles of formal, informal, and independent learning. *Educational Technology Research and Development, 62*, 367–384. doi:10.1007/s11423-014-9337-6.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*, 159–174. doi:10.2307/2529310.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research, 77*, 575–614. doi:10.3102/0034654307309921.

Lock, J. V. (2006). A new image: online communities to facilitate teacher professional development. *Journal of Technology and Teacher Education, 14*, 663–678. doi:10.1080/15405702.2014.929378.

Mouza, C. (2002). Learning to teach with new technology. *Journal of Research on Technology in Education, 35*, 272–289. doi:10.1080/15391523.2002.10782386.

Munzert, S., Rubba, C., Meißner, P., & Nyhuis, D. (2015). *Automated data collection with R: A practical guide to web scraping and text mining*. West Sussex: Wiley.

Plair, S. K. (2008). Revamping professional development for technology integration and fluency. *The Clearing House: A Journal of Educational Strategies, Issues, and Ideas, 82*, 70–74. doi:10.3200/TCHS.82.2.70-74.

Remler, D. K., & Van Ryzin, G. G. (2011). *Research methods in practice: Strategies for description and causation*. Thousand Oaks: SAGE Publications.

Rosenberg, J. M., Greenhalgh, S. P., Koehler, M. J., Akcaoglu, M., & Hamilton, E. (2016). An investigation of State Educational Twitter Hashtags (SETHs) as affinity spaces. *E-Learning and Digital Media, 13*, 24–44. doi:10.1177/2042753016672351.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Thousand Oaks: SAGE Publications.

Snee, H., Hine, C., Morey, Y., Roberts, S., & Watson, H. (2016). Digital methods as mainstream methodology: An introduction. In H. Snee, C. Hine, Y. Morey, S. Roberts, & H. Watson (Eds.), *Digital methods for social science: An interdisciplinary guide to research innovation* (pp. 1–11). New York: Palgrave Macmillan.

Visser, R. D., Evering, L. C., & Barrett, D. E. (2014). #TwitterforTeachers: the implications of Twitter as a self-directed professional development tool for K–12 teachers. *Journal of Research on Technology in Education, 46*, 396–413. doi:10.1080/15391523.2014.925694.

Welser, H. T., Smith, M., Fisher, D., & Gleave, E. (2008). Distilling digital traces: Computational social science approaches to studying the internet. In N. Fielding, R. M. Lee, & G. Blank (Eds.), *The SAGE handbook of online research methods* (pp. 116–141). Thousand Oaks: SAGE Publications, Ltd.