Chapter 30
Using Twitter to Form Professional Learning Communities:
An Analysis of Georgia K-12 School Personnel Discussing Educational Technology on Twitter

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ABSTRACT

Social media has become an important tool for informal teacher professional development. Although there is a growing body of research investigating issues across the US, there is a lack of research on teacher professional development taking place on Twitter in Georgia, USA. In this research, the authors applied digital methods to analyze 5,425 entries from educators participating in a state-level, weekly, synchronous chat about educational technology (#TECHTalkGA) on the social media platform Twitter. Findings include that participants utilized the chat for organization, planning, and classroom technologies, with a predilection toward specific hardware and software topics. Limitations and implications for future research are discussed.

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INTRODUCTION

Teachers are required to maintain their professional knowledge, and the process of maintaining current professional knowledge often is described as *professional development*. Professional development can be categorized as formal or informal (Hodges, 2015). Formal professional development often is experienced in traditional formats such as face-to-face workshops, conference sessions, or webinars led by an expert or experts. Informal professional development may take many forms, but increasingly online social networking tools are utilized. Professional development was the most common educational purpose for social networking identified in the reviewed literature (Galvin & Greenhow, 2020, p. 21).

In addition to formal forms of teacher professional development, teachers have accepted informal professional development experiences such as EdCamp meetings or online professional learning networks (e.g. Carpenter, 2014; Trust et al., 2014). One platform for informal online professional development has been through communicating (e.g., sharing resources) through social media (Rosenberg et al., 2016; Greenhalgh et al., 2020). These informal professional development experiences are typically not led by a single expert, but are led by teachers, for teachers. The focus of this paper is a specific use of the free-to-access online service Twitter (http://www.twitter.com) as a professional learning network by education professionals. .

BACKGROUND

Online Education and Online Professional Learning

In the last two decades, the mainstream growth of the Internet has led to transformative change in education, particularly higher education, as the Internet has provided new opportunities for online and distance learning (Allen & Seaman, 2010; Shea & Bidjerano, 2010). Commensurate with this change has been a rise in the sphere of online activity known as social media – networks of users tied together via Web 2.0-based applications that offer individuals an opportunity to generate and share content of their own (Kaplan & Haenlein, 2010). Noting that the term *social media* is hard to define in a world where almost all technologies feature a social component, Kaplan and Haelein (2010) defined *social media* as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow creation and exchange of user generated content" (p. 61). Examples of social media are large social networks like Twitter, Facebook, Tumblr, or sites like Instagram and YouTube, which focus on one type of media.

Online education has been steadily growing, and as of 2008, nearly 4.6 million students were enrolled in some form of online education (Gabriel, 2010). Recent economic downturns have driven millions of people to look online for new learning opportunities and careers. Between 2007 and 2010, online education enrollment increased 25% (Allen & Seaman, 2010; Shea & Bidjerano, 2010). Universities – whether public, private, or for profit – are increasingly pushing online education as part of their curricula (Gabriel, 2010). In some cases, online education is considered necessary for these institutions' long-term survival (Gabriel, 2010; Kaya, 2010). As universities and other institutions of higher education move to implement more online education, they also struggle with the quality of the education (Kaya, 2010). Lack of engagement and motivation is seen as one of the central problems in the current landscape of online education. Online education – sometimes known as e-learning – offers significant advantages in

flexibility, individuality of instruction, and fewer geographic and temporal limitations; it has also been shown to have significant drawbacks, such as student isolation, the need for tutors, and lack of participation (Wu, Tennyson, & Hsia, 2010; Wu, Tennyson, Hsia, & Liao, 2008; Yang & Liu, 2007). Research has shown that online learning can be a disengaging experience (Barbour & Plough, 2009; Palloff & Pratt, 2007). The flexibility and convenience of taking a class online is an enticing prospect to many students, but staying engaged in an online course, whether synchronous or asynchronous, requires a high level of motivation (Barbour & Plough, 2009).

Online Communication, Social Media, and Personal Learning Environments

The pedagogical concept of Personal Learning Environments (PLEs) challenges the dominance of learning management system (LMS) usage in online courses, bringing a student-centered and bottom-up perspective to online education. The concept of PLEs is relatively recent and, as such, no central, agreed-upon definition of a PLE exists, though some key common elements appear in the literature. McElvaney and Berge (2010) defined a PLE as "the sum of websites and technologies that an individual makes use of to learn" (para. 18). This definition is a broad, inclusive one, but it is an acknowledgment that online learning can, and does, take place in spheres beyond the typical LMS-housed world of online education. To be sure, LMSs are included in this definition, but so are social media like Facebook or Twitter, blogs, video sharing sites, and informational clearinghouses like Wikipedia, to name a few. In much the same manner as students learn outside of the face-to-face classroom context, so, too, do online students. Online students might learn from articles posted by friends on Facebook, have heated debates replying to posts using a political Twitter hashtag, or share home renovation ideas on Pinterest. These are all learning activities, however removed they are from the formality of an online classroom. In a sense, all people engaged in online activity have their own personal online environment made up of the websites they frequent, including social media sites that employ hashtags.

The thinking behind PLEs has been that instruction should be situated in an environment more congruent with the learners' typical technology usage for their personal lives (Attwell, 2007). In a PLE, each online learner may create her and his own personal learning environment and can choose to engage with the course materials and assignments using the tools more closely aligned with each learner's nonacademic life (Sclater, 2008; Van Harmelen, 2008), including social media like Facebook, Instagram, Twitter, and Pinterest. In this type of learning environment, students have more choice about how they engage with the material and can use tools with which they are more comfortable. Students rarely encounter environments like LMSs in their personal online lives, yet many of them spend time traversing the Internet, tweeting, social networking, posting photos to Instagram, putting videos on YouTube and TikTok, and engaging in online discussions. These active online personal lives stand in contrast to the lesser-motivated online educational lives of students.

The PLE concept could be a benefit to teachers and students alike, as it allows, almost mandatorily, for differentiated teaching as it moves between online platforms. Students receive more variety in their instruction and teachers have more control over which technologies, tools, and platforms they use to create and deploy the content. As Mott (2010) describes, an ideal PLE features student choice, meaning that they can select tools that most match their needs and interests. However, this approach might be more fractious and decentralized than an LMS, with content and communication possibly happening in multiple places. This might prove confusing and complicated for inexperienced faculty and students, and there could also be privacy and FERPA issues for the use of some of the tools (Mott, 2010). It could

also be time-consuming and costly to maintain the disparate tools needed to teach a course, and the data is not always available or connects with institutional systems like online grade books and class roles (Mott, 2010). Technical support is also split up between tools and platforms, meaning little control over outages and technical issues and splintered support apparatus between providers (Mott, 2010). PLEs support modular, student-centered, constructivist approaches that offer teachers and students the choice to engage with content and course technology in a manner that more meets their needs and interests, but this combination of creative possibility for teachers means multiple tools and non-standardized technology usage from student to student. This could be highly rewarding and offer lots of pedagogical possibilities, but it might require extra time and effort.

To understand the concept of the PLE and the contrast between personal and academic online activity, it is important to also understand the development of the Web 2.0 paradigm. Web 2.0 has been a philosophical shift as much as a technological one, representing a change in how people create and share content on the Internet, moving from developer-generated to user-generated and shared content (Cormode & Krishnamurthy, 2008; Greenhow, Robelia, & Hughes, 2009; Ravenscroft, 2009). In the early Internet days of the 1990s, retroactively known as the era of "Web 1.0," content was delivered in a top-down manner by a limited number of content providers (Cormode & Krishnamurthy, 2008; Greenhow et al., 2009). Although Web 1.0 was touted as being "interactive," beyond its e-commerce role, it functioned as little more than a repository of knowledge, akin to an encyclopedia or dictionary, or a series of news articles generated by the major media (Cormode & Krishnamurthy, 2008; Greenhow et al., 2009). This version of the Internet mirrored traditional educational practices, expert-driven and top-down, with users functioning as passive receptors of information (Dede, 2008; Greenhow et al., 2009). Most user-generated content was relegated to communication-based communities, like message boards, chat rooms, and bulletin boards, and posting content online required knowledge of programming hypertext markup language, otherwise known as HTML (Greenhow et al., 2009). In the late 1990s, and even more so in the early 2000s, the top-down paradigm of content generation started to shift toward the user, as new tools – dubbed Web 2.0 – helped users generate and post content to the Web themselves (Greenhow et al., 2009). Websites and tools like blogs, YouTube, wikis, Twitter, and social networking sites all accurately represent the movement in user-generated content that characterizes Web 2.0.

What is Twitter?

Twitter is an online social media platform that allows users to communicate publicly. Twitter can be accessed with a variety of digital devices through web browsers or dedicated apps. The unique structure of Twitter allows for synchronous or asynchronous conversations on various topics from news, culture to education (Greenhalgh, et al., 2020). Communication with Twitter centers around sending out tweets to one's followers and receiving tweets from the individuals (or entities) they follow in their timeline. A *tweet* is a message consisting of text (up to 280 characters) and media files such as images, animations, or videos can be attached with each message. It is common to identify tweets with special keywords called *hashtags*. For example, a hashtag identifying a tweet as relevant to teachers would be "#teachers." Galvin and Greenhow (2020) noted that the use of hashtags and synchronous chats have been repeatedly found to be important to teachers, and that Twitter has been found to be the most popular social networking service for K-12 teachers. Use of hashtags has been found to be similar to "affinity spaces" (Greenhalgh & Koehler, 2017), which helps organize the conversation and context of the discussions.

How is Twitter Used by Educators?

Twitter is utilized for various purposes in education. Teachers find it to be an efficient, accessible, and interactive tool for staying on top of novel ideas, education advances, trends, and educational technology (Carpenter & Krutka, 2015). New teachers have used it to form mentoring networks (Risser, 2013). It has been integrated into the learning process to enhance the linguistic competence of secondary school students (i.e. Cano, 2012), and it has been embraced by educators as a way to form professional learning networks (Carpenter & Krutka, 2014; Coleman et al., 2018; Davis, 2015). In an analysis of several thousand tweets from teachers, Fischer et al. (2019) observed that "Twitter reflects aspects of high-quality professional development" (para. 1). Educators use Twitter to share information and resources with colleagues all around the world, thus possibly alleviating feelings of isolation experienced by some teachers (Carpenter & Krutka, 2014; Trust et al., 2016; Tucker, 2019). It also has been used as just-in-time teacher professional development in response to (tragic) current events (Greenhalgh & Koehler, 2017), and as a way to connect teachers during pandemic-related school closings (Hogan, 2020). Researchers have noted that state-level Twitter chats involving educators are thriving, but also that there is more to be known about these chats (Greenhalgh, 2020; Rosenberg et al., 2016).

The #TechTalkGA hashtag is an informal hashtag created by educators who work and live in Georgia, USA to share resources and thoughts about the use of educational technologies. It was formed by educators who are interested in using technology in their classrooms, professionals who work in school libraries, and other district professionals who are involved and interested in increasing the effective usage of technology in schools. Due to its informal and voluntary nature, information regarding its founders, founding date, or other elements that defines its structure does not exist by design (Rosenberg et al., 2016). In fact, the non-existence of this information is what defines these spaces: they are shared and not owned.

Theoretical Framework

To structure our investigation, we used the *Enriching Professional Learning Networks* (EPLN) framework introduced by Krutka, Carpenter, and Trust (2017). The EPLN framework describes a teacher professional learning network as consisting of people, spaces, and tools. Within EPLN, questions are asked such as: **Who** are the people in the PLN?, **Which spaces** are conducive to professional growth?, and **What tools** are acquired by participating in the PLN? Applying EPLN as our lens for this investigation provides a structure for our two research questions.

The Present Study

To address the need to know more about state-level Twitter chats, the focus of the present research is examining K12 educators' use of the Twitter hashtag, #TECHtalkGA, the Georgia-centered Twitter professional learning network with a specific focus on using technology for teaching and learning. #TECHtalkGA functions as both a weekly online chat and an asynchronous portal for educators in Georgia focusing on topics related to technology in education. Our purpose in this study was to examine this network for Georgia educators to fill the gap in the literature about state-level Twitter chats and investigate the nature of the conversation in this hashtag. Two research questions guided our examination of the hashtag data:

1. What is the nature of the activity of the Twitter discussions using the #TECHtalkGA hashtag?

   a. How is #TechTalkGA used across time?
   b. What types of Twitter interaction types were present across time?
2. What is the nature of the content discussed using the Twitter hashtag #TECHtalkGA?

Methods

Digital methods were utilized for the present research. Rosenberg et al. (2016) note that "digital methods are new research techniques that have been built around the collection and analysis of data coming from Twitter and similar sources" (p. 27). While we have applied newer tools and techniques to our data, the use of public data mining has been "an emerging research method for the past two decades" (Kimmons & Veletsianos, 2018, p. 492) and other researchers have established the appropriateness and utility of automated digital methods for quantitative content analysis (e.g. Greenhalgh, 2020). Digital methods may include setting up automations to collect and store publicly available data in Google Spreadsheets. For example, in this study, by using a script we were able to collect a large amount of public data (Tweets) in a Google Spreadsheet and analyze them using computational tools. This exploratory data analysis is "a different approach to analysis that can generate valuable information and provide ideas for further investigation" (Pertl & Hevey, 2010, p.456).

Data Sources and Collection

From January 2019 to April 2020, by using a publicly available script, Twitter Archiving Google Sheet (TAGS; Hawksey, 2014), we collected and stored a total of 5425 tweets by automatically searching for the hashtag #TechTALKGA at every hour and save them to a Google Sheet. Greenhow, Galvin, and Staudt Willet (2019) note that studying these tweets as "digital traces" (p. 181) allows researchers "opportunities to conduct authentic and useful research of social media behavior, in the contexts where it actually occurs, to better inform practice and policy" (p. 182).

Once the tweets were stored in the spreadsheet, it was exported as a data frame to be analyzed using quantitative and computational qualitative methods. We did not find unwanted tweets to be a problem in the data we collected, but data sets should be examined for possible spam entries (Carpenter, Willet, Koehler, & Greenhalgh, 2019). Using the *tidytags* R package (Staudt Willet & Rosenberg, 2021) we were able to remove deleted or private tweets.

Data Analysis and Procedures

To prepare the data for analysis, we followed the following steps. First, using tidytags R package (Staudt Willet & Rosenberg, 2021), we cleaned the data off of the protected and deleted tweets. Although tidytags can pull numerous variables for each tweet (e.g., location, urls, etc.), due to the nature of our research questions we were only interested in time, interaction, and tweet text data. Using the built-in functions inside tidytags, we created an edgelist to identify the usage types (e.g., retweet, quote tweet, etc.). This allowed us to perform analyses on the tweet data regarding the usage frequency and types that were investigated the first research question.

In addition to providing basic descriptive statistics, we also analyzed the content of the Tweets using the *Quanteda* package in R (Benoit, et al., 2018). Quanteda allows researchers to analyze the content of the Tweets using a corpus-centered approach to understand overall trends. Corpus here refers to the

text, in other words the content of each tweet. By creating a corpus from the tweets, we created a data that is composed of each word of each tweet. Using this corpus data, we were able to clean up the words that would not contribute to the findings (e.g., http, #TechTalkGA, personal pronouns, etc.) or were a regular part of the tweets sent to this hashtag (e.g., "A1" for answering tweets to questions asked during weekly chats). In order to understand the content discussed in #TECHtalkGA, our initial analysis was to take a look at the most frequently used words in the hashtag.

To prepare the data for the corpus analyses, first we converted the tweet text data into Quanteda corpus. Using the built-in functions in the package we were able to conduct "dictionary analysis, exploring texts using keywords-in-context, computing document and feature similarities, and discovering multi-word expressions through collocation scoring" (para. 1). After removal of the stopwords, and creation of the corpus text data, we analyzed both the nature of activity (using regular statistics), and also explored the frequency of certain keywords, as well as how the content of the tweets were related to each other (i.e., textplot networks). To prepare the figures, we used ggplot2 package available in tidyverse (Wickham et al., 2019).

Findings

The findings are organized by research questions.

Research Question 1: What is the nature of the activity of the Twitter discussions using the #TECHtalkGA hashtag?

First, we examined the activity on #TechTalkGA over time as seen in Figure 1. The data showed that from January 2019 to April 2020 the highest levels of activity (i.e., number of Tweets) for #TECHtalkGA occurred mostly on synchronous chat nights (Monday evenings), when the regularly scheduled chat occurred. During this period, users frequently tagged (i.e., @ mentions, n = 7346), retweeted (n = 1152), sent direct responses to each other (n = 943), and quoted other tweets (n = 672), as seen in Figure 2. Periods of relatively low activity are during winter and summer breaks.

Next, we analyzed the dataset to determine the most active participants in terms of the number of tweets they sent and received. We found that participation was skewed: only four users had been power users of the hashtag, accounting for almost half the number of tweets (n = 2401). The most sought out member was the organizer of the weekly Twitter chats associated with the hashtag. The top sender list was highly similar to the top receiver list.

Research Question 2: What is the content discussed using the Twitter hashtag #TECHtalkGA?

Our analysis revealed that there were a total of 5399 unique words identified, after grouping similar words by the first four letters. The most frequently used word was "tech," (n = 940) being followed by "teac," (n = 911) and "lear" (n = 688). Using these letter combinations allowed us to capture various forms of words. For example, using "teac" captures words like "teach", "teaching", and "teacher".

As can be seen in Figure 3, the most frequently used words reflect the main components of educational technology: learning, teachers, students, time, school. The frequency of words technology, edtech (n = 518), and google (n = 422), indicate that technology was a central focus of the PLN (34%). It also is

*Figure 1. Hashtag Activity January 2019 - April 2020**
**Note. Green points are days with more than the number of average Tweets.*

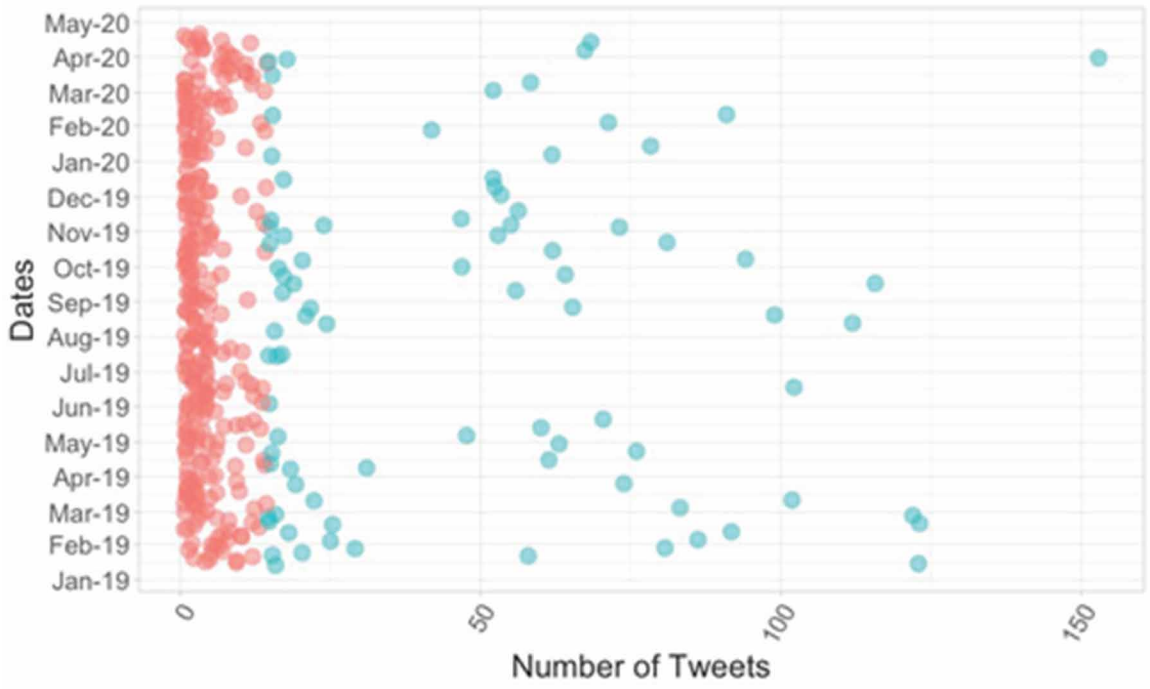


Figure 2. Interaction Types Across the Timeline

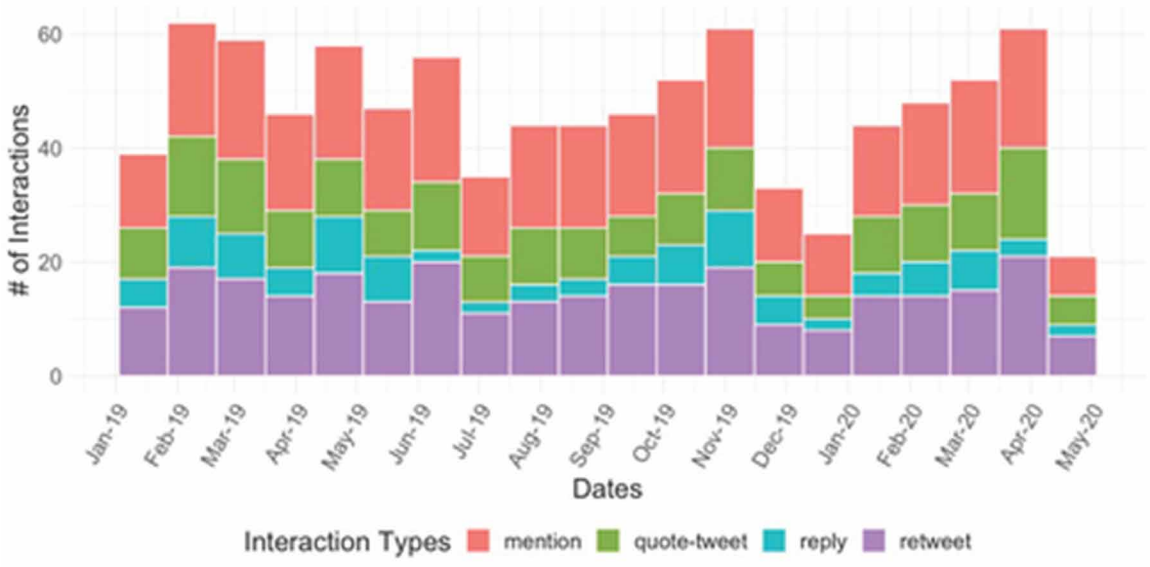
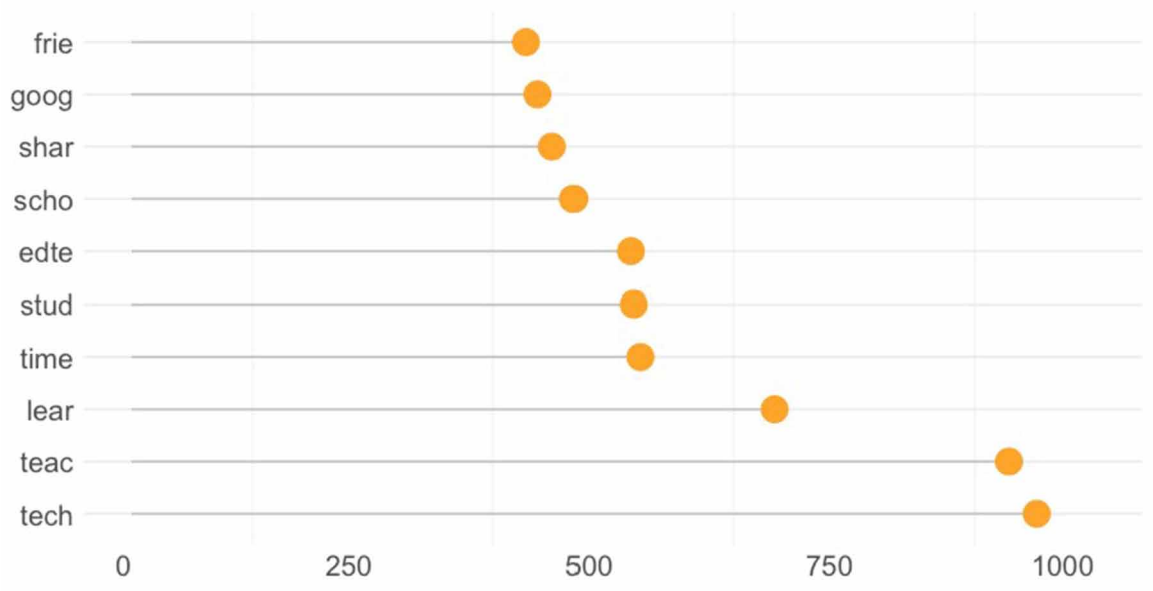


Figure 3. Word Frequency January 2019 - April 2020



evident that the hashtag served some social functions, as indicated by the frequency of the words "share" and "friend" in the most frequently used words.

As it can be seen in Table 1, friend and share were usually used in the context of inviting others to the weekly chats or introducing themselves during these chats. The words school, edtech, student, teach, learn, and tech were contextualized within educational technology where the participants talked about the use of technology for teaching and learning purposes. Google was used to talk about Google-specific tools and apps, and indicates the popularity of Google tools in schools.

In addition to populating the most frequently used topics, we ran a follow-up analysis to see how much the users talked about some of the more technology integration related topics in comparison to topics that relate to the overall design and integration of technology-rich learning. The International Society for Technology in Education (ISTE) publishes various, well-known and accepted standards related teaching and learning with technology. So, we chose some keywords from the ISTE Standards for Educators as well as other more technology-centered words that were frequently used in our corpus: "empow", "construct", "innovat", "design", "computational", "think", "creative", "collabor","technology", "google", "tool", "digital". We observed that most words in our ISTE vocabulary did not frequently occur in tweets tagged with the hashtag of focus, especially some of the more specific words such as "computational" or "constructionism" (Figure 4). In contrast, the technocentric words relating to specific software or hardware more frequently occurred in the corpus.

Finally, to get a sense of the conversation involving the hashtag, above and beyond stand-alone words, we analyzed the context in which the words co-occurred. This analysis gave us a sense of which words were used in the context of the others, enabling us to make some conjectures about the content of the conversation. Using the feature co-occurrence matrix (FCM) created through Quanteda, we created a text network plot. First, using the topfeatures function, we selected the most frequently used 30 words. Next, we created a network plot depicting the frequency of occurrence and co-occurrence (the minimum

Table 1. Sample Tweets for the most frequent keywords in TechTalkGA tweets

Keyword	Tweet
friend	Get ready for tonight's #TECHtalkGA at 9pm (EST), sharing our best WFH tips! **Remember to invite a friend!**
google	#TECHtalkGA A4: Most recently, I've been "teaching" more & more ppl about **Google** Meet, Microsoft Teams, Flipgrid, and Screencastify!
share	Q1: Welcome to #TECHtalkGA! **Share** your name/dist/role and where you were in 2009!
school	#TECHtalkGA A3: I am so incredibly proud to work in @**FCSchoolsGA**! We have some of the best Ts ever, who truly care about Ss; who are working harder than ever to design "qual learning exps" for Ss from afar with ZERO prep! They are amazing!! Never been prouder!
edtech	#TECHtalkGA Q2: What's the number one thing you think Ts need to understand about using **#edtech** in the classroom?
student	#techtalkga A4: I've done the flipped classroom several years, and I'm often asked to speak about it. Just like other tech, a flipped classroom won't fix bad teaching. But, it can be a technique that can turn class time a more **student-centered** environment.
time	You guys! #GaETC19 is THIS WEEK! I'm so pumped! If you are attending, be sure to join in the #TECHtalkGA chat tonight at 9pm to talk about how to get the most out of our **time** at the conference!
learn	#TECHtalkGA A4: Some the recommendations from the authors were things like "keep your lessons engaging" That's easy to say, but difficult to do if you haven't seen it WITH TECH. Be purposeful about how Ss use it. Teach them how to use it to **learn**. Model it for learning.
teach(er)	#TECHtalkGA returns to our normal format tonight focusing on how we support students, **teachers**, and each other! Come share; join the convo at 9pm!
tech(nology)	@iste Regional chat: #TECHtalkGA on Mondays at 9pm! For #ETCoaches, MSs, and anyone passionate about **technology** in education! All are welcome, even if you're not in GA!

threshold was set to .85). In our network plot, the size of the words and the links between them represent their proportional frequency. In other words, if a word occurs more frequently or two words appear in the same context more frequently their text size and link width would be proportionally bigger.

As seen in Figure 5, we were able to group the discourse into three categories: planning, organization, and classroom technology. Organization included conversations such as organizing the synchronous chat hour the next week, while planning seems to focus on planning to attend an upcoming conference (GAETC19), and classroom technology included using technology to teach and learn.

DISCUSSION

With respect to the EPLN framework, our investigation of the data related to research question 1 revealed answers to the questions, *Who are the people in the PLN?,* and *Which spaces are conducive to professional growth?* First, it seems like the answer to the *who* question is that there were relatively few people active in the discussion and the most involved member was the organizer of the discussion. As for spaces conducive to professional growth, it must be noted that the *space* consists of the online discussion utilizing the #TECHtalkGA hashtag, but it may be considered in two parts: the synchronous chat held on Monday evenings, and the use of the hashtag asynchronously at other times of the week. For maximum engagement with the other participants in the PLN, participants should plan to join the chat during its synchronous portion on Monday nights.

Figure 4. Frequency of Combined Keywords in #TECHtalkGA

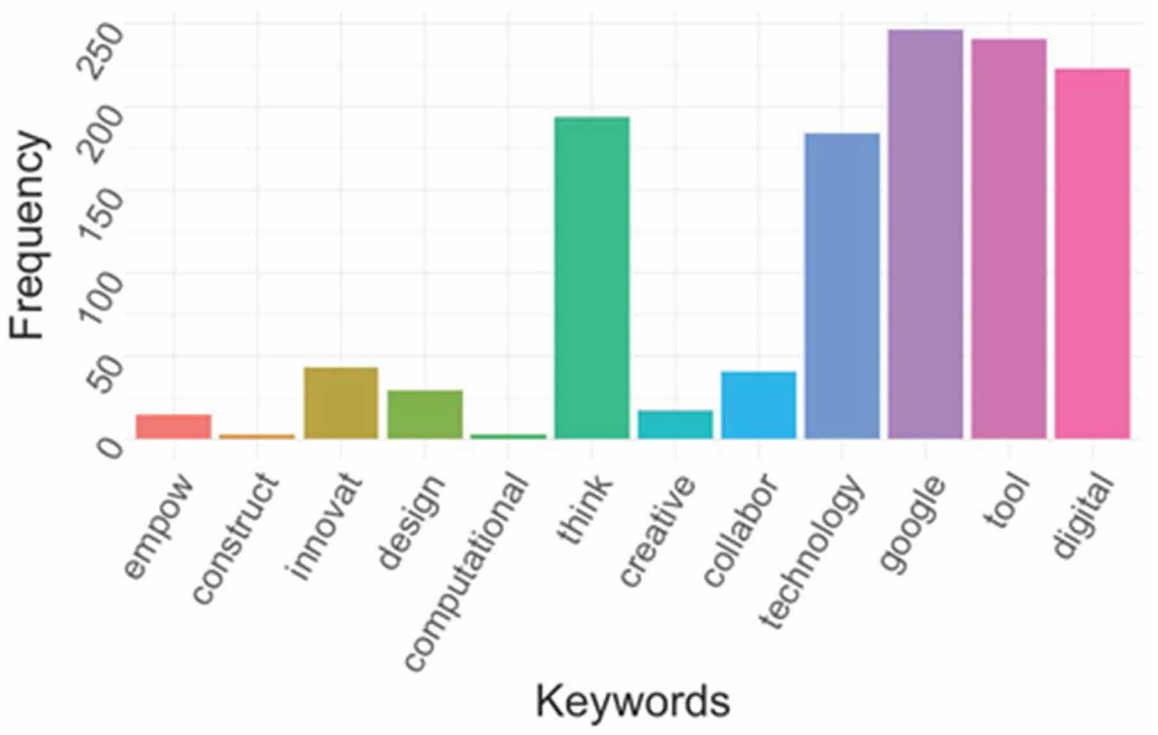
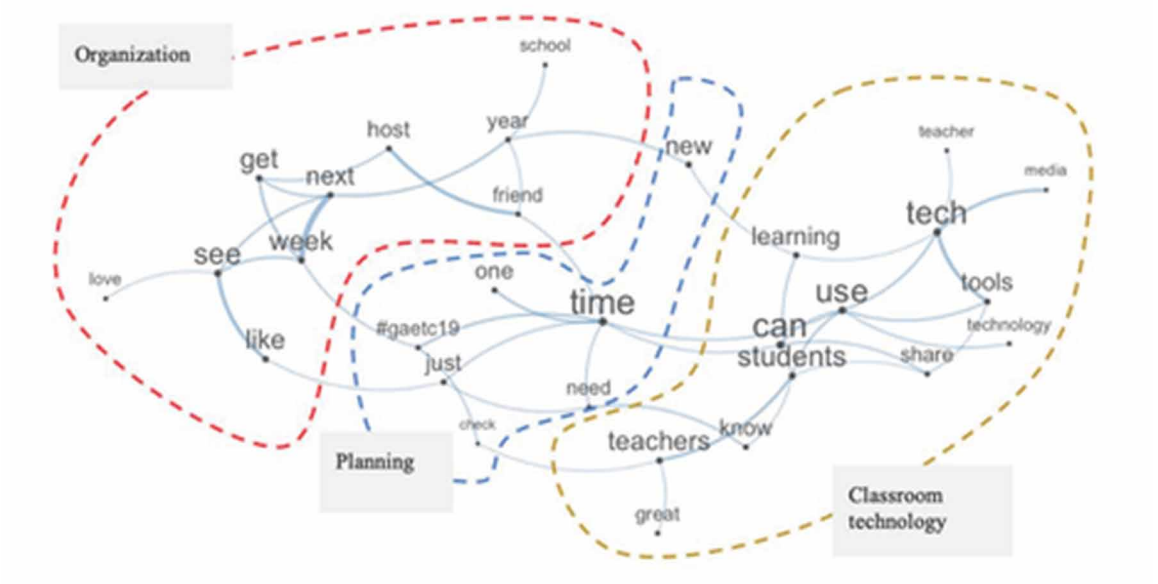


Figure 5. Co-occurrence Matrix



Our observation of seeing a few participants dominating the #TECHtalkGA discussions is consistent with the "low active participation, yet high professional value seems to define the typical Twitter PD experience" observed by (Galvin & Greenhow, 2020, p. 18). We observed in particular that the use of the hashtag was mostly during the typically scheduled Monday night synchronous chats and that there were comparatively lower levels of activity with the hashtag outside of the synchronous chats and on breaks in the school year (i.e. summer). Based on this finding, we can argue that teachers use the hashtag during the school year, and tend to engage more during times that allow for more interaction. As identified by Greenhalgh et al. (2020), there is a difference between the participation during chat and non-chat times in terms of tweets' content (e.g., more work-related discussions during non-chat contexts). The chat and the synchronous communication seem to serve social purposes more, but attract a small number of participants.

In the weekly non-chat contexts we observed that there was a smaller group of individuals who dominated the communication in terms of contributing original content, and active participation in the discussion consisted mostly of retweets or mentioning another user than replies or quoting tweets. This conforms with Greenhalgh et al.'s (2020) findings in that non-chat use of the Twitter hashtags for informal PLN's tend to lend themselves to more passive participation, as well as acts that aim to share and disseminate content. The acts of retweeting and mentioning require less cognitive involvement with the conversation than replying and tweeting, which may explain the frequency of the types of interactions that we observed. The results may also indicate that the majority of users may view the hashtag as a source of information to be read or quickly shared more than a community for active discussion.

With respect to the EPLN framework, our investigation of the data related to research question 2 revealed answers to the question, *What tools are acquired by participating in the PLN?* Our analysis of the content of the conversation showed that the hashtag was centered on technology hardware and software and associated planning and organization for hardware and software, and much less so on concepts related to leveraging the power of technology for student learning. That is, the conversation was most often focused on specific technology products (e.g. Chromebooks or Google tools) instead of established models of technology integration. Still, the observed conversations are clearly within the categories of teacher professional learning observed by Greenhow, Galvin and Staudt Willet (2019) of resource exchange, community building, and individualized needs. This suggest that #TechTalkGA as a PLN platform serves its purpose by allowing its participants to share and disseminate knowledge. The content of the conversation reflects the issues that immediately the teachers have to tackle more than issues that require more deliberation and longer-term planning. Ideally topics regarding issues in educational technology, which would be a focus on concepts of student empowerment, design, creativity, etc., would be covered, more, but our data is valuable in that it reflects what the participating teachers worry about in their day to day teaching. Veletsianos (2017) notes that "the hashtag becomes a tool to serve the needs of its users" (p. 290), and in this case #TechTalkGA's users' needs seem to focus on more technology-use related and practical issues.

Although it is impossible for the authors to gain deep understanding of PLNs mutual engagement, joint enterprise, and shared repertoire (Wenger, 1998) using the digital methods gave us a powerful new way to understand large volumes of conversation happening very quickly and efficiently. Such approaches show promise and will give researchers more analysis power as the software is developed further, especially given the fact that these are open-source and free tools.

LIMITATIONS

This research is not without a few limitations. The major limitations are related to the research methods used. First, it is impossible with the quantitative methods used to know the intentions and desires of the PLN members regarding what they perceive as the purpose of the PLN. The author's interpretations of the PLN discussion were based on their own notions of what the participants should be discussing. Interviewing or survey some participants may negate some of those notions, leading to different interpretations. Also, it is common in Twitter chats to comment and reply with non-text content like memes, videos, etc. These elements were present in the #TECHtalkGA tweets but could not be analyzed with our chosen digital methods, which analyzed text only. The lack of ability to analyze the non-text responses has been noted in previous literature (i.e. Greenhow, Galvin, & Staudt Willet, 2019). While these are viewed as limitations, the chosen methods allowed us to perform analysis on a large dataset that would be practically impossible to analyze in a timely or reliable manner using more traditional approaches to analysis.

CONCLUSIONS AND FUTURE RESEARCH

This paper provides an example of new methods to analyze state-level teacher professional development conversations using digital traces as data and digital methods, gaining some insights into what teachers are discussing and the terminology they are using. All cited resources in this article and software used are open-source and have user-guides as well as well-documented examples. We hope that these methods could easily be applied to other hashtags for other communities of educators. Based on the observations made in the present paper one can determine that at the state-level, teachers will participate in a synchronous Twitter chat organized by a particular hashtag and that they will share information on professionally relevant ideas such as planning, organization, and classroom technology. As Greenhalgh (2020) notes, regional educational Twitter hashtag spaces "are defined by different practices, different social dynamics, and presumably different goals" (p. 18). Depending on the participating teachers' needs and motivations, they may find participation in this or similar discussions to be what Krutka, Carpenter, and Trust (2017) describe with their framework for *enriching professional learning networks*.

Some questions for future research studies worth pursuing would include: What are researchers and teacher educators to do with the observations from the present study? Is it appropriate for them to join this, or similar PLNs, and attempt to drive the conversation to issues they may view as more important? Should teacher professional learning or graduate degrees for teachers use the findings to revise their preparation programs either to focus more on what in-service teachers are discussing, or to determine what concepts are not being discussed and to enhance teacher preparation curriculum in those areas? Would it be beneficial to encourage pre-service teachers to participate in the PLN as a form of informal mentoring and inclusion in genuine conversations as described in Sheridan and Young (2016)? And finally, it would be worthwhile to investigate the teachers' use of Twitter as a PLN during the school closings of the COVID pandemic of 2019, if any, and if they did in what ways they found use for it (socially and academically).

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