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# Informal Professional Development on Twitter: Exploring the Online Communities of Mathematics Educators

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## ABSTRACT

Professional development in its most traditional form is a classroom setting with a lecturer and an overwhelming amount of information. It is no surprise, then, that informal professional development away from institutions and on the teacher's own terms is a growing phenomenon due to an increased presence of educators on social media. These communities of educators use hashtags to broadcast to each other, with general hashtags such as #edchat having the broadest audience. However, many math educators use the hashtags #ITeachMath and #MTBoS, communities I was interested in learning more about. I built a Python script that used Tweepy to connect to Twitter's API, using try/except blocks to catch HTTP status codes that Twitter occasionally passes through the API. When it was finally completed, a sample of such tweets was collected and then processed using Python to determine polarity, objectivity, and word frequency, first as a group and then by choice of hashtag. Additional analysis included Latent Dirichlet Allocation and hierarchical clustering, and conversations between individuals were analyzed for topic and complexity to understand the extent of interactions. This information will be used to determine the extent of professional development (PD) that teachers do on Twitter simply by actively participating in such communities and ways to improve informal PD. It was determined that there is a significant amount of professional development opportunities on Twitter, but they are muddled by a lot of other content. Further research into the types and the frequency of collaborations on top of the existing latent topics could provide insight into the applications of informal professional development.

## 1. INTRODUCTION

Professional development (PD) for educators is an ever-changing practice, with the rise of technology changing how teachers and students alike learn. Twitter is one example of such technology that has become a data-rich resource; it plays a surprising role in professional development outside of the classroom due to its growing communities of educators that collaborate and share resources. These educators are using social media, specifically Twitter, to share resources and information in ways different from traditional professional development. While there are many general education communities on Twitter for collaboration and PD such as #edchat, for this project, the focus was kept on the mathematics education communities in particular for several reasons. First, approaching professional development for mathematics educators is different from other areas of professional development, and furthermore, mathematics communities have been noted to have a high amount of information sharing in comparison to overall content. (Forte, Humphreys, & Park, 2012) Applying Twitter to the mathematics education community, there are many opportunities for professional development, collaboration, and support on social media. Specifically, on Twitter, there

are two math education communities that I wanted to analyze by content and users. Such math communities use the hashtags #MTBoS (Math Twitter Blog-o-Sphere) and #ITeachMath. Research into these communities is important to understand how teachers are collaborating outside the classroom and how professional development can be turned into an everyday opportunity for educators.

## 2. LITERATURE REVIEW

Many research projects have been done following Carpenter and Krukta's publication on the dynamics of teachers on Twitter. They noted that "Twitter potentially offers PD opportunities that differ from traditional approaches because it is immediate, is personalized, and can draw on networks that are less restricted by time and place" (Carpenter & Krukta, 2014). Collaboration between educators is more personal on Twitter than in classrooms because it involves experiences from instructors outside of their institution. According to research done by Lisa Chamberlin and Kay Lehmann, "Twitter involves higher learning beyond just standard teacher/student interaction. Faculty can reach out to other faculty (both within their own institution and around the globe) for brainstorming...

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As a macro tool, disseminating messages to others outside their own institution's brick and mortar encourages a community of learning to continue beyond the scope of the content" (Chamberlin & Lehman, 2011). These Twitter communities encourage the diversification of education practices by connecting educators who would not have the opportunity to collaborate in person; it opens each educator up to new resources and perspectives that they would not get from traditional institutional professional development. It also enables the teachers to try new things in the classroom, whereas traditional professional development in the form of summer classes is easily forgotten by the time the classroom setting occurs in the fall. Furthermore, it increases the number of people reached by using hashtags, which are

### 3. MOTIVATION

While many researchers have discussed the PD of educators as a whole on Twitter, fewer studies have been done into math educators specifically. It is the combination of this, along with the fact that data mining is an excellent area to strengthen skills, that piqued my interest. Learning how to do this would be useful for me because it opens new career possibilities to consider and learn about as working with REST API's is a skill that is applicable in almost any field due to the fact that it can be used by almost any business to understand consumer interactions and target markets. This learning opportunity combined with my passion for mathematics and personal interest in math education made this research perfect for me.

### 4. METHODOLOGY

#### *Understanding the Twitter API*

Twitter uses an API (Application Programming Interface) that allows developer accounts, or clients, to communicate with it and send requests. The API is a Representational State Transfer (REST) API, which means that the state of the server as well as requests are driven by the client. My client, as well as all clients, was made using a developer account. This grants credentials to your client to access the Twitter API, through which requests can be made.

#### *Creating a Twitter Stream*

After researching various Python libraries that streamline access to the Twitter API, I decided on using a library named Tweepy due to its widespread use and myriad resources. Before using this new library, I familiarized myself with the documentation, then began coding a program to stream tweets that filtered for the hashtags #ITeachMath and #MTBoS. These tweets were saved to a CSV file (CSV) with minimal metadata to be used later. It was imperative to not do too much to the tweets as they were being saved due to the risk that the connection would be closed due to an overload of requests (the stream getting backed up due to a high number of tweets). Therefore, I wrote a separate program that hydrated the tweet (using the tweet ID, retrieved all metadata of the tweet from Twitter) using tware, another Python library that interacts with the Twitter API, recursively searched for replies to the tweet, and placed the

full tweet object (returned by API as a JSON object) in a CSV with all its information. Furthermore, the entire dataset of tweets was analyzed for subjectivity, content, polarity, and word frequency. The original CSV was also sent through a program that created an edge list based on user ID and the user IDs of their followers. This edge list was used to create a social network graph to understand some basic statistics (for example, graph diameter, average path length, and the ratio of edges to nodes) of the communities and to determine the differences between them.

#### *Sorting the Twitter Data*

The tweets collected through the stream varied largely on topic but were generally one of several types: questions, amplifications, replies, opinions, and original posts. A program that was written in Python opened the CSV containing the streamed tweets, sorted the tweets into three categories: original tweets, retweets, and reply tweets (conversations), and quantified information about the tweets into graphs as seen in Figure 3. Furthermore, the tweets ran through a hashtag classifier to put the #ITeachMath and #MTBoS communities into separate CSVs and turned it into qualitative data, as seen in Figure 3. Another program that used Latent Dirichlet allocation and hierarchical clustering was used to determine the topics of tweets.

#### *Conversation Data and Treeverse*

Conversations captured in the data set were indicative of many things. Using Treeverse, a plugin that brings Twitter conversations to life, I was able to visualize several tweets that had a high number of responses. The tweet with the most replies in this data set was one by @Exemplars, which stated "We're going to help some #teachers #clearthelists today! Follow us and share your list with us, and we'll select a few teachers to support today and tomorrow! #support\_a\_teacher." Many of the responses to this tweet did not lead to a conversation (Most likely because it was more of a "contest" than a discussion-initiating tweet). However, another tweet by @brielliephant, asks "#iteachmath I am really trying to stress that I want to see and hear student thinking and trying to denormalize cheating. Does anyone provide answer keys for all practice so students can self assess and self correct? It eliminates the idea that the right answer is most important." It drew 35 responses, and as seen in Figure 2, many of the subsequent responses initiated a conversation. For example, one user wrote "@Brielliephant I have an answer bank. [Students] Ss know that their work must lead to the answer and answer must be found in answer bank. Really gets Ss invested in process and realizing when they need help," and another user wrote "@Brielliephant I post all my answer keys online and Ss follow a procedure similar to the in in D. Bruce Jackson's article "Homework Sandwich." Students grade it with a check (got it on 1st try), X (got it on 2nd try) or ? (I still have a question). The X has some stigma though, may change it." Such conversations are exactly what I was looking for because that is the type of collaboration and resource sharing I was interested in finding.

### Analysis of the Data

After running the set of tweets through a program for basic content analysis, it was clear that #MTBoS is used more for questions and other content while #ITeachMath is used more for blog posts and general discussion, indicated by its percent in overall tweets in Figure 3. Also seen in Figure 3, a clear comparison of both communities was made as well as the case where both hashtags were used. It can be inferred from these pie charts that the network using both hashtags is best for amplification of a tweet because the percentage of retweets is significantly higher in this network than #MTBoS and #ITeachMath communities. From there, the data set was run through another program that created an edge list to build a sociogram in Gephi. The communities are organized in very dense sociograms, with the network of individuals using both hashtags being denser while both the #MTBoS and #ITeachMath networks have a large number of smaller clusters with connections to other groups within that network. Since the tweets were already quite specific in their content (math-related), it was difficult to put an exact label on the Latent Dirichlet Allocation method of determining topics. However, some relevant keywords in the four most frequent topics included: 1, "awesome", "fraction", and "cool"; 2, "thank", "question", and "solve"; 3, "year", "great", and "school"; 4, "classroom", "good", and "resource". As one can tell, these words make it difficult to put a precise label on any one topic. Figure 1 also demonstrates the polarity and subjectivity of this set of tweets, with the mean of the polarity being approximately between 0.00 and 0.10 and the mean of the subjectivity being approximately between 0.00 and 0.20, indicating a rather objective and emotionally neutral data set. To summarize, there is a significant amount of informal professional development on Twitter, but it is apparent that it is muddled with retweets and other types of tweets, such as blog posts.

### 5. FUTURE WORK

Research following this project should focus on how to use this research in connection with professional development -- be it ways to improve institutional professional development by using the online informal professional development as an example or determining what topic is the least or most engaging in each network and using that information to begin new discussions. There is a lot to be gathered from the conversations between educators on Twitter, and I have only scratched the surface. A deeper analysis into the most popular discussion topics, the quality of these conversations, and the available support system for new educators would give further insight into the behavior and classroom practices of these teachers, which could then be used to change the traditional professional development courses that are impersonal and sometimes ineffective. Furthermore, this topic can be expanded into other areas of social media to see which platform educators collaborate on most frequently and also which platform has the most opportunities for quality PD.

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### 7. FIGURES

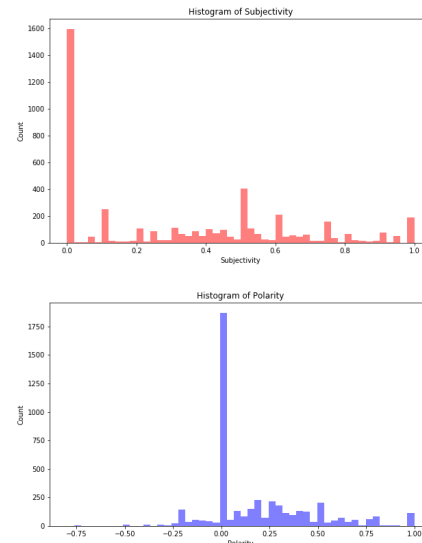


Figure 1. In a sample of tweets, the subjectivity of the tweets was fairly objective, with 0 being objective and 1 being very subjective. The polarity of most of the tweets were fairly neutral, with -1 being very negative and 1 being very positive.

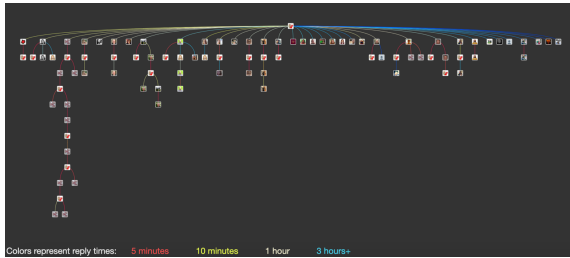
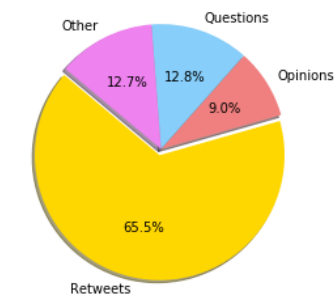
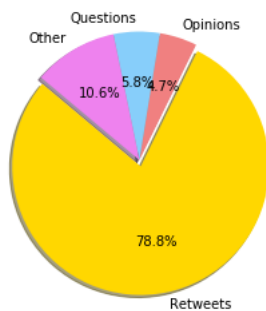


Figure 2. This tree diagram represents a conversation through Treeverse, a program that retrieves all replies to a tweet and colors by response time. It is clear that the conversations have great depth as many of the children have at least one child, or "reply." There are many factors that can contribute to the quality of the conversations, but it is apparent that there is a correlation between conversation depth and the topic of the initial tweet.

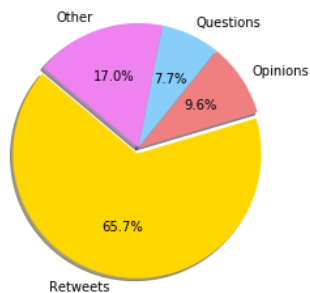
However, as seen in the #MTBoS pie chart, a greater percentage of such tweets are questions instead of opinions, while the #ITeachMath pie chart demonstrates a greater number of opinion-based tweets instead of questions. From this, it can be inferred that in a general sense, the #MTBoS community is used more for questions, while #ITeachMath is used more for blog-type posts and general discussion. It can also be drawn that the network using both hashtags is best for amplification of a tweet because the number of retweets is significantly higher in this network than #MTBoS and #ITeachMath communities.



Pie chart of tweet types using #MTBoS



Pie chart of tweet types using both hashtags



Pie chart of tweet types using #ITeachMath

Figure 3. In the same sample of tweets, which were divided by hashtag, the data set consisted mostly of retweets.