

FEATURE: CROWDSOURCING

Microblogging in Open Source Software Development: The Case of Drupal and Twitter

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// Microblogging is a popular form of social media that has quickly permeated both enterprise and open source software development communities. However, how exactly open source communities can leverage microblogging isn't yet well understood. //

SOCIAL MEDIA HAS become an important means of communication in modern society, as evidenced by the widespread use of wikis, blogs, and social networking sites for both personal and professional purposes within organizations. Among the different social media, a significant one is microblogging.¹ Originally intended to provide brief personal text updates, it has rapidly expanded to play a more informative and interactive role in communication and collaboration across a wide variety of organizations and endeavors, including software development.^{2,3} Most studies of microblogging have focused on enterprise settings, with one in particular focusing on various types of interactions such as asking questions, sharing information, coordinating, and broadcasting updates.⁴ The prospect of integrating microblogging tools into software development environments seems especially promising.^{5,6}

Microblogging is used extensively in open source software (OSS) communities, but that usage hasn't been studied in-depth.⁷ To help OSS communities steer their microblogging efforts toward an optimal utilization, we investigated microblogging's current use in OSS development. Specifically, we looked at microblogging in the Drupal OSS community, with its more than 17,000 globally distributed developers. Drupal is a popular, award-winning content management system that has more than 10 years of history and seven major releases. In contrast to enterprise settings that use microblogging tools such as Yammer, StatysNet, Communote, and Present.ly,⁸ the Drupal community has used Twitter since 2007 (see the "What Is Twitter?" sidebar).



Research Approach

To understand how Drupal developers use and benefit from Twitter, we conducted an exploratory case study that analyzed both Drupal's group Twitter accounts and several of its developers' individual accounts. The group accounts helped us understand the community's collective use of Twitter, whereas the individual ones showed us how Drupal's developers use Twitter in their daily activities. Given the large Drupal developer community, we focused on the subcommunity that works on Drupal 7 (D7), a recent branch that's Drupal's self-proclaimed "best work yet" (<http://drupal.org/drupal-7.0>). The process chain in Figure 1 shows D7's release timeline.

We included all 10 Drupal group Twitter accounts listed on the Social Media Directory webpage in the Drupal portal (<http://drupal.org/social-media>). For individual accounts, we obtained a list of 206 D7 contributors in 2008, when D7 was still in its main development phase (this number increased to more than 400 at the time of this study in 2012; our data comes from www.knaddison.com/drupal/drupal-7-who-providing-patches-next-release). We used the Drupal Member Directory to find these contributors' Twitter account names (<http://drupal.org/profile>). All but one of the 141 developers we found on Twitter had created their accounts before January 2011 (the first official D7 release). To make the study feasible, we selected the Twitter accounts of 12 developers who committed the most to the D7 code base according to <http://cran.r-project.org/web/packages/twitterR/index.com>, plus the two coordinators' accounts. (A coordinator in Drupal is a "cat herder" who



WHAT IS TWITTER?

Twitter is a well-known implementation of microblogging that started in April 2006. Twitter messages, called "tweets," have a maximum length of 140 characters. Relationships between people with a Twitter account are unidirectional, meaning that one user can "follow" another, but the followee doesn't need to "follow" back the follower.

All tweets are public by default, although it's possible to "protect" tweets by making them visible to selected users only. Messages can be directed to a particular person, by prefixing the recipient's username with an "@" sign. Interesting tweets can be "retweeted" (RT), so the original tweet can reach a wider audience. People can "like" a tweet by clicking the "favorite" link associated with each tweet.

Tweets can be "tagged" using hashtags to highlight a topic. For instance, people tweeting about "microblogging" could put the hashtag "#microblogging" in their tweet. Users can then find any instance of that hashtag by searching for it.

A Twitter account can belong to either an individual or a group of people, even though it's always represented by a single Twitter name. By group account, we mean a Twitter account maintained by a group of people; individual accounts are owned by an individual user.

helps get as many new contributors as possible; drupal.org/user/24967.) They're the core developers and constitute the most active part of the D7 development community.

In keeping with an existing study of OSS community blogging,¹⁰ our analysis focused on two aspects: Twitter usage and Twitter content. To understand Twitter usage, we analyzed quantitative information on the selected Twitter accounts, including number of tweets, frequency of tweeting, and number of followers/followees. To determine the nature of communication via Twitter, we analyzed a collection of tweets from the selected Twitter accounts. First, we retrieved the tweet contents from our studied accounts using the `twitterR` package via the statistical data-mining tool R (www.r-project.org). This pack-

age extracts tweets through Twitter's API. In total, we retrieved 12,167 tweets from both the group accounts and the selected D7 developers' individual accounts. Because we focused on D7, we decided to restrict the time range of tweets from July 2008 (release of the first development snapshot of D7) to January 2011 (the first official release of D7), which covers D7's main development phase of D7 (indicated in Figure 1). We filtered the retrieved tweets using four keywords—"drupal 7," "drupal7," "#d7," and "(space)d7(space)"—to exclude tweets that aren't explicitly related to D7. This resulted in a total of 568 tweets from 16 out of the 24 studied accounts, 363 of them from 10 individual accounts. (We admit that filtering tweets using these keywords might have inadvertently excluded

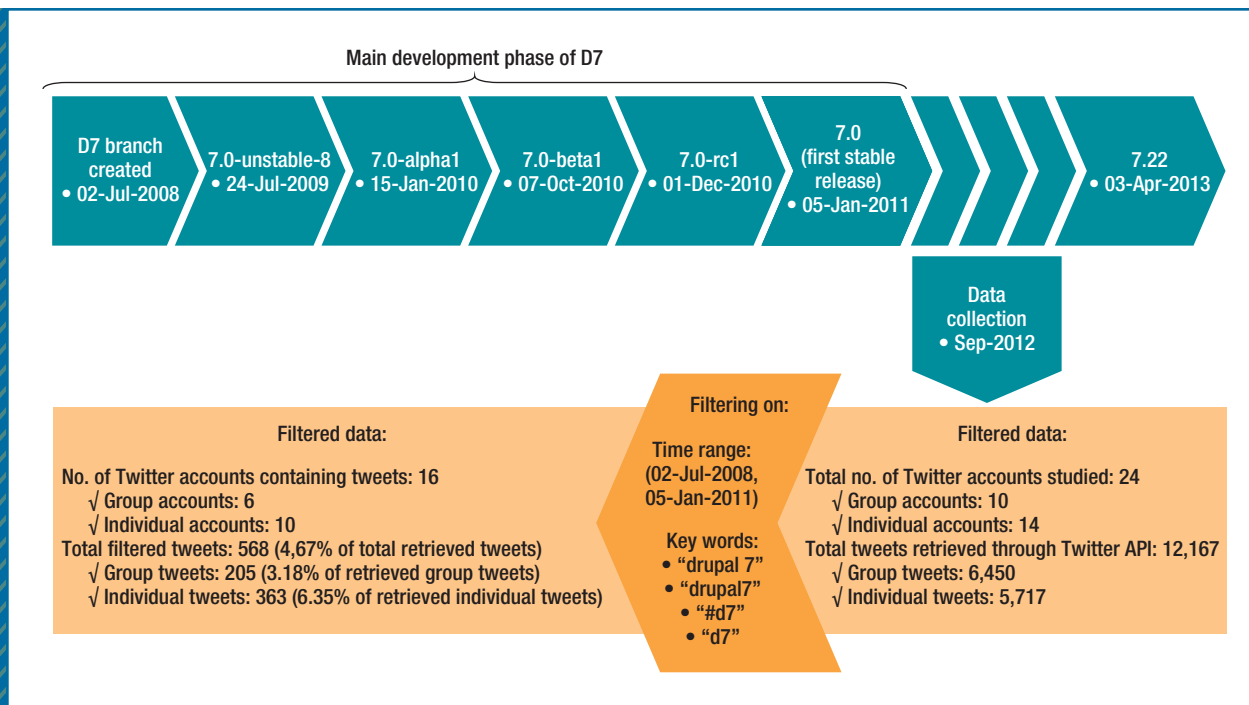


FIGURE 1. The D7 release timeline and our data collection process.

any tweets that don't contain them but could be D7 related. The 568 tweets therefore represent the minimal amount of D7 tweets.)

Next, we analyzed these D7-related tweets via a coding process, with one of us acting as the main coder and another checking the coding. We used the interaction types as a set seed categories^{4,8} and classified each tweet into one or more categories. As we coded the tweets, new categories emerged for the tweets that didn't fit any of the seed categories; the tweets already coded were then revisited to check if they would fit any of these new categories. For instance, one new category is “express sentiment.” Based on this finding, we manually conducted a sentiment analysis and further categorized those tweets in terms of “positive sentiment” and “negative sentiment.” We also ana-

lyzed the “retweet,” “favorite,” and “@” (directedness) properties of all tweets to understand the responses generated by them in the Twitter sphere. As a final step, through a process of synthesizing the categories, we identified several higher-level themes.

The Drupal Community's Twitter Usage

Table 1 lists the Twitter usage of the Drupal community represented by the selected accounts (sorted by creation date). As shown, most individual Twitter accounts (86 percent) were created between 2007 and 2008. Considering that Twitter started in 2006, this suggests that D7 contributors were early Twitter adopters. The group accounts were created much later; most (80 percent) were created after 2008. Both group and individual accounts are active in

terms of the number of accumulated tweets and the tweeting frequencies (tweets per month).

Some group accounts provide a constant and steady stream of tweets (such as @drupal or @drupalplanet), while others with specific purposes (such as @drupalcon) have tweeting “peaks” that generally occur during major events, such as a new version release or a Drupal conference. (The graphics at http://figshare.com/articles/Drupal_Group_Twitter_Accounts_Tweets_Frequency_Diagrams/748791 show the tweeting frequencies of the 10 Drupal group accounts.) D7 contributors usually have stable tweeting behavior. Generally speaking, the developers' tweeting frequencies are higher than those of group accounts. However, developers tweet not only about work but also about their personal lives. Table 1 also

TABLE 1

An overview of the studied Drupal Twitter accounts.

Account name	Function/role	Creation date	No. of followers	No. of followees	No. of tweets	Tweeting frequency (tweets/ month)
Group Twitter accounts						
@drupal	Main Drupal account	25-Mar-07	33,889	173	1,382	21.3
@drupalcon	Drupal Conference account	26-Feb-08	9,499	2,027	4,339	78.9
@drupalplanet	Drupal related announcements (code, infrastructure, etc.)	19-Feb-09	7,443	3	5,602	130.3
@DrupalAssoc	The Drupal Association's official twitter account	19-Feb-09	6,248	7	588	13.7
@drupal_infra	General information about Drupal infrastructure	02-Apr-09	1,264	1	64	1.6
@drupalsecurity	Republish Drupal Security Advisories & related news	24-Apr-09	2,066	31	394	9.6
@drupaldocs	Updates from Drupal documentation team	16-Jul-10	1,103	377	297	10.6
@drupalcore	Drupal core major happenings and opportunities to contribute	24-Aug-11	3,393	0	130	10.8
@drupal_org	Drupal.org development team	01-May-12	826	4	99	19.8
@drupal8changes	All change records for Drupal 8 core	15-May-12	677	0	94	18.8
Individual Twitter accounts						
@dries	Coordinator, Drupal founder	06-Mar-07	19,688	8	6,689	99.8
@drewish	Developer	10-Mar-07	1,086	121	2,059	30.7
@dave Reid	Developer	14-Mar-07	2,273	667	14,575	217.5
@webchick	Coordinator, core developer	29-Apr-07	8,094	1,269	3,218	48.8
@DamZ	Developer and drupal.org administrator	02-Jul-07	1,608	41	1,251	19.9
@gaborhojtsy	Core developer and module maintainer	31-Jul-07	2,619	165	5,924	94
@weitzman	Migration engineer and developer	31-Jul-07	2,370	112	1,056	16.8
@Catch56	Developer	01-Mar-08	1,205	254	1,104	20
@RobLoach	Developer	02-Mar-08	1,349	399	2,402	43.8
@chx	Edge case engineer and developer	11-Apr-08	2,832	99	7,986	147.9
@Arancaytar	Developer	25-Jul-08	91	167	2,112	41.4
@joelfarris	Technical product manager and developer	07-Oct-08	479	274	5,028	104.8
@boombatower	Testing subsystem maintainer and developer	13-Jan-09	182	4	134	3
@Crell	Developer and database system maintainer and architect	21-Feb-09	2,230	135	13,523	307.3

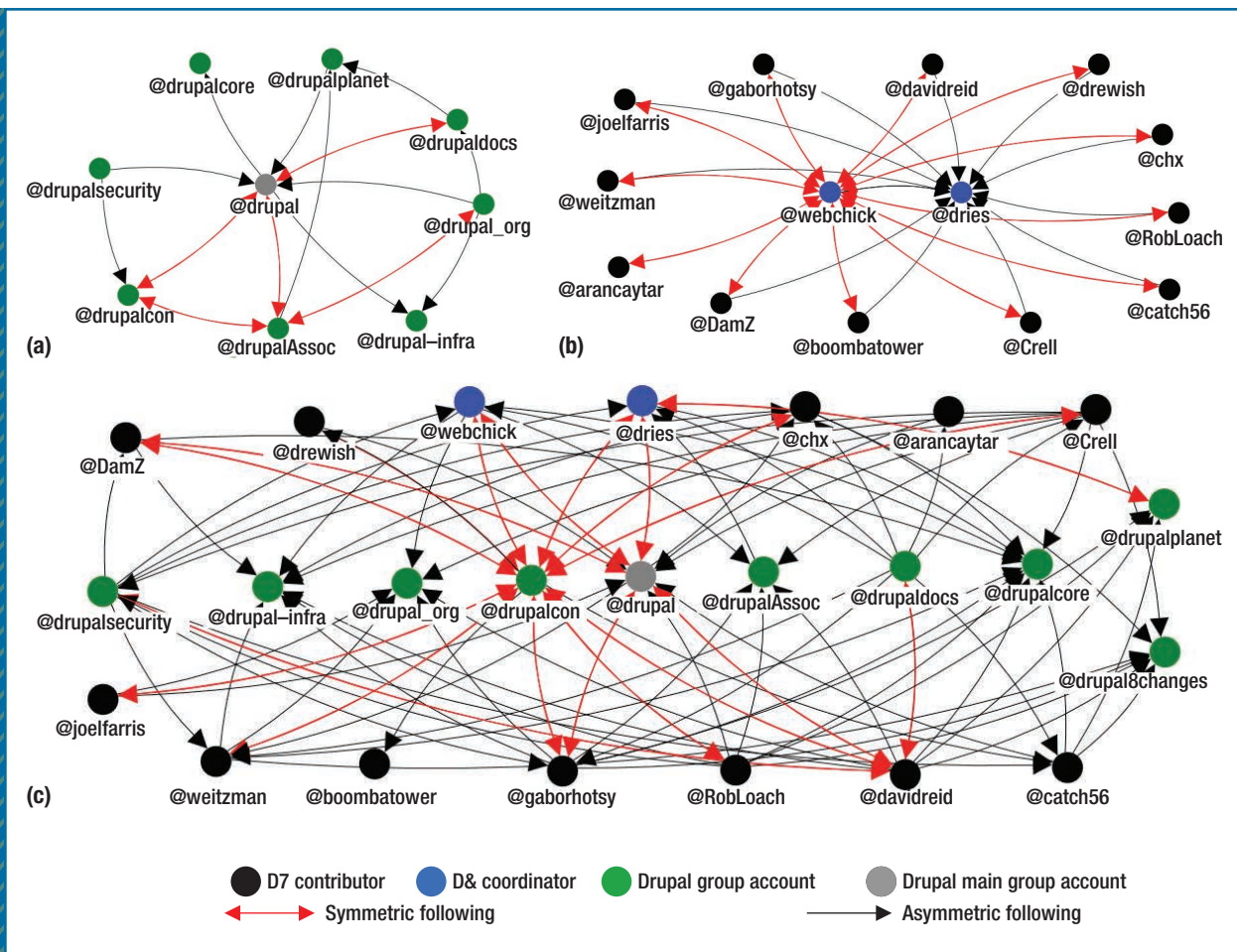


FIGURE 2. The “following” links among the selected Twitter accounts: (a) following within group accounts, (b) following between the two coordinators’ accounts and the other individual accounts, and (c) following between the group accounts and the 14 individual accounts.

shows that group accounts have large numbers of followers but don’t follow many other accounts, except for @drupalcon and @drupaldocs. The developers’ individual accounts likewise have larger numbers of followers than followees.

Figure 2 illustrates the “following” linkages within and between the group and individual accounts, a close look at which can reveal the underlying communication structure in the Drupal community and information flow via Twitter.

Figure 2a shows that the following linkages within the group accounts are loose—few of them are symmetric, and @drupal, the most-followed group account, is the central node of the network. The figure doesn’t show isolated group accounts (those that don’t follow and aren’t followed by other group accounts). In comparison, the D7 developers’ accounts are much more closely linked through the following relationship, many of which are symmetric. Figure 2b focuses on

the links between the two D7 coordinators and the other 12 developers. The difference between the two coordinators is evident: @dries, followed by all, follows no other members; and @webchick follows everybody and is followed by everybody except @dries. We can argue that the social network formed by this structure suggests different roles played by the members in the community. In this case, @dries is a leader, and @webchick is a manager.

Figure 2c shows that there are also close linkages between individual and group accounts. Most developers follow at least one group account. On the other hand, some group accounts follow D7 developers, too. Therefore, some symmetric following links are formed. @drupaldocs (the documentation team) is the only group account that none of the D7 developers follow.

D7 Twitter Content

Our analysis of D7-related tweets shows that some group tweets follow a unified format and others have a more personal touch. But generally, tweets from the group accounts are impersonal and informative. In contrast, the D7 developers' individual tweets are more versatile, interactive, and revealing of the affective states of developers. Table 2 is an overview of the findings from our analysis of D7 Twitter content.

Majority of Tweets Contain URLs

More than half (53 percent) of the individual tweets and 87 percent of the group tweets contain Web links to project-related information, issues, or discussion. Group tweets containing the links are usually generated automatically by the Twitter service embedded in various Drupal-related systems. For example, the tweet below was automatically generated by the Drupal community website and contains a URL pointing to it:

"Drupal Front Page: How we will make Drupal 7 simple to use <http://ow.ly/1NJ7>" @drupal 01-Apr-09.

Most of the links direct followers to different parts of the Drupal.org community website, as well as other Drupal-related websites; other tweets point to Drupal developer blogs or

TABLE 2



Findings from the D7 Twitter content.

Key themes	Percentage of group tweets	Percentage of individual tweets
Tweets containing URLs	87%	53%
Tweets providing updates	53%	30%
Crowdsourcing tweets	8%	6%
Tweets expressing emotions	6%	40%
Tweets as thank-you notes	2%	7%

D7-related websites. These web links, serving as information pointers, constitute an information map of the project that anybody can explore or interact with. For example, some of the information pointers in the analyzed tweets contain references to issues in Drupal's issue tracker (<http://drupal.org/project/issues>). Registered users can comment on an issue through the tracker's website, while unregistered users can comment by replying to the tweets directly.

Positive Emotions Are Openly Shared

Besides pointing to information sources, many tweets announce upcoming events and provide updates of projects, tasks, and developer status. In our set of sampled tweets, about a third (30 percent) of individual tweets and half (53 percent) of group tweets provide D7 updates.

What makes these update-oriented tweets from individual accounts interesting is that they also display the developers' personal emotions and feelings intertwined with the tasks they work on. Most of these tweets convey positive emotions with respect to the results that have been achieved; these are often retweeted or marked "favorite" by followers. For example, when the first release of the D7 series came out, five of the

developers listed in Table 1 tweeted about it, such as @webchick:

"#Drupal 7 is now out! Friendly and powerful #opensource #CMS so awesome it won't fit in 140 chars. Try it! <http://drupal.org/7>" @webchick, 05-Jan-11.

This was retweeted by 255 of her 8,094 followers (including @dries) and favorited by 18 of them. The retweet from @dries was further retweeted by 80 of his followers. He also tweeted twice about the new release directly, and the two tweets were retweeted 111 and 103 times, respectively.

We found very few arguments or negative feelings expressed in the tweets. From our sample, only two tweets could be considered to express any negative tones, and they weren't retweeted.

Crowdsourcing Appeals Spread with "Motivational Sparks"

Another important use of Twitter we identified is to broadcast "crowdsourcing" appeals for completing tasks (6 percent of individual tweets and 8 percent of group tweets). Tweets don't directly delegate or assign tasks to specific individuals. The targeted audience is usually the community and general public.

The crowdsourcing tweets often come from the two coordinators, especially @webchick. In contrast to the general calls for help from group accounts and other individual accounts, @webchick's crowdsourcing tweets are often combined with

personal tweets. However, within our dataset, we didn't find evidence that these crowdsourcing tweets have actually reached any potential volunteers and elicited responses from them. Therefore, Twitter's efficiency

retweeted as they're usually directed to a specific community member.

Twitter and OSS, So What?

Our study shows that Twitter can support developers in open source communities in several ways.

Twitter externalizes tacit knowledge, saves it persistently, and makes it publicly available.

short but motivational phrases to encourage participation:

"Attn #drupal people: Core hack sprint tomorrow on IRC! Help D7 be more kick-ass, learn new tricks, and have fun, too! :) #ireviewdrupal" @webchick, 07-Aug-09.

This fits her role as an active manager, as Figure 2b shows.

Some crowdsourcing tweets are retweeted by followers, spreading the calls for help further. For instance:

"Ok, folks! We're about 24 hours away from #Drupal 7.0. Please git clone git://git.drupal.org/project/drupal.git and test! :D" @webchick, 04-Jan-11.

This was retweeted by 61 of @webchick's followers, including @dries, whose retweet was in turn retweeted by another 61 of his followers. Crowdsourcing tweets from the group accounts seemed to attract less attention. Very few of them were retweeted, and only by a few followers (usually one to five). This suggests that personal appeals for contributions have more im-

act than the less personal group tweets. However, within our dataset, we didn't find evidence that these crowdsourcing tweets have actually reached any potential volunteers and elicited responses from them. Therefore, Twitter's efficiency

Contributions Are Often Appreciated with Explicit Thank-You Notes

Tweets are also used as thank-you notes (7 percent of individual tweets, 2 percent of group tweets), either directed to specific persons, groups of people (using hashtags such as #drupalchix for Drupal's female developers), or a general audience:

"Much to be done yet, but thanks so much to everyone who's helped on the D7 docs up to the launch, you rock! #rockthedocs #drupal" @drupaldocs, 05-Jan-11

One interesting aspect of these tweets is that these thank-you notes often include a URL to the contribution:

"Drupal 7.0 article in @LinuxJournal: <http://bit.ly/id42qQ> Thanks @katherined!" @dries, 05-Jan-11.

This way, the names of contributors as well as their concrete contributions are shared with the community. Such tweets aren't often

Information Radiator

Twitter can serve as a virtual information radiator for an open source community. When a community grows more connected through Twitter use, the distribution of information within that community should become quicker, minimizing misunderstandings between colleagues who don't meet face-to-face very often if at all.¹¹ Both the group and individual tweets contain the latest updates as well as links to relevant information sources. Furthermore, information is spreading efficiently through retweeting, which generally happens within the first hour of the original tweet being published.¹² A distinctive characteristic of the OSS development model is that developers are dispersed and work asynchronously. Therefore, work must be visible to distributed members to facilitate development. Our study shows that Twitter makes the Drupal development process more transparent through constant streams of updates of the project's progress.

The majority of analyzed tweets contain URLs that point to artifacts that developers have worked on. These include several aspects of the development process, such as submitted requests and changes, crucial decisions, important milestones, or even team retrospectives. This pervasiveness of URLs is also reported to be important by Github, another open source project.¹³ This facilitates easy traceability of an ar-

tifact's development history, which in turn helps us understand its evolution. The Drupal community's use of Twitter demonstrates an effective way of making these URLs more accessible to a wide audience.

Knowledge Preservation

Knowledge preservation is another significant role of Twitter. While spoken communication and chat tools such as IRC (Internet Relay Chat) are "mostly fleeting and not useful as a durable process of knowledge sharing and further development,"⁶ in Drupal's case, Twitter externalizes tacit knowledge during informal communication, saves it persistently, and makes it publicly available.

This is particularly significant for "lurkers." Both the group and individual developers' accounts attract large numbers of followers, many of whom can be potential contributors, if properly motivated and given the right access to the community knowledge base. Twitter provides another channel to access to the community knowledge base in addition to forums, mailing lists, and so on. Meanwhile, crowdsourcing tweets can suggest areas where contributions are most needed at any one moment. The motivational phrases in these tweets encourage potential contributors to join and become part of the community. Microblogging as a crowdsourcing mechanism hasn't received much attention in previous studies,¹⁴ but we found clear potential for it.

Self-Organization Facilitator

Twitter facilitates an effective self-organization of developers. In enterprise microblogging, "coordinating others" is the second largest interaction type after "providing updates,"²⁴ which implies that communication via enter-

prise microblogging influences what other team members do. In our study, however, we didn't find directed tweets to assign/delegate tasks to a developer directly. While some community members play coordinating roles (such as @dries and @webchick), they aren't there to grant "commit bits to repositories before you can do work,"¹³ or to approve releases.

Our analysis supports the "cooperation without coordination" model common to many OSS projects.¹⁴ Coordination in OSS projects is often through a self-organizing process of task selection.¹⁵ Our study shows that Twitter's coordination value, if any, is minimal, perhaps due to its broadcasting nature and limited message length.¹⁴ Therefore, we argue that Twitter shouldn't be stretched to support interactions such as coordination that requires more media-rich communication channels.


Positivity Spreader

Distributed software developers feel more connected to each other when they're able to share not only activities but also their mood.¹⁶ Drupal team members use Twitter to fulfill this purpose. Tweets from the Drupal community are much more emotional, which is distinctively different

they tweet about their work. However, community developers seem to refrain from both tweeting and spreading tweets with negative tones, focusing instead on spreading positive emotions. The frequent thank-you tweets also contain positive messages that help motivate developer involvement in the community, offering member recognition and a sense of achievement or belonging to a community. This is an important and relatively easy way for community members to maintain their social bonds.¹⁴

Due to our limited sample, we provided only a partial view of the tweeting phenomenon in the Drupal community here. It remains to be seen whether other OSS communities demonstrate similar microblogging behaviors: it isn't clear how effective Twitter is compared to other communication media commonly used in OSS communities, such as mailing lists, forums, and IRC. It's also intriguing to see how often and voluntarily developers use Twitter as a sideline, and what factors influence their microblogging behaviors. While more research is needed to better understand these and other questions, our study

Crowdsourcing tweets can suggest areas where contributions are most needed at any one moment.

of Drupal clearly demonstrates how microblogging can support a large distributed software development endeavor. Microblogging could reshape the way people collaborate and engage in software development. 



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