What Drives User Contribution in an Online Community? A Study in Contributor Influence and User Status

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ABSTRACT

Online communities (OC's) depend on shared interests and user interactions mediated by technology. Successful OC's find ways to encourage these interactions to grow communities. Many OC's have influential users that help grow the community by their very presence and contributions. However, the process for identifying users having the greatest impact is not trivial. This study offers a new method for identifying these influential users through the creation of modified Hirsch indices, which improves upon the current method of using contribution counts or a survey method of polling other users. We validate the new measures against user status and then analyze the measures by correlating them against postings, thread starts, and views and replies to the thread starts for a shared interest OC.

Keywords

Hirsch Index, Influence, Online Community, Online Identity, Replies, Threads, User Status, Views, Virtual Community.

INTRODUCTION

An online community (OC), sometimes called a virtual community, is defined as being an "aggregation of individuals or business partners who interact around a shared interest, where interaction is at least partially supported and/or mediated by technology and guided by some protocols or norms" (Porter 2004). Our research looks at OC's from the point of view of the health of the OC and how to maintain vibrancy in the OC. Unlike a website that is 'selling' a tangible product, owners of an OC are offering a product requiring interaction and visits from the OC's users. The OC is dependent upon these interactions and visits to remain healthy and vibrant. As long as the users of the OC consider this service to be of value the owners can reap the benefits of providing this service. From the point of view of the users, the OC is of value when the user is able to find relevant and interesting information on the OC. But the producers of the service of the OC are also the users, so the users are both the producers and consumers of the content of the service. So the success of the OC is in the interest of both the users and OC owners.

Successful OC owners are interested in maintaining OC vibrancy. Once an OC has gained interest and a critical mass of users, the vibrancy and health of the OC is dependent on the production of the content via user submissions, viewing and reading of this content, and interest in the content by the users of the OC. Many OC's struggle to maintain this vibrancy as interest, use, and contributions start to decline signaling the death of the OC.

This study examines a niche 'fan' community OC. The OC provides a service of informing the community about the communal interest in a large university's athletics program. The owners of this type of OC realize that user contributions are crucial to the survival of the OC and that user-generated content is why other members of the community visit the OC and read the postings, and thus, positively contribute to the health and growth of the OC. Typically these OC's rely on banner advertising which generate revenue only when many users visit the site and see these advertisements. Thus, user vibrancy is of utmost importance in these contexts.

This paper examines the effect of user status on the vibrancy of the OC. Based on social presence and social influence theory, some have argued that contributions to a web site by high status users will increase the vibrancy of the OC and thus contribute to the success of the site (Assmann et al. 2009; Cheng et al. 2006). To examine this idea, this paper continues the

line of research that uses bibliometric indices to assess the influence of contributors to the OC (Young 2011a; Young 2011b).

The rest of the paper is formatted as follows. First, we introduce some background research in the area of OC's. Second, we introduce the context of the research. Third, we explain the methodology used. Fourth, we present the data and data analysis. Finally, we conclude with a discussion of our findings.

BACKGROUND

The success of an OC is tied directly to user participation. An OC is only as good as the vibrant contributions made by the users of the community (Assmann et al. 2009; Cothrel et al. 1999). OC's that die out tend to lose interactions from the users and the material becomes outdated and communication in the OC becomes stagnant. Even with high participation by the users, this does not guarantee the health of the OC as user participation is not static (Mousavidin et al. 2009). OC's tend to evolve in a distinct community lifecycle (Iriberri et al. 2009), with a beginning period, a middle period where the usage of the OC becomes more and more vibrant, and an ending period where the OC tends to go out of fashion and loses the interest of the OC community. The challenge for OC owners is to extend the middle growth period, or at least maintain the exchange level during the middle period, as long as possible so that the OC participants do not lose its interest in the OC. Examination of smaller OC's is lacking (Shen et al. 2006), however, many papers have looked at larger OC's such as MySpace, Facebook, and eBay. The smaller OC's have been mostly ignored until recently (Clavio 2008).

Assessing OCs based on User Status

One way to analyze the use of OC's is to look at the users motivations and interests. OC's are sometimes a place where users are able to find a sense of community (Zhang 2010). Many OC's create a sense of community by having a common cause of goal for the users. Many OC's also incorporate a hierarchical user status (Chen et al. 2011; Spring et al. 2008; Stewart 2005), which can be used as an incentive to induce user participation (Cheng et al. 2006), but also create users whose sole goal is to gain user status (Lampel et al. 2007).

User status research has focused on social capital (Ganley et al. 2006; Law et al. 2008), social presence (Shen et al. 2009; Shen et al. 2006), and social identification (Shen et al. 2008; Zheng et al. 2007). According to social capital theory, users are more likely to exchange intellectual capital and create new intellectual capital when structural, cognitive, and relational dimensions are met (Nahapiet et al. 1998). The structural dimension is where users are connected through a network of ties. The cognitive dimension is where the users share a narrative and language. The relational dimension is where users have strong relational characteristics such as trust, norms of cooperation, obligation, and identification. One dictionary definition of identity is "the individual characteristics by which a person or thing is recognized" (Collins 2010). User status ties to this notion of identity or identification.

In social presence theory, presence is defined as "the perceptual illusion of nonmediation" (Lombard et al. 1997). The term 'perceptual' means "this phenomenon involves continuous (real time) responses of the human sensory, cognitive, and affective processing systems to objects and entities in a person's environment" (Lombard et al. 1997). The 'illusion of nonmediation' happens "when a person fails to perceive or acknowledge the existence of a medium in his/her communication environment and responds as he/she would if the medium were not there" (Lombard et al. 1997). This theory suggests a substantial mental model of a user "is activated immediately upon detection of behavior that suggests the presence of another intelligence", where the social interaction is mediated by technology (Biocca et al. 2003). Finally social identification theory predicts a user's identification with an OC "that one has chosen volitionally stems from an understanding that membership entails significant benefits" (Dholakia et al. 2004).

Assessing Vibrancy of the OC

Another issue in OC research that targets smaller OCs is the reliance on survey research, administered either to users or owners of the OC (Law et al. 2008; Marett et al. 2009; Schaedel et al. 2010; Shen et al. 2008; Shen et al. 2009; Zheng et al. 2007). These studies utilize survey tools and then depend on the ability of the survey taker to measure the validity of contribution of users in the OC. Problems with this methodology exist, however. First the data collected is susceptible to the survey takers opinions and feelings, which are susceptible to biases of the survey taker. Another problem is that the answers to surveys and the instruments are inexact. Some 'wiggle room' exists with the use of Likert scales, both on the part of the survey takers and the researchers whom interpret the data. We propose a more suitable source of information would be based on observation of the behavior of the users in the OC. We develop a measure that is based on the actions of the users in the OC. In particular we are targeting the 'views' of postings and the 'replies' to posting that are initiated by the OC users. We describe this measure, which is based on the Hirsch index, later in the Methodology section.

This paper expands current research on the use of the Hirsch index (Cuellar et al. 2012) to measure the contribution levels of the users. The Hirsch index (h-index) utilizes the citation counts of a publication in order to measure the impact of the author of that publication. The h-index is defined as follows: "A scientist has index h if h of his/her Np papers have at least h citations each, and the other (Np − h) papers have no more than h citations each" (Hirsch 2005). In order to measure the h-index of a researcher you need to sort all publications by the author by citations to each publication. When the rank number of the publication overtakes the citation number, you have your h-index. What makes the h-index powerful is that it is a measure that is based on publication frequency and publication influence based on citations. In order to increase your h-index by one, you need to publish one more paper with more than h citations. To get a higher h-index, a researcher cannot just publish many papers or just gain many citations on one paper, they must do both.

The h-index has created a buzz in the bibliometric literature with papers that praise the use, extend the use, and criticize the use of the h-index (Egghe 2006; Glanzel 2006; Hirsch 2007; Sidiropoulos et al. 2006). Some of the criticism of the h-index have been that the h-index is time sensitive which was addressed with the hc-index (Sidiropoulos et al. 2006), and that the h-index is not sensitive to publications that have a larger than normal impact, which was addressed with the g-index (Egghe 2006). The introduction of the h-index has spawned much research in non-bibliometric fields where they use the h-index to measure the impact of authors in fields such as chemistry, physics, economics, and the IS field (Truex III et al. 2009; Truex III et al. 2011).

We find there are similarities between an OC and academic publishing. We also find the essence of the h-index can be applied to measure impact a user has with their postings in an OC. A user post in a forum is similar to a publication by a researcher. The reply to a posting by another user is similar to a citation of a publication. Applying this h-index based measure will allow us to identify influential users better than simple post counts or user opinion surveys, which are what most OC's are currently using to identify influential users (Chen et al. 2011; Ganley et al. 2006; Spring et al. 2008).

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

User status is one of the key drivers used by OC users to determine the importance of postings. This conclusion is deduced from the relation dimension of social capital theory and social presence theory. First, from the relation dimension we apply the concept of identification, where a user in an OC is recognized in some fashion. We use user status as identity, which is a public measure that is recognized by another user on the OC as a measure of the social worth of the first user. When a user goes on to the OC and browses through the postings they will attach more validity and trust to the postings by users with relatively higher status. According to Social Presence Theory, once a user starts to peruse the postings, the user's mental model will be activated and more likely to click on a posting when the user detects or identifies the author of the posting to be of a higher status or 'another intelligent' user. With the OC we are analyzing, we are able to see how many times a particular posting is viewed and replied to. The use of the posting in the community can be measured by the number of times that the users read and reply to threads. With the data we have gathered we will be able measure the user status by using the OC assigned user status, the modified h-indices for a time period and see if these correlate with future views and replies. Thus we have a set of hypotheses:

H1a: Contributions from users with higher user status will have an increased number of views in the OC.

H1b: Contributions from users with higher user status will have an increased number of replies in the OC.

We posit that users with higher user status have already chosen the OC, which means they have chosen the OC 'volitionally' by understanding the benefits of joining the OC. From Social Identification Theory and Social Capital Theory, we learn that once a user is vested into using the OC they will tend to keep contributing to the OC, hence continuing to create more intellectual capital and reaping the benefits of the OC. So, users who gain users status will also be more likely to start threads and continue to create postings. Thus,

H2a: Users with higher user status will start more to threads on the OC.

H2b: Users with higher user status will contribute more posts on the OC.

Since traditional measures of user status are based on the number of postings made, our H2b may seem like a tautology; however, this is not the case. We are looking at higher user status in one time period and the thread starts and postings in a subsequent time period. We split our data collection process into two distinct phases. First, data on posts was collected for one year to establish the traditional and h-index based measures of user status. Next, another year of data was collected to test the hypotheses. User status is held constant at the level achieved through the first data collection period, and the posts used to determine the measures are not included in the data used to test the hypotheses. This ensures posts are used once, either to determine the measures or to test predictions, never for both.

RESEARCH CONTEXT

BigUFans.com is a website for the athletic teams that represent Big U. Big U is a public university in the state university system, over 150 years old, and located in the southeast United States. Big U is a large tier-one research university with over 30,000 students. The major sport for Big U is college football, although they field competitive teams in basketball and baseball, all of whom compete in the NCAA Division I.

There are five major OC's dedicated to Big U. BigUFans.com is the largest free and independently owned OC of these five. BigUFans.com was created in 1999 and is owned by an alumnus of Big U, who is one of the authors of this paper. BigUFans.com allows anyone to browse postings and content. However, a user must be registered and signed into the site before creating original posts or replying to original posts. The website is completely free to its members and visitors and generates almost all revenue from advertising. The health and vibrancy of the BigUFans.com website as measured by site traffic, user contributions and interactions is crucial for its owners.

There are 17 moderators and six administrators of BigUFans.com. Administrators are responsible for all aspects of running and monitoring the community. Moderators are given specific topic boards within the site to monitor and moderate. Registered members may become moderators or administrators only at the invitation of the publisher of the site. Both administrators and moderators are expected to evaluate the content of message board postings for possible spam, duplicate posts, posts in wrong topic folders, advertising, and incendiary posts. When any of these are found administrators and moderators are able to remove such posts or place them into the appropriate areas, as well as flag the users who created the posts for possible banning of their user accounts. Feedback from the OC community tends to be positive in that the message posts normally have less flaming, incendiary posts, advertising, and off topic postings.

During the 2011 football season (August through January), BigUFans.com averaged 2.9 million page views, 1075 new posts, 89 topics started, and 167,000 unique visitors per month. During the season, on average, the OC is visited by 1,017 signed in users and adds 5 new members per day. On a typical visit the average user views 5.2 pages. The users on average consist of males (92%), hold a college degree (72%), and are of middle to upper income (71%). During the 2010 off-season (February through July), BigUFans.com averaged 2 million page views per month. During 2011 less than 4% of the signed in users created new threads and less than 30% posted a reply. Currently, BigUFans.com automatically gives user status to members according to the contributions as measured by the total number of posts that the user has made in the message board (see table 1). This status is displayed under each user's username for all postings in BigUFans.com message board.

User Status	Number of Posts Required	Number of Registered Users with this Status	StatusNo
Administrator	n/a	6	n/a
Moderator	n/a	17	n/a
Scout Team	0	20470	1
Third Team	13	1363	2
Second Team	50	1086	3
First Team	250	590	4
All-Conference	1000	179	5
All-American	2000	121	6
Hall-of-Fame	5000	47	7

Table 1. BigUFans.com user status/posting required and coding of StatusNo.

METHODOLOGY

Data was collected on BigUFans.com for calendar years of 2009, 2010, and 2011. This data resulted in 3632 distinct authors and 70,825 distinct threads started. Data for each thread includes a user identification (userID), the number of views that the thread received, and the number of replies to the thread. This allows us to identify the impact of the thread started by each user. We also tied each userID to their user status, number of threads that they started, and the number of postings that they authored. Postings include both thread starts and replies to another user's thread. We tied numbers to the user status: Scout Team (1), Third Team (2), Second Team (3), First Team (4), All-Conference (5), All-American (6), and Hall-of-Fame (7).

Hirsch indices were calculated for each userID after data was imported into a spreadsheet. A Java program was written to allow the calculation of the h-indices. This allowed us to measure the impact of each user. We then imported the resulting impact measure data into SPSS to calculate correlation values and evaluate the hypotheses.

Measures

There are two primary variable categories used in this study: thread views/replies and user posts. Two distinct measures can be associated with a thread: the number of 'views' of the thread and the number of 'replies' to the thread. While a 'view' constitutes evidence that a thread was opened by someone visiting the OC and the thread was shown on the screen to the visitor, a 'view' does not necessarily indicate that the visitor has read the posting. A 'reply' on the other hand is a visible cognitive response to the thread posting whereby we can assume that there is some level of reading by the responder, and thus, some cognitive influence by the thread starter on the responder. This assumption is strengthened by the moderators culling off topic posts and "spam" posts, which would not indicate any influence of the original post on the replies.

Two types of h-indices measure the impact. First, we measured the impact of each thread started by a unique user to find the user influence on other OC members. Second, we identified the hv-index which is calculated similar to the bibliometric version of the h-index (Egghe 2006). Third, we selected all threads started by a unique userID and ranked them according to the 'views' to each posting. The point when the rank number was smaller than the actual 'views' was identified as the hv-index. The hr-index is calculated in the same manner, except the ranking was calculated by using 'replies' instead of 'views'.

The second category of variables includes the number of postings associated with a particular user. Postings were measured by associating each unique userID with the number of threads started and the number of total postings by that userID. The 'threads started' are the set of postings associated to the userID's that initiated each thread. This means that for each thread we identified, the author of the first posting was credited as having started a thread. The number of 'total postings' is the total number of postings that a particular user made to the message board, including both thread starts and replies to threads. For example, if a user has an hv-index of 100 that means that the user has at least 100 thread starts that have garnered at least 100 views each. If a user has an hr-index of 50 that means that the user has at least 50 thread starts that have garnered at least 50 replies each.

Instrument Validation

To validate the two new measures, hr and hv, we compared them to the old measures of user status. First, we calculated the measures for each user id, using one calendar year of data (2009 and 2010) to initialize the measures. Second, we used the 2010 and 2011 calendar-year data to observe the views and replies of thread starts by each userID. Third, we ran correlation analysis between the user status, hr, and hv measures for 2009 and 2010 and the reply and view numbers for 2010 and 2011, to see how well each of the measures is able to predict user actions. The output is measured by the threads started, posts submitted, replies to posts, and views to posts, all measured for distinct user ids.

The data was run in SPSS and the correlation matrix using Kendall's Tau is presented in Table 2. The status number (Status) was assigned according to Table 1. The highly correlated predictor for each set of years is indicated in **bold**. We have data for two sets of consecutive years (2009 to 2010, and 2010 to 2011) and data from two years separated by one calendar year (2009 to 2011). For 2009 to 2010 (lower right quadrant of table 2), we see that hv (in 2009) has the best predictive power as hv correlates best with threads, replies, and views to these threads (in 2010). Status is second and the hr-index is weakest to predict user impact in 2010, only achieving about half of what hv is able to predict. For 2010 to 2011 (upper left quadrant of table 2) we see that still hv is top in three of the four output measures. For both years we do see a spike in the prediction power of status to predict user posts in the subsequent year. This is not too surprising as user status is a direct measure of posts.

We have on dataset across two years with predictor measures made in 2009 to predict output in 2011 (upper right quadrant). Note that over a period of two years user status has lost it's predictive power, where even the hr measure is a better predictor of user behavior and impact two years in the future. Again hv is the best at predicting the four output measures across two years. So, while we need to expand this dataset to include the lifetime of the OC, we cautiously conclude that the hv measure seems to be the best predictor, and hr is a weaker predictor, of future user behavior and impact. Note that the lower left quadrant of data was included for completeness but is data form 2010 predicting behavior in 2010, which is tautological and thus the data here is highly correlated.

		2010 hr	2010 hv	2010 Status	2009 hr	2009 hv	2009 Status
2011 Threads	Correlation Coefficient	.089(**)	**.253(**)**	.242(**)	.046(**)	**.147(**)**	.005
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.746
2011 Posts	Correlation Coefficient	.144(**)	.288(**)	**.457(**)**	.082(**)	**.179(**)**	.171(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
2011 Replies	Correlation Coefficient	.089(**)	**.241(**)**	.233(**)	.048(**)	**.140(**)**	.011
	Sig. (2-tailed)	.000	.000	.000	.001	.000	.425
2011 Views	Correlation Coefficient	.084(**)	**.239(**)**	.229(**)	.044(**)	**.136(**)**	-.002
	Sig. (2-tailed)	.000	.000	.000	.002	.000	.889
2010 Posts	Correlation Coefficient	.425(**)	.637(**)	.933(**)	.179(**)	.302(**)	**.411(**)**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
2010 Threads	Correlation Coefficient	.641(**)	.971(**)	.689(**)	.151(**)	**.301(**)**	.224(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
2010 Replies	Correlation Coefficient	.659(**)	.865(**)	.655(**)	.159(**)	**.300(**)**	.232(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
2010 Views	Correlation Coefficient	.632(**)	.900(**)	.666(**)	.151(**)	**.293(**)**	.220(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

** Correlation is significant at the 0.01 level (2-tailed).

Table 2. Correlation Table of Predictor variables vs. output measures using Kendall's Tau

FINDINGS AND HYPOTHESES

From table 2 we find that hr, hv, and status were positively correlated with views (hr, hv, and status respectively, .084, .239, .229, .151, .293, .220 for one year, .044, .136 for two years) and replies (,089, .241, .233, .159, .300, .232, for one year and .048, .140 for two years), which confirmed H1a and H1b. For one year, status is good at predicting views and replies, but we found that over two years the h-indices were better at predicting views and replies. In fact, in the two-year data, status was not able to predict any user behavior or impact except for postings. We conclude that the h indices can be used to predict user impact over multiple years while user status gives us indication only over the subsequent year.

The three measures were also positively correlated to threads (hr, hv, and status respectively, .089, .253, .242, .151, .301, .224 for one year and .046 and .147 for two years) and posts (.144, .288, .457, .179, .302, .411, for one year and .082, .179, .171 for two years) confirming H2a and H2b. Here we see that status is actually a good predictor over two years of posts and a strong predictor of posts over a one-year period. This is not surprising as status is gained through posts. The drop off of users that come and go explains the loss in predictive power over a longer period of time.

SUMMARY

This research extends past research by (Cuellar et al. 2012) as well as the use of user status in OC's. Two variants of the h-index, the hr and hv-indices, were used to measure user influence. We set out to see if user status really did correlate with the

users influence in the OC.

There are several risks for taking the h-index and using it in OC research. First, the hr and hv indices are bound to be higher than h-indices in bibliometrics. The bibliometric h-index is tied to citations of publications while the hr and hv-indices are tied to views and replies in a message board system. Publications in academia are more rigorous outputs that take a much longer time to develop than a posting on an OC. Given this, we expect the frequency and the raw numbers to be higher for the hr and hv-indices compared to the h-index in bibliometrics. Second, with the hv-index, a 'view' is just a click on a thread and the subsequent download and showing on the computer monitor. A 'view' does not necessarily indicate 'reading' by the user.

Third, with the hr-index, a reply may be related to the topic at hand but may also be completely off topic. A reason for an off-topic reply may be that the user is trying to gain higher status without actually making a valid point in their reply. We believe there are two reasons to overlook this limitation. First the administrators and moderators try to make sure such off-topic replies are dealt with and deleted. Second, in order to assess the validity of a reply one must read all replies to all posts. Reading everything is not in the spirit of the h-index, which was created to allow a quick read of influence without having to read all articles that are cited.

Fourth is a problem inherent in the h-index. The length of time that a researcher has been publishing has direct impact on the h-index. The longer a researcher has been publishing the more likely the researcher is able to garner a higher h-index. Similarly, the hr and hv-indices are both dependent on the amount of time that the user has been active on the OC. Fifth, also inherent in the h-index, is the researcher that has only a few highly cited papers will not gain a high h-index. This is the 'one-hit-wonder' problem. The hr and hv-indices suffer from this as well. Those users that begin only a few threads that have many responses and a high impact, will be influential in the community, but will not appear so in the indices. In bibliometrics the g-index (Egghe 2006) dealt with the 'one-hit-wonder' problem and the hc-index (Sidiropoulos et al. 2006) dealt with the time problem. Both of these may be extensions to this research stream for OC's in the future.

We also realize the use of this particular college sports fan site may not generalize to all OC's. However, we believe the contribution of using the hr and hv-indices, which improves on the survey methodology, is that the measure can be generalized to assess user contribution in many environments. We also realize the lack of a direct business use by the users of a free sports fan site but argue that competition in college fan OC's is high and that the revenue dollars generated by this OC constitute a legitimate business.

Some additional possible future research may look into the questions of (1) How specific events involving BigU influence user participation? Specifically how does an event affect page views prior to and after the event? (2) How do the hr and hv-indices of a user change over time? (3) Can our findings be generalized to other OC's and/or others areas in IT (such as knowledge management) involving user participation?

We believe the current research is relevant to academia and the users and owners of OC's. User status is correlated to a simple count of postings for the OC studied. While this count is the only method of granting user status currently, we believe that many OC owners would be interested in a better metric for assessing user contribution and impact in their OC's. If a better user status granting method is implemented, the users would also benefit from increased efficiency when searching through messages to discover relevant postings.

CONCLUSION

This research is part of an ongoing research stream that is examining how developed OC's can continue to grow and generate page views, interest, and online social interactions within the community and stay valuable in the eyes of the users. We were able to show the new measures, hr and hv, were better predictors than user status over a period of time. Furthmore we were able to show that the predictors, hr, hv, and user status is correlated with thread starts and postings, and more importantly, is correlated to the impact measures replies and views.

The current research attempted to address an issue faced by OC's from the user's point of view, examining user status. User status is important to a user because it is a measure of how well the user is contributing to the OC and can be used to compare to other users on the OC. We believe that the implementation of a more accurate measure of impact such as the hr and hv-indices can improve on traditional user status measures. We also believe that for researchers, the current use of survey based data collection can be improved by the collection of usage data. This data can be used to calculate hr and hv-indices, which are quantitative measures of impact that can improve on current measures of user impact.

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