Knowledge and Social Networks in *Yahoo! Answers*

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Abstract

This study defines and explores relations between knowledge-seeking and social relationship networks, using data from a popular Q&A social network site. Our theoretical framework draws on Motivation, Common-goods, and Social capital theories to generate an understanding of the interrelationship of the two types of networks. A dataset consisting of 19 months of activity on Q&A Yahoo! Answers provides the basis for answering the following questions: Does a reciprocal relationship exist between the two networks? Is there a positive correlation in either size or growth between the two? Who are their members and actual participants? How does the social capital created by the social activities influence the asker's satisfaction? Finally, can the growth of one network come at the expense of the other?

Findings suggest a positive correlation between the knowledge-seeking network and the social network; Social capital does contribute to askers' satisfaction and furthermore, under certain conditions, one network might grow at the expense of the other. Theoretical and practical implications for the mutual dependency of social ties and informational provision are discussed.

1. Introduction

Social Q&A is a Web-based information-seeking service in which questions are asked and answers given by the users themselves. The service offers (1) a method for presenting a request for needed information; (2) a place where others can respond to that person's information need; and (3) a community built around such service and based on active participation [38].

Yahoo! Answers is the world's largest question-answer system. Its declared mission is to be "*the one place where the world shares what they know to help each other out.*" *Yahoo! Answers* is a community site: anybody can ask and answer [14]. The heterogeneous

interactions, which include actively participating in regulating the system, turn *Yahoo! Answers* into a social network [3, 33]. *Yahoo! Answers* also encourages with its rewards system such acts as voting for the answers offered, selection of "best Answer" (BA), citing interesting questions, and even reporting abusive behavior. Users raise discussion topics to garner others' opinions or simply for fun [47].

Unlike discussion groups where users can write on a specific subject and relate to each other's words, in *Yahoo! Answer*, one can only ask a question or answer it. There is no conversation support mechanism. Hence two networks co-exist in *Yahoo! Answers*; a knowledge-seeking network and a social activities network. The knowledge seeking network consists of both *conversational questions* which are asked for the purpose of stimulating discussion and *informational questions* which are asked with the intent of obtaining information [13].

We define the social network to consist of all activities not related to actually asking or answering a question. This includes five parameters: (1) the number of stars that a question rates ("interesting") and the number of participants who star a question; (2) the number of "thumbs up" and "thumbs down" to answers, their ratio, and the number of people who participated in the evaluation; (3) the number of comments to a closed question and the number of participants who commented; (4) the number of votes for a "Best Answer" (BA) and the number of participants who voted in this category; and (5) the number of "stars" awarded to the BA.

Though Q&A sites are defined as communities [26, 33, 46] where the participants' activity creates a social network, not much was written on the two co-existing networks that compose Q&A sites; the social network and the knowledge-seeking network.

This study explores these networks and addresses the following questions: What is the relationship between a

knowledge-seeking network and a social network? Do reciprocal relations exist between the two network types? Is there a positive correlation in growth between the two? Who are their respective members, and who are their actual participants? How does the social capital created by the social activities influence the asker's satisfaction? And under what conditions might the growth of one network come at the expense of the other?

2. Literature Review

2.1. Question-and-Answer Sites as Social Networks

Online question-and-answer services, are variously known as Social Q&A and Social Reference [35], Community Question Answering (CQA) [33] (Co-training Community Question Answering) [26], and QABB (Questions and Answers Bulletin Board) [29].

Q&A sites are online communities, where anyone could ask and answer and share knowledge, and all the data are public and immediately searchable [27]. Participants' activity, whether for knowledge sharing or socializing, create ties to other users through asking and answering questions and establish a social network even if not intended [33, 36, 37, 44].

Though much of the content reflects unsubstantiated opinions, questioners prefer to obtain personalized answers to their individual queries [4] and having the opportunity to connect socially with others is a good enough reason to prefer these sites over a search engine [28].

In recent years, several researchers indentified *Yahoo! Answers* as "*an example of a community site organized around questions and answers*" [4] and as "*an online community*" [5] especially since in *Yahoo! Answers* anybody could ask and answer questions [3, 14] and the site fully meets Golbeck's accessibility, relationship and a support criteria for a web-based social network [11].

All these studies support our main motivation to distinguish between the knowledge-seeking network and the social network in *Yahoo! Answers,* to explore the activities in both networks and to understand the correlation between them.

2.2. Roles in Q&A Sites
Turner et al. [43] and Wellman [44] identify five archetypes:"Answer people", "Questioner", "Trolls", "Spammers / Binary Posters" and "Flame Warrior

/Conversationalist", participates in online communities. This section will focus on the answerer who volunteers to respond to questions in Newsgroups and QABB and will present her motivations and importance to the Q&A sites.

Participation in discussion groups and Q&A sites is paradoxical. The content is available to all members, but since no single individual is required to contribute to the site's content; indeed, the "rational consumer" might be a "lurker," consuming the medium without making contributions. Watching others talk and becoming familiar with a community's content makes lurkers feel they belong to that community. Another frequent explanation of lurking is free-riding, defined as using a common good without contributing to it [40]. Yet, if no one contributed, there would soon be no medium to consume, and this is the dilemma of so-called "public goods" [32].

Most on-line communities exhibit a "90-9-1 rule": 90% of the users are "lurkers" who never contribute, 9% contribute a little, and 1% account for almost all the action [8, 40]. Only 4% of members in open-source development communities' account for 50% of answers on a user-to-user help site [24] and in *Naver*, only 1% of the answerers contributed between 22% and 52% of the answers in the different categories [30].

Askers can also be answerers; while this is rare [14], it does occur where users chat informally [1]. In two leading Q&A sites *Yahoo! Answers* and *Naver* only 5% of all users were found to act as both asker and answerer [6, 30].

Regarding the nature of the participation in newsgroups, 50% of social, hobby, and work mailing lists had no traffic over a period of four straight months [9]. In Q&A sites most answerers prefer to act in a single (topic) category [10], ask one question only [47] and tend over the years to quote or relate to the answers of others and not to answer themselves [26].

The low participation rates in *Yahoo! Answers* can be explained by (1) "social loafing" [25], meaning individual contributions to a group effort are reduced when that effort is not unique, or as the size of the group grows; (2) relevant questions that were non-observed, which the user cannot detect [12] or (3) a lack of motivation to solve someone else's problems [12].

Our study uses the knowledge-seeking network's roles such as asker and answerer and the social network's

roles to explore the correlation between the two networks in *Yahoo! Answers.*

2.3. Motivations in Q&A Sites

Many studies explore the motivation for participate in Q&A activities and related them to several fields:

(a) Professional skills such as gaining reputation and structural connection to the network [45] learning and reviewing material [30] and using relevant experience [29].

(b) Interpersonal connectivity such as helping others [30], expressing appreciation or affiliation, providing or receiving social support [47] and commitment due to the nature of relationship [29].

(c) Belonging to a community such as participating in the social network as a hobby [30], building a sense of community [45], connecting socially and experiencing the social capital [29].

(d) Asker's characteristics and personality such as altruism, obligation, humor and ego [29]

(e) Community mechanism such as; having answers selected as "best answers" or commented on [8, 18] and having the opportunity to obtain better, more numerous, and longer responses [48]. Usability had little role in explaining user motivation [25].

Theories such as Uses and Gratifications (U&G), where users actively seek particular media with the goal of gratifying an existing need, were also suggested as explanations for users' motivations to contribute to online communities [25]. Surprisingly enough Wasko and Faraj [45] found that expectations of reciprocity or high levels of commitment to the network *are not* significant in explaining motivations for sharing. Raban and Harper divided the answerer's motivations into internal (intrinsic) and external (extrinsic) groups, mentioning *Yahoo! Answers* as a Q&A which "*uses extrinsic motivations heavily to invite user contributions and increase the quality of answers*" [32].

The explanations for the user's motivation to contribute and share knowledge are varying. No matter what is the explanation, the contributions' outcome is clear and crucial for the existence of online communities and Q&A sites. Our study explores some of the motivations (social capital and community mechanism) and their correlations with the asker's satisfaction in *Yahoo! Answers*.

2.4. Quality and Satisfaction

Satisfying a user's information need was the goal of Q&A systems [5]. People turn to their social networks rather than use search engines in order to satisfy their information needs [29]. However, QABB suffer from diverse answer quality with a low percentage (17% - 42%) of correct answers [2, 41].

The asker satisfaction could be derived from both textual features and non-textual features. Whereas textual features such as accuracy, completeness, and relevance are used to measure the relevance of an answer to the question, the non-textual features help estimate the quality of the answer [19]. Several studies found signaling value in non-textual features of answers such as:

(a) Previous experience and interaction with the tool [26]

(b) Features such as; answer length, ranking (thumbs up minus thumbs down) and the answerer's reputation [3, 5].

(c) Response time; "*In asynchronous CMC, a quick response is one of the only non-verbal tools that can be used to signal immediacy, care, and presence*" [21].

Our study does not use content analysis and uses only the non-textual features such as ranking and response time to explore the community's estimations, the social capital and their correlations to the asker's satisfaction in *Yahoo! Answers.*

2.5. *Yahoo! Answers*

Launched on July 5, 2005, *Yahoo! Answers* enables participants to ask and answer questions on any topic. It provides more than 20 million answers per month. In its early years, *Yahoo! Answers* handled 96% of all answering and questioning activity on the Internet and this platform was judged to be not only the largest Q&A site but also the one that delivered the best answers [6].

Yahoo! Answers serves many needs - answering questions, receiving support, and requesting everyday advice [1] - all of which can be divided into Informational Questions and Conversational Discussions [13]. It was found that about 40% of the *Yahoo! Answers* questions were opinion-type questions, asking for an opinion, evaluation, or point of view [22].

Along with its rapid growth in 2006 and 2007, the quality of *Yahoo! Answers* responses to factual questions went into decline. Its expertise depth and question content were deemed to be subjective-oriented, the information was noisy, ungrammatical, vague, and poorly stated [26] and its content was found to be barely at the high school level [1]. Nevertheless, *Yahoo! answers* provided good answers to two specific

question types: "Complicated Answer" and "Opinions" [28] and in categories where the answerers were active on specific topics and not supplying answers in multiple categories [1].

Yahoo! Answers has 24 top categories and more than 1,600 sub-categories in total. Some are huge with more than 100,000 active users per month and some have only a few active users per month. These differences are critical to our activity level analysis and the size analysis of *Yahoo! Answers*.

Yahoo! Answers process is quite straightforward. An asker puts a question to *Yahoo! Answers* by selecting a category and entering the question subject (title) and, optionally, giving details (description). At this point other users can act in one of two ways: (a) Knowledge driven acts - answer the question; (b) Social driven acts - tagging other users' answers (Thumbs up or Thumbs down) and questions (e.g., awarding stars for quality) or, later, commenting on the question and/or voting for the Best Answer.

Each question has a lifecycle, starting in an "open" state in which answers are received. If the asker is satisfied with any of the answers, she can choose it as a best answer and provide feedback, such as assigning stars to the best answer or offering textual feedback. If the asker did not indicate a best answer within four or eight days (extended time), the best answer is chosen by the community in a voting process. Once a best answer is chosen, the question is "resolved" although comments can be added to both closed and resolved questions.

In our view, the group's social activities in *Yahoo! Answers*—namely, starring questions, commenting on and rating answers, and voting for the "Best Answer"—are all part of the social capital that is created by the *Yahoo! Answers'* mechanism. This social capital comprises "*networked ties of goodwill, mutual support, shared language, shared norms, social trust, and a sense of mutual obligation that people can derive value from*" [17]. In the following hypotheses, we will explore the effect of the social capital on the asker's satisfaction.

3. Hypotheses

Users may continue to participate in a site for different reasons than those that led them to the site [25]. Asking or answering questions might lead to meeting new interesting people and vice versa, evaluating questions and answers might lead to participating in asking or answering. This possible diffusion leads us to explore the relationship between the knowledge-seeking network and the social network in *Yahoo! Answers* (H1).

Since the social capital was found to be important in predicting contribution to the site [25] and was found to be influential on the user satisfaction [17, 29, 39, 44] we will explore the correlation between the social capital and two parameters: the community's contribution and the asker's satisfaction (H2).

Finally we will explore the correlation between "pure" social activities (people who engage in social activities to the exclusion of other activities on the system) and two parameters: (a) the asker's satisfaction and (b) the correlation between "pure" social activity and the level of overall-activities in the network (H3).

H1: The size and growth of both knowledge- seeking networks and social networks are positively correlated across categories.
H1.1: A high volume of knowledge activity will correspond to a high volume of social activity (such as Thumbs up/ down, starring questions, voting and commenting) across categories.
H1.2: Across categories, a positive growth correlation exists between the two networks. Categories experiencing a growth in knowledge- seeking will experience growth in social network, as well.

On one hand, the knowledge-seeking network causes people to interact and creates social activity. On the other hand, social activity exposes random users to *Yahoo! Answers* content and encourages them to participate in asking and even answering questions.

Since no definite causal direction can be established between the knowledge-seeking network and the social network, we explored the following correlations between the two systems:

H2: A correlation will be found between the social network's parameters which create a social capital and the asker's evaluation of the quality of the answers.
H2.1 The social network's positive evaluations (Thumbs up, Question stars) will be positively correlated with the asker's satisfaction parameters (Best Answer stars).
H2.2: The social networks' negative evaluations (Thumbs down) will be positively correlated with poor satisfaction parameters of the knowledge network (asker's Best Answer's stars).
H2.3: The size of the social network (number of users' starring and evaluating) will be positively correlated with the correlation between the group's evaluations and asker satisfaction.

Categories with a positive community atmosphere (many "Thumbs up" answers and "interesting" stars to questions) will create social capital. This situation, in return, will increase the contribution to the site [25], as it will influence the quality of the answers and will increase the user satisfaction [25] in terms of a higher average number of "stars" given to the Best Answer. Categories with a negative community atmosphere (many "Thumbs down" to answers) will create poor social capital. This, in turn, will influence the quality of the answers and create lower asker satisfaction rates. Categories with a larger community will exhibit more accurate "Wisdom of Crowds," causing higher correlations between the group's evaluation and the asker's evaluation in the different categories.

H3: in categories in which the social activity is carried out by users who do not participate in the knowledge-seeking activity, we expect to find:
H3.1 A negative correlation between the volume of the "pure" social activity and the size of the network.
H3.2 A negative correlation between the volume of the "pure" social activity and the number of answers per question.
H3.3 A negative correlation between the volume of the "pure" social activity and the asker's satisfaction rates regarding the "Best Answer."

Yahoo! Answers was established as a Q&A site, and as such the user's main reason for entering the site is to ask and answer questions. Nevertheless, besides lurkers, who are an intrinsic part of question answering sites [32], there are people who use this platform solely as a social network, meaning that their activity involves commenting, voting, and rating, but not offering questions or answers.

The effect of this phenomenon on questioning and answering is now explored. On the one hand, H1 assumes that the knowledge-seeking network and the social network go hand in hand. On the other hand, it can be assumed that since people's resources are limited, a successful social network might emerge at the expense of the knowledge- seeking network. We argue that in categories where the share of "pure" social activity is high, the size of the overall network and the total number of answers per question will be small, and the rates of asker satisfaction with the answers obtained will be low.

4. Research Methodology

For an initial analysis of the size and growth of the knowledge-seeking network and the social network, we used data that had been collected from 19 months of

Yahoo! Answers activity. The sequential data was divided into distinct phases. This kind of division was used previously [16, 23, 42, 44].

During this time period, approximately 20 million knowledge-seeking activities were executed each month, the number of users ranging between 6.4 million and 9.2 million each month. All knowledge-seeking activities were explored as were four types of social activities: (1) starring a question as interesting, (2) giving thumbs up or thumbs down to a question, (3) commenting on a question, and (4) voting for the "Best Answer."

The hypothesized relationships were estimated, using more than 1600 sub-categories in *Yahoo! Answers*. In most cases, the direction of influence between the knowledge-seeking network and the social network is uncertain; therefore, correlation analysis was employed as the main analysis tool. The explanatory power of the correlations was evaluated by looking at the Pearson Correlation value; unless otherwise stated, the significance was (2-tailed) $p < 0.001$.

Data were collected from the *Yahoo! Answers* servers, using Yahoo!'s administrative tools for almost a year. The data reported here consist of all the relevant activities between January 1, 2009, and August 31, 2010, excluding July 2009, data for which were missing.

5. Main results

Since *Yahoo! Answers* categories vary in size, we analyzed the data accordingly. Three sets of results are presented for each correlation check: one for the whole *Yahoo! Answers* network (1622 sub-categories, 100% of the categories) (SET A); one for the biggest categories (369 categories, 22% of the categories), each with a total number of users of more than 20,000 for the 19-month activity time period (SET B); and one for the top categories (310 categories, 18% of the categories), each with more than 40,000 users over the 19-month time period (SET C).

The results for the size correlation and the growth correlation between the two networks are presented first; these are given in terms of the number of nodes and the volume of interactions. Next are the results for the correlation between a group's social capital and the asker's satisfaction with the answers. This is followed by the results for the correlation between the "pure" social network activities and the knowledge-network parameters.

H1.1 Results - A high correlation (0.57, 0.64, 0.67) was found between the average number of members per Q&A activity in the knowledge- seeking network (askers and answerers) and the average number of members per Q&A activity in the pure social network (number of nodes) for Sets A, B and C. A very high correlation (0.88) was found between the knowledge-seeking (questions and answers) activity and the social activity (number of interactions) for Sets A, B and C.

H1.2 Results - A very high correlation was found between the growth in knowledge-seeking activity (in nodes) and the growth in number of people who give stars (0.57, 0.71, 0.79) and evaluations (0.9, 1, 0.9) for Sets A, B and C.

A very high correlation was found between the growth in knowledge-seeking activity (in nodes) and the growth in questions' stars (0.32, 0.64, 0.87), comments (0, 0.7, 0.79) and Thumbs up (0.84, 1, 0.92) for Sets A, B and C.

H2.1 Results - The data show a moderate positive correlation (0.28, 0.34, and 0.36, respectively, in compatibility) between the group's evaluation of the quality of the question (*Question stars*) and the asker's satisfaction with the "Best Answer" chosen (Stars) for Sets A, B and C. The data support a moderate positive correlation (0.32) between the group's evaluation of the quality of the answer (*Thumbs up*) and the asker's satisfaction with the "Best Answer" chosen (Stars) and support a for Sets B and C. The data do not support a correlation for Set A (low significance).

H2.2: Results - The data indicate a moderate negative correlation (-0.32) between the group's negative evaluation of the quality of the answers (*Thumbs down* per *all Thumbs*) and the asker's satisfaction with the "Best Answer" chosen (Stars) for Sets B and C. The data *do not* support a correlation for Set A (low significance).

H2.3: Results - A strong positive correlation (0.84) was found between the size of the group (starring questions and evaluating answers) and the correlation between the group evaluations and asker satisfaction for Sets A, B and C.

H3.1 Results - The data show a weak negative correlation (-0.2) between the share of "pure" (non-informational) social activity and the size of the knowledge-seeking activity for Sets B and C. The data do not support a correlation for Set A (low significance).

H3.2 Results - The data indicate a weak negative correlation (-0.28) between the share of "pure" (non-informational) social activity and the average number of answers per question for Sets B and C. The data do not support a correlation for Set A (low significance).

H3.3 Results - The data show a weak negative correlation (-0.27) between the volume of "pure" (non-informational) social activity and the average number of Best Answer stars for Sets B and C. The data do not support a correlation for Set A (low significance).

The findings support almost all of the hypotheses for sets B and C. These sets focus on the biggest categories where many users are involved in the knowledge - seeking and in the social activities. The data support only H1 for Set A (whole 1610 categories). We assume that since Set A consists of hundreds of small categories with a few users and a minimum level of activity, the data is noisy and can't generate clear and significant statistical insights.

6. Discussion

More people who seek information might generate more social interactions. When people interact socially on *Yahoo! Answers* (in other words, provide ratings or "thumbs up" or vote), they are exposed to the content of the questions and answers, and therefore they might be drawn into the informational exchange as well.

The positive correlation between the group's evaluation of the quality of the answers and the asker's evaluation might have two explanations: (1) since the group members and the asker are equally interested in the same issues, they might subscribe to similar opinions and, hence, think alike from the outset; (2) a second explanation might be related to the synchronicity of the inputs. Since the user chooses a "Best Answer" only after the group has judged the answers, the group's input might influence the asker's evaluation.

The results also provide an indication that social capital plays a role underlying knowledge contribution. Consistent with previous work [29, 32, 45], the present study leads to the conclusion that once the individual is given a chance to share knowledge and the experience of sharing is positive, knowledge contribution will occur. The positive social atmosphere created by the "*Thumbs up*" and the "*question stars*" is correlated with the quality of the answers as seen by the asker. This is not a trivial finding. It points to a significant impact of the social sphere on the informational sphere.

The strong positive correlation between the size of the group (number of participants in the social network who starred questions and evaluated answers) and the correlation between group evaluations and asker satisfaction supports the "Wisdom of Crowds" expectation, since increased numbers of people participating in the evaluation leads to a better ability to predict asker satisfaction.

The weak negative correlation between the share of those who stick to social activity alone and the size of the knowledge-seeking activity (numbers of questions and answers) is explained by the phenomenon of people who interact only with social tools. These users participate in the social network and do not partake in the knowledge-seeking network. Though the knowledge-seeking network and the social network are positively correlated across categories and grow together, the relative part of those who only do social activities declines as the knowledge-seeking network grows larger.

Because users who participate in the social network do not necessarily use the knowledge-seeking network, the social activity in some categories is carried out by users who participate only in the social activities. As a consequence, these categories will have fewer people who answer questions and the size of the group that answers and the average number of answers per question will be relatively small. In these categories the rate of asker satisfaction with the Best Answers will be low, as we found in [34], compared to that in categories in which the knowledge-seeking activity and the amount of answers is average or above.

7. Conclusions and Future Work

The aim of this study was to investigate relationships between the two types of networks that compose Q&A sites in general and *Yahoo! Answers* in particular. We are interested in exploring social and informational networks and the cross-fertilization of user motivation between them. The results provide qualified support for most of the hypothesized relationships. They indicate that the knowledge network and the social network are correlated in size and growth, and also uncover some subtle variations in this correlation.

The results provide some evidence that the contributions by people who engage in social activities to the exclusion of other activities on the system, might come at the expense of knowledge-seeking activities. In categories in which the social activity had no knowledge-seeking attached to it, the overall volume of the latter activity and the average number of answers

per question was smaller than in categories in which social activities and knowledge-seeking activities co-occurred. In addition, the social parameters indicating the group's satisfaction with answers were positively correlated with the asker's satisfaction with the answer, meaning that the social network can predict asker's satisfaction.

One potential explanation of this result is the common and popular "Wisdom of Crowds" expectation, according to which groups can successfully predict whether an answer is satisfying or not. A potential influence of the group's evaluation on the asker might also explain these results, which would create a distinctive and directional link between the social network and the knowledge-seeking network. Consistent with theories of "Wisdom of Crowds," the larger the group that evaluates answer's quality, the more it is correlated with askers' evaluation of the quality of the "Best Answer."

The results resonate with previous works [29, 32, 45] and provide an indication that social capital plays a role underlying knowledge contribution and that maintaining a critical mass of active social participants is important for the knowledge-seeking network.

Thus, an interesting area of further research would look for more ties between the two networks, whether resulting from behavioral theories or from the mechanism of each platform.

Since user satisfaction was found to be a good predictor of user's intention to participate in the future [25] an interesting further research would be to define and capture the satisfaction parameters of the social network's users. Comparing them to the well-known satisfaction's features, textual and non-textual [5, 19] of the information seeking network's users will be the next research issue.

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