Motivating Scholars' Responses in Academic Social Networking Sites: An Empirical Study on ResearchGate Q&A Behavior

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Abstract

The advent of academic social networking sites (ASNS) has offered an unprecedented opportunity for scholars to obtain peer support online. However, little is known about the characteristics that make questions and answers popular among scholars on ASNS. Focused on the statements embedded in questions and answers, this study strives to explore the precursors that motivate scholars to respond, such as reading, following, or recommending a question or an answer. We collected empirical data from ResearchGate and coded the data via the act4teams coding scheme. Our analysis revealed a threshold effect—when the length of question description is over circa 150 words, scholars would quickly lose interest and thus not read the description. In addition, we found that questions, including positive action-oriented statements, are more likely to entice subsequent reads from other scholars. Furthermore, scholars prefer to recommend an answer with positive procedural statements or negative action-oriented statements.

Keywords: Social Q&A, ResearchGate, Library and information science

1. Introduction

The advance of Web 2.0 technology makes it possible for academics from different countries to work together with the support of online collaborative platforms (Berdun & Armentano, 2018), such as academic social networking sites (ASNS) (Crawford, 2011). ASNS, such as ResearchGate and Academic.edu, assist scholars in communicating with others, sharing academic resources, or seeking information or advice (Jeng, He, & Jiang, 2015). For instance, ResearchGate claimed to have over 15 million users by September of 2018 (ResearchGate, 2018). ASNS can be regarded as a social question and answer (Q&A) platform where scholars post and answer academic questions (Jeng, DesAutels, He, & Li, 2017). Though ASNS provide social Q&A platforms for academics to use, they cannot guarantee the success of interactions among scholars. Like other social Q&A platforms, motivating users to interact in the community is crucial to ASNS because,

for example, receiving no responses to their questions will make users to feel disappointment and reduce their use of ASNS. It is important for ASNS to publish both questions and answers which will attract attention and encourage responses, such as reads, follows, and recommendations.

In the literature, some studies have found that receiving responses to questions plays an important role in retaining users of social Q&A platforms, such as in the contexts of Sina Weibo and Stack Overflow (Liu & Jansen, 2013; Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011; Zhe & Jansen, 2018). Another main research stream of social Q&A platforms focuses on the quality of questions and answers in order to understand how their features, such as specificity, clarity, and the amount of details, determine the level of subsequent responses (Chua & Banerjee, 2015a; Liu & Jansen, 2017). However, little research has attempted to investigate how the statement features included in questions and answers on academic Q&A platforms affect responses from other scholars. According to Jeng et al. (2017), in academic social network settings (such as ResearchGate), the way of phrasing content is much more important compared to generic Q&A platforms (such as Sina Weibo) as professional knowledge is required on ASNS, which calls for cautious phraseology (Li, He, Zhang, Geng, & Zhang, 2018).

In addition, prior research on responses on social Q&A platforms have investigated responses to either questions or answers, few studies have been conducted to compare the impacts of statement features included in questions and/or answers on responses to them respectively in one study. There is a need to explore whether statement features included in questions and/or answers affect the responses to them differently in order to understand how to attract users to response to questions and answers in ASNS.

To address the above research gaps, this study explores the precursors of scholars' responses to both questions and answers on ASNS by employing both content and quantitative analysis based on a collected dataset of 445 questions and their associated 8,457 answers from ResearchGate. Specifically, this research aims to scrutinize how the statement features (such as problems-focused, procedural, socio-emotional, and action-oriented communication) included in questions and answers posted on ASNS affect scholars' responses (including following, reading, answering, and recommending of questions as well as recommending of answers) to them. The act4teams coding scheme, a tool developed to analyze group interactions, was employed in this study to detect the types of key statements included in questions and answers via content analysis (Kauffeld, 2006a). Further statistical regression analysis was conducted to investigate the impact of the different statement features on their responses.

The remainder of this paper is structured as follows: in the next section, a literature review of ASNS, scholars' online interactions, factors motivating online responses, and studies on the act4teams coding scheme is presented. Thereafter, we introduce the research design and methodology followed by the data analysis and research results. Finally, we conclude the paper by summarizing both contributions and limitations of this study.

2. Literature Review

2.1 Studies on Academic Social Networking Sites

According to Elsayed (2016), ASNS can be defined as specialized platforms where researchers take part in various academic activities, including dissemination, communication, and exchange of professional knowledge. The impacts of ASNS on academic communities have been studied in recent years (Elsayed, 2015; Kjellberg, Haider, & Sundin, 2016; Muscanell & Utz, 2017; Yan & Zhang, 2018). Through summarizing the literature, two distinct streams in ASNS research can be distinguished.

A number of studies have focused on investigating the functionalities and impacts of ASNS. Some studies have adopted bibliometric approaches to explore users' differences in ASNS regarding their disciplines as well as countries of living (Luis Ortega, 2015; Thelwall & Kousha, 2015). Some researchers

have combined conventional metrics and altmetrics indexes, such as the number of citations, views, and downloads of articles on ASNS, to investigate the impact of ASNS on users (Hoffmann, Lutz, & Meckel, 2016; Thelwall & Kousha, 2015; Yan & Zhang, 2018). The interaction on ASNS, such as dissemination and sharing of research on ASNS, has refashioned the works of academia (Hoffmann et al., 2016; Shrivastava & Mahajan, 2017). Users' activities on ASNS have been also found to affect their ResearchGate (RG) scores (Copiello & Bonifaci, 2018; Kuo, Tsai, Wu, & Alhalabi, 2017). In the study of Orduna-Malea et al. (2017), RG scores were found to be built upon the asking or answering of questions in ResearchGate. Less interaction with other scholars on ResearchGate leads to a lower RG score, irrespective of users' efforts in sharing their publication with others.

Another main research stream in the field of ASNS focuses on investigating user behavior, such as user addition (Almousa, 2011; Jeng et al., 2015), publication sharing (A. M. Elsayed, 2016), the usage of ASNS (Muscanell & Utz, 2017), and user engagement in ASNS (Jeng et al., 2015; Muscanell & Utz, 2017; Thelwall & Kousha, 2015). For instance, Muscanell & Utz (2017) explored why and how academics utilize ResearchGate and found that users did not perceive many benefits from engaging in this site. Singson & Amees (2017) researched the membership of ResearchGate among scholars with empirical data from Pondicherry University, revealing that the main reason for joining ResearchGate was to connect with scholars with similar research interests. Jeng et al. (2017) investigated the difference of information exchange behaviors among scholars from three subjects (Library and Information Service, History of Art, and Astrophysics) and found that the impact of scholars' motivation to post questions on ASNS is greater than disciplinary factors.

Recently answer quality on ASNS has also attracted the attention of researchers (Li, He, & Zhang, 2016; Li et al., 2018). Li et al. (2018) characterized the answer quality on ResearchGate based on 1,021 answers collected among three different disciplines and found that high-quality answers on ASNS tend to be provided by scholars with higher academic reputations (e.g. more followers, etc.) and include objective information. However, prior research mainly focuses on answer quality in ASNS, and little research has attempted to investigate how the statements in the questions and answers affect responses from other scholars and whether the impact varies across questions and answers on ASNS.

2.2 Studies on Online Interactions between Scholars

Along with a popularity of social media, ways of communication between scholars have changed greatly over the past decades (Sugimoto, Work, Lariviere, & Haustein, 2017). In this vein, ample research has been conducted on scholars' interactions on social media (Cosima Bullinger, Hallerstede, Renken, Soeldner, & Moeslein, 2010; Sugimoto et al., 2017), particularly on the factors affecting their interactions in social media (Holmberg & Thelwall, 2014; Ke, 2013).

Past studies alleged that social media facilitated scholarly communication (Holmberg & Thelwall, 2014). For instance, it has been suggested that Twitter is one of the most widely used social networking site for scholars to communicate in the same research fields and to initiate research-related discussions (Van Noorden, 2014). Chaudhry et al. (2012) examined how Twitter has been used by physicians at American Society of Clinical Oncology (ASCO) annual meetings in 2010 and 2011. Based on 12,644 tweets from physicians, they found that Twitter is a useful tool to assist physician scholars in disseminating news on relevant medical advancement. Gruzd et al. (2012) examined the role of social media in academia based on interviews of 51 scholars and found that building new relationships with other scholars is a main reason they use social media in academic life (Gruzd et al. 2012).

In addition, previous research showed that interactions among scholars are affected by various factors, such as age, ethnicity (Ke, 2013), and discipline (Holmberg & Thelwall, 2014; Jeng et al., 2017). Based on

data collected from ResearchGate, Jeng et al. (2017) employed mixed methods to identify and compare the patterns of information exchange between scholars across three different disciplines and found that good understanding of scholar interaction patterns contributes to a better design of user interfaces and improves user experience.

2.3 Studies on Factors Motivating Online Responses

Prior research has examined factors encouraging users to engage in interactions in academic social Q&A platforms (Chua & Banerjee, 2015b; Li et al., 2016; Shi, Du, & Xu, 2018), such as ResearchGate, NedHelp, Zhihu, etc.. Some studies mainly characterized those who provide information at academic Q&A platforms, such as users' authority on the platform (e.g., academic reputation, RG score) or social relationship (e.g., number of followers, number of friends) (Jin, Huang, & Wang, 2017; Li et al., 2018). Another focus has been on the content of questions. The numbers of words and sentences included in questions on academic Q&A platforms have been found to be associated with the responses (Shi et al., 2018; Zhe & Jansen, 2018). Jin, Huang, & Wang (2017) found that the more followers a scholar has on ASNS, the more they receive votes indicating that their answer was helpful. Table 1 presents a detailed summary of the findings regarding the motivation of online responses.

Both ASNS and generic social Q&A sites were investigated to explore the factors motivating online responses. Previous research on interactions on generic social Q&A sites mainly focused on basic features of content and content providers. However, this paper argues that, in studying interactions online, there are two key distinctions between generic social Q&A platforms and academic social Q&A sites. First, academic questions and answers are domain specific, which demand professional knowledge to participate in interactions (Goodwin, Jeng, & He, 2014). Thus, the statements made in the interaction process on ASNS are more crucial to triggering responses from peers compared with general social Q&A sites. Second, users of generic Q&A sites tend to be anonymous, while users on academic Q&A sites are scholars whose academic credentials are clearly evident to other scholars (Li, He, Jeng, Goodwin, & Zhang, 2015; Li et al., 2018). The features of ASNS require scholars to pay more attention to their own statements when raising or answering questions on ASNS than on generic social Q&A sites.

Furthermore, prior studies on academic social Q&A platforms focused on the answer quality, ignoring the characteristics of questions. However, a question and its associated answers are both important in the interaction process. In addition, previous research on ResearchGate has verified that the way answers are phrased, including the specificity and the level of details, influences the number of recommendations from other scholars (Deng, Tong, & Fu, 2018; Li et al., 2018). Nevertheless, it remains unknown if the particularities of both questions and answers motivate subsequent responses from other scholars. In particular, there is a paucity of knowledge on how different statements trigger particular responses to questions and answers differently from other scholars. In this vein, this study adopted a mixed-method design of qualitative content analysis and statistical regression analysis in an attempt to explore the impacts of the statement features of questions and answers that motivate responses among scholars.

2.4 Instruments for Analyzing Group Interactions

According to social exchange theory, interactions between group members can be described as a dynamic and interdependent exchange process that constitutes social relations (Cropanzano & Mitchell, 2005; Sauer & Kauffeld, 2016). Past studies have employed various classification methods to analyze the interaction process between group members (Kauffeld & Lehmann-Willenbrock, 2012), including act4teams (Kauffeld, 2006a), the system of multiple-level observation of groups (SYMLOG) (Bales, 1980), and Bales' Interaction Process Analysis (IPA) (Bales, 1950). These instruments for group interaction analysis have been

widely utilized across various research scenarios (Berdun & Armentano, 2018). For example, Moloney-Krichmar, and Preece (2005) employed Bales' IPA to understand group interactions in an online health community. Berdun & Armentano (2018) proposed a new approach to building cooperative profiles in an online collaborative game by using a SYMLOG coding scheme. Act4team has also been applied to explore interactions in the context of team meetings and discussions (Kauffeld & Lehmann-Willenbrock, 2012; Schneider et al., 2018).

Developed by Kauffeld (2006a), the act4teams coding scheme stems from a wide-ranging review of previous studies on teams, interactions, problem-solving processes, and expertise (Kauffeld & Lehmann-Willenbrock, 2012). Built on early coding schemes on group interactions, such as IPA (Bales, 1950) and the Conference Coding System (CCS) (Fisch, 1994), the act4teams coding scheme offers a validated instrument which facilitates the understanding of group interactions (Kauffeld & Lehmann-Willenbrock, 2012). The act4teams coding scheme was developed on the assumption that group interactions can be characterized by negative and positive behaviors (Kauffeld, 2006b). Act4teams distinguishes four different kinds of group interactions, including i) problem-focused statements; ii) socio-emotional statements; iii) procedural statements; and iv) action-oriented statements (Schneider et al., 2018). Socio-emotional statements, procedural statements, and action-oriented statements can be divided into both positive and negative aspects (Kauffeld & Lehmann-Willenbrock, 2012; Schneider et al., 2018). In the work of Kauffeld & Lehmann-Willenbrock (2012), 44 observative categories were identified, as shown in Table 2.

Table 2 Act4teams coding scheme (Kauffeld & Lehmann-Willenbrock, 2012)

Problem-focused statements	**Procedural statements**	**Socio-emotional statements**	**Action-oriented statements**
Problem	**Positive:**	**Positive:**	**Positive:**
Describing a problem	Goal orientation	Encouraging participation	Interest in change
Connections with a problem	Clarifying	Providing support	Taking responsibility
Defining the objective	Procedural suggestion	Active listening	Action planning
Solution	Procedural question	Reasoned disagreement	
Describing a solution	Prioritizing	Giving feedback	**Negative:**
Problem with a solution	Time management	Listening the atmosphere	No interest in change
Connections with a solution	Task distribution	Separating opinions from facts	Complaining
Organizational knowledge	Visualizing	Expressing feelings	Empty talk
Knowing who	Weighing costs/benefits	Offering praise	Seeking someone to blame
Questions	Summarizing		Denying responsibility
		Negative:	Terminating the discussion
	Negative	Criticizing/running someone down	
	Losing the train of thought in details and examples	Interrupting	
		Side conversations	
		Self-promotion	

These categories can be used in compiling statements made in an interaction process. For instance, problem-focused statements aim at understanding problems, resolving problems, or evaluating solutions (Kauffeld & Lehmann-Willenbrock, 2012). Positive procedural statements seek to promote discussions among scholars, such as statements of goal orientation and clarification (Kauffeld & Meyers, 2009). Negative procedural statements are those that may lead to a loss of thought. For instance, lengthy soliloquy and superfluous explanations could result in other participants bewilderment (Kauffeld & Lehmann-Willenbrock, 2012). Socio-emotional statements describe relational interaction between group members

Table 1 A summary of studies on factors motivating online responses

Resource	Research Context	Methodology	Independent Variable	Dependent Variable
Kang (2018)	Naver Knowledge-iN	Online survey Structural equation modeling	Confirmation; Justice w/sites [a]; Justice w/askers [b]; Satisfaction; Perceived self-worth (mediator); Perceived playfulness (mediator)	Continuance intention
Li et al. (2018)	ResearchGate	Web crawled data Regression analysis	Answerer's history; Answerer's academic reputation; Academic-related content characteristics; No-academic content characteristics	Votes of answers
Shi et al. (2018)	MedHelp	Web crawled data Regression analysis	Closeness centrality; Eigen centrality; Subjectivity; Polarity; Communities; Notes; Status; Post; Sentences; Wordcount of content; Wordcount of title	Answer number
Zhe & Jansen (2018)	Weibo.com	Web crawled data Regression analysis	Informativeness; Attractiveness; Urgency; Politeness; Posting Style; Posting time period; Topical category; Activeness; Historical interactions	Response rate
Jin et al. (2017)	Zhihu.com	Web crawled data Regression analysis	Words; Pictures; Followers; Friends; Weibo; Description; Signature; Number of answers the author had written; Number of times questions had been browsed; Time period	Votes of answers
Li et al. (2016)	ResearchGate	Web crawled data Content analysis	Criteria related to content of academic text, sources of text, users' beliefs and preferences, users' previous experience and background, users' situation, text as a physical entity, other information and sources, texts' layouts and structure, social environment	Answer quality
Chua & Banerjee (2015b)	Yahoo! Answers	Web crawled data Content analysis	Level of details, readability, quality and promptness; Answerer reputation; Question types	Answer effectiveness
Li et al. (2015)	ResearchGate	Web crawled data Content analysis Regression analysis	RG scores; Impact points; Inst. RG score; Inst. Impact points; Response time; Answer length; Social length; Consensus building; Factual information; Providing resources; Refer to other researchers; Providing opinions; Providing person experience	Answer quality

Notes: [a] Justice w/sites = Active users' perceived justice with online knowledge-sharing sites; [b] Justice w/askers = Active users' perceived justice with askers.

and include positive and negative statements (Kauffeld & Lehmann-Willenbrock, 2012). Previous research has identified positive socio-emotional statements as a team requirement (Beck & Keyton, 2009). In contrast, disparaging comments about others are categorized as negative socio-emotional statements. Action-oriented statements depict members' willingness to improve their work (Kauffeld & Lehmann-Willenbrock, 2012). Positive action-oriented statements are related to proactive behavior (Frese, Garst, & Fay, 2007). Behaviors such as seeking someone to blame are linked to negative action-oriented statements.

Act4teams has been widely used to analyze interaction behaviors that take place during meetings or discussions (Kauffeld & Lehmann-Willenbrock, 2012; Lehmann-Willenbrock, Meyers, Kauffeld, Neininger, & Henschel, 2011; Schneider et al., 2018). For instance, Kauffeld & Lehmann-Willenbrock (2012) coded interaction data derived from 92 team meetings via the act4teams coding scheme, aiming to understand what makes a team meeting successful. Analyzing videos of software engineering meetings among 32 students, Schneider et al. (2018) explored how proactive and supportive statements affect interactions in these meetings via the act4teams coding scheme as well.

Act4teams has proven to be a useful tool in understanding group interactions. In academic Q&A platforms, questions tend to be posted with descriptions which provide background information and appeal for help. Other scholars will provide answers to help questioners solve specific problems. The online interactions on academic Q&A platforms are group interactions similar to face-to-face group discussion and meetings but happen in the form of virtual group discussion in the online environment. In this study we assume that scholars' online discussion on a specific question is a kind of group interaction, since the scholars form a *de facto* virtual group discussing issues triggered by the same question. Therefore, it is reasonable to employ act4teams, an instrument for analyzing group interactions, to analyze statements in questions and answers on the academic Q&A platforms.

We believe this method can be applied to the context of ASNS to entice useful insights to the online interaction behavior among scholars.

3. Method

Considering its popularity among scholars and its emphasis on discussions (Lin, 2012; Thelwall & Kousha, 2014), ResearchGate was selected to be the research context in this study. ResearchGate only allows users with email addresses affiliated with academic institutions to register, making it appropriate for the current research.

3.1 Data Collection and Coding

Because the knowledge of a field is a prerequisite of conducting content analysis (Jeng et al., 2017), this study selected questions under the label of "Library and Information Science" (LIS) as objects of analysis, which is in line with the professional background of the researchers. In August 2017, we searched for the term "library and information" on ResearchGate, and collected questions from the first 30 pages of retrieval results for further analysis. In the 30 pages, a total of 774 questions were displayed. These 774 questions resulted in a sample size manageable for manual coding. Thereafter, all the questions were studied by two researchers with a LIS background; questions not belonging to LIS and duplicate questions were excluded from the sample. The final sample included 445 questions and 8,457 associated answers. For each question, we collected data regarding titles, descriptions, the number of answers and recommendations of each question, and answers to the questions as well as the amount of recommendations for each answer. A screenshot showing the features of questions and answers on the ResearchGate Q&A platform is offered in Figure 1.

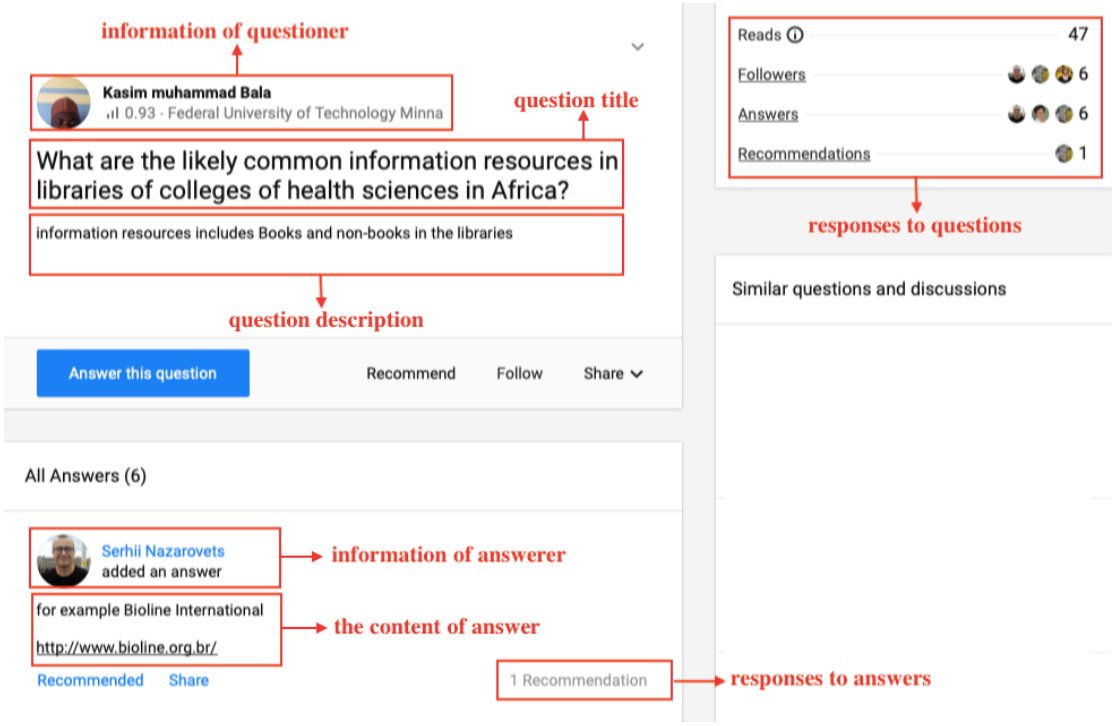

Figure 1: The layout of ResearchGate interface regarding questions and answers

In correspondence to the act4teams coding scheme illustrated in Table 2, we classified the answers into 7 groups, including problem-focused statements, positive procedural statements, negative procedural statements, positive socio-emotional statements, negative socio-emotional statements, positive action-oriented statements, and negative action-oriented statements. Extracted from ResearchGate, examples in our dataset pertaining to each classification are provided, as shown in Table 3.

Table 3 Examples of the classification

Classification	Examples
Problem-focused statements	*"Actually, I think the crucial question is to look at how the current challenges facing librarians."*
Positive procedural statements	*"May I suggest that the real issue here is the 'future "librarian'?"*
Negative procedural statements	*"I would like to help. In this case, I could not."*
Positive socio-emotional statements	*"Thank you, I enjoy reading your comment and clarification very much!"*
Negative socio-emotional statements	*"I must, however, disagree with your rant about multi-author publications."*
Positive action-oriented statements	*"And Matt, thanks for the UK link. I'll also check it out."*
Negative action-oriented statements	*"Of course, further discussion related to this matter is not required."*

3.2 Data Analysis

On the ResearchGate Q&A platform, scholars can follow, read, answer, and recommend a posted question or an answer. Accordingly, in this study, scholars' responses to a question are measured by the numbers of i) recommendations, ii) reads, iii) followers, and iv) answers that the question received, while responses to answers are measured by the number of recommendations obtained from other scholars. Software Nvivo 11 and R were used for content and quantitative analysis, respectively.

As noted above, question descriptions were categorized separately by two research assistants. We measured the inter-rater reliability on the categorization results. If the categorization results from the two coders exhibited poor consistency, the reliability of the results would suffer so Cohen's kappa values were used to quantify the agreement in the coded results between the two coders. The Cohen kappa value for statements made in question descriptions was 0.66, suggesting that the coded results reached a substantial agreement (Viera & Garrett, 2005). Disagreement in the results was later resolved through a discussion between the two coders and a third researcher.

We then coded all the answers via the following six coding steps. First, from a random selection of samples from the pool of 8,457 answers, we created a training data set of 1,000 answers and an evaluation data set of 1,000 answers, and the remaining answers (N = 6,457) were divided into two sets. Second, the training set was coded separately by two research assistants. Each answer was studied and relevant statements were identified. Third, differences in the coding of the training set were resolved through discussions with a third researcher. Through the discussions, a shared common understanding on the way to code was achieved between two coders. Fourth, the evaluation data set of 1,000 answers was coded independently by the two research assistants based on their understanding obtained from step three. In the fourth step, Cohen's kappa values were used to quantify agreement in the coded results of evaluation dataset. The Cohen's kappa value was 0.65, indicating that coding results are reliable (Viera & Garrett, 2005). Fifth, the assistants had a meeting with the third researcher to resolve any differences revealed in the coding results of the set for evaluating. Sixth, each coder categorized the answers in one of the two remaining sets.

We extracted features pertaining to both questions and answers and incorporated these features as precursors of subsequent scholar responses. For questions, the numbers of recommendations, reads, answers, and followers represent the dependent variables of interest (Responses to questions). Concerning answers, we modeled the number of recommendations for each answer (Responses to answers). Tobit regression was employed in the analysis. We deem Tobit regression appropriate for the study because the dependent variables, i.e. the amounts of recommendations, reads, followers, and answers were constructed as non-negative numbers and their values were bounded in range, not following normal distribution (Greene & William, 2003). Tobit regression has been widely employed in past studies in the analysis of similarly censored dependent variables, such as review helpfulness votes (Li, Cui, & Gao, 2015; Zhai, Zhang, Dao, & Li, 2017).

4. Results

4.1 Descriptive Statistics

As mentioned above, the final sample includes 445 questions that garnered 8,457 answers. On average, every question received 19.0 answers (SD = 137.4). In the data, 41 (9.2%) questions received only one answer. In addition, 74.6% of the questions (N = 332) received no more than 10 answers. Noticeably, there are 11 questions receiving 100 or more answers.

In the dataset, 445 questions were posted by 366 scholars. Among these scholars, one user raised 19 questions, accounting for 4.3% of the total questions. Most of the users (89.6% or N = 328) only put forward one question. Among the 8,457 answers collected, we could not locate the answerers' profile information of 24 answers because their profiles were deactivated. Therefore, the 24 answers were removed from our data analysis due to the lack of important information, such as RG scores.

Among the valid 8,433 answers, we found 2,556 unique users. The most active users contributed to 584 (69.3%) answers. On average, a user posted 3.3 answers, although 66.5% (N = 1700) of users contributed to

only one answer. Noticeably, nine users posted over 100 answers, contributing to 2238 (26.5%) answers in the sample.

A Pearson correlation analysis was performed regarding the numbers of followers to a question, answers to a question, reads for a question, and recommendations for a question, as shown in Table 4. All the correlation coefficients were significant at $p< 0.001$(2-tailed). The results show that the number of followers of a question is positively related to its number of answers (r = 0.587, $p< 0.001$), the amount of reads (r = 0.599, $p< 0.001$), and the number of recommendations (r = 0.710, $p< 0.001$). Moreover, the correlation between the amount of answers and reads is positive (r = 0.309, $p< 0.001$); the same applies to the correlation between the amount of answers and the number of recommendations (r = 0.698, $p< 0.001$). There is also a positive relationship between the number of reads and recommendations (r = 0.327, $p< 0.001$).

Table 4 Correlation coefficients of questions' characteristics

	Followers	**Answers**	**Reads**	**Recommendations**
Followers	1			
Answers	0.587***	1		
Reads	0.599***	0.309***	1	
Recommendations	0.710***	0.698***	0.327***	1

Notes: ***Marked figures significant at $p< 0.001$(2-tailed)

Table 5 summarizes the results of a content analysis on statements made in both question descriptions and answers. Specifically, 417 of 445 (93.7%) question descriptions include problem-focused statements. Meanwhile, 103 question descriptions were complemented with positive socio-emotional statements, accounting for 23.1% of all the questions. In addition, 43 (9.7%) positive procedural statements and 24 (5.4%) positive action-oriented statements were found in the question description. Scholars were less likely to describe questions with negative procedural statements, negative socio-emotional statements, and negative action-oriented statements as none of these statements were found in all the questions. This is reasonable as problem-focused, positive socio-emotional, and positive procedural statements are all related to solving a problem effectively, which is in line with the intents of questioners. In contrast, negative statements tend to make other users less likely to respond to questions (Kauffeld & Lehmann-Willenbrock, 2012).

The distribution of different statements derived from the 8,433 answers are offered in Table 5. Problem-focused statements can be widely observed in the sample, appearing in 70.3% (N = 5,929) of the answers, followed by positive socio-emotional statements (N = 2,342, 27.8%). Action-oriented statements (N = 438, 5.2%) were less likely to be posted on the ResearchGate Q&A platform. Only 122 (1.4%) positive action-oriented statements and 316 (3.7%) negative action-oriented statements were found in the answers. Regarding procedural statements, positive procedural statements (N = 1,055, 12.5%) were used more often than negative procedural statements (N = 269, 3.2%).

Table 5 Statistics of statements made in question descriptions and answers

Classification	**Question descriptions**		**Answers**	
	Number	**Percentage**	**Number**	**Percentage**
Problem-focused statements	417	93.7%	5929	70.3%
Positive procedural statements	43	9.7%	1055	12.5%
Positive socio-emotional statements	103	23.1%	2342	27.8%

Positive action-oriented statements	24	5.4%	122	1.4%
Negative procedural statements	0	0	269	3.2%
Negative socio-emotional statements	0	0	362	4.3%
Negative action-oriented statements	0	0	316	3.7%

Note: the number of negative procedural statements, negative socio-emotional statements and negative action-oriented statements are all 0.

4.2 Detecting Questions' Features

The Tobit model statistics indicate a decent goodness of fit with a highly significant likelihood ratio ($p< 0.001$) (Veall & Zimmermann, 1996). The model explains 8.5%, 13.8%, 8.6%, and 6.4% of variances in the numbers of question recommendations, reads, followers, and answers, respectively.

Table 6 displays the results of the Tobit model analysis concerning the responses to questions from scholars. The results indicated that the RG score and squared value of the RG score of questioner (Model I: $\beta = 0.804$, $p< 0.001$; Model II: $\beta = 0.260$, $p< 0.01$; Model III: $\beta = 0.420$, $p< 0.001$; Model IV: $\beta = 0.553$, $p< 0.01$) have significant and positive impacts on the numbers of recommendations, reads, followers, and answers regarding questions.

Question title length has no significant effect on the numbers of question recommendations ($\beta = -0.017^{n.s.}$), followers ($\beta = -0.009^{n.s.}$), and answers ($\beta = -0.011^{n.s.}$), although it negatively affects the amount of question reads ($\beta = -0.019$, $p< 0.1$). The length of question descriptions has negative impacts on the numbers of answers ($\beta = -0.001$, $p< 0.05$) and recommendations ($\beta = -0.001$, $p< 0.1$), even though it exerts no effect on the amounts of question reads and followers.

The presence of problem-focused statements, positive-emotional statements, and positive socio-emotional statements were all found to have no significant impact on the numbers of question recommendations, followers, reads and answers. Nevertheless, question descriptions, including positive action-oriented statements leads to more question reads ($\beta = 0.474$, $p< 0.1$), but have no significant impact on the numbers of question recommendations, followers, or answers.

Because both numeric and categorical variables (including dummy variable processing) are included in the regression model, the generalized variance inflation factor (GVIF) was used to examine the possible multicollinearity issue in the analysis. As shown in Appendix A, the results reveal that multicollinearity is not a concern because the GVIF for the all independent variables were below the suggested threshold of 5.0 (Hair, Anderson, Tatham, & Black, 1998).

In descriptive data analysis, we observed evidence of a threshold effect by plotting the length of question descriptions against other response variables, including the amount of question reads, recommendations, followers, and answers, as shown in Figure 2. As highlighted by the red vertical line in the figure, when the length of a question's descriptive content is beyond a certain threshold (circa 150 words), the amount of question reads, recommendations, followers, and answers will decline sharply. In other words, when the length of question description is very long or longer than a threshold, scholars would prefer not to read the question and are hence less likely to recommend, answer, or follow the question. Therefore, ASNS questioners should control the length of descriptive content of their questions in order to retain other scholars' attention, which is important to trigger more subsequent responses to the question.

Table 6 Tobit analysis results for questions (N = 445) & answers (N = 8433)

Variable	Questions				Answers
	Model I	**Model II**	**Model III**	**Model IV**	**Model V**
	Recommendations	**Reads**	**Followers**	**Answers**	**Recommendations**
constant	-1.117$^{n.s.}$	**536.100*****	**1.516****	**1.735***	**-4975.000**$^{+}$
RG Score^2	**-0.078*****	**-0.038***	**-0.044*****	**-0.059*****	**-0.772*****
RG Score	**0.804*****	**0.260****	**0.420*****	**0.553*****	**2.905*****
Length of a question title / answer	-0.017$^{n.s.}$	**-0.019**$^{+}$	-0.009$^{n.s.}$	-0.011$^{n.s.}$	**-0.237****
Length of question description	**-0.001**$^{+}$	-0.000$^{n.s.}$	-0.001$^{n.s.}$	**-0.001***	-
Problem-focused statements	-0.190$^{n.s.}$	-0.002$^{n.s.}$	-0.062$^{n.s.}$	-0.221$^{n.s.}$	**-1.513*****
Positive procedural statements	-0.183$^{n.s.}$	-0.048$^{n.s.}$	-0.157$^{n.s.}$	-0.329$^{n.s.}$	**3.069*****
Negative procedural statements	-	-	-	-	-0.524$^{n.s.}$
Positive socio-emotional statements	0.195$^{n.s.}$	0.128$^{n.s.}$	-0.064$^{n.s.}$	-0.079$^{n.s.}$	**-1.458*****
Negative socio-emotional statements	-	-	-	-	**-2.269*****
Positive action-oriented statements	-0.031$^{n.s.}$	**0.474**$^{+}$	0.013$^{n.s.}$	-0.071$^{n.s.}$	-0.618$^{n.s.}$
Negative action-oriented statements	-	-	-	-	**2.141*****
Year of when questions or answers were posted			***Control variable***		
Model statistics					
Log likelihood	-474.4(df =18)	-718.9 (df = 18)	-566.6 (df = 18)	-676.5 (df = 18)	-12460.0 (df = 20)
R^2	8.5%	13.8%	8.6%	6.4%	12.4%

Notes: $^{***}p< 0.001$; $^{**}p< 0.01$; $^{*}p< 0.05$; $^{+}p< 0.1$; $^{n.s.}$ = not significant. Because the values of three variables including **Negative procedural statements**, **Negative social-emotional statements**, and **Negative action-oriented statements** are all **0**, there is no points to include them into Tobit regression, we excluded those three variables in our regression.

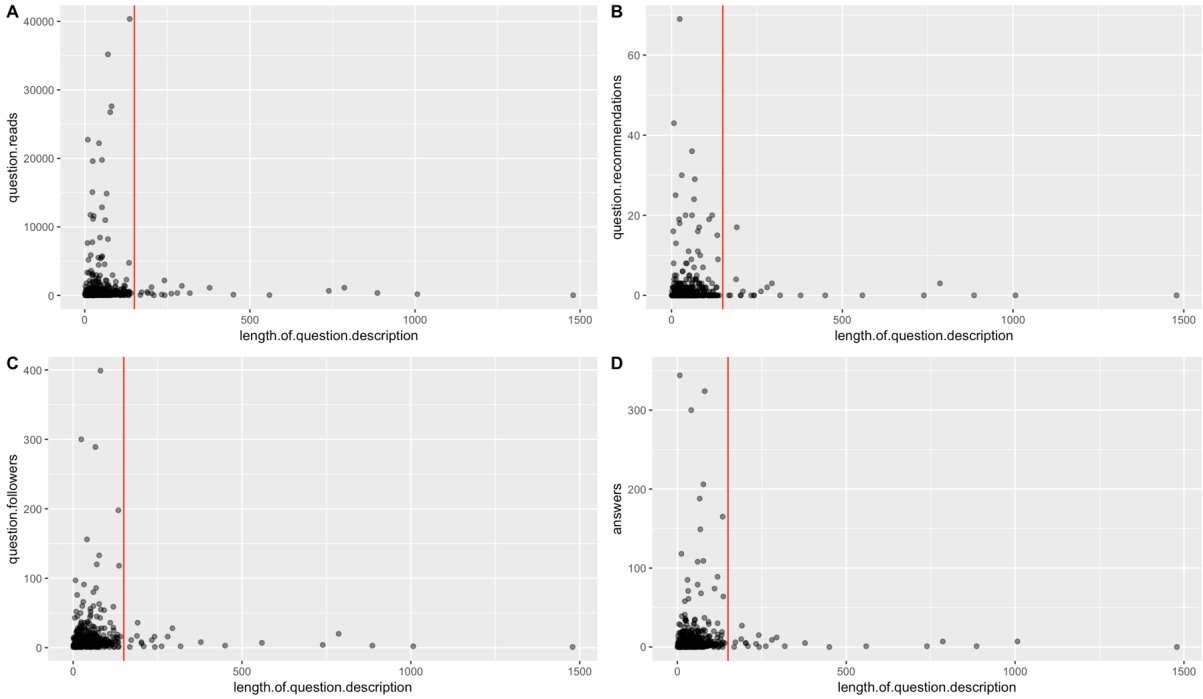

Figure 2: The relationships between the length of question description and different type of responses

4.3 Detecting Answers' Features

To predict the number of recommendations to answers, a Tobit regression analysis was conducted as well, the results of which are shown in Table 6. The model statistics indicate a goodness of fit with a highly significant likelihood ratio ($p< 0.001$) (Veall & Zimmermann, 1996). As shown in Table 6, both linear ($\beta = 2.905$, $p< 0.001$) and squared ($\beta = -0.772$, $p< 0.001$) coefficients of answerers' RG score were significant. In other words, answerers with higher RG scores are likely to receive more recommendations to their answers. On the contrary, the length of answers is negatively related to the number of answer recommendations ($\beta = -0.237$, $p< 0.01$). In addition, answers, including positive procedural statements ($\beta = 3.069$, $p< 0.001$) and negative action-oriented statements ($\beta = 2.147$, $p< 0.001$), are related to more answer recommendations. In contrast, answers with problem-focused ($\beta = -1.513$, $p< 0.001$), positive ($\beta = -1.458$, $p< 0.001$), or negative socio-emotional statements ($\beta = -2.269$, $p< 0.001$) received less answer recommendations. Negative procedural statements ($\beta = -0.524^{n.s.}$) and positive action-oriented statements ($\beta = -0.618^{n.s.}$) have no significant impact on the amount of answer recommendations. The model explains 12.4% of variances in the number of answer recommendations.

5. Discussion

In this study, we employed both qualitative content analysis and statistical analysis to explore the responses to questions based on a pool of 445 questions and 8,433 answers collected from ResearchGate. Applying an act4teams coding scheme, this study sheds light on the statements made online by scholars and their impacts. We found that well-organized descriptions of questions containing positive action-oriented statements are more likely to attract responses from other scholars. Regarding answers to questions, our findings show that answers containing positive procedural statements and negative action-oriented statements are more likely to be recommended by others.

5.1 Statements Made in Questions and Answers

Based on our analysis, we found that scholars tend to make a problem-focused statement in question descriptions when compiling questions on the ResearchGate Q&A platform. This is reasonable as one of the subcategories of problem-focused statements is about describing a problem (Kauffeld & Lehmann-Willenbrock, 2012). We also found that positive socio-emotional statements appeared more often in question descriptions than other kinds of positive statements. The reason for the discrepancies might be that many questioners would like to include socio-emotional statements in question description to encourage others' participation in the academic Q&A activities.

When it comes to statements in answers, our results reveal that problem-focused statements play a key role, which is consistent with the findings of Kauffeld & Lehmann-Willenbrock (2012) in the context of face-to-face interactions. This seems reasonable as problem-focused statements aim at understanding and resolving problem as well as evaluating solutions. When scholars provide answers to questions on ResearchGate, they prefer more problem-focused statements in answers in order to help the questioners and other scholars understand their specific solutions to address the raised problems in questions. For procedural statements, positive statements have stronger impacts than negative statements. However, when it comes to action-oriented statements, negative statements clearly outperform positive statements. This result is consistent with the observations of demotivating action in groups (Kauffeld & Lehmann-Willenbrock, 2012). One explanation might be that negative action-oriented statements, such as complaining, can cause discussions to spiral into a complaining cycle, in which each querulous statement is chasing the next (Lindsley, Brass, & Thomas, 1995).

5.2 Features of Questions

In this study, some features of questions were found to affect the responses to questions.

Firstly, we found that the length of the question titles and the question descriptions have no effect on motivating followers. In contrast, the length of question description is negatively related to the amounts of answers and recommendations. This finding is inconsistent with the research finding of Zhe & Jansen (2018) that individuals prefer to answer longer questions on the generic social Q&A site, such as Sina Weibo. The discrepancy might be explained by the different research context in this study. As mentioned above, there are obvious distinctions between academic social Q&A and generic social Q&A platforms. Interestingly, when a question description contains more than circa 150 words, the question does not receive high numbers of reads, followers, recommendations, or answers. One possible explanation might be that scholars' time and efforts on ResearchGate is relatively limited and less than on generic social Q&A sites, and a longer question description refrains scholars from reading the questions as it will take them more time and efforts on reading it.

Secondly, our results show that questioners' RG scores have positive effects on triggering other scholars' responses. Questions posted by scholars with high RG scores are more likely to attract other scholars to follow, answer, read, and recommend questions. One possible explanation would seem to be that RG scores indicate users' scholarly reputation and popularity on the platform (Yan, Zhang, & Bromfield, 2018). In other words, a more reputable and popular scholar can make a stronger impact than those who are less known in the community, and this applies to the impacts of their questions as well. Another reason might be that responses to questions are influenced by the questioners' RG scores indirectly. Because users tend to follow researchers with high RG scores, when a scholar with a high RG score posts a question, more ASNS users will also notice the question as followers of this scholar.

Thirdly, regarding the statements made in question descriptions, we found that only positive action-oriented statements have a positive relationship with the number of reads. One possible explanation could be that positive action-oriented statements include planning concrete actions. On ResearchGate, the questions raised by scholars normally will be more complex compared to the questions from generic social Q&A sites and need specific knowledge in a field to answer these questions. Those questions with more positive action-oriented statement will encourage responses from other scholars on ResearchGate as positive action-oriented statement is beneficial for group interactions, particularly when solving complex problems (Gollwitzer & Sheeran, 2006). This finding is consistent with the report that positive action-oriented statements have a positive impact on face-to-face interactions (Kauffeld & Lehmann-Willenbrock, 2012). It seems that positive action-oriented statements play a key role in improving group interactions not only in face-to-face interactions but also in online interaction.

5.3 Features of Answers

Concerning the precursors of recommendations to answers, we found that scholars' RG scores exert a significant influence. It is likely that answers from those with high RG scores are of a better quality and thus deserve to be recommended. Investigating the quality of academic answers on ResearchGate, Li et al. (2015) also noted that good answers tend to relate to high RG scores. Furthermore, scholars tend to recommend answers with fewer words. However, Li et al. (2018) found that high-quality answers in Library and Information Science is positively associated with the length of answers when exploring the characteristics of high-quality academic answers on ResearchGate. This inconsistency may be partially attributed to a small sample size of only 353 answers from LIS in the research of Li et al. (2018). Another reason might be that Li et al. (2018) mainly investigated the high-quality answers, and answers with more explanation and longer length of answers might make users perceive the answers to be with high-quality. In this study we focused on the recommendations to answers. Scholars would recommend answers with words as they might think that scholars prefer to read short but not long answers.

In addition, only positive procedural statements and negative action-oriented statements are positively related to the number of recommendations to answers. The use of statements, such as clarifying, visualizing, and summarizing, in group-interaction was positively related to recommendations from other scholars. This is consistent with prior studies, which report that positive procedural statements help avoid negative interaction process (Kauffeld & Lehmann-Willenbrock, 2012). On ResearchGate, if the answers to questions contain clear goals to help address problems raised in questions and clarify how to do with solutions, other scholars might think the answers should be useful to other scholars and would like to recommend the answers to other scholars for their future use of the knowledge in their research. Contrary to the findings of Kauffeld & Lehmann-Willenbrock (2012), we observed that negative action-oriented statements were positively linked to recommendations. While the study of Kauffeld & Lehamann-Willenbrock (2012) investigated face-to-face interactions, our study focused on online interactions. In face-to-face interaction, the negative action-oriented statements can lead to the end of the interaction. However, on ResearchGate, the group interaction can continue via recommendations of the answers to others even though there are negative action-oriented statements in answers. The negative action-oriented statements in answers means that the answers provide sufficient knowledge and information in the solutions to address the problems raised by questioners and no further actions are needed to check the solutions. Thus, scholars think that the knowledge provided in the answers might be useful for others, and would recommend the answers to others.

6. Implications and Limitations

Our study contributes to a number of new theoretical insights. First, it provides a new perspective to study the impacts of questions and answers on Q&A platforms. As noted earlier, prior research dominantly focused on studying the features of information or information providers, while paying little attention to the impacts of the statements made by users. This study is among the first to explore the impacts of statements in motivating scholars to respond to questions and answers. In addition, the impact of the statements on online responses varies between questions and answers. Our data found that positive action-oriented statements are more likely to garner subsequent responses (such as reads) to questions while positive procedural statements and negative action-oriented statements seem more likely to attract online responses (such as recommendations) to answers. Furthermore, this study applied act4teams to understand group interactions in the context of ASNS. As stated earlier, act4teams is normally used in studying interactions of face-to-face meetings or online teams (Kauffeld & Lehmann-Willenbrock, 2012; Schneider et al., 2018). In this vein, this study extends the application of act4teams to the research context of ASNS. Following the act4teams code schema, some features of questions and answers were found to lead to responses, such as reads to questions and recommendation of answers.

Our findings offer a number of practical implications to promote scholars' interactions online regarding questions and answers. Firstly, when describing questions, it is important for questioners to limit the number of words to no more than 150. In addition, adding positive action-oriented statements in a question is an effective way to attract other scholars. Secondly, providing suggestions to questioners on how to organize question descriptions might strengthen the impacts of questions. Thirdly, for answerers, it is important to control the length and exercise concision so that other scholars will be more likely to recommend the answer.

There are several limitations to this study. To begin with, act4teams coding scheme includes categories from distinct dimensions but making them exclusive. As a result, a conflict could be produced during data analysis because coders have to code one statement in only one category. Next, act4teams coding system was developed for specific contexts such as problem-solving and decision-making. Therefore, findings in this study may not be generalized to other forms of online group interactions. In addition, our study only focused on the RG score of questioners and answers without considering social relationships of users. For instance, the numbers of followees and followers of a scholar who participates in questions could be taken into consideration in a future study. Finally, our findings are based on ResearchGate, which may not be generalizable to other ASNS. Therefore, it would be interesting to compare ResearchGate with other ASNS regarding the mechanism that drives scholars to interact.

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Appendix A. GVIF among independent variables

variables	Question				Answer
	Model I Recommendation	Model II reads	Model III followers	Model IV answers	Model V Recommendation
RG Score^2	2.718	2.426	2.426	2.447	3.303
RG Score	2.810	2.472	2.472	2.495	3.415
Length of a question (or an answer)	1.064	1.065	1.065	1.065	1.087
Length of a question description	1.046	1.035	1036	1.040	-
Problem-focused statements	1.214	1.172	1.173	1.173	2.106
Positive procedural statements	1.109	1.093	1.094	1.091	1.460
Negative procedural statements	-	-	-	-	1.066
Positive socio-emotional statements	1.054	1.059	1.058	1.057	1.531
Negative socio-emotional statements	-	-	-	-	1.073
Positive action-oriented statements	1.170	1.157	1.157	1.155	1.011
Negative action-oriented statements	-	-	-	-	1.181
Year of a question (or an answer)	1.221	1.195	1.195	1.194	1.416