How to promote students to share more knowledge with peers?

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Abstract. Education experts are trying to encourage students to contribute knowledge among them through online peer assessment so as to enhance the understanding of knowledge. As an online knowledge community, peer assessment will also fail due to the reluctance of students to return the favor and share knowledge. Many studies on this topic have highlighted the importance of contribution of knowledge for students which forms a virtuous feedback loop for the impression of knowledge. However, it is unclear how what influences its development. Motivated by this, this study explored why students contribute knowledge to others through online peer assessment. Empirical panel count data were collected from Peer review platform. The results from a negative binomial regression model with user fixed effects indicate that student's peer recognition and organization interaction have a positive impact on his knowledge-contribution behaviors. The findings can help guide the development and operation of peer assessment.

1. Introduction

In the past decade, teaching evaluation is outstanding in the field of teaching. Various online peer assessment systems have been applied in numerous domains, including education science, science projects, and webpage design.[1, 2] Web-based Peer assessment that combine web technologies are thought to greatly enhance community interactivity for their student. Evaluation is no longer limited to the evaluation of products and individual progress and it requires students to possess high-level thinking skills such as developing, analyzing, and solving problems rather than memorizing outcomes. [3, 4] A particularly critical way of evaluation is peer assessment.[5] Peer assessment can stimulate deeper learning and produce better learning outcomes.[6] The role of students has also changed from a passive subject to an active student, who practice self-learning and assessment tasks in the process.

One of the key determinants of a successful online community is the active participation of its members in community activities to create and share knowledge.[7, 8] However, studies have shown that knowledge sharing in peer assessment continues to be an area that is under-researched compared to the other processes in web-based peer assessment.[9] The factors that influence the success of online peer assessment are insufficiently understood despite many researchers have investigated peer assessment can facilitate knowledge contributing among students. Although numerous studies have emphasized the significance of motivation to share knowledge in various online communities,[6] the influence factors on knowledge contributing in peer assessment is rarely examined. The factors of students to share knowledge differ from other online knowledge communities because peer assessment is distinctly characterized, and they provide unique task knowledge. The goal of peer assessment is to share and address task problems and to allow students gain support from their classmates. The students of peer assessment primarily desire to gain non-monetary rather than monetary benefits. At the same time, because of the complex interests among students, they are required to participate in the assessment anonymously. This differs from some online communities where people benefit by gaining monetary rewards or reputation.[10, 11]

The success of online peer assessment in contributing knowledge requires that the students be responsible in contributing their knowledge by suggestions, since some student would rather withhold knowledge than share it with others.[12] Some people like sharing their knowledge to help others, while some expect to benefit from others.[3] Therefore, identifying the influencing factors affecting knowledge contributing behavior through online peer assessment would help us choose and implement the right tools to encourage students to contribute their knowledge, which is beneficial for students.[13] Therefore, the main purpose of this study is to identify influencing factors that affect students sharing knowledge based on peer assessment. The remainder of this study is organized as follows. In Section 2, we review the literature on knowledge sharing and propose hypotheses. Section 3 introduces the research data corpus and the variables to test the hypotheses. Section 4 presents the model for data analysis and results. A discussion of the results, as well as limitations and future research, are in Section 5.

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2. Theoretical foundations and research hypotheses

2.1. Theoretical foundations

The great success of knowledge contribution on online communities has attracted many researchers to explore the theories behind it. Social cognitive theory, social capital theory, and social exchange theory have been frequently mentioned in previous studies.[14, 15] In peer assessment community, student behavior is a product of multiple influence. As students may contribute their knowledge based on a strong motivator such as reciprocity,[16] Social cognitive theory, social capital theory, and social exchange theory could provide valuable insights for explaining the contexts under which individuals may decide either to engage in knowledge contributing behaviors or to withhold their knowledge.[17] As major students of social exchange in peer assessment, student's behavior may significantly influence their classmate behavior and, in particular, their assessment behaviors.

Over the past fifty years, social exchange theory has been continuously developed, expanded, and revised. It can be defined as an exchange, whether tangible or intangible, between at least two parties, offering varying rewards. It is extensively applied to analyze and predict organizational or group behavior. This theory underscores that information sharing is a form of social interaction among students. Unlike economic exchange theory, which prioritizes external interests, social exchange theory values intrinsic rewards. The benefits of social exchange highlight non-specific obligations that cannot be quantified physically. Consequently, social exchange often engenders feelings of belonging, personal responsibility, gratitude, trust, and loyalty. Therefore, social exchange tends to produce feelings a sense of belonging, personal responsibility, gratitude, trust and loyalty. Social capital theory posits that social relationships within a society can serve as valuable resources.[15] Social capital is described as "the sum of the actual and potential resources that are embedded in, available through, and derived from the network of relationships an individual or a social unit possesses." This theory is distinct from other social theories in that it is rooted in interpersonal relationships and is commonly divided into three productive clusters: structural, relational, and cognitive.[18] Based on the principles of learning within a social context, social cognitive theory [14] differs from most behavioral and social theories that concentrate on isolated factors affecting individual or group behavior. Social cognitive theory focuses on reciprocal determinism in the interplay between students and their environments, asserting that human behavior results from the combination of individual, organizational, and environmental influences. It encompasses five categories: individual psychological determinants, observational learning, self-regulation, moral disengagement, and environmental determinants.

2.2. Research model and hypotheses

In order to explore factors of knowledge contributing behaviors in peer assessment, we draw on the social cognitive theory, social capital theory, and social exchange theory to conceptualize a research model for this study (see Fig. 1). We hypothesize that perceived reciprocal benefit, perceived enjoyment, perceived status, outcome expectation, and the power of knowledge are some of the main factors that influences knowledge contributing among students via online peer assessment.

Knowledge self-efficacy or competence is considered to be the judgements of students regarding their capabilities to organize and execute courses of action required to achieve specific levels of performance.[19] Knowledge self-efficacy or competence can help motivate individuals to contribute knowledge with others.[20] Most knowledge communities encourage members to provide information to others, and the knowledge self-efficacy members in the knowledge communities considered to be the understanding of knowledge.[21] When people find that they have a good understanding of knowledge, they will have more confidence in their personal social status and value, which improves their involvement in the organization. Considering that their knowledge abilities are recognized, people are more willing to share what they believe to be valuable in order to achieve self-worth and realize their potential. Previous studies have also suggested and confirmed that there is a positive correlation between knowledge sharing and self-worth. But In online peer assessment community, whether students with higher self-worth are willing to contribute more knowledge to others has not been justified. Therefore, we propose the following assumptions:

H1a. Knowledge self-efficacy has a positive impact on general knowledge contributing behavior in online peer assessment.

H1b. Knowledge self-efficacy has a positive impact on specific knowledge contributing behavior in online peer assessment.

According to social exchange theory, an exchange relationship can involve both economic resources and socio-emotional resource.[17] Reciprocity behavior has been highlighted as a benefit of students engaging in social exchange and reciprocal benefits has been recognized as an important factor affecting knowledge contributing. Reciprocal creates and maintains exchange relationships, which in turn may lead to the sharing of good quality knowledge.[22] For example, when reciprocal benefits exist between individuals and organization, the students believe that the community can provided the benefits they expect, they are more willing to contributing their resources to communities. This means that the higher the degree of reciprocal benefits, the more likely it is that students will be willing to share their knowledge with other members in the organization.[20] The following hypotheses are proposed:

H2a. Reciprocal benefits has a positive impact on general knowledge sharing behavior in online peer assessment.

H2b. Reciprocal benefits has a positive impact on specific knowledge sharing behavior in online peer assessment.

Reciprocity theory suggests that feedback from other members, particularly positive feedback from peers, impacts a user's future engagement within a community.[18] Research has demonstrated that the contributions made by members are significantly influenced by the recognition they anticipate from others.[23] It has been noted that newcomers who receive positive feedback are more inclined to persist in sharing their knowledge within the community.[24] In peer assessment communities, tasks submitted by students are subjected to a range of evaluations by their peers. These evaluations can range from critical reviews to commendations. Individuals who receive expressions of gratitude are more motivated to contribute their knowledge and increase their involvement in the community. Consequently, we propose the following hypothesis:

H3a: Peer recognition has a positive impact on general knowledge contributing behavior in online peer assessment.

H3b: Peer recognition has a positive impact on specific knowledge contributing behavior in online peer assessment.

Interactive activities such as communication and discussion among students are significantly related to knowledge contribution behaviors.[25] Numerous studies have corroborated that student interactions positively influence knowledge sharing.[25] Within peer assessment communities, students are required to complete course tasks, necessitating communication and discussion through organized interactions. These organized interactions offer students opportunities for receiving suggestions and feedback for task refinement, serving as a key motivator for establishing peer assessment communities. Additionally, these communities help alleviate feelings of isolation, fostering a learning environment that enhances interaction and equips students for advanced studies. By contributing their knowledge on tasks, individuals seek acknowledgment from peers, which fosters mutual trust within the community.[26] Consequently, contributing knowledge within peer assessment settings becomes even more critical to facilitate or benefit from organized interactions. Hence, we propose the following assumptions:

H4a. Organization interaction has a positive impact on general knowledge sharing behavior in online peer assessment.

H4b. Organization interaction has a positive impact on specific knowledge sharing behavior in online peer assessment.

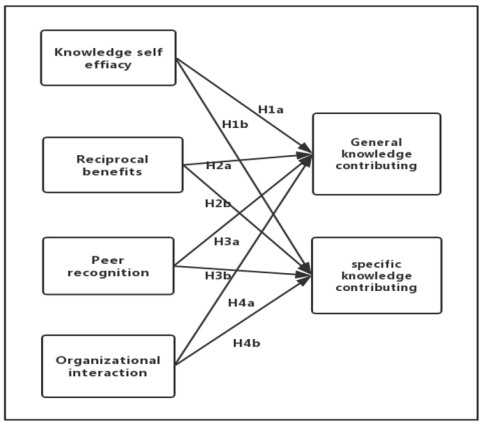

Fig. 1. Research framework

3. Data and methods

3.1. Data collection

Our final corpus contains 1762 data points composed of 84 users' knowledge-contribution behaviors. Java and C languages are used in the study, which introduces applications of computer programming in enterprises, organizations and individual use. The course aims to develop students' ability to learn the process that leads from an original formulation of a computing problem to executable computer programs. This is a two credit, 9 weeks (''mini-semester'') course. For each course, after training students on peer code review, the course teacher creates a certain number of assignments (12 assignments in both cases of this research) with medium difficulty and schedules them at specific intervals (one week on average in this research). The due time of each assignment should be carefully managed by teachers to assure learning quality and prevent students from being too tired and nervous. As part of the course's tasks, students were asked to submit tasks and perform peer assessment via Peer review platform—a web-based on-line assessment and knowledge sharing system, described in the following.

3.2. Measures

As discussed before, there is a dependent variable, knowledge contribution, and four latent independent variables, knowledge self-efficacy, reciprocal benefits, peer recognition, organizational interaction (see Table1).

In Peer review platform, students have two main roles, the solver and questioner. As solver, individuals can contribute suggestions to others. Therefore, the user's number of suggestions is the most variable to measure his knowledge contribution to the peer assessment community. In this article, we use the number of suggestions provided by student to represent his knowledge contribution.

Knowledge self-efficacy. In peer assessment, knowledge self-efficacy is reflected in the course score,

and each member will be tested to assess their knowledge. This test takes the same form as the online task in Peer review platform, a java programming case that is considered by students to represent their understanding of the course knowledge. We adopt a student's test score as score to represent a user's sense of self-worth, which is the score in the JAVA test.

Reciprocal benefits. if individuals believe they can obtain reciprocal benefits from other others by sharing their knowledge, they are more likely to have a high knowledge sharing intention. In Peer review platform, knowledge of equal value form others is considered to be reciprocal benefits. When students receive knowledge provided by others, he can determine his or her knowledge contribution behavior based on other party. We therefore employ the number of knowledge to represent the reciprocal benefits of knowledge contributors in Peer review platform.

Peer Recognition. When individuals contribute a suggestion, he expects responses, especially positive responses.[18] In Peer review platform, students who provided task may receive praise from other members. We therefore employ the number of praise to measure the scale of positive feedback received by a member.

Organizational interaction. Online communities give people a platform in the process of knowledge seeking. In peer assessment, students can instantly comment on knowledge with providers or others. In Peer review platform, registered members can argue with knowledge providers or recipients based on topics, questions, and members that they are interested. We therefore employ the number of communication between members to represent the organizational interaction.

The results of the matrix of correlation coefficients between variables is less than 0.6, and does not cause multi-collinearity problem when performing regression analysis.

Table 1. Variable description

Variable name	Measure item	description
Knowledge provided	*General Knowledge provided*	The number of *General* knowledge comments provided by student
	Specific Knowledge provided	The number of *Specific* knowledge comments provided by student
Knowledge self-efficacy	*Score*	Test score of student
Reciprocal benefits	*General Knowledge received*	The number of *General* knowledge comments received from student
	Specific Knowledge received	The number of *Specific* knowledge comments received from student
Peer recognition	*Praise*	The number of praise for student
Organizational interaction	*Communication*	The number of communication between members

4. Analyses and results

Knowledge contribution, as dependent variable, is the number of comment provided by students. All the dependent variables are non-negative integers. Although they differ in assumptions of the conditional mean and variance of the dependent variable , both negative binomial regression models and Poisson regression models are designed to analyze the count data. The Poisson regression models assume that the conditional mean is equal to the variance. Negative binomial regression model does not assume that the mean and variance are equal, and introduce a parameter to correct for over-dispersion when the variance is greater than the conditional mean in the data.[27] Therefore, this study adopts the negative binomial regression model to explore students' knowledge contribution behaviors in online peer assessment communities.

Table 2 demonstrates the results of two count panel data regression models, the negative binomial regression model of general knowledge. Similar to the linear regression model, the effect of the independent variable on the dependent variable is determined by the regression coefficient. The positive (negative) sign of the regression coefficient indicates that the independent variable has a positive (negative) impact on the dependent variable. As is shown under the coefficient column of the negative binomial regression results in Table 2, praise and score are positively correlated to students' knowledge contribution behaviors at same significance levels ($p<0.01$). Hypothesis 1a and hypothesis 1b investigate the impact of knowledge self-efficacy on knowledge-contribution behaviors. We argue that knowledge self-efficacy has a positive impact on general knowledge contributing behavior and specific knowledge contributing behavior in online peer assessment. In this paper, the student's test score is employed to represents knowledge self-efficacy in online peer assessment communities. Contrary to our expectations, the empirical results indicate that the coefficient is not significant, both for general knowledge and specific knowledge. Therefore, hypothesis 1a and 1b are rejected. Hypothesis 2a and hypothesis 2b investigate the effect of reciprocal benefits on knowledge-contribution behaviors. We argue that reciprocal benefits have a positive impact on general knowledge sharing behavior and specific knowledge contributing behavior in online peer assessment. In peer assessment communities, reciprocal benefits refer to other users' knowledge contribution. Contrary to our expectations, the empirical results indicate that the coefficient is not significant, both for general knowledge and specific knowledge. Therefore, hypothesis 2a and 2b are rejected. Hypothesis 3a and hypothesis 3b investigates the impact of the peer recognition effect on knowledge-contribution behaviors. We argue that peer recognition has a positive impact on general and specific knowledge contributing behavior in online peer assessment. In this paper, peer recognition represents other members' responses to student's knowledge contribution. The regression results indicate that the coefficient for peer recognition is positive and significant ($p < 0.001$), both for general

knowledge and specific knowledge. Therefore, hypothesis 3a and hypothesis 3b are supported; others members' feedback has a positive impact on general and specific knowledge contributing behavior in online peer assessment. Hypothesis 4a and hypothesis 4b investigates the impact of the organizational interaction effect on knowledge-contribution behaviors. We argue that organizational interaction has a positive impact on general and specific knowledge contributing behavior in online peer assessment. In this paper, organizational interaction represents the scale of communication between students. The regression results indicate that the coefficient for organizational interaction is positive and significant ($p < 0.001$), both for general knowledge and specific knowledge. Therefore, hypothesis 4a and hypothesis 4b are supported; organizational interaction has a positive impact on general and specific knowledge contributing behavior in online peer assessment.

Table 2. Negative binomial regression n result when General knowledge contribution is used as the dependent variable

	General knowledge provided		*Specific knowledge provided*	
	Coef.	Sig	Coef.	Sig
General Knowledge received	-0.0		0.003	
Specific Knowledge received	-0.006		-0.003	
Praise	0.022	***	0.034	***
Communication	0.062	***	0.061	***
Score	-0.021		0.047	
N	*1762*		*1762*	
Pseudo R^2	*0.05*		*0.05*	

*** p<0.01, ** p<0.05, * p<0.1

5. Discussion

The main aim of this study is to identify the factors affecting students' intention to contribute knowledge with others in peer assessment community. Based on social cognitive theory, social capital theory, and social exchange theory, this paper reveals that students' peer recognition, and organizational interaction play important roles in knowledge-contribution behaviors. The empirical data were collected from Peer review platform, and negative binomial regression was employed to test the proposed hypotheses. The empirical results indicate that other members' recognition and organizational interaction have a positive impact on knowledge-contribution behaviors.

Contrary to prior studies, our empirical results indicate that the knowledge self-efficacy and reciprocal benefits is not significant. This suggests that the knowledge self-efficacy and reciprocal benefits are not significant factors for students in contributing knowledge in peer assessment. There are some reasons for this ''unexpected'' result. As an assessment course, student's assignments in Peer review platform will be recorded. If students perceive that knowledge contributing reduces their competitiveness within the class, they will not contribute their knowledge, whether it is general knowledge or specific knowledge. Unlike online social media communities, students in the online peer assessment community are anonymous. Most students of social media communities are encouraged to provided personal information, which distinguishes student from others. Establishing one's identity in social media communities is seen as an important motivation for knowledge contribution for students, not only helping them improve reputation and self-esteem, but also expanding the possibility of future reciprocity. The students spend time and effort to contribute knowledge and answer each other's' questions, and they expect that they will benefit from it and expect other students to contribute their respective ideas in kind. Therefore, the reduction in the expectation of perceived reciprocal benefit will weaken them to contribute knowledge.. The anonymity of the online peer assessment community reduces the likelihood of students reciprocity in the future, and as a result, the reciprocal benefits do not affect the knowledge contribution as we expected. In addition, unlike social media where students voluntarily participate in knowledge contributions, such as Facebook, Quora and Zhihu, the peer assessment community as a mutual evaluation community for JAVA study, all students who choose this course are forced to participate in the knowledge contribution in Peer review platform. Therefore, knowledge contribution may only be regarded as an assignment or task for JAVA course, and students will not be fully engaged in community interactions. Despite their strong knowledge self-efficacy, they lack the enthusiasm and will not promote their knowledge-contributing behavior, both for general knowledge or specific knowledge.

Regarding peer recognition and organization Interaction, the empirical results indicate that the recognition from other students and communication between students related to the outcome of knowledge contributing, highlighting the fact that students expected recognition and the importance of interaction among students. It indicated that peer recognition and organization Interaction are not weakened by the anonymity of community and "forced" participation. The results showed that frequent communication between students affected their knowledge contributing behavior, which indirectly encouraged the feeling of participation. Another possible explanation is that frequent communication and interaction between students

enhances the perception of identity, which is weakened during the anonymous assessment process. These findings are supported by some studies, which reported that students who engage in knowledge contributing within social media communities have outcome expectations, such as such as gaining peer recognition, elevating their level of knowledge, making new acquaintances. When their expectations are realized, they will be more willing to contribute knowledge in virtual communities. Overall, the results of this study enhanced understanding of why students contribute knowledge to others on peer assessment communities, and therefore raise the considerations for educators to strengthen and change their respective practices.

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