HOW DOCTORAL STUDENTS AND GRADUATES SHARE KNOWLEDGE IN ACADEMIC VIRTUAL COMMUNITIES: A STRUCTURAL EQUATION MODELING ANALYSIS

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ABSTRACT

This study investigates the factors that influence the sharing behaviours of academic community members and examines academic community members’ willingness to share a mediating role. This study selects 224 individuals from Renmin University of China’s Economy Forum. It employs exploratory and confirmatory factor analyses to design measurement models and investigate the data. A structural equation model is developed to explore the mechanism that influences knowledge-sharing behaviour in academic virtual communities. Altruistic behaviour and community atmosphere clearly have positive effects on the willingness to share. A community atmosphere has clear positive effects on sharing behaviour. The willingness to share has clearly positive effects on sharing behaviour. Compared with other professions, the impact of altruistic behaviour, community atmosphere and self-efficacy on willingness to share and the impact of willingness to share on sharing behaviour are more evident for economic management professionals.

Key words: Virtual Communities; Knowledge Sharing; Altruistic Behaviour; Self-Efficacy; Community Atmosphere


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1. INTRODUCTION

The term “virtual community” was introduced by Howard Rheingold in his book The Virtual Community in 1993. In 2000, Rheingold stated that a virtual community is a network of interpersonal relationships formed after a group of community members establishes sufficient public discussions on the internet that are sustained for a long
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period of time. A virtual community has the features of free expression, a lack of concentrated controls, many-to-many transmissions, and voluntary behaviours. As an efficient carrier or platform for sharing information and knowledge, a virtual community represents a new method and mode of communication. The virtual community model has been regarded as an efficient method for promoting knowledge sharing. Knowledge sharing is defined as sharing personal and organizational knowledge with other members via various communication methods. Academic virtual communities provide a convenient path or environment for their community members to acquire knowledge. Moreover, they facilitate members’ knowledge sharing at a low cost. Studies have demonstrated that knowledge sharing is the central purpose of members’ participation in community activities (Shih, Tsai, Wu, & Lu, 2006). Therefore, virtual communities have gradually become an important platform for community members to discuss and share their knowledge because the service is fast and convenient and includes a wide variety of members.

Recently, virtual communities have developed rapidly in conjunction with the widespread use of the internet and continuous improvements in information technology. An increasing number of scholars have become accustomed to discussing and resolving academic issues within academic virtual communities. Knowledge sharing in virtual communities has also attracted academic attention. Duan, Huang, and Yang (2014) employed social resource exchange theory to study the effects of trust on knowledge sharing from the perspectives of emotion, position, and information. Their results reveal that emotional trust has positive effects on collecting and contributing knowledge, whereas cognitive trust has positive effects on knowledge collection. Wang and Yang (2012) explored the relationships among trust, team interaction, and knowledge sharing in a study on research teams. They reported that trust and team interactions have positive impacts on knowledge-sharing behaviours and that team interactions play a mediating role between trust and knowledge sharing.

There are fundamental differences between the factors that influence knowledge sharing in virtual and real communities. Academic virtual communities have provided interactive social networks for individuals who are separated by time and space. They also facilitate their community members’ efforts to learn, communicate, and share their knowledge. Studies have found that factors that influence knowledge-sharing behaviours via the internet include the willingness to share, self-efficacy, and altruistic behaviours. Hsu, Ju, Yen, and Chang (2007) stated that the self-efficacy of community members has both direct and indirect positive effects on knowledge-sharing behaviours. Li and Liu (2014) employed a structural equation model (SEM) to study the relationship between trust and the willingness to share knowledge among community members. They found that trust has direct and indirect positive impacts on the willingness to share knowledge. Lin, Hung, Chen (2009) found that reciprocal factors have clearly negative impacts on article-posting behaviour. In other words, the greater the extent to which community members expected reciprocal results, the less likely they were to share knowledge. Zhang and Zhou (2010) found that self-efficacy, outcome expectancy, and the willingness to share have clear positive effects on knowledge-sharing behaviours in academic virtual communities. Li (2013) stated that the willingness to share, trust, reciprocity, and altruistic factors influence knowledge-sharing behaviours. Chang and Chuang (2011) studied the impacts of individual motivation and social capital theory on knowledge-sharing behaviours in virtual communities. Hsu, Teresa, Yen, and Chang (2007) discussed the factors that influence knowledge-sharing behaviours in virtual communities from the perspectives of the
individual and the environment. Kong (2009) analysed the factors that influence knowledge sharing in virtual communities and proposed a knowledge-sharing mechanism for virtual communities. Zhou and Lu (2009) studied the roles of obeying, accepting, and internalizing knowledge-sharing behaviours among virtual community members using social influence theory.

Peter (1986) stated that interpersonal social exchanges begin with social attraction. If one community member receives useful information or knowledge from another, the two will continue to cooperate with one another. Xu and Ye (2011) applied social cognitive theory and social exchange theory as their basis for studying the factors that influenced knowledge sharing in virtual communities. They divided knowledge-sharing behaviours in academic virtual communities into reviewing, posting articles (establishing a topic), and responding to articles (participating in discussions). Zhang, Zhu, and Huang (2014) systemically described the dimensions and critical features of academic virtual communities with Web 2.0. They further explored two critical technologies, the element model and dynamic knowledge combination scheduling, and knowledge-sharing process. De Ridder (2006) found that the search for knowledge is one of the major drivers of knowledge sharing and that the more knowledge an individual acquires, the greater his willingness to contribute knowledge. Chowdhury (2005), however, studied the mechanisms underlying the effects of trust and emotion on knowledge sharing and argued that their effects differ. Ng and Chua found that the relationship between cognitive trust and cooperative behaviour is non-linear. Within a certain scope, cognitive trust enhanced community members’ potential for cooperation, whereas excessive cognitive trust resulted in so-called “free ride” behaviours, which reduced members’ willingness to cooperate.

To date, studies have primarily focused on the factors that influence knowledge sharing among virtual community members, which primarily include trust and reciprocity. In addition, scholars have developed models to study knowledge-sharing behaviours based on social cognitive theory and social exchange theory. However, for academic virtual communities with strong professional traits, studies are scarce. In addition, most previous studies have used qualitative analysis, whereas quantitative analysis in this domain has not attracted much academic attention.

The current study selected academic communities that are relatively more professional in character as its research objects and collected data from academic community members. Structural equation modelling (SEM), a popular quantitative method in the literature, was employed to investigate and analyse the collected data. In academic communities, the effects of self-efficacy, altruistic behaviours and community atmosphere on knowledge-sharing behaviours were empirically investigated. In addition, the willingness to share was assumed to play a mediating role when studying academic community members’ internal psychological activities. The study provides suggestions and strategies for the standardization and popularization of academic communities.
2. RESEARCH HYPOTHESES

2.1 ALTRUISTIC
The word “altruistic” was first proposed by Auguste Comte, a French sociologist. Comte employed the term to refer to a selfless act performed by one community member towards other members. Network altruism refers to a type of voluntary behaviour that has no obvious selfish motives and is implemented in a network environment, which will benefit others while bringing losses on oneself. “Material loss” refers to the network expense, time, effort, virtual network currencies, and other resources that one spends in helping others. There are six forms through which altruistic behaviours are expressed online: technical services, information consultations, online resources, spiritual support, game support, and social assistance. Altruistic behaviours among academic virtual community members include providing information to other members, uploading online resources, and supplying technical support. Therefore, altruistic behaviours directly influence the willingness to share and sharing behaviours. As a result, the following hypotheses were proposed:

H1: Altruistic behaviours have direct positive effects on the willingness to share knowledge.

H2: Altruistic behaviours have direct positive impacts on knowledge-sharing behaviours.

2.1.1. Community atmosphere
In this study, atmosphere was defined as a high-level individual environment with specific roots and its own characteristics. Shang, Ai, and Wang (2012) stated that a community atmosphere is a positive, long-lasting social environment that promotes interpersonal communications to share knowledge among community members and that a community atmosphere has clear positive impacts on sharing behaviours. Li (2013) proposed the notion of an internet community atmosphere, defined as an internet community with its own behavioural characteristics and content structure. Different communities often exhibit different characteristics. Therefore, the following hypotheses were developed:

H3: A community atmosphere has direct positive impacts on the willingness to share knowledge.

H4: A community atmosphere has direct positive impacts on knowledge-sharing behaviours.

2.1.2. Self-efficacy
Self-efficacy was first proposed in the 1970s by Albert Bandura, a psychologist at Stanford University in the United States, and it became a crucially important concept in the field of education in the mid-20th century. Self-efficacy is defined as the personal capability to complete certain actions in certain situations. In virtual communities, self-efficacy has been shown to actively affect the willingness to share and sharing behaviours. The self-efficacy of community members has direct and indirect positive effects on the willingness to share and sharing behaviours (Hsu et al, 2007). Members who are committed to contributing information to their organizations are likely to be willing to provide and acquire knowledge (Lin, 2007). Self-efficacy is closely related to knowledge sharing (Cabrera, Collins, & Salgado, 2006). As a result, the following hypotheses were proposed:
H5: Self-efficacy has direct positive impacts on the willingness to share.
H6: Self-efficacy has direct positive impacts on sharing behaviours.

2.2 WILLINGNESS TO SHARE
Willingness is the individual expectation of completing an action, the subjective feasibility of a behaviour, or the best latent variable for predicted behaviours. As previous studies have demonstrated, the willingness to share allows knowledge sharing to become an efficient tool for managing knowledge, and sharing generates benefits for participants. Therefore, reinforcing the willingness to share within an organization, establishing reasonable, tacit knowledge communication, and providing a platform to facilitate knowledge transfer considerably enhances organizational knowledge creation (Mládková, 2012). Joseph and Jacob (2011) defined the willingness to share as the degree to which individuals subjectively believe that they actively or voluntarily share their knowledge; this willingness directly influences organizational knowledge sharing. The essence of knowledge sharing involves enhancing an organization’s core capabilities via tacit knowledge exchange. Seba, Rowley, and Lambert (2012) proposed that willingness to share should be further enhanced through conventional cognitive approaches. Additionally, the relationship between communication and knowledge sharing is a major topic in the field of knowledge management. Among specific groups of community members, the willingness to share has been found to exert an important influence on sharing behaviours. Based on the aforementioned findings, the following hypothesis was proposed:

H7: The willingness to share has direct positive impacts on knowledge-sharing behaviours.

Based on the aforementioned hypotheses, the theoretical framework can be depicted by the linear model shown in Fig. 1.

Figure 1 Theoretical framework of job involvement
Academic virtual communities are one type of socialized online platform for sharing information. They provide a convenient platform for community members to acquire knowledge and improve their academic perspectives. Academic virtual communities have helped their members to acquire knowledge, expand their academic perspectives, improve their scientific research capabilities, and discuss academic issues. This study selected an in-school community as its research subject and formulated a model to measure knowledge sharing in virtual communities by reviewing studies and interviews. The study also developed SEMs for knowledge sharing in virtual communities and empirically analysed related knowledge-sharing issues.

3. METHODS

3.1 PARTICIPANTS
To address our research aims, this study considered academic virtual community members as research subjects and employed a random sampling method to solicit responses to the structural questionnaire. To guarantee the reliability of the sample, a community with a large number of participants was selected as the group to which questionnaires would be administered. The sample data were collected at the Renmin University of China’s Economy Forum. A total of 243 questionnaires were received, of which 227 were valid, for an effective response rate of 92.18%. The respondents’ demographic distribution in this study indicated that males and females accounted for 61.6% and 38.4% of the sample, respectively. Those aged between 20 and 25, 25 and 30, 30 and 35, and above 35 accounted for 65.6%, 20.8%, 6.8%, and 6.8% of the sample, respectively. With respect to majors, business management, science and engineering, arts, and other majors accounted for 69.2%, 24.4%, 5.2% and 1.2% of the sample, respectively.

3.2 MEASURES
Taking academic virtual communities as the research background, this study investigated the relationship between the knowledge-sharing willingness and sharing behaviour of virtual community members and explored the influencing factors of members’ knowledge-sharing willingness and sharing behaviour and the influencing mechanism of willingness to share on sharing behaviour. The development processes of the measurement scale can be described as follows:

(1) Sharing behaviour and willingness to share. This study combined studies on related knowledge sharing at home and abroad and extracted the major factors that influence the sharing behaviour of community members. In light of the particularity of academic virtual communities, these factors were categorized and analysed, and representative problems were extracted to compile corresponding items.

(2) Offline open questionnaire and forum. Respondents were selected for the investigation and forum from undergraduates and young teacher groups who had a relatively high rate of using academic virtual communities. They were required to list factors that might stimulate or inhibit their active participation in knowledge sharing. By means of summarization, factors with relatively high frequency were identified and compiled.

(3) Online posting. By means of authoritative academic virtual communities such as www.emuch.net and www.pinggu.org, discussion topics were posted. Through the
follow-up discussions by community members, the influencing factors of sharing behaviour were summarized.

(4) Expert interview. Through consultations with experts in organizational behaviour and academic community administrators, the influencing factors of sharing behaviour identified in the three ways discussed above were further developed and extracted.

The created questionnaire included a scale, demographic statistic items and the virtual community experience. The measurement scale for undergraduates’ knowledge sharing in virtual communities contained 18 items, including five factors: self-efficacy, altruistic behaviours, community atmosphere, willingness to share and sharing behaviours. The questionnaire used a 6-point Likert-type scale. The answers to each question fell within one of six categories: “totally disagree”, “mostly disagree”, “somewhat disagree”, “somewhat agree”, “mostly agree”, and “totally agree” (1 = “totally disagree” to 6 = “totally agree”).

3.3 PRE-SURVEY
To guarantee the reliability and validity of the questionnaire, this study also developed a pre-survey. Considering that the postgraduate and young teacher groups were relatively active in academic virtual communities, 160 postgraduates and young teachers were randomly selected from colleges and universities in Shandong Province as the pre-survey sample. In the sample, males accounted for 56.2% and females accounted for 43.8%. Those who were under 25 years old, between 25 and 35, and above 35 accounted for 16.8%, 76.2% and 17% of the sample, respectively.

With the pre-survey data, a reliability analysis was conducted using SPSS 20.0. The results showed that the overall Cronbach’s α coefficient of the scale was 0.912 and that the Cronbach’s α coefficients for altruistic behaviour, community atmosphere, self-efficacy, willingness to share and sharing behaviour dimensions were 0.825, 0.803, 0.911, 0.872 and 0.810, respectively. The overall reliability of the questionnaire and each dimension’s reliability coefficient were above 0.7, indicating good measurement reliability.

SPSS 20.0 was employed to conduct an exploratory factor analysis of the pre-survey data. The chi-square statistically significant probability derived by the overall Bartlett test of sphericity of the questionnaire was 0.00. The KMO value was 0.934, which was greater than 0.9; therefore, the data were suitable for the factor analysis. In the process of conducting an exploratory factor analysis of each dimension, a rotation factor analysis based on the Equamax method was conducted. The results indicated that all the indices converged into five valid factors whose eigenvalues were greater than 1. Finally, five factors were chosen, self-efficacy, community atmosphere, altruistic behaviours, willingness to share and sharing behaviours, with 15 watch variables. Among these factors, altruistic behaviours included watch variables C14, C15 and C17; community atmosphere included C3, C4 and C5; self-efficacy included C7, C8 and C9; willingness to share included C1, C2 and C6; and sharing behaviours included C12, C16 and C18. The load factors of watch variables for each dimension were all greater than 0.7, indicating that the variables had rather good convergent validity.
4. RESULTS

4.1. CONFIRMATORY FACTOR ANALYSIS

This study employed SEM to explore and analyse the factors that influenced knowledge-sharing behaviours in academic virtual communities.

To ensure the validity of the measurement, we conducted the confirmatory factor analysis (CFA) and compared the goodness of fit of the four models (Table 1), namely, the default model (the meditational model), the single-factor model (all the items converging on one single dimension), the three-factor model (incorporating the dimensions of self-efficacy, altruistic behaviours and community atmosphere), and the four-factor model (incorporating willingness to share and sharing behaviour). The results indicated that for the default model, $\chi^2/df=2.214$, GFI=0.904, CFI=0.953, PGFI=0.603, RMR=0.073, RMSEA=0.073, all reaching the critical level, whereas the GFI's of the other three models did not reach the acceptable level. Compared with the other three models, the default model had a better goodness of fit. The GFI's of the single-factor model all reached the critical level. However, the sample data could not match the single-factor model; that is, the single-factor model could not account for all the variances. According to the test method of the Harman single-factor common method variance (Ardichvili, Page, & Wentling, 2003), the sample data did not have the problem of obvious common method variance.

Table 1 CFA model fit

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\chi^2/df$</th>
<th>GFI</th>
<th>CFI</th>
<th>PGFI</th>
<th>RMR</th>
<th>RMSEA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default model</td>
<td>177.12</td>
<td>80</td>
<td>2.214</td>
<td>0.904</td>
<td>0.953</td>
<td>0.603</td>
<td>0.073</td>
<td>0.073</td>
<td>0.00</td>
</tr>
<tr>
<td>Single-factor model</td>
<td>2163.1</td>
<td>105</td>
<td>20.60</td>
<td>0.263</td>
<td>0</td>
<td>0.158</td>
<td>0.473</td>
<td>0.294</td>
<td>0.00</td>
</tr>
<tr>
<td>Three-factor model</td>
<td>238.3</td>
<td>85</td>
<td>2.80</td>
<td>0.871</td>
<td>0.925</td>
<td>0.617</td>
<td>0.089</td>
<td>0.089</td>
<td>0.00</td>
</tr>
<tr>
<td>Four-factor model</td>
<td>205.3</td>
<td>82</td>
<td>2.504</td>
<td>0.892</td>
<td>0.940</td>
<td>0.609</td>
<td>0.125</td>
<td>0.082</td>
<td>0.00</td>
</tr>
<tr>
<td>Critical value</td>
<td>1–3</td>
<td></td>
<td>&gt;0.9</td>
<td>&gt;0.9</td>
<td>&lt;0.6</td>
<td>&lt;0.08</td>
<td>&lt;0.08</td>
<td>&lt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

4.2. ANALYSIS OF RELIABILITY AND VALIDITY

According to the factor analysis results, the factor load and average variance extracted (AVE) are shown in Table 2. According to Fomell and Larker (1981), when the AVE is greater than or equal to 0.5, the measurement model has good convergent validity. The model’s AVE values were between 0.577 and 0.731, all greater than 0.5; therefore, the default model had good convergent validity. The CR values of the model dimension were between 0.801 and 0.891, all greater than 0.7; therefore, the model had good construct reliability.

SPSS 20.0 was employed to conduct a reliability analysis of the questionnaire’s Cronbach’s $\alpha$ coefficient, showing the overall Cronbach’s $\alpha$ coefficient to be 0.893. The Cronbach’s $\alpha$ coefficients for the altruistic behaviour, community atmosphere, self-efficacy, willingness to share and sharing behaviour dimensions were 0.84, 0.854, 0.902, 0.883 and 0.786, respectively. The questionnaire’s overall reliability and each dimension’s reliability coefficient were above 0.7, indicating good measurement reliability.
Table 2 Validity index of the default model

<table>
<thead>
<tr>
<th>Item</th>
<th>Altruistic behaviours</th>
<th>Community atmosphere</th>
<th>Self-efficacy</th>
<th>Willingness to share</th>
<th>Sharing behaviours</th>
<th>AVE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>C14</td>
<td>0.819</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.577</td>
<td>0.802</td>
</tr>
<tr>
<td>C15</td>
<td>0.661</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.601</td>
<td>0.818</td>
</tr>
<tr>
<td>C7</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>0.838</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.726</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>0.757</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td></td>
<td>0.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td></td>
<td>0.874</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td></td>
<td>0.776</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td></td>
<td></td>
<td>0.893</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td>0.787</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C18</td>
<td></td>
<td></td>
<td>0.851</td>
<td></td>
<td></td>
<td>0.58</td>
<td>0.801</td>
</tr>
<tr>
<td>C16</td>
<td></td>
<td></td>
<td>0.833</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C12</td>
<td></td>
<td></td>
<td>0.568</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3. CORRELATION ANALYSIS

SPSS 20.0 was selected to analyse various dimensions to determine their true correlations. The results are summarized as follows (Table 3).

Table 3 Significance values of measurement model

<table>
<thead>
<tr>
<th>Path relationship</th>
<th>Estimate</th>
<th>S.E.</th>
<th>C.R.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing behavior ←−community atmosphere</td>
<td>-0.461</td>
<td>0.225</td>
<td>-2.045</td>
<td>*</td>
</tr>
<tr>
<td>Sharing behavior ←−altruistic behavior</td>
<td>0.637</td>
<td>0.195</td>
<td>3.26</td>
<td>**</td>
</tr>
<tr>
<td>Sharing behavior ←−self-efficacy</td>
<td>-0.41</td>
<td>0.255</td>
<td>-1.608</td>
<td>0.108</td>
</tr>
</tbody>
</table>

Note: *** p<0.001, ** p<0.01, * p<0.05 (two-sided test). C.R.: critical ratio, S.E.: standardized estimates.

The correlation coefficient of self-efficacy and the willingness to share was 0.891, which was clearly statistically significant at 0.001. The correlation coefficient of self-efficacy and sharing behaviour was 0.134, which was not significant. The correlation coefficient of community atmosphere and sharing behaviour was 0.878 at the 0.001 significance level. The correlation coefficient of community atmosphere and sharing behaviour was -0.057 at the 0.01 significance level. The correlation coefficient of altruistic behaviour and willingness to share was 0.866, statistically significant at the 0.01 level. The correlation coefficient of altruistic behaviour and sharing behaviour was -0.035, which was significant at the 0.05 level. The correlation coefficient of sharing willingness and sharing behaviour was 0.113, significant at the 0.01 level.

Based on correlation analysis, the aforementioned correlation coefficients were clearly statistically significant at the 5% level, except for self-efficacy. Moreover,
self-efficacy and altruistic behaviour were negatively correlated with sharing behaviours.

According to the correlation analysis, there was a correlation among the willingness to share and sharing behaviours and altruistic behaviours, community atmosphere, and self-efficacy. Regarding the structural relationship between the willingness to share or sharing behaviours and other factors, AMOS 20.0 was selected for a confirmatory factor analysis to develop the SEM for further discussion.

4.4. STRUCTURAL MODEL

The CFA results indicated that the default model had quite good goodness of fit and had a better fit with the data and that the model could be employed to analyse the structural relationship between variables. AMOS 20.0 was used for the valuation operation to derive the path coefficients and significance (Figure 2 and Table 4, respectively). The parameter estimation results showed that the standard path coefficients for the effects of altruistic behaviours, community atmosphere and self-efficacy on the willingness to share were 0.275 (C.R.=3.062, P<0.01), 0.284 (C.R.=3.251, P<0.01), and 0.455 (C.R.=5.600, P<0.001), respectively. Altruistic behaviours, community atmosphere and self-efficacy had significant positive impacts on the willingness to share; therefore, H1, H3 and H5 were supported. The standard path coefficients for the effects of altruistic behaviours, community atmosphere and self-efficacy on sharing behaviours were -0.543 (C.R.=-2.725, P<0.01), -0.527 (C.R.=-2.724, P<0.01), and 0.075 (C.R.=0.365, P=0.715), respectively. Both altruistic behaviours and community atmosphere had a significant negative impact on sharing behaviours, whereas self-efficacy had no significant impact on sharing behaviours; therefore, H2, H4 and H6 were not supported. The standard path coefficient of the impact of the willingness to share on sharing behaviours was 0.941 (C.R.=2.824, P<0.01), and willingness to share had a significant positive impact on sharing behaviour; therefore, H7 was supported.

Figure 2 Path coefficient analysis of the structural equation model

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Table 4 Significance values of the structural equation model

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>S.E.</th>
<th>C.R.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness to share &lt;--- altruistic behavior</td>
<td>0.5</td>
<td>0.063</td>
<td>7.966</td>
<td>***</td>
</tr>
<tr>
<td>Willingness to share &lt;--- community atmosphere</td>
<td>0.418</td>
<td>0.073</td>
<td>5.731</td>
<td>***</td>
</tr>
<tr>
<td>Willingness to share &lt;--- self-efficacy</td>
<td>0.253</td>
<td>0.085</td>
<td>2.96</td>
<td>**</td>
</tr>
<tr>
<td>Sharing &lt;--- willingness to share</td>
<td>0.982</td>
<td>0.384</td>
<td>2.559</td>
<td>*</td>
</tr>
<tr>
<td>Sharing behavior &lt;--- community atmosphere</td>
<td>-0.736</td>
<td>0.239</td>
<td>-3.076</td>
<td>**</td>
</tr>
<tr>
<td>Sharing behavior &lt;--- altruistic behavior</td>
<td>-0.046</td>
<td>0.233</td>
<td>-0.199</td>
<td>0.842</td>
</tr>
<tr>
<td>Sharing behavior &lt;--- self-efficacy</td>
<td>-0.574</td>
<td>0.22</td>
<td>-2.609</td>
<td>**</td>
</tr>
</tbody>
</table>

Note: *** p<0.001, ** p<0.01, * p<0.05 (two-sided test).

Partial Least Squares (PSL) is suitable for the model processing of small-sample latent variables. Therefore, this study used smartPLS3 to conduct a group analysis of the SEM of sharing behaviour according to the gender and professional background of academic virtual community members.

4.4.1. Analysis of gender groups

As indicated in Table 5, in academic virtual communities, a rather large difference existed between male and female community members in terms of the relationships among altruistic behaviour, community atmosphere, self-efficacy, willingness to share and sharing behaviour. With a 5% confidence level, the influence effect of altruistic behaviour and community atmosphere and the self-efficacy of male community members on willingness to share was significant; the standard path coefficients were 0.337, 0.372 and 0.197, respectively. The influence effect of altruistic behaviour, community atmosphere and self-efficacy and willingness to share on sharing behaviour was not significant. With a 5% confidence level, the influence effect of altruistic behaviour of female community members on willingness to share was significant; the standard path coefficient was 0.625. The influence effect of community atmosphere and self-efficacy on willingness to share was not significant. The influence effect of community atmosphere and willingness to share on sharing behaviour was significant; the standard path coefficients were -0.371 and 0.623, respectively, whereas the influence effect of altruistic behaviour and self-efficacy on sharing behaviour was not significant.

Table 5 Analysis of gender groups

<table>
<thead>
<tr>
<th>Path</th>
<th>AL→WB</th>
<th>CA→WB</th>
<th>SE→WB</th>
<th>AL→SB</th>
<th>CA→SB</th>
<th>SE→SB</th>
<th>WB→SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.</td>
<td>0.337</td>
<td>0.372</td>
<td>0.197</td>
<td>0.176</td>
<td>0.218</td>
<td>0.274</td>
<td>0.223</td>
</tr>
<tr>
<td>P</td>
<td>0</td>
<td>0</td>
<td>0.004</td>
<td>0.327</td>
<td>0.189</td>
<td>0.074</td>
<td>0.155</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.E.</td>
<td>0.625</td>
<td>0.172</td>
<td>0.128</td>
<td>-0.021</td>
<td>-0.371</td>
<td>-0.222</td>
<td>0.623</td>
</tr>
<tr>
<td>P</td>
<td>0</td>
<td>0.126</td>
<td>0.075</td>
<td>0.93</td>
<td>0.014</td>
<td>0.184</td>
<td>0</td>
</tr>
</tbody>
</table>
How Doctoral Students and Graduates Share Knowledge in Academic Virtual Communities: A Structural Equation Modeling Analysis

4.4.2. Analysis of professional background groups

In terms of the relationship among altruistic behaviour, community atmosphere, self-efficacy and willingness to share and sharing behaviour in academic virtual communities, both an economic management professional background and a non-economic management professional background have an important influence on the willingness to share and sharing behaviour of community members. Relatively speaking, the altruistic behaviour, community atmosphere and self-efficacy of community members with an economic management professional background had a significant influence on willingness to share, and the influence of willingness to share on sharing behaviour was also significant. For community members who were non-economic management professionals, only the paths of altruistic behaviour and self-efficacy on willingness to share passed the significance test.

As indicated in Table 6, for community members who were economic management professionals, with a 5% confidence level, the influence of altruistic behaviour, community atmosphere and self-efficacy on willingness to share passed the significance test, with path coefficients of 0.542, 0.112 and 0.253, respectively. The influence of community atmosphere on sharing behaviour passed the significance test with a path coefficient of -0.262. The influence of willingness to share on sharing behaviour passed the significance test with a path coefficient of 0.307. With a 5% confidence level, the influence of altruistic behaviour and self-efficacy on sharing behaviour did not pass the significance test. For non-economic management professionals, with a 5% confidence level, the influence of altruistic behaviour and self-efficacy on willingness to share passed the significance test with path coefficients of 0.412 and 0.146, respectively, whereas other influencing paths were not significant.

Table 6 Analysis of professional background groups

<table>
<thead>
<tr>
<th>Path</th>
<th>AL→WB</th>
<th>CA→WB</th>
<th>SE→WB</th>
<th>AL→SB</th>
<th>CA→SB</th>
<th>SE→SB</th>
<th>WB→SB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Management Professionals</td>
<td>S.E.</td>
<td>0.542</td>
<td>0.112</td>
<td>0.253</td>
<td>0.153</td>
<td>-0.262</td>
<td>-0.411</td>
</tr>
<tr>
<td>P</td>
<td>0</td>
<td>0</td>
<td>0.011</td>
<td>0.207</td>
<td>0.006</td>
<td>0.246</td>
<td>0.003</td>
</tr>
<tr>
<td>Non-economic Management Professionals</td>
<td>S.E.</td>
<td>0.412</td>
<td>0.371</td>
<td>0.146</td>
<td>0.173</td>
<td>-0.379</td>
<td>-0.134</td>
</tr>
<tr>
<td>P</td>
<td>0</td>
<td>0.459</td>
<td>0.034</td>
<td>0.47</td>
<td>0.215</td>
<td>0.061</td>
<td>0.084</td>
</tr>
</tbody>
</table>

5. DISCUSSION AND CONCLUSIONS

This paper chose members of virtual academic communities as research subjects. Through questionnaires distributed in the virtual community network, data were collected, and a SEM was constructed for the influencing factors of community members’ sharing behaviours in virtual communities. The paper analysed the impacts of altruistic behaviours, community atmosphere and self-efficacy on virtual academic community members’ willingness to share and sharing behaviours. The empirical results of this study have important theoretical and practical implications, as shown below.

(1) In virtual communities, altruistic behaviours are key factors for community members’ willingness to share knowledge and knowledge-sharing behaviours. According to the definition of altruistic behaviour in a virtual network by Wang et al. (2004), the “material loss” introduced by sharing knowledge in a virtual community is mainly manifested in terms of time consumption. Such consumption always occurs during leisure time and may produce non-material rewards, such as a certain level of
psychological self-satisfaction or a realization of self-value. Therefore, for virtual community members, altruistic behaviour in the network can promote their willingness to share knowledge.

(2) Community atmosphere has a positive impact on community members’ willingness to share knowledge and a significant negative impact on their sharing behaviours. However, the results of Shang (2009) show just the opposite, indicating that a favourable community atmosphere can simultaneously promote community members’ willingness to share and inhibit their sharing behaviours. These results might occur because there are sufficient reference resources in communities with good atmospheres; thus, many community members will wait for others to offer them resources. This type of mentality is quite prevalent, which might mean that community members eventually sit idle and enjoy the fruits of others’ labours.

(3) In a virtual community, self-efficacy has a significant positive impact on members’ willingness to share, but it has no significant impact on sharing behaviours. According to conclusions reached by Ardichvili et al. (2003), community members with low self-efficacy are always unwilling to share their own knowledge with others. In a virtual academic community, however, timely and effective communication between community members is lacking, and the desired effect cannot be achieved after the knowledge is shared, which may result in a low sense of achievement. In the long run, community members with high self-efficacy will not take the initiative to contribute knowledge.

(4) In a virtual community, there is rather strong consistency between the willingness to share knowledge and sharing behaviours ($\beta=0.941$). The willingness to share knowledge plays a partial mediating role in the impact of altruistic behaviours, community atmosphere and self-efficacy on knowledge-sharing behaviours. This result shows that there is a certain distance between community members’ willingness to share knowledge and the actual knowledge-sharing behaviours that it generates. As Joseph and Jacob (2011) note, the essence of knowledge sharing involves improving the organization’s core capacity by transmitting and sharing the organization’s implicit knowledge, and a good community atmosphere and community members’ altruistic behaviours play obvious roles in facilitating community members’ willingness to share and sharing behaviours. However, to make virtual academic members put their willingness to share knowledge into action, it is necessary for virtual community administrators to increase community members’ sense of self-efficacy after they share knowledge through material and non-material means, such as community member bonuses or the establishment of a hierarchical system.

(5) Significant gender differences exist in the willingness to share and sharing behaviour of academic virtual community members. First, altruistic behaviour of both males and females has a significant positive influence on willingness to share. However, the degree of influence for females ($\beta=0.625$) is significantly higher than that for males ($\beta=0.337$). Second, community atmosphere and self-efficacy have a significant positive influence on males’ willingness to share, whereas their influence on females’ willingness to share is not significant. Third, willingness to share has a significant positive influence on female sharing behaviour, whereas its influence on male sharing behaviour is not significant.

(6) A significant difference exists in terms of profession with regard to the willingness to share and sharing behaviour of academic virtual community members. Altruistic behaviours of both economic management professionals and non-economic management professionals have a significant positive influence on willingness to
share. However, the degree of influence for economic management professionals ($\beta=0.542$) is higher than the degree of influence for non-economic management professionals ($\beta=0.412$). Self-efficacy has a significant positive influence on willingness to share. However, in terms of the degree of influence, the self-efficacy of economic management professionals ($\beta=0.253$) is higher than that of non-economic management professionals ($\beta=0.146$). Community atmosphere has a significant positive influence on the willingness to share of economic management professionals, but it does not have such an influence on the willingness to share of non-economic management professionals. Community atmosphere and willingness to share have a significant positive influence on the sharing behaviour of economic management professionals, whereas their influence on the sharing behaviour of non-economic management professionals is not significant.

Considering academic communities as the area of interest, the current study employed SEMs to empirically analyse community members’ knowledge-sharing behaviours. This study makes the following novel contributions.

(1) This study employs empirical analyses to investigate academic community members’ knowledge-sharing behaviours. Previous studies have focused on knowledge sharing, but their quantitative analyses are insufficient. Therefore, empirical research has yet to be fully exploited to study academic community members’ knowledge-sharing behaviours.

(2) The willingness to share is accorded a mediating role to establish SEMs for knowledge sharing in academic communities. Moreover, this approach systematically reveals the motivation for and psychological mechanisms of academic community members’ knowledge-sharing behaviours.

(3) The results of this study demonstrate that the community atmosphere and community members’ self-efficacy have indirect effects on knowledge-sharing behaviours in academic communities. Moreover, they have positive effects on the willingness to share. The willingness to share moderates the relationships between community atmosphere and self-efficacy and knowledge-sharing behaviours. In addition, altruistic behaviour does not have a positive effect on academic community members’ willingness to share or sharing behaviours.

The present study referred to previous studies and interviews to determine its research variables and employed a pre-test to modify its questionnaire. The research model fit the data well, with certain factors more closely related than others. Nonetheless, there are limitations as this cross-sectional study could not determine strict causality. Further analyses could overcome such limitations by focusing on the aforementioned phenomenon when selecting a given group. In addition, due to its nature, the self-rating questionnaire employed in this study may include common method bias. Employing certain statistical techniques could alleviate these disadvantages in future studies. Only altruistic behaviour, community atmosphere, and self-efficacy were investigated here; however, there are many other factors that could influence knowledge sharing. Future research could study those factors. For example, community members’ sharing behaviours could be investigated based on various psychological and environmental factors.
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How Doctoral Students and Graduates Share Knowledge In Academic Virtual Communities: A Structural Equation Modeling Analysis


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