

# **Undergraduates' Electronic Resources Diffusion at the Peking University: an Exploration on Language Impacts**

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## **ABSTRACT**

Most studies on Chinese academic resource selection have used a qualitative approach, focusing on issues such as resource distribution and accessibility. To fill the research gap, we analyze the responses of 190 undergraduate students of the Peking University to a questionnaire survey, revealing various academic resources' access methods, usage frequency, and access obstacles, while exploring underlying factors affecting resources usages with a focus on the language impacts. Further, the application of innovation diffusion model to study the utilization of library electronic resources is novel.

Our findings showed that open-shelf books, electronic journals, and open access resources were highly utilized because of their high quality. Electronic resources was displacing printed resources. Based on Bass's innovation diffusion model, diffusion of different electronic resources among undergraduate students fitted well with the S-curve, though with significantly different slopes, i.e., significantly different diffusion rate between English and Chinese resources. In particular, difficulties in accessing Western databases was identified because of students' limited information literacy and language ability.

## **Keywords**

Academic resources, Chinese undergraduate students, accessibility, innovation diffusion, electronic resources, language impact

## 1. INTRODUCTION

Universities and colleges in China have been making efforts to enrich their academic resources with a library-centered mode, focusing on hardware construction and resources acquisition, while often overlooking the actual utilization. This results in a considerable gap between the collections and students' practical need of academic resources. In addition, the difficulty of accessing academic resources and students' limited knowledge of accessing such resources means that many academic resources are under-utilized. Therefore, it is necessary to investigate college students' information need of academic resources, determine the current status and problems of under-utilization, identify influencing factors, and provide recommendations for improvement.

As such, the objectives of this study were to: (a) reveal the usage characteristics of different academic resources, (b) investigate the current displacement effect between electronic and printed resources, and (c) explore the innovation diffusion process of undergraduate students' usage of electronic academic resources. Further, during our study, a very interesting theme emerged: the impact of language (Chinese vs English) ranging all the way from need, adoption, to diffusion, which has been rarely reported in the literature for major universities in the East. Therefore, this is chosen as the focus of this paper.

Most studies on Chinese academic resource selection have used a qualitative approach, focusing on issues such as resource distribution and accessibility. Few studies have investigated empirically in Chinese undergraduate students' resource usage patterns focusing on the causes and consequences of usage, with a quantitative method. Further, the application of innovation diffusion model to study the utilization of library electronic resources, especially employed as a lens to explore language impacts, is novel.

## 2. Theoretical background

Studies on access to academic resources access usually apply the theory of information access. For academic resource classification and access, Zhao (2008) divided the resources into printed resources and electronic resources by the information carrier, and provided further classification scheme, including books, serials, and special literatures. Scholars have examined the uses of these resources from different perspectives.

Based on the study of users' practical needs, some scholars indicated a series of factors (e.g., Wang, 2001; Qiu, 2006; Cui, 2008; Xiong and Zhang, 2009). These viewpoints of the factors can be summarized as: personal information literacy, wide user-scope, and characteristics of user information needs, such as diversification,

high-quality requirements, personalization, and self-support (Wang, 2001). From the perspective of information environment, Xiong and Zhang (2009) defined other facts, such as information overload, information hysteresis, low automatic indexing accuracy, unguaranteed coverage rate, inaccuracy precision in information retrieval, poor information retrieval services, and limited search functions. These obstacles to information access discovered in various research has motivated us to re-examine academic resource access in a holistic manner.

There are not much work on applying the diffusion of innovations theory in Library and Information Science research. One early attempt of can be traced back to the work of Minishi-Majanja and Kiplang'at (2005), who explored the use of information and communication technologies in some doctoral research projects. Walton (2014) found students in a US liberal arts institution indicated leisure reading, research, forced adoption, and convenience were positive factors in their choice to use an e-book, while in-class reading was a negative factor. Walton treated e-book as an innovation and applied some elements of diffusion of innovations in the study. But these work did not attempt to fit the S-curves according to the original Bass Diffusion Model (Bass, 1969) as described in the next paragraph.

In the study of the technological innovation diffusion process, one of the earliest contribution is Bass Diffusion Model, in which he offered a method to fit a curve for the innovation diffusion process. Later, Granovetter (1983) built a weak-chain advantage theory, which suggested that in innovation networks, individuals with similar characteristics tended to form a small faction, and the weak-type chains are the sides linking these individuals in different factions. Rogers (1995, p.5) defined diffusion as "a process by which an innovation is communicated through certain channels over time among the members of a social system". He also proposed the four main elements that influence the spread of an innovation: the innovation itself, communication channels, time, and a social system. The four elements contained the innovation of technologies, tools, knowledge and ideas, as well as the process and conditions of information transmission, the innovation persuasion and acceptance. In the innovation diffusion process, the acceptance rate appeared as the 'S' curve. With the above theories and models, we designed a survey study and created fit curves to find out the situations and problems in undergraduate students' access to academic resources, with a special focus on the language impact.

### **3. Hypotheses and methods**

#### **3.1 Hypotheses Formulation**

Based on literature review and a preliminary interview with students, we proposed the following hypotheses:

**H1: Undergraduate students have consistent preferences in academic resources.**

For printed and electronic-based academic resources, we believe that undergraduate students have consistent preferences. They prefer open-shelf storage, Chinese electronic journal databases, and network open-access resources. However, for printed version of journals, dissertations, Western electronic databases, electronic teaching references, multimedia resources, and other types of printed material, the popularity is probably lower due to the characteristics of resource access and students' capacity constraints.

**H2: Electronic resources are displacing printed resources.**

Electronic resources offer flexibility in access, as they could be easily accessed from search engines or from online databases; they could also be conveniently copied, saved, and distributed. Therefore we hypothesized that electronic resources has a substitution effect to printed resources.

**H3: The diffusion of electronic resources is consistent with the innovation diffusion model.**

In the initial investigations, we found that academic resources usage increase with the students' ability and academic levels as they progress from freshman to senior. We also sensed that for certain categories of resources, the ratio may increase dramatically between the different levels, and then reach a plateau. The process was basically consistent with the innovation diffusion process in the undergraduate group, which was also consistent with our experience.

## **3.2 Research approaches**

### **Sampling**

The survey was conducted at Peking University in Beijing, China. The participants were drawn from all four levels of undergraduate students and all colleges of the University. 248 questionnaires on academic resource access were distributed and 231 responded, in which 190 valid samples served as data source for the final survey, with a response rate of 76.6%.

### **Methods**

According to the different types of academic resource carrier, we divided the questionnaire into two parts, one for printed resources and another for electronic resources, and then established categories for each part. For each specific academic resources, we measured usage frequency, level of knowledge, and factors affecting the utility effect. These variables were used to test H1 and H2.

For H3, we also used statistical data to measure the real growth rate of users for specific resources, and used the non-abstract functions for data fitting. We measured the two channels of mass communication and interpersonal communication, and the four stages of knowledge, persuasion, decision, and confirmation. To

comply with assumptions of the Bass model, we regarded the university as a small social system, ignoring the external social factors and considering individuals performing independently. To test our hypothesis, we adopted two equations of the Bass model (Bass, 1969, p.219), and recast them for our analysis:

$$1). N(t) = (p + qY(t)) * (m - Y(t)) \text{ ①}$$

$$2). P(t) = MP \times \frac{1}{1 + e^{-4 \times \frac{MS}{MP} \times (t - t_0)}} \text{ ②}$$

## 4. Data analysis

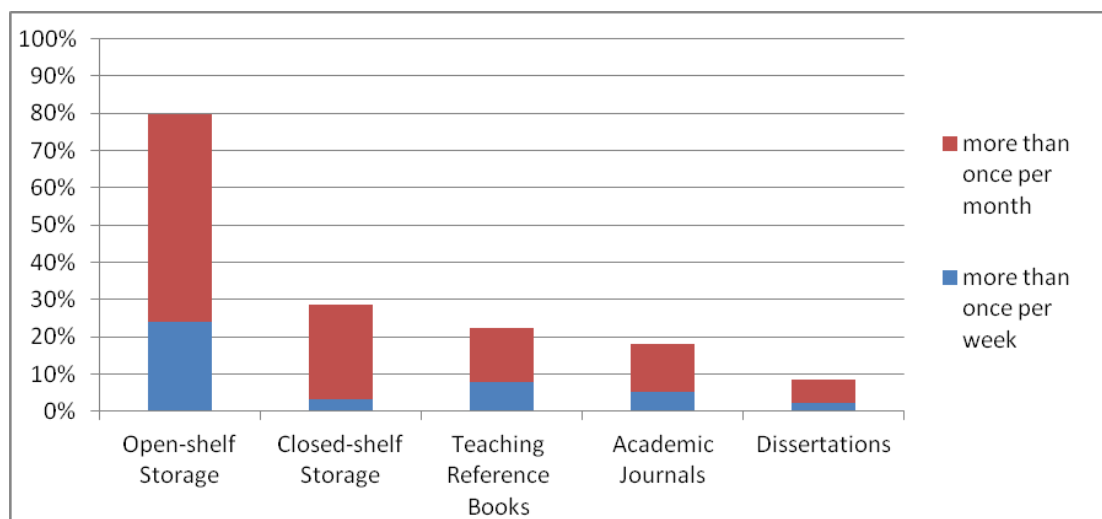
### 4.1 Undergraduates' academic resource preferences

Since the two main types of academic resource carriers (print and electronic) have different characteristics in practical usage, we took the comparison and tested them separately.

#### 4.1.1 Printed academic resources preferences

Figure 1 indicated the frequency of printed resources access, and the sum of the red and blue part in the bar represents the percentage of users who often access such resources for more than twice per month. In Figure 1, we can see that the open-shelf storage were more popular than the others options, meanwhile the printed academic journals and dissertations only had very low access frequency.

Figure 1. Access frequency of library storage



Since the library open-shelf storage was not all related to academic applications, we conducted further

①  $N(t)$  represents the portion of adopters at time  $t$ ,  $p$  represents the coefficient of innovation,  $q$  represents the coefficient of imitation,  $m$  represents the ultimate number of adopters,  $Y(t)$  represents the number of previous adopters before time  $t$ .

②  $P(t)$  represents the coefficient of innovation by time  $t$ ,  $MP$  represents the ultimate number of adopters,  $MS$  represents the ultimate growth rate of adopters,  $t_0$  represents the time of turning point, when the growth rate starts coming down.

analysis on the proportion of students' open-shelf book usage. These data suggested that the most popular resources were academic monographs, followed by teaching reference books, science and history books, and other leisure reading materials. Among these books, the first two kinds accounted for the vast majority, with a sum of 71.7%, which illustrated that the undergraduate students' open-shelf library resources access were mostly on academic resources.

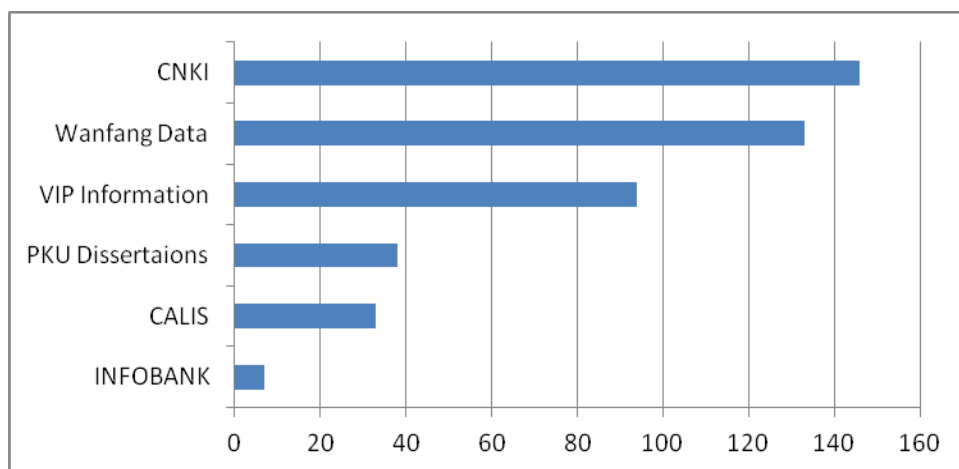
#### 4.1.2 Electronic academic resource preferences

A variety of academic resources via electronic carriers also differed in usage among college students:

First, various resources had significantly different access frequencies. Undergraduate students more frequently used Chinese full-text electronic databases, including journals and dissertations, as well as open-access resources on the Internet. In our investigation, 96.3% of the participants have used these two kinds of resources. However, only 56.4% and 74.5% student participants had accessed to electronic books and multimedia resources in library, respectively. Further, about 64.4% of the students had used Chinese databases and open access resources for more than twice per month, while the percentage for another two kinds of resources was only 34.9%.

Secondly, the language of academic resources had a significant influence on access. Figures 2 and 3 shows the top 6 of full-text database resources access, and the horizontal axis represented the number of users. Comparing the use of individual databases, in nearly 200 respondents, regular users of CNKI<sup>①</sup> and Wanfang Data<sup>②</sup> (both in Chinese) were about 150, with a proportion of more than three-quarters, while the most popular foreign language database JSTOR had just a proportion of one seventh.

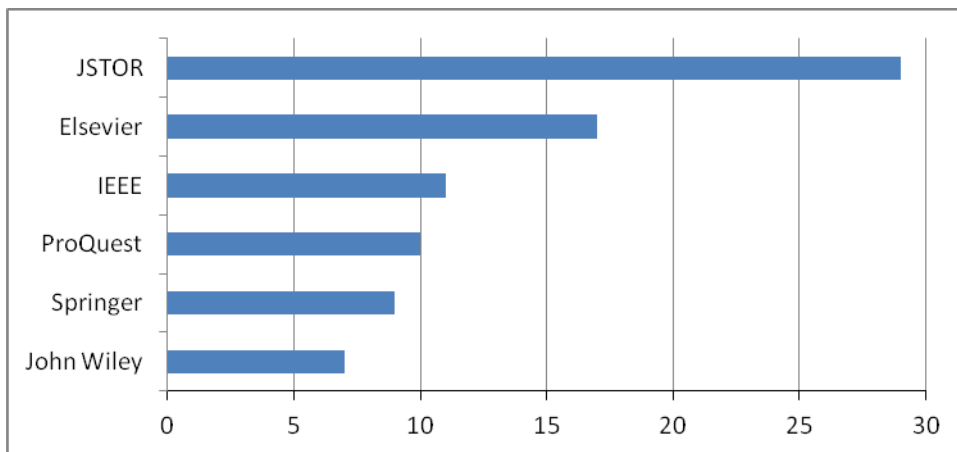
Figure 2. Access of Chinese Databases



<sup>①</sup> China National Knowledge Infrastructure: <http://www.cnki.net/>

<sup>②</sup> <http://www.wanfangdata.com.cn/>

Figure 3. Access of Western Databases



#### 4.1.3 Factors affecting resource selection

After the confirmation of undergraduates' preference on open-shelf storage, Chinese electronic databases, and open access resources, we did further exploration on the factors affecting the use of various academic resources.

Figures 4 and 5 compare the most important factors selected by the respondents in typical Chinese and Western journals database usage. It can be found obviously that "language problem" in Western resources was a very prominent factor, and the undergraduates did not have sufficient language skills to search and use academic information in a foreign language. However, most undergraduates rated Western journals high in richness, novelty, and timeliness, which suggested that the quality of the foreign resources were widely recognized. On the contrary, the academic quality, coverage, and timeliness of Chinese databases were not satisfying, each had about a third of respondents expressing dissatisfaction. And according to further statistics presented in Table 1, although the Chinese database search volume were 6 times higher than Western databases, the amount of downloading were only 2 times higher, which probably also indicated the quality of Chinese database resources not very satisfying to the students.

Figure 4. Influencing factors of Chinese database usage

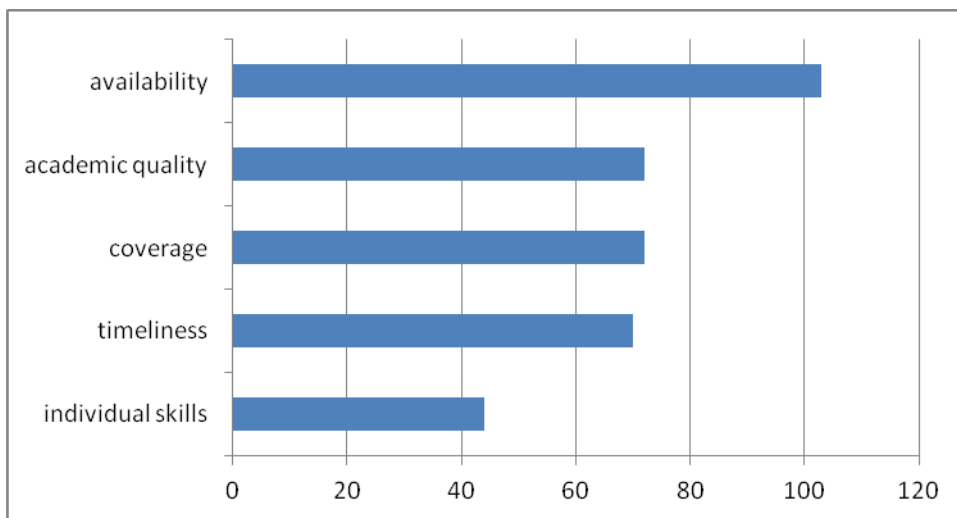


Figure 5. Influencing factors of Western database usage

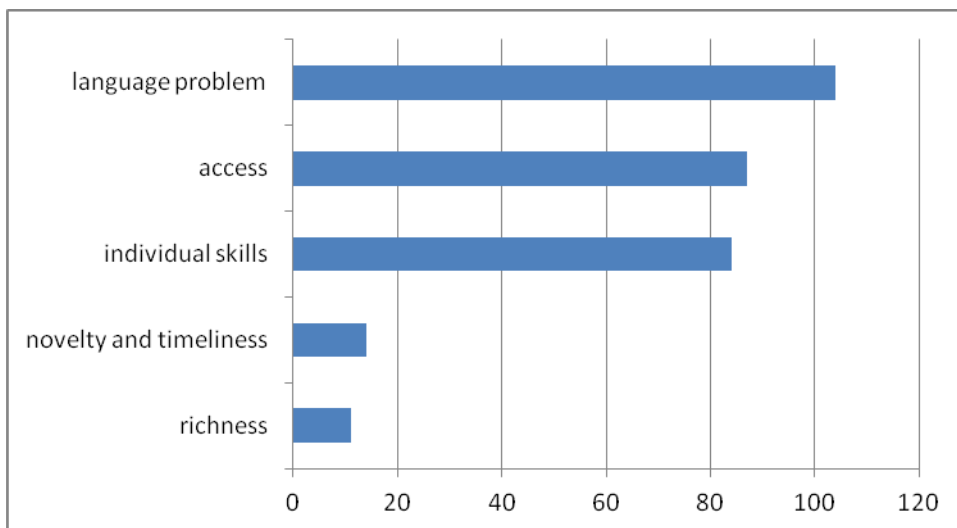


Table 1 Monthly statistics of Chinese and Western databases

	<b>Query</b> (times per month)	<b>Full-Text Downloads</b> (times per month)
<b>Western databases</b>	2,908,096	4,156,023
<b>Chinese databases</b>	18,825,686	8,656,333

Another comparison of Figures 4 and 5 revealed additional factors that influence the use of these databases. First was the availability of resources, including the difficulty of obtaining Chinese and Western database permissions. Despite the university library’s significant investments in various database access rights, almost half students still considered resources access to be a major problem. Second, students’ individual skills, such as keyword selection and retrieval, and their foreign language proficiency in Western academic resources usage also had an impact.

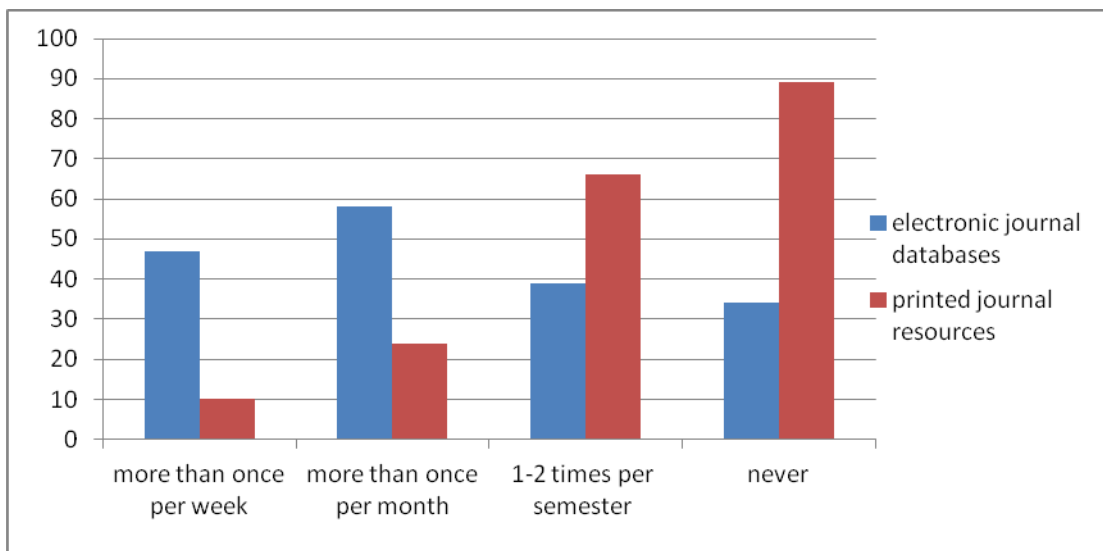
#### 4.2 Comparison on electronic resources and printed resources.



Electronic academic resources were found to substituting printed resources, especially in journals resources. As for traditional academic book resources, they did not show similar substitution trend, probably because of the limited number of the electronic books and the students' traditional reading habits.

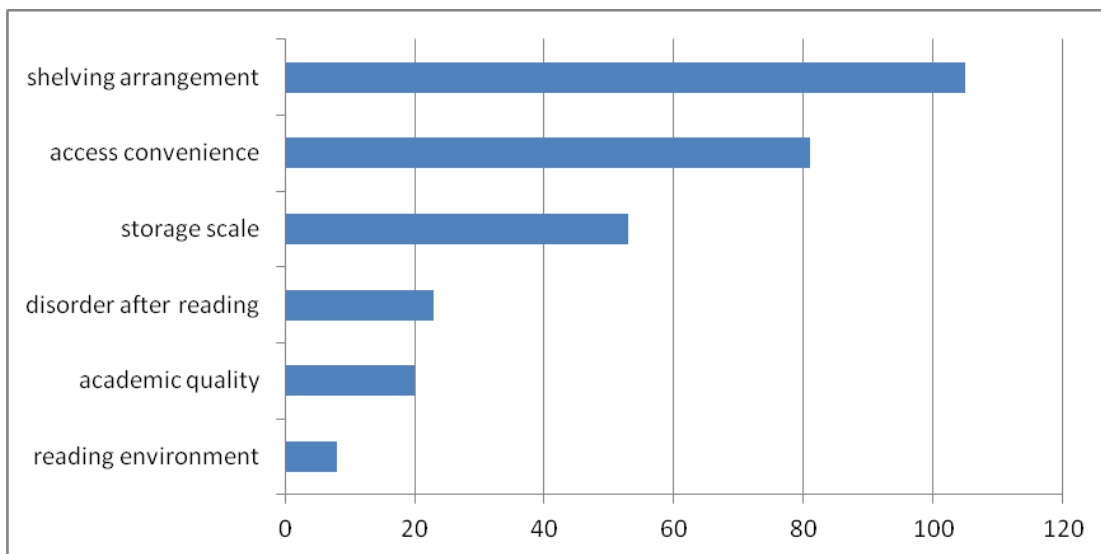
Here we took journal resources as example. Figure 6 compares the access frequency of the printed and electronic resources. The usage of the two types of journals presented the opposite distribution. Especially for the printed journal resources, with an increase in the usage frequency, the usage proportion decreased significantly. It should also be noted that only a small portion of the undergraduates accessed journal resources frequently. If we set the boundary at 1-2 times per month, about 60% of respondents accessed the electronic journals frequently, while the number for traditional printed journals was less than 20%.

Figure 6. Access frequencies of electronic and printed journals



In addition, the survey also found the factors affecting the use of printed journals, and the flaws in carrier characteristics determined the lack of competitiveness of printed journals. As shown in Figure 7, the shelving arrangement, the access convenience and the number of storage were the main crux, while the electronic versions had none of these problems because of the characteristics of the carrier.

Figure 7. Influencing factors of printed journals access

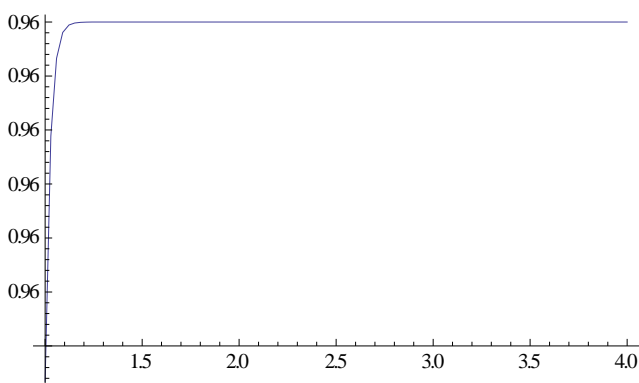


### 4.3 The diffusion of electronic resources

To test hypothesis H3, we use the Bass Diffusion Model to made fitting curves of the academic resources' diffusion rate, and obtained the curves of all types of resources in the study.

The first aspect examined was the traditional library book storage. As is shown in Figure 8, the freshmen already had a high utilization rate of the printed books, and in the next four years, the growth rate was very slow. We could see that paper-edition books was one of the most traditional and commonly used resources, and its use reached a steady state during in the freshman year. So in the next four years, the diffusion of paper-edition book resources did not match the process of innovation diffusion.

Figure. 8 Bass curve of printed books



In contrast, the diffusion curves of both Chinese and Western databases, electronic books, and open-access resources showed clear S-shape curves respectively with differences in shape and growth rate in Tables 9-12.

Figure 9. Bass curve of Chinese electronic databases

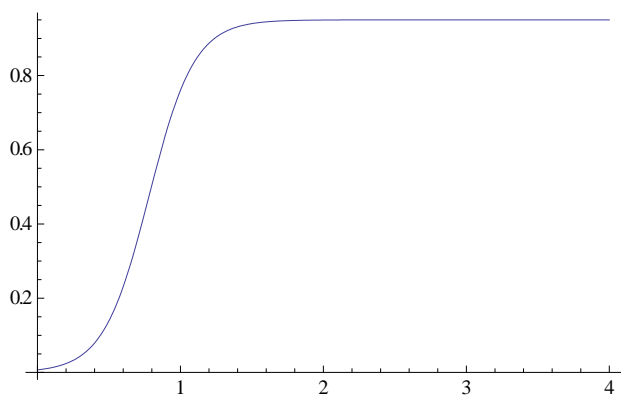


Figure 10. Bass curve of Western electronic databases

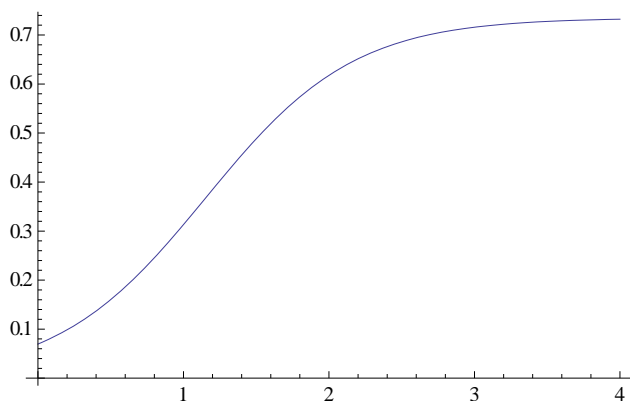


Figure 11. Bass curve of electronic books

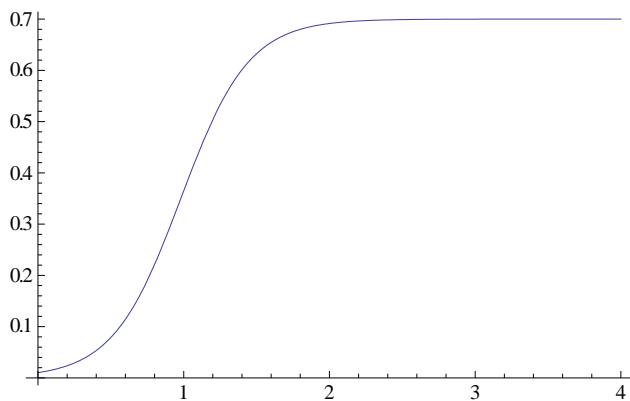
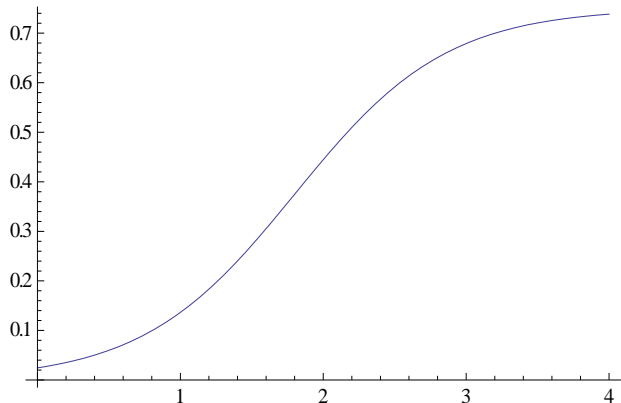


Figure 12. Bass curve of open access resources



The curves in Figures 9 and 11 had the similar shape, which means the diffusion process of Chinese full-text databases and the electronic books had an exponential increase in the students' first two years and then they reached a plateau. Some differences also existed in the process, for example, the popularity of Chinese electronic periodicals eventually approached nearly 100% in the undergraduates, while the percentage of electronic books was only about 70%. Figures 10 and 12 showed two smoother S-curves, which mean the diffusion process of Western databases and open access resources occurred more slowly and evenly.

In general, the diffusion pattern of these four kinds of common electronic resources fitted the S-curves of diffusion of innovation model well.

## **5. Discussion**

### **5.1 Undergraduate students have consistent preferences in academic resources.**

The data comparison of access frequencies showed a phenomenon that, for printed paper resources, most of the undergraduates had a uniform preference on the library open-shelf academic collection; and for electronic resources, electronic databases and open access resources. In addition, the statistic results also showed foreign language obstacle in academic resource access. According to Peking University library statistic data of monthly access and downloading on both Chinese and Western database (Table 1), the Chinese database query volume reached 6 times of the Western ones, which was basically consistent with our practical survey data.

Meanwhile, based on the statistical data, we discover the relevant factors in three main aspects: (i) quality of academic resources, (ii) convenience of resource access, including the limitations of access privilege, etc., and (iii) limited individual ability to utilize resources, including access skills and language barriers. Further, the significant gap in academic quality between Chinese and Western databases should be taken seriously.

### **5.2 Electronic resources are displacing printed resources.**

This displacement phenomenon was supported by the use typical academic resources, especially journal articles. The data analysis results, as indicted on Figures 4 and 5, supported our hypothesis. The electronic resources with carrier advantages had a displacement effect on the traditional printed resources, and playing a greater role in undergraduate academic applications. If this trend continues, the survival of printed journals will be in question.

### **5.3 The diffusion of electronic resources is consistent with the innovation diffusion model.**

In Figures 9-12, these S-shape curves supported the hypothesis that the diffusion of electronic resources is consistent with the Bass Diffusion Model. However, the different slopes of the S-shapes reflects different

characters in diffusion process.

For the similar curves in Figures 9 and 11, we found some difference. For Figure 9, the common academic resource requirement of freshmen led to a high increase rate of the Chinese journals database. To finish course papers, freshmen indeed need an academic resource platform that can immediately fulfill their needs. As Chinese electronic journal databases had fewer obstacles in language and accessibility for them, they were much easier to be adopted, leading to a stable but high rate of diffusion and an advanced penetration degree in steady state. In contrast, although the increasing rate of electronic books in Figure 11 was similar, it did not reach the same penetration degree. Through further investigation, we found that these academic electronic books were mainly provided by the library and some other public platforms, most of which had limitations in access permissions. Compared to journal articles, the academic quality of e-books cannot be guaranteed, and they are often inconvenient to search for the particular contents. These limitations influenced the knowledge and persuasion stage of the diffusion process, leading to a lower final penetration.

As for Figures 10 and 12, the explanations are also different. Observing that library training could not cover a full range and interpersonal communication between students from different cohorts was limited, Western databases had encountered difficulty in the first knowledge acceptance stage. Taking the undergraduate foreign language capabilities into consideration, as well as the different requirements of foreign academic resources in different faculties, the persuasion and decision stages also met many significant resistances. Only specific academic requirements and concrete practice can promote the utilization of these Western databases, as most student papers are written in Chinese. For these reasons, the diffusion curve shows a significantly smaller slope than the Chinese one, and the popularization state were only reached in the junior and senior levels in which students had higher academic requirements. The same situation occurred in the open access resources. Due to the cognitive limitations in the freshmen year, the knowledge and persuasion stages have many barriers. However with increased learning experience and practical usage of such resources, the value of these higher-quality resources was gradually recognized and the students gradually improved their ability in retrieval and utilization. The growth curves in these two charts reflected the undergraduates' slow but steady improvement in cognitive level and adoption.

Meanwhile, traditional printed resources did not fit the S-curve mostly because many freshmen have had contact with these resources continually before attaining university. The diffusion graph may even be shown as just like a straight line segment representing the plateau of the stable adoption.

## 6. Conclusions

Based on the findings in this paper, language has demonstrated important impacts on the undergraduates' need, adoption, and diffusion of electronic resources at the Peking University. Other main factors which influenced the undergraduates' access to academic resources include the quality of academic resources, the convenience of resource access, and the students' individual capability. In practical use, the undergraduates did have consistent preferences in general, leading to the phenomenon of utilization centralized on several specific resources, while other types of excellent academic resource were not fully utilized. In addition, with reference to the Bass Diffusion Model, our findings have shown that the undergraduate students had a significant learning process in the utilization of many new-style high-quality electronic academic resources.

The results also confirmed that the acquisition policy of Peking University Library has successfully balanced the need of the majority in Chinese resources, while providing abundant Western resources to uphold academic standards. To make better use of the high-quality Western database resources, also at a much higher cost, more training and guidance should be provided, say, by library and faculties in collaboration, to encourage and facilitate students to do so in order to further enhance their ability in learning and academic research.

For further research, we are planning to study more successful cases overcoming language barriers in the East, such as Hong Kong and Singapore, as well as other countries like Taiwan and Japan, with our research partners, with whom we have done collaborative researches on mobile library services (Ko et al., 2015) and motivation of librarianship studies (Ho et al., 2016). We are also interested in the contemporary reading behavior of student on mobile devices (Wang et al., 2016), which also have impact on new acquisition policies.

## References

- Bass, F. M. (1963). A Dynamic Model of Market Share and Sales Behavior. Winter Conference American Marketing Association, 263-276.
- Bass, F. M. (1969). A New Product Growth Model for Consumer Durable. *Management Science*, 15(5), Theory Series, 215-227.
- Cui, D. (2008). A Study on Open Access Resources and Their Evaluation. Unpublished doctoral dissertation, Northeast Normal University, Jilin.
- Granovetter, M. (1983). The Strength of Weak Ties: A Network Theory Revisited. *Sociological Theory*, Vol.1, 201-233
- Ko, E. H., Chiu, D. K., Lo, P., & Ho, K. K. (2015). Comparative study on m-learning usage among LIS students from Hong Kong, Japan and Taiwan. *The Journal of Academic Librarianship*, 41(5), 567-577.
- Ho, K. K., Lo, P., Chiu, D. K., San Kong, E. W., Chen, J. C. C., Zhou, Q., ... & Dalsgard, S. (2016). Intrinsic vs. extrinsic motivations of Master of Library and Information Science students: A cross-cultural comparative study. *Journal of Librarianship and Information Science*, 0961000616664564.
- Minishi-Majanja, M. K., & Kiplang'at, J. (2005). The diffusion of innovations theory as a theoretical framework in Library and Information Science research. *South African Journal of Libraries & Information Science*, 71(3).
- Qiu, Y. (2006). The Barriers and Solutions of Open Access in Academic Resources. *Journal of Information* 25(7), 128-130.
- Rogers, E.M. (1995). *Diffusion of Innovation*, fifth ed. Free Press, New York.
- Wang, H. (2001). Strategic Research on Library Users' Information Demands and Satisfaction under Network Environment. *Henan Library Science Journal* 21(2), 37-43.
- Wang, Y. (2006). A Study on Acquisition Strategies of Network Open Access Academic Information Resources. *Journal of Library Science in China* 32(162), 76-78.
- Wang, P., Chiu, D. K., Ho, K. K., & Lo, P. (2016). Why read it on your mobile device? Change in reading habit of electronic magazines for university students. *The Journal of Academic Librarianship*.

Walton, E. W. (2014). Why undergraduate students choose to use e-books. *Journal of Librarianship and Information Science*, 46(4), 263-270.

Xiong, H., Zhang, Ch. (2009). Research on the Barriers to Users' Information Access in Network Environment. *Information Science* 27(02) , 179-200.

Zhao, D. (2008). *Modern Information Retrieval*. Peking University Press, Beijing.