

Usage Beliefs' Change and Interaction during Technology Acceptance of Academic Information Services

Duanwu Yan ^a, Jiali Tang ^{b,*}, Beibei Xia, Guoxiao Liu

School of Economics & Management, Nanjing University of Science & Technology, Nanjing, Jiangsu, China

^ayanwu123@sina.com, ^bjiali_tang@163.com

*Corresponding author

Keywords: Technology Acceptance, Belief Adjustment, Latent Growth Curve Model, Tracking Experiment

Abstract: [Purposes] The purpose of this study is to investigate the participants' dynamic beliefs and acceptance intentions of using the academic information services as well as the relationship between these dynamic beliefs, taking academic resources database as an example. [Methods] This study was carried out at a large university with a total of 125 freshmen participating in the tracking experiment for a total of three cycles. Latent growth curve model are applied to analysis questionnaire data with LISREL8.7. [Results and Conclusions] The results supported the changes of belief structures over time. The levels of user beliefs (self-efficacy, perceived usefulness, and intention to use) were on the rise with the increase in the use of document database systems, while the belief of perceived ease of use did not significantly change. Self-efficacy has always influenced perceived ease of use and perceived usefulness.

1. Introduction

With the constant emergence of new technologies, technology acceptance has attracted extensive and sustained attention of scholars. Related theories like Technology Acceptance Model (TAM) [1], Unified Theory of Acceptance and Use of Technology (UTAUT) [2], Social Cognitive Theory (SCT) [3] have been widely adopted and confirmed to help explain users' acceptance of information technology (IT). However, these theories still have some limitations in explaining the changes of individuals' beliefs and continued use of technology beyond the initial stage. In most previous studies, users' beliefs were considered as static and incomplete, because the data is captured from static cross-sectional study which merely examining the static state of the respondents at a certain time point.

Recently, there have been some studies about users' continuance behavior related to IT acceptance, adoption and use considered that users' beliefs may change over time. For instance, Lee verified that IT usage time and experience are vital factors influencing users' beliefs of software technology acceptance, taking Excel 2007 as an example [4]. Sun and Jeyaraj provided preliminary evidence on the fact that individuals' IT innovation adoption and continuance may be influenced by different factors over time [5]. Hsieh explained the students' continuous use of ePortfolio and analyse the key enablers of users' change of beliefs and attitudes from adoption stage to continuous use stage based on the longitudinal investigation [6]. Mou examined how trust interacts with other consumer beliefs such as perceived usefulness (PU) and how these beliefs together influence consumer intentions and behavior concerning e-services at both the initial and latter stages of use [7]. However, there have been few studies on the users' belief change during IT acceptance in the context of academic information services. It is necessary to conduct research on the acceptance and continuance use of academic information services and to explore how the users' beliefs evolve.

Therefore, based on TAM and related psychological theory and the work of Lee [4], this study takes the academic resource database as an example to understand the beliefs' change during academic information service system acceptance and to probe into the relationships among different

beliefs and their rates of change.

2. Theoretical Background

2.1 Technology Acceptance Model

Technology Acceptance Model (TAM) fundamentally posits the causal chain of belief-attitude-intention-behavior to explain and predict the process of accepting a new IT [1]. It includes two key beliefs: perceived usefulness (PU) and perceived ease of use (PEOU). PU is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance”, and PEOU refers to “the degree to which a person believes that using a particular system would be free from effort”.

2.2 Social Cognitive Theory

Social Cognitive Theory (SCT) [3], originated in psychology, is a learning theory based on the idea that people learn by observing others. SCT explains human behavior through a schematization of triadic reciprocal causation (personal, behavioral and environmental). Self-efficacy is a core part of SCT, referring to the extent to which an individual believes that they can master a particular skill. Individuals with high self-efficacy are more likely to believe they can master challenging problems and they can recover quickly from setbacks and disappointments. Self-efficacy is not static. It can be developed or increased with the accumulation of positive experience [8].

2.3 Theory of Cognitive Dissonance

Cognitive dissonance is the mental discomfort (psychological stress) experienced by a person who simultaneously holds two or more contradictory beliefs, ideas, or values [9]. Cognitive dissonance theory proposes that in order to reduce dissonance and seek psychological consistency between expectations and reality, individuals need to continually adjust their cognitions (perceptions of the world) or their actions in the real world.

2.4 Hypothesis

Self-efficacy, a core part of social cognitive theory, is considered to be dynamic in some studies [10, 11], and have a reciprocal influence on behavior over time. Particularly, in the context of information system (IS), users may adjust self-efficacy over time with increasing experience of using the academic database system. Thus, self-efficacy may show a dynamic pattern, which leads to the following hypothesis.

Hypothesis 1: Users’ self-efficacy of an academic database system will change during their adopting process.

To address the limitation of the TAM, scholars (e.g. [4,6]) have expanded the model with other theories. To understand the dynamics of ease of use and usefulness, and intention to use an academic database system over time, this study embedded cognitive dissonance theory into the theoretical model to explain the relationships among belief constructs over time. Thus, we assume users may adjust their beliefs such as ease of use and usefulness over time when using the technology which may even adjust their intention to use and propose the following hypothesis:

Hypothesis 2: Users’ perceived ease of use, perceived usefulness, and intention to use an academic database system will change over time.

Social cognitive theory is often employed with TAM to investigate the relationships among self-efficacy, ease of use, and usefulness. The research showed that self-efficacy can influence ease of use serving as an external variable [12]. Thus, the following hypotheses are suggested:

Hypothesis 3: The initial level of self-efficacy in an academic database system has a positive influence on the initial level of perceived ease of use.

Hypothesis 4: The rate of change in self-efficacy in an academic database system over time has a positive influence on the rate of change in perceived ease of use.

Although concrete results about the relationship between self-efficacy and usefulness have not been proposed in prior studies, there are a considerable number of studies indirectly support the

possible relationship between them. For instance, self-efficacy and usefulness is found to have a significant correlation of 0.42 for a "getting information" model and of 0.39 [13] or 0.19 [12] for a "purchasing" model. Accordingly, the following hypotheses are suggested:

Hypothesis 5: The initial level of self-efficacy in an academic database system has a positive influence on the initial level of perceived usefulness.

Hypothesis 6: The rate of change in self-efficacy in an academic database system has a positive influence on the rate of change in perceived usefulness.

According to TAM, ease of use and usefulness are the determinants of intention to use, and usefulness can also affect the relationship between ease of use and intention to use. Therefore, we can assume that similar relationships exist in their initial levels and subsequent changes:

Hypothesis 7: The initial level of perceived ease of use has a positive influence on the initial level of perceived usefulness.

Hypothesis 8: The rate of change in perceived ease of use over time has a positive influence on the rate of change in perceived usefulness.

Hypothesis 9: The initial level of perceived ease of use has a positive influence on the initial level of intention to use.

Hypothesis 10: The rate of change in perceived ease of use over time has a positive influence on the rate of change in intention to use.

Hypothesis 11: The initial level of perceived usefulness has a positive influence on the initial level of intention to use.

Hypothesis 12: The rate of change in perceived usefulness over time has a positive influence on the rate of change in intention to use.

3. Methodology and Results

The experimental data was captured by tracking experiments and questionnaires. This study took primary users who never used the database of academic resources as target groups to track their acceptance of academic resource databases by periodically organizing laboratory-based experiments. A total of 125 freshmen from the Department of Information Management and Communication Engineering participated in the tracking experiment for a total of three cycles (45 days as a cycle). The questionnaire contains a total of 13 items that are rated on a 7-point Likert scale.

3.1 Validity and Reliability

Table 1 Results of multi-group factor analysis and reliability

	Time 1				Time 2				Time 3			
Items	PEU	PUF	IU	SE	PEU	PUF	IU	SE	PEU	PUF	IU	SE
PEU1	1.00				1.00				1.00			
PEU2	1.02				0.93				1.12			
PEU3	0.98				0.97				1.04			
PEU4	1.11				1.04				0.92			
PUF1		1.00				1.00				1.00		
PUF2		0.94				0.94				1.08		
PUF3		1.02				1.07				0.97		
IU1			1.00				1.00				1.00	
IU2			0.95				1.12				0.96	
IU3			1.06				0.95				1.04	
SE1				1.00				1.00				1.00
SE2				1.10				1.06				0.93
SE3				1.05				1.03				0.93
Cronbach α	0.83	0.84	0.85	0.76	0.86	0.87	0.85	0.81	0.80	0.85	0.88	0.83
Fit-Indices	$\chi^2/df=2.5$				CFI=0.95				NNFI=0.93			
									RMSEA=0.11			

-SE [Self-Efficacy], PEU [Perceived Ease of Use], PUF [Perceived Usefulness], IU [Intention to Use]

Multiple-groups confirmatory factor analysis (MGCFA) was used to test the equivalence of measurement at different time points (see Table 1). All items load properly onto the designated constructs and the significance level of their t-values are below 0.05. Reliabilities of the variables range from 0.76 to 0.88, which is well above an acceptable level of 0.70 indicating stability and consistency of the data (Nunnally, 1978). The ratio of χ^2/df ($=2.5$) fell within the criterion of more than 2.0 and less than 3.0 and GFI and AGFI were higher than 0.90, indicating goodness of fit.

3.2 Hypothesis Testing

We employed a parallel process latent growth curve model using two-step approach. First, the slope and intercept in the latent growth model for each belief construct are identified, and then the identified slopes and intercepts were used for hypotheses testing about the relationships among the rates of change of self-efficacy, ease of use, usefulness, and intention to use. Covariance matrix (see Table 2) was employed to test the growth curve model the hypotheses in both steps.

Table 2 Correlation matrix, means, and standard deviations

	SE1	SE2	SE3	PEU1	PEU2	PEU3	PEU4	PUF1	PUF2	PUF3	IU1	IU2	IU3
SE1	1.00												
SE2	0.85	1.00											
SE3	0.65	0.78	1.00										
PEU1	0.43	0.36	0.52	1.00									
PEU2	0.29	0.44	0.28	0.39	1.00								
PEU3	0.22	0.46	0.66	0.51	0.45	1.00							
PEU4	0.42	0.43	0.42	0.42	0.23	0.35	1.00						
PUF1	0.35	0.52	0.25	0.21	0.32	0.24	0.71	1.00					
PUF2	0.23	0.40	0.33	0.28	0.24	0.36	0.56	0.89	1.00				
PUF3	0.36	0.37	0.29	0.36	0.33	0.24	0.38	0.21	0.02	1.00			
IU1	0.06	0.28	0.05	0.04	0.54	0.28	0.04	0.25	0.22	0.53	1.00		
IU2	0.25	0.51	0.45	0.24	0.13	0.43	0.47	0.45	0.58	0.05	0.26	1.00	
IU3	0.13	0.51	0.46	0.12	0.35	0.31	0.46	0.51	0.52	0.15	0.36	0.14	1.00
M	5.51	4.87	4.90	5.21	6.12	5.80	5.01	5.25	5.13	5.74	5.18	6.01	5.77
SD	1.47	0.98	1.39	1.21	1.21	1.24	1.53	1.42	1.42	1.11	1.24	1.14	1.19

-SE [Self-Efficacy], PEU [Perceived Ease of Use], PUF [Perceived Usefulness], IU [Intention to Use], M [Mean], SD [Standard Deviation]

As shown in Table 3, goodness of fit-indices of the individual growth curve models in terms of RMSEA, CFI, and TLI are higher than the acceptable levels. Intercept (5.02, $p<0.01$) and slope (0.25, $p<0.05$) of self-efficacy is significant which indicates H1 is supported. So does perceived usefulness (intercept: 5.16, $p<0.01$, slope: 0.15, $p<0.05$) and intention to use (intercept: 5.68, $p<0.01$, slope: 0.21, $p<0.01$). In other words, users' levels of self-efficacy, perceived usefulness, and intention to use are found to increase with experience of using a database. However, the slope of perceived ease of use was non-significant which means the level change of perceived ease of use is not significant from Time 1 to Time 3. These results reveal that H2 is partially supported.

Table 3 Parameter estimates and fit indices for latent growth curve models

Variable	Intercept	Slope	Df	X ²	P	RMSEA	CFI	NNFI	GFI	AGFI
Self-Efficacy	5.02**	0.25*	1	0.20	0.65	0.00	1.00	1.00	1.00	1.00
Perceived Ease of Use	5.71**	0.29	1	0.71	0.36	0.00	1.00	1.00	1.00	1.00
Perceived Usefulness	5.16**	0.15**	1	1.23	0.27	0.05	0.98	0.97	1.00	1.00
Intention to Use	5.68**	0.21*	1	0.86	0.36	0.00	1.00	1.00	1.00	1.00

** $p<0.01$, * $p<0.05$

We employed the fitting individual growth curve models for examination of the relationships among initial levels and rates of changes in the constructs. The slope of self-efficacy has a significant influence on that of perceived usefulness ($\beta=0.21$, $p<0.05$), which significantly influences that of intention to use ($\beta=0.41$, $p<0.05$) in turn, supporting H6 and H12. Due to its non-significance, the slope of perceived ease of use was not included in the testing model. Therefore, H4, H8 and H10 could not be examined. Likewise, H3, H5, H7, H9 are supported

according to the data in Table 3.

4. Summary

This paper investigated the changes of belief over time by conducting an empirical research on user acceptance of the academic database system. First, it is found that the beliefs of users' self-efficacy, perceived usefulness, and intention to use are dynamic in the process of using an academic database system. Belief is a guide to action. However, the consequences of human action may have a feedback effect on beliefs. That is to say, users tend to adjust and update their self-efficacy, perceived usefulness and intention to use based on their usage experiences, which is similar with the theory of cognitive dissonance. Specifically, the results suggest that the levels of user beliefs (self-efficacy, perceived usefulness, and intention to use) were on the rise over time. It indicates that there exists a positive feedback between the experiences of using CNKI and users' beliefs. However, the belief of perceived ease of use did not significantly change over time. One possible reason behind the phenomenon may be that perceived ease of use is more related with the first impression about the academic database system. The functions and interfaces of CNKI have not changed during the experiment.

Second, the results indicate that the initial level of self-efficacy significantly influences the levels of ease of use and usefulness, which concurs with prior studies [4]. More significantly, it was found that rate of change in self-efficacy positively affects that in usefulness, indicating that change in self-efficacy can possibly lead to change in usefulness in the context of academic information services. Last but not least, TAM was supported to be applied to a longitudinal dynamic pattern. While most prior studies have identified the relationships among the variables based on TAM at a certain point of time, this study expands the model over a period of time. This study focused on the user's continuous use behavior, and provided authentic proof that ATM can be applied to the longitudinal dynamic environment.

Of course, we acknowledge some limitations to our study. Firstly, the sample was a convenient sample collected from students and the number of respondents was limited. Secondly, linear relationships among the constructs were assumed in this study. However, non-linear relationships of attitudes and subjective norms with technology acceptance could emerge. Third, this research only took into account several common factors in the field. There may be many other factors (e.g. affective factors) which would influence user acceptance of an information service system.

References

- [1] Davis, F. D. Perceived usefulness, perceived ease of use, and user acceptance of information technology, *J. MIS Quarterly*, 13.3 (1989): 319-340.
- [2] Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. B. User acceptance of information technology: Toward a unified view, *J. MIS Quarterly*, 27.3 (2003): 425-478.
- [3] Compeau, D. R., Higgins, C. A., & Huff, S. L. Social cognitive theory and individual reactions to computer technology: A longitudinal study, *J. MIS Quarterly*, 23.2 (1999): 145-158.
- [4] Lee K, Yan A, Joshi K. Understanding the dynamics of users' belief in software application adoption, *J. International Journal of Information Management*, 31.2 (2011): 160-170.
- [5] Sun Y, Jeyaraj A. Information technology adoption and continuance: A longitudinal study of individuals' behavioral intentions, *J. Information & Management*, 50.7 (2013): 457-465.
- [6] Hsieh T C, Chen S L, Hung M C. Longitudinal test of ePortfolio continuous use: an empirical study on the change of students' beliefs, *J. Behaviour & Information Technology*, 34.8 (2015): 838-853.
- [7] Mou, J., Shin, D.H., & Cohen, J. Understanding trust and perceived usefulness in the consumer acceptance of an e-service: A longitudinal investigation, *J. Behaviour & Information Technology*,

36.2 (2017): 125-139.

[8] Parschau, L., Fleig, L., Koring, M., Lange, D., Knoll, N., Schwarzer, R., & Lippke, S. Positive experience, self-efficacy, and action control predict physical activity changes: A moderated mediation analysis, *J. British journal of health psychology*, 18.2 (2013): 395-406.

[9] Festinger, L. (1957). A theory of cognitive dissonance, *J. American Journal of Psychology*, 207 (1957): 2112–2114.

[10] Gwaltney, C. J., Shiffman, S., Balabanis, M. H., & Paty, J. A. Dynamic self-efficacy and outcome expectancies: prediction of smoking lapse and relapse, *J. Journal of abnormal psychology*, 114.4 (2005): 661.

[11] Fisher, Y. The sense of self-efficacy of aspiring principals: exploration in a dynamic concept, *J. Social Psychology of Education*, 14.1 (2011): 93-117.

[12] Venkatesh, V. Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model, *J. Information systems research*, 11.4 (2000): 342-365.

[13] Pavlou, P.A., & Fygenson, M. Understanding and predicting electronic commerce adoption: An extension of the theory of planned behavior, *J. MIS Quarterly*, 30.1 (2006): 115-143.