11th International Conference on e-Learning (ICEL 2016), Universiti Sains Islam Malaysia, Kuala Lumpur, Malaysia, 2-3 June 2016

Teachers' knowledge and technology acceptance: a study on the adoption of clickers

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Abstract

Teacher acceptance is the key for the successful implementation of a new technology in education settings. While the Unified Theory of Acceptance and Use of Technology (UTAUT) offers a well-validated solution in explaining the behavioral intention of adopting an emerging technology, there are research gaps in understanding the determinants of the components in the model. Extending the previous model and applying it in the context of adoption of student response system (a.k.a. clickers), the current study explored the underlying factors that influence the core components of UTAUT—effort expectancy, performance expectancy, social influence, and facilitating conditions. In particular, the study examined the impact of teachers' knowledge on the evaluation of those components. Incorporating the concepts of Technological Pedagogical Content Knowledge (TPACK), the study attempted to investigate the association of teachers' knowledge and the major components in UTAUT. Fifty two teachers from 7 faculties at the Hong Kong Polytechnic University participated in our teacher survey between May and July 2015. Pearson's correlation analysis reveals that technological knowledge was positively correlated with effort expectancy (p<.01), performance expectancy (p<.01), and behavioral intention (p<.01). Further, there were positive associations between TPACK and performance expectancy (p<.01), effort expectancy (p<.01), facilitating conditions (p<.01), as well as behavioral intention (p<.01). Findings supported the hypothesis that teachers' knowledge is relevant to the perception on performance expectancy, effort expectancy, and facilitating conditions. In terms of theoretical implication, the current study extends the UTAUT by integrating the key concepts of TPACK in explaining the adoption of an emerging technology. As for practical implication, the study sheds light on strategies for successful implementation of clickers in university settings.

Keywords

TPACK, Unified Theory of Acceptance and Use of Technology, student response system, clickers, teaching with technology

Background—Teachers' attitude and adoption of technology

The higher education settings utilize more and more pedagogical strategies incorporating technology, with significant advancement of information technology in recent decade. The ubiquitousness of e-learning technology opens new arrays of possibilities in innovative teaching practice to engage student learning. Nevertheless, whether a new technology can be successfully introduced in classrooms also depends on teachers' attitudes towards technology, as teachers in general have the autonomy to choose the technology that fits their pedagogical needs. Previous studies pointed out that teachers' attitudes are important factors in determining technology usage (e.g. Stols et al., 2015; Coffman, 2015; Ekman, Lundin, & Svensson, 2015). Therefore, to promote active learning with technology in tertiary education settings, it is imperative to understand teacher acceptance of technology and examine the underlying determinants of it.

Theoretical background and research model—The Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK)

In exploring the acceptance of technology adoption, the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al.'s, 2003) offers a parsimonious solution on efficient deployment of technology. The model integrates eight models and theories relevant to technology acceptance—Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Technology Acceptance Model (Davis, 1989), the Motivational Model (Davis, Bagozzi, & Warshaw, 1992), the Theory of Planned Behavior (Ajzen, 1991), the Combined Technology Acceptance Model and Theory of Planned Behavior (Taylor & Todd, 1995), the Model of PC Utilization (Thompson, Higgins, & Howell, 1991), the Innovation Diffusion Theory (Moore & Benbasat, 1991; Rogers, 1995), and the Social Cognitive Theory (Bandura, 1986)—to predict usage behavior of an innovation. Four core constructs are posited to affect the behavioral intention to use technology: performance expectancy, effort expectancy, social influence and facilitating conditions. Performance expectancy is defined as the degree to which an individual perceives that using the emerging technology will enhance job performance. Effort expectancy is defined as the degree of ease to adopt that emerging technology. Social influence refers to the degree to which an individual perceives important others think that he or she should adopt that emerging technology. Facilitating condition is the degree to which an individual believes that there is organizational and technical infrastructure available supporting the adoption of the emerging technology. UTAUT is a general theory, and tailoring the theory to specific contexts will increase its validity in a particular setting.

Contextualizing UTAUT for education settings, the current study attempted to extract specific factors in teaching that may influence the key constructs of UTAUT. Teaching is an intricate discipline requiring various sets of proficiency, apart from the subject contents to be delivered. Mishra and Koehler (2006) summarizes several core components essential to good teaching practice, comprising of knowledge of subject content to be taught, knowledge of methods of teaching, as well as, newly emerged in recent years, knowledge of technology. The three main components of teachers' knowledge, namely Content, Pedagogy, Technology, build the foundation of the TPACK model (Mishra and Koehler, 2006; Koehler & Mishra, 2009). Further, technological pedagogical content knowledge (TPACK) is derived from the interaction among these bodies of knowledge. It is the knowledge of integrating technology into teaching in various content areas (Figure 1).

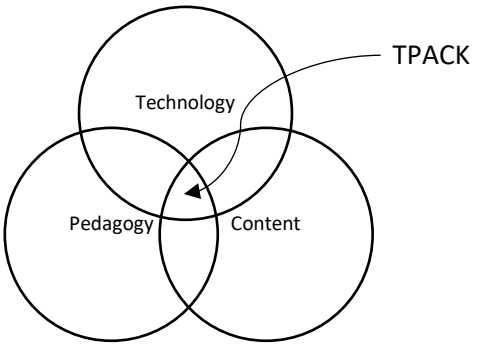

Figure 1. Technological Pedagogical Content Knowledge (TPACK) model

Hypotheses of the current study

This study explored if these essential components in teaching (i.e. knowledge of content, pedagogy, and technology), influence any of the key constructs of UTAUT. Prior studies have revealed that computer efficacy is a predictor of effort expectancy, performance expectancy, as well as behavioral intention (e.g. Hsu et al. 2009; Macharia and Pelser 2012; Padilla-Melendez et al. 2008; Compeau and Higgins 1995; Agarwal et al. 2000; Chau 2001; Lai 2008). People with higher level of computer efficacy tend to be less frustrated by the hindrance encountered, more likely to hurdle the problems, incline to appreciate the usefulness of the emerging technology, and thus the likelihood for them to use it in the future increases. The current study hypothesized that there is a positive relationship of Technology Knowledge with effort expectancy, performance expectancy, and behavioral intention.

Further, aligning more with the context of teaching in specific disciplines, the current study was also interested in looking at the relationship between TPACK knowledge, which is a subtle knowledge involving the use of technology, and the key constructs of UTAUT. TPACK knowledge is the interactions among content, pedagogy and technology knowledge. It is more than just the knowledge of all three discrete constructs. It highlights the adoption of technology to establish new epistemologies on existing knowledge (Koehler & Mishra, 2009). We posit that not only the knowledge on technology can influence one's perception on the usefulness and ease of use of an emerging technology, but also the knowledge on how to use the technology in a specific setting plays a significant role. The current study hypothesized that the TPACK knowledge is positively associated with effort expectancy, performance expectancy, and behavioral intention of using the emerging technology.

The emerging technology adopted in the current study—the student response system (SRS)

The emerging technology adopted to verify the hypotheses of the current study is the student response system. The student response system (SRS), also known as "Clickers", is a medium device allowing students in class to respond teachers' questions instantly with simple keypads or smart devices. The student response system facilitates interactions between teachers and students, particularly in large class environments. Past studies have demonstrated the associations of SRS with classroom engagement of students, and with interactive formal assessment (Gok, 2011; Hepplestone, Holden, Irwin, Parkin, & Thorpe, 2011; Kay & LeSage, 2009). With regard to teaching, SRS helps promoting contingent teaching (Draper & Brown, 2004), collecting instant feedback from students (Cleary, 2008), actualizing just-in-time-teaching (Novak, 2011), improving class engagement (Stowell, Oldham, & Bennett, 2010), as well as facilitating students' attendance and retention of knowledge (Caldwell, 2007; Campbell & Mayer, 2009; Kay & LeSage, 2009).

Method

Participants

Teachers from the Hong Kong Polytechnic University who had adopted the student response system had been invited to join the current study. To increase the representativeness of the samples, teachers from various disciplines were invited to join the study. A survey was launched on an online platform (LimeSurvey, commonly known as MySurvey at the Hong Kong Polytechnic University) between May and July 2015. Teachers from 7 faculties, Faculty of Applied Science and Textiles, Faculty of Business, Faculty of Construction and Environment, Faculty of Engineering, Faculty of Health and Social Sciences, Faculty of Humanities, and School of Hotel and Tourism Management had participated in the survey. Fifty two teachers had completed the survey before the deadline on July 2015. Details of the distribution of teachers are presented in Table 1.

Table 1 Details of the distribution of teachers adopting SRS who had completed the teacher survey

Faculty/ School	Frequency	Percent	Cumulative Percent
Faculty of Business	11	21.2	21.2
Faculty of Health and Social Sciences	14	26.9	48.1

Faculty of Engineering	4	7.7	55.8
Faculty of Humanities	3	5.8	61.5
Faculty of Applied Science and Textiles	4	7.7	69.2
School of Hotel and Tourism Management	15	28.8	98.1
Faculty of Construction and Environment	1	1.9	100
Total	52	100	

Instruments

The teacher survey comprised of 70 items tapping various dimensions of the Technological Pedagogical Content knowledge (TPACK) model, and the Unified Theory of Acceptance and Use of Technology (UTAUT). Items of TPACK and UTAUT were adapted from the studies of Schmidt et al. (2009) and Venkatesh et al. (2003). Results were represented on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

All data obtained were analyzed with the Statistical Package for the Social Sciences (SPSS), version 22.

Results

Descriptive statistics

Table 2 presents the descriptive statistics for various dimensions of TPACK and UTAUT. With the minimum rating of 1 (strongly disagree) and maximum rating of 5 (Strongly agree), the mean ratings for various dimensions of TPACK are ranging from 3.43 to 4.15. As for UTAUT, the mean ratings for various dimensions are between 3.30 and 3.88. For the TPACK model, the highest mean score is the Content Knowledge (*M*=4.15, *SD*=.74), and the lowest mean scores are Technology knowledge (*M*=3.43, *SD*=.78) and TPACK knowledge (*M*=3.75, *SD*=.72). With regard to the UTAUT, the highest mean scores are Facilitating Condition (*M*=3.88*, SD*=.58), and Behavioral Intention (*M*=3.88, *SD*=.77), whilst the lowest mean score is Social Influence (*M*=3.30, *SD*=.78).

Table 2 Descriptive statistics of various dimensions of teachers' knowledge as measured by TPACK and technology acceptance as measured by UTAUT

	Minimum	Maximum	Mean	Std. Deviation
Teachers' knowledge (TPACK)				
Technology knowledge	1.00	5.00	3.43	0.78
Content knowledge	1.00	5.00	4.15	0.74
Pedagogical knowledge	1.29	5.00	4.10	0.65
TPACK knowledge	1.40	5.00	3.75	0.72
Technology acceptance (UTAUT)				
Performance expectancy	2.00	5.00	3.78	0.77
Effort expectancy	2.25	5.00	3.76	0.66
Social influence	1.25	5.00	3.30	0.78
Facilitating condition	2.50	5.00	3.88	0.58
Behavioral intention	1.75	5.00	3.88	0.77

Scores range from 1 to 5, with higher scores represent higher level of knowledge/technology acceptance

Correlation analysis

A Pearson product-moment correlation coefficient was computed to assess the relationship among various dimensions of TPACK and UTAUT. Table 3 presents the correlation among various dimensions of TPACK and

UTAUT. There were positive correlations of Technology Knowledge, with Performance Expectancy (r=.32, p<.05), Effort Expectancy (r=.41, p<.01), and Behavioral Intention (r=.30, p<.05). Teachers with higher ratings in Technology Knowledge reported that SRS are useful in teaching, SRS are easy to use, and will keep using SRS in the future. Moreover, Pedagogy Knowledge was found to be positively associated with Facilitating Condition (r=.42, p<.01). How best the methods of instruction is relevant to perceived resources necessary to implement SRS. Further, positive relationships were demonstrated between TPACK Knowledge, with Performance Expectancy (r=.38, p<.01), Effort Expectancy (r=.37, p<.01), Facilitating Conditions (r=.51, p<.01), and Behavioral Intention (r=.28, p<.05). Teachers with higher TPACK knowledge tended to more appreciate the usefulness of clickers, the easiness of using clickers, the availability of resources of using clickers, and more likely to use clickers in the future. However, there were no correlations among Content Knowledge and all dimensions of UTAUT. Teachers' knowledge on their discipline is not significantly linked to any dimensions of UTAUT.

Table 3 Correlation table of various dimensions of teachers' knowledge as measured by TPACK to technology acceptance as measured by UTAUT

	Technology acceptance—UTAUT				
	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions	Behavioral Intention
Teachers' knowledge—TAPCK					
Technology Knowledge	.32*	.41**	.17	.17	.30*
Content Knowledge	.07	.20	-.02	.21	.24
Pedagogy Knowledge	.20	.25	.12	.42**	.18
Technological Pedagogical Content knowledge	.38**	.37**	.10	.51**	.28*

*p<.05 **p<.01

Discussions and implications

The current study demonstrated the association of TPACK and UTAUT, in particular how teachers' knowledge may influence the determinants of behavioral intention of using SRS. The study provided important implications for both practice and research in using SRS and enriching the UTAUT model with teachers' knowledge.

Implications for practice

The benefits of SRS is well-validated. It greatly facilitates the engagement of students and the interactivity in class. In the current study, factors that may affect the acceptance of SRS were examined with statistical analysis. The study demonstrated that Technology Knowledge and TPACK Knowledge were associated with the perceptions about performance expectancy, effort expectancy, and behavioral intention of using SRS. This implies that training and support for teachers should focus on sharpening not only the technological proficiency, but also the skills of adopting technology to deliver particular subject contents or in specific disciplines. The practical implication appeared to be especially important when considering the lower mean scores of both Technology Knowledge and TPACK Knowledge. Therefore, to successfully disseminate the student response system over the campus, it is essential to regularly upgrade teachers' knowledge on technology, and more importantly, the methods of applying the technology in their own disciplines, so that teachers can confidently and effortlessly adopt the technology matching their unique teaching needs, as well as optimize the effectiveness of using the technology.

Implications for research

The current study was the first systematic attempt to explore the association between teachers' knowledge and UTAUT. The study extended previous efforts on UTAUT by examining possible determinants of the key constructs of UTAUT. The findings supported the hypothesis of the positive relationship of Technology and TPACK knowledge, with Performance Expectancy, Effort Expectancy, and Behavioral Intention of using SRS.

One interesting point to note is that the results demonstrated that Pedagogical Knowledge and the TPACK knowledge are associated with Facilitating Conditions of UTAUT. Teachers with higher rating in Pedagogy and TPACK Knowledge perceived that there are more resources available, both tangible and intangible, for them to implement the student response system. One possible explanation is that the array of skill sets required to remove the barriers of transferring knowledge from teachers to students (i.e. pedagogy knowledge and TPACK knowledge), and that to remove barriers to access resources for running the technology (i.e. facilitating condition), shared some similar properties per se. Future study can examine the core competencies of teachers and identify if there are any core skills that attribute to both dimensions.

Future directions

The current study employed the correlational design and did not provide any information on the directionalities of the relationships among variables of TPACK and UTAUT. Future studies can utilize other experimental designs to support the causal relationship of teachers' knowledge on perception of various dimensions, especially effort expectancy and performance expectancy, of the UTAUT model. Further, to offer a better picture of the interrelationships among various dimensions of the two models, a structural equation model can be adopted in future effort to understand the technology acceptance of teachers in university settings. The sample size of the current study is not large (n=52). Future studies can increase the sample size to improve the representativeness of the sample as well as the conclusiveness of the results. The findings will also be consolidated through triangulation with in-depth qualitative analysis of focus group studies.

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