A study of Chinese technical and vocational college teachers' adoption and gratification in new technologies

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Abstract

The problem motivating this research is the rapid introduction of educational technologies and the strong push to use new technologies in technical and vocational training in China coupled with varied responses and uneven adoption of new tools on the part of practitioners. This study investigated the factors that influence technical and vocational college teachers' adoption and appreciation of information and communication technology (ICT) in China using the technology adoption and gratification (TAG) model. At total of 535 teachers from public technical and vocational colleges were surveyed using a purposive sampling procedure. The survey data were analyzed through structural equation modeling. Findings suggest that the use of ICT had three primary determinants: teaching purpose, research purpose and academic purpose. Technical and vocational college teachers' technology adoption and gratification was directly and indirectly predicted by their computer self-efficacy, intention to use, perceived ease of use and usefulness of ICT. Most importantly, the TAG model accounted for 77% of the variance in teachers' gratification using those predictive variables. This research successfully applied the TAG model and it further fosters recommendations for future investigations. This study contributes to theoretical, methodical and practical understandings of the use of ICT in technical and vocational education, which has been much less explored than in K-12 education and university settings.

Practitioner Notes

What is already known about this topic

- Information and Communication Technology (ICT) helps explain teacher acceptance.
- Investigations have revealed that many gaps exist in identifying ICT facilities, access, skills and usage in technical and vocational education.
- Studies have suggested that ICT development requires significant training on the part of teachers and creates new demands for students.

What this article adds

- This research exhibited that vocational and technical college teachers' use of ICT had three primary determinants: teaching purpose, research purpose and academic purpose.
- Chinese technical and vocational college teachers' adoption and gratification in new technologies were directly and indirectly predicted by their computer self-efficacy, intention to use, perceived ease of use and usefulness of ICT.
- The findings of this study recommend that the quality of teaching, learning and research in vocational and technical education could be enhanced through the application of emerging ICT.

Implications for practice and/or policy

- The larger goal is to use the results as a basis for future studies in the relatively unexplored area of ICT use and adoption in teaching and training in developing countries.
- By conducting cross-cultural studies, researchers could be able to comprehend the overall scenarios of ICT in vocational and technical education as proposed.
- This study contributes to theoretical, methodical and practical understandings of the use of ICT in technical and vocational education, which has been much less explored than in K-12 education and university settings.
- Teachers' skills to use ICT should be enhanced through ongoing training programs offered by the authorities of technical education.

Introduction

The use of information and communication technologies (ICTs, broadly understood to include a wide variety of digital technologies) has altered the daily activities of mankind (Keane, Keane, & Blicblau, 2016), not only in everyday life but also in the domains of learning, teaching and research (Islam, 2016). The ICT evolution has been measured by access, use and skills development (Kyriakidou, Michalakelis, & Sphicopoulos, 2013). However, many gaps exist in identifying ICT facilities, access, skills and usage in higher education, including lack of internet access (Siddiquah & Salim, 2017), physical access among faculty (Soomro, Kale, Curtis, Akcaoglu, & Bernstein, 2018), changes in learners' cognition, economic viability (Ram & Sinha, 2017) and sufficient ICT skills to take advantage of new technologies (Thanji & Vasantha, 2016). When the focus is on technical and vocational education, the gaps increase (Islam, 2016). ICT can play an important role in addressing these challenges. Therefore, ICT has become an imperative part of education in nearly all contexts (Batane & Ngwako, 2017). The issue addressed herein is identifying the reasons why educators in Chines technical and vocational institutions are sometimes reluctant integrate new technologies into their courses.

Teachers have been using multimedia and digital resources for training in China and elsewhere for many years. Effective use of these resources often requires innovative ways of delivering technical and vocational information and designing meaning learning activities using such technologies as learning games, digital graphics, animations and videos, interactive simulations and virtual and augmented realities. In addition, ICTs are now used for various regular work-related tasks, which makes using those technologies in training relevant and often necessary (Khan & Markauskaite, 2018). Not surprisingly, there is a growing demand for incorporating ICT in mainstream teaching in technical and vocational education (Bliuc, Casey, Bachfischer, Goodyear & Ellis, 2012; Khan, 2015). Due to the rapid changes in digital technologies, there are now many skills gaps confronting many organizations, especially technical and vocational colleges (Arnaldo & Comendador, 2017), which is the focus of this research.

In spite of the educational potential of digital technologies, the necessary infrastructure in many technical and vocational institutions in China and developing countries is not always adequate. The high initial costs to acquire, install, operate, maintain and replace digital devices and associated equipment is one challenge that needs to be overcome. In addition, making effective use of digital technologies in training and education requires significant training on the part of teachers and creates new demands for students (Buttar, 2016). Ezenwafor (2015) argued that technical and vocational education and training teachers should periodically update their technology competencies to remain relevant in the 21st century. Others have made similar arguments; without training, ongoing professional development support and sustained commitment from institutions, the needed updating of teacher skills is unlikely to occur. Batane and Ngwako (2017) identified that preservice teachers' technology competency should be estimated and then targeted for improvement during preservice teacher training and continued afterward with ongoing professional development.

However, one of the latent variables inhibiting progress is scant or out-of-date resources available in preservice training and in technical and vocational schools in many developing countries, including China. Lack of resources can prevent preservice teachers from gaining competence in using technology effectively. The result is that educators frequently struggle in effectively integrating technology in their teaching. Effective technology integration requires multiple capabilities, including technology use, positive attitudes about teaching with technology and new skills in linking technology to learning goals in appropriate pedagogical designs (Becuwe *et al.*, 2017; Spector & Park, 2018). The rapid development and spread of new educational technologies often results in poorly understood pedagogical models with few exemplars of large-scale sustained success in spite of many impressive projects (Bennett, Dawson, Bearman, Molloy, & Boud, 2017; Spector, 2016). Among the findings of prior research is the notions that satisfaction is a reliable measure and predictor of the quality and usefulness of teaching and learning (Keller, 2010; Spector & Park, 2018; Wu, Tennyson, & Hsia, 2010). According to Diep, Zhu, Struyven, and Blieck (2017), satisfaction among peers tends to result in improved achievement due to perceived gratification. An indication of the need for further investigation in China is the *2018 Technology Outlook for Chinese Vocational Education: A Horizon Project Report* (BNU-SLI, 2018).

This study used the validated technology adoption and gratification (TAG) model (Islam, 2016) to explore the underlying predictors of technical and vocational college teachers' adoption and gratification of ICT use in China. The larger goal is to use the findings as a basis for future studies in the relatively unexplored area of ICT use and adoption in teaching and training in developing countries.

Literature review

The technology adoption and gratification (TAG) model, proposed by Islam (2016), is based on three complementary models: (1) technology satisfaction (Islam, 2014), (2) technology acceptance (Davis, Bagozzi, & Warshaw, 1989) and (3) online database adoption and satisfaction (Islam, 2011). The TAG model elucidates the adoption and gratification of ICT in terms of how teachers perceive computer self-efficacy of technology, which in turn will directly influence their motivation in the form of perceived usefulness and ease of use, and would indirectly affect their gratification, intention to use and actual use.

The TAG model also recognizes that teachers are using ICT for their teaching, academic and research purposes as shown in Figure 1. It is worth noting that this model was designed for general use in higher education and is not restricted to use by teachers in technical and vocational institutions Basically, the TAG model consists of the constructs of computer self-efficacy and gratification with the technology acceptance model (TAM) as latent or emergent. According to Yueh, Huang, and Chang (2015), the TAM has become comprehensively applied in the development of information technology over the past few decades. TAM comes from a revision of the theory of reasoned action (TRA), a model focused on the determinants of consciously intended behaviors (Fishbein & Ajzen, 1975). The TRA states that belief has a positive effect on attitudes and leads to intention. Investigators have attempted to validate TAM and its modified models in information systems, library sciences, human computer interactions and educational contexts. Examples include the adaptations of learning management systems (Ros *et al.*, 2014), online learning environments (Esteban-Millat, Martínez-López, Pujol-Jover, Gázquez-Abad, & Alegret, 2018), e-learning systems (Al-Azawei, Parslow, & Lundqvist, 2017), ICT applications (Zejno & Islam, 2012) and online exams (Liu, Chen, & Lu, 2015). However, these researchers validated or extended TAM for measuring students' or teachers' acceptance of technology. The literature reveals a huge gap in conducting research on technical and vocational college teachers' ICT use
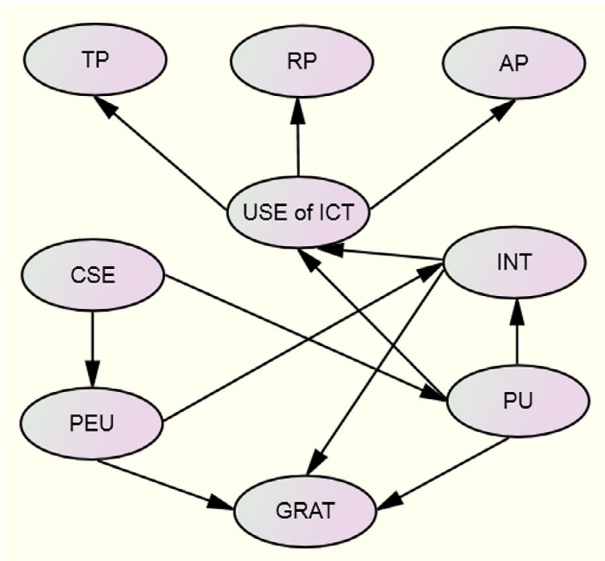

Figure 1: Technology Adoption and Gratification Model (Islam, 2016). Note: computer self-efficacy (CSE), actual use (USE of ICT), gratification (GRAT), perceived usefulness (PU), intention to use (INT), perceived ease of use (PEU), teaching purpose (TP), research purpose (RA) and academic purpose (AP)

(Naweed & Rose, 2018). As such, this study applies the TAG model to investigate technical and vocational college teachers' adoption and gratification in using ICT for performing their teaching and research activities. The causal associations among the dimensions of the TAG model are discussed in the next section.

Hypotheses testing using the TAG model

In this section, we include a brief but pertinent discussion in regards to the factors of the TAG model affecting technical and vocational college teachers' ICT use and their gratification in teaching and research. Based on the literature review along with the TAG model, we constructed a total of eight hypotheses and explored the relationships among latent variables: computer self-efficacy, actual use, gratification, perceived usefulness, intention to use and perceived ease of use.

Self-efficacy is a concept discovered by Bandura in explaining social cognitive theory (Bandura, 1977) and is defined as a personal judgment of how well one can execute courses of action required to deal with prospective situations (Bandura, 1982). Later, Caprara *et al.* (2008) instigated a focus on a significant amount of studies in the education system. That is based on the judgments while making choices with a serious dilemma, rather than focusing on the skills one has. In addition, teachers' self-efficacy has a significant effect on their using technology in a traditional or constructive way (Teo, 2009). According to Moos and Azevedo (2009), self-efficacy is an important indicator of study for analyzing learning with computer-based learning environments. Recently, the TAG model (Islam, 2016) observed that computer self-efficacy is a powerful predictor in explaining university teachers' technology adoption and gratification where Islam (2015) expressed that it refers to the university teachers' beliefs in their computer competency to use ICT. In line with this definition, we assume that computer self-efficacy will refer to the technical and vocational college teachers' beliefs in their own computer capability to use ICT in teaching and research. From the insights of computer self-efficacy related researches, we found that perceived usefulness and ease of use were directly affected by computer self-efficacy in using blended e-learning systems (Al-Azawei *et al.*, 2017), electronic textbooks (Chiu, 2017), ICT (Islam, 2016), computer simulations (Liu & Huang, 2015) and wireless internet (Islam, 2014). However, such causal relationships are not frequently validated in assessing vocational and college teachers' ICT adoption and gratification in a Chinese context. Therefore, our first hypothesis is as follows:

H1: technical and vocational college teachers' perceived usefulness and perceived ease of use will be directly affected by their computer self-efficacy in using ICT.

The main exogenous variables, namely, perceived ease of use and usefulness of the TAM (Davis *et al.*, 1989) were adapted as mediating variables of the TAG model where Islam (2015) defined that perceived usefulness refers to the university teachers' opinion of the advantages derived from using the ICT. Afterward, Islam also explained that perceived ease of use refers to the university teachers' view of how easy it is to use the ICT in higher education. The TAM and TAG model claimed that perceived usefulness and ease of use are the valid antecedents of intention to use along with other researchers (Chang, Hajiyev, & Su, 2017; Islam, 2016; Kim, Hwang, Zo, & Lee, 2016). Furthermore, we intend to test the assumption that intentions are directly influenced by perceived ease of use and perceived usefulness, two factors commonly explored in the human factors literature.

H2: technical and vocational college teachers' intention to use will be directly affected by their perceived ease of use and perceived usefulness in using ICT.

According to Islam (2015), gratification was defined as the degree to which the use of ICT is congruent with prior values, desires and experience of the university teachers. In line with this definition, the TAG model stated that university teachers' gratification was affected by their intention to use, perceived ease of use and usefulness of ICT (Islam, 2016). Recently, researchers asserted that learners' perceived satisfaction and intention to use were directly influenced by their perceived ease of use and usefulness of e-learning instead of learning styles (Al-Azawei *et al.*, 2017). In doing so, we pretend that technical and vocational college teachers' gratification would be explained through these existing relationships.

H3: technical and vocational college teachers' gratification will be directly affected by their perceived ease of use, perceived usefulness and intention to use ICT.

In regards to the TAM (Davis *et al.*, 1989), it was proved that actual use is directly affected by intention to use information systems followed by numerous studies (Yueh *et al.*, 2015). However, the TAG model has recently been claimed that teachers' actual use of ICT is significantly affected by their perceived usefulness (Islam, 2016), and the model also explains that actual use refers to the teachers' opinions of how often they use ICT for their teaching and research purposes (Islam, 2015). Although it is not clear how these relationships could be established in measuring vocation and technical college teachers' actual use of ICT.

H4: technical and vocational college teachers' actual use will be directly affected by their perceived usefulness and intention to use of ICT.

The contemporary literature exhibited that technical and vocational college teachers' indirect associations between their intention to use and computer self-efficacy, followed by gratification and computer self-efficacy mediated by perceived ease of use and usefulness of ICT as being rarely examined, except for the TAG model, although it was validated for university teachers (Islam, 2016). Similarly, the TAG model also found that teachers' actual use was indirectly affected by their perceived usefulness and computer self-efficacy mediated by intention to use and usefulness respectively. Finally, teachers' gratification was also influenced by their perceived ease of use and usefulness mediated by intention to use ICT. These extensive findings are unknown for the technical and vocational college teachers.

H5: technical and vocational college teachers' intention to use will be indirectly affected by their computer self-efficacy mediated by perceived usefulness and perceived ease of use of ICT.
H6: technical and vocational college teachers' actual use will be indirectly affected by their perceived usefulness and computer self-efficacy mediated by intention to use and perceived usefulness respectively.
H7: technical and vocational college teachers' gratification will be indirectly affected by their computer self-efficacy mediated by perceived usefulness and perceived ease of use of ICT respectively.
H8: technical and vocational college teachers' gratification will be indirectly affected by their perceived usefulness and perceived ease of use through intention to use of ICT.

Methodology
This study selected three technical and vocational colleges from two provinces of China, namely Maanshan Technical College in AnHui, Changsha Aeronautical Vocational and Technical College in AnHui and Hunan Petrochemical Vocational Technology College in HuNan. These colleges are the top among other technical and vocational colleges and are under the jurisdiction of the Institute of Vocational & Adult Education at East China Normal University (ECNU). As such, researchers were able to get the permission to conduct this research among the colleges through the ECNU. According to the technical and vocational college rules and regulations, the questionnaire

was distributed among 1480 teachers through the head of each department in their colleges. All the teachers were involved within the 20 professions. We adapted a 7-point Likert scale Chinese version questionnaire from prior studies (Islam, 2015, 2016) that contained a total of 82 items for measuring all the constructs of the TAG model as shown in Table 1. Teachers' anonymity was confirmed during the survey and their personal information was protected. This study received 563 questionnaires through a purposive sampling technique where 28 incomplete responses were removed before performing data analyses using SPSS 21.0 and AMOS 16 to test exploratory factor analysis of the instrument and validate the TAG model respectively.

The data set consisted of 55.8% male and 44.2% female teachers. Of these, 1.1% held a doctorate degree, 51.4% owning a master's degree and 47.4% were undergraduate holders. Furthermore, 2.1% were between 20 and 24 years of age, 20.7% were between 25 and 29 years of age, 25.0% were between 30 and 34 years of age, 19.1% were between 35 and 39 years of age, 12.9% were between 40 and 44 years of age and 20.2% were above 45 years of age. The sample size met the demand to test the research hypotheses using structural equation modeling (SEM) as supported by Hair, Black, Babin, and Anderson (2010). The judgment of the models fit indices that were conducted according to the Tucker–Lewis Index (TLI), comparative fit index (CFI) and the root mean square error of approximation (RMSEA) with 90% confidence interval (Hu & Bentler, 1999).

Results

To validate the measurement model using confirmatory factor analysis (CFA) in testing convergent and discriminant validity, we achieved a total of 48 valid items from the EFA. Firstly, we analyzed a three-factor measurement model that included teaching purpose (TP), research purpose (RP) and academic purpose (AP) using 12 items to confirm that they are the first-order factors of USE of ICT. The analysis indicated that the findings of the three-factor measurement model were adequate, suggesting fitness of the model based on the following fit statistics: $\chi^2 = 191.225$; $df = 51$; $p = .000$; RMSEA = .072; CFI = .960; TLI = .949. The model also suggested significant interrelationships among these factors such as AP <--> TP ($\beta = .67$; $p < .000$); RP <--> AP ($\beta = .51$; $p < .000$); RP <--> TP ($\beta = .56$, $p < .000$). Then we also estimated the second-order factor which is USE of ICT. The results showed that the first-order factors were loaded under the second-order factor and suggested statistically significant impact on it. This meant that the instructors' USE of ICT was measured by TP ($\beta = .86$, $p < .000$); RP ($\beta = .65$; $p < .000$); AP ($\beta = .79$; $p < .000$), where TP was the strongest predictor among others. This valid second-order factor was integrated with others. However, six-factor measurement of PEU, PU, GRAT, CSE, INT and USE of ICT was re-specified to ensure its validity concerns. The modification indices of AMOS output confirmed that the two items (CSE15 and PEU10) were largely correlated with others indicating multicollinearity, which affected the convergent and discriminant validity issue. Thereby, these

Table 1: Dimensions of the TAG model measured by the questionnaire

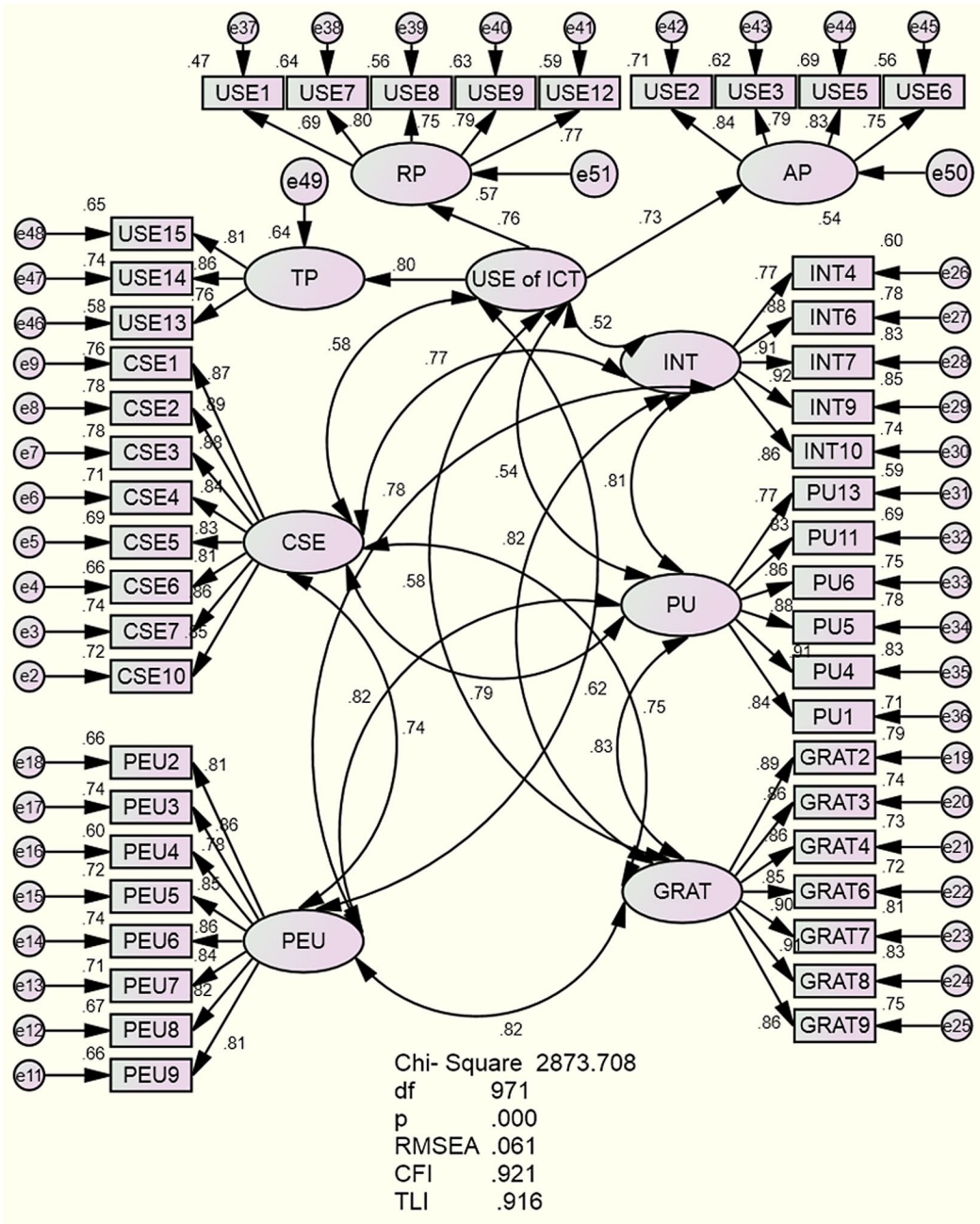| Dimensions	Likert scale	No. of items
Computer self-efficacy	1–7 (strongly disagree → strongly agree)	15
Perceived ease of use	1–7 (strongly disagree → strongly agree)	15
Perceived usefulness	1–7 (strongly disagree → strongly agree)	16
Intention to use	1–7 (very unlikely → very likely)	10
Actual use of ICT	1–7 (never → always)	16
Gratification	1–7 (very unsatisfied → very satisfied)	10

Figure 2: Six-Factor Measurement Model. Note: computer self-efficacy (CSE), actual use (USE of ICT), gratification (GRAT), perceived usefulness (PU), intention to use (INT) and perceived ease of use (PEU)

two problematic parameters were isolated from the measurement model. The re-specified six-factor measurement model contained 46 valid items for its dimensions alone with the first-order factors of USE of ICT as indicted in Figure 2. The model identified significant interrelationships

among six major constructs such as PEU, PU, GRAT, CSE, INT and USE of ICT. The items belonging to those constructs were also statistically significant where loadings of the items were greater than .69 (see Appendix A). The re-specified measurement model fitted the data reasonably well, with $\chi^2 = 2873.708$; $df = 971$; $p = .000$; RMSEA = .061; CFI = .921; and TLI = .916.

To examine convergent and discriminant validity, we used scalar estimates of AMOS output to gain the values of correlations and standardized regression weights. The assumptions of the validity was calculated based on composite reliability (CR), average variance extracted (AVE) and square roots of the AVEs. According to Hair *et al.* (2010), the values of CR and AVE were recommended to be greater than .50. For this study, we found that all the values of CR for the six-factor measurement model were larger than .808 and the AVEs for the constructs were greater than .584. On the other hand, the values of the square roots of the AVEs were indicated that they are significant and greater than the correlations (Fornell & Lacker, 1981) between the six latent variables as shown in Table 2. All these findings related to convergent and discriminant validity and have been suggested for further assessment.

Research model and hypotheses testing

The measurement was transformed to the structural model using single-headed arrows to estimate the proposed eight hypotheses on the TAG model through the maximum likelihood estimation procedure. Firstly, we judged fit indices based on the suggestions (Hu & Bentler, 1999) and found the TAG model fitted the data reasonably well, with $\chi^2 = 3104.234$; $df = 977$; $p = .000$; RMSEA = .064; CFI = .911; and TLI = .906. To test all the hypotheses, the causal connections between the constructs were examined through path coefficients in assessing the strength of the associations of exogenous, mediating and endogenous variables. The TAG model suggested that all the proposed hypotheses are valid based on the paths and critical ratio (CR), while all p values are smaller than .01. For instance, Figure 3 illustrated that technical and vocational college teachers' perceived usefulness ($\beta = .82$, CR = 17.912) and ease of use ($\beta = .77$, CR = 17.673) were directly affected by their computer self-efficacy in using ICT. Meanwhile, teachers' intention to use was directly affected by their perceived ease of use ($\beta = .39$, CR = 7.548) and usefulness ($\beta = .53$, CR = 9.560) in using ICT. Besides, technical and vocational college teachers' gratification was directly affected by their intention to use ($\beta = .30$, CR = 6.161), perceived ease of use ($\beta = .32$, CR = 6.748) and usefulness ($\beta = .36$, CR = 6.897) of ICT. Similarly, teachers' actual use of ICT was also directly affected by their perceived usefulness ($\beta = .36$, CR = 4.005) and intention to use ($\beta = .24$, CR = 2.750). These results provided supports for first four hypotheses.

The remaining four hypotheses were evaluated using the Sobel test (Sobel, 1982) and found to be valid. The results suggested that technical and vocational college teachers' intention to use ICT was indirectly affected by their computer self-efficacy mediated by perceived usefulness (Chi-square, $\chi^2 = 7.230$; $p = .000$) and ease of use (Chi-square, $\chi^2 = 6.813$; $p = .000$). Teachers'

Table 2: The results of convergent and discriminant validity

	CR	AVE	CSE	PEU	PU	INT	USE of ICT	GRAT
CSE	0.956	0.730	**0.855**					
PEU	0.946	0.687	0.742	**0.829**				
PU	0.940	0.725	0.792	0.824	**0.852**			
INT	0.941	0.761	0.773	0.779	0.806	**0.873**		
USE of ICT	0.808	0.584	0.580	0.625	0.544	0.523	**0.764**	
GRAT	0.958	0.767	0.752	0.818	0.833	0.818	0.577	**0.876**

Bold numbers show the square roots of the AVEs.

actual use of ICT was indirectly affected by their perceived usefulness (Chi-square, $\chi^2 = 2.966$; $p = .001$) and computer self-efficacy (Chi-square, $\chi^2 = 3.782$; $p = .000$) mediated by intention to use and perceived usefulness respectively. Besides, technical and vocational college teachers' gratification was indirectly affected by their computer self-efficacy mediated by perceived usefulness (Chi-square, $\chi^2 = 4.941$; $p = .000$) and ease of use (Chi-square, $\chi^2 = 5.820$; $p = .000$) respectively. Finally, teachers' gratification was also indirectly affected by their perceived usefulness (Chi-square, $\chi^2 = 4.546$; $p = .000$) and ease of use (Chi-square, $\chi^2 = 4.525$; $p = .000$) through intention to use of ICT. The total variance for endogenous variables and mediating variables alone with their standardized direct and indirect effect size are shown in Table 3.

Discussion

The results of our research have several theoretical and practical implications derived from the TAG model validated to investigate the factors that influence technical and vocational college teachers' adoption and gratification of ICT. Our findings suggested that technical and vocational college teachers' perception of ease of use and advantage of ICT were directly affected by their computer ability. In addition to the TAG model's (Islam, 2016) own findings that had been established in teachers' ICT use, new studies suggested by researchers (Al-Azawei *et al.*, 2017; Chiu, 2017; Liu & Huang, 2015) have observed the relationships which are consistent with our study. These results prove that technical and vocational teachers' skills to use ICT should be enhanced through ongoing training programs offered by the authorities of technical education so that teachers will feel the provided ICT facilities are easy to use, and they can obtain huge benefits in performing their activities.

Accordingly, the findings indicated that teachers' intention to use ICT was directly affected by their perceived ease of use and usefulness as claimed by previous researchers (Chang, *et al.*, 2017; Kim *et al.*, 2016). However, they did not validate these relationships for technical and vocational teachers in China. These results are adequate to clarify that teachers' intention to use ICT extensively depends on their experiences in terms of it being easy to use and the advantages of such services.

Interestingly, our findings acknowledged that teachers' gratification in using ICT relies on their ease of use along with perceived usefulness and intention to use. It is obvious that teachers' gratification will increase when they feel the provided ICT facilities are beneficial and can easily be used. Besides, teachers are willing to use ICT for performing their future teaching and research related works. Our results are in line with the TAG model (Islam, 2016), although the model was developed for university teachers. Subsequently, the up-to-date literature articulated that students' intention and satisfaction were affected by their ease of use and usefulness of e-learning instead of learning styles (Al-Azawei *et al.*, 2017).

Technical and vocational college teachers' actual use of ICT was directly affected by their intention to use and perceived usefulness, whereas the TAM (Davis *et al.*, 1989) indicated that the actual use was predicted by the intention to use an information system. These results are congruent with the TAG model (Islam, 2016). Findings of our research recommended that teachers' use of ICT largely depends on if their future intentions and benefits are being presently gained through such kinds of service for improving the quality of teaching, learning and research activities in vocational education. Therefore, it is suggested to the authorities of technical and vocational education to ensure that teachers are using ICT for accomplishing their tasks, so they can obtain substantial advantages. This could be done through ongoing research activities.

Our results also revealed that teachers' ease of use and benefits of ICT use mediate them to have indirect relationships between their computer abilities and future intentions followed
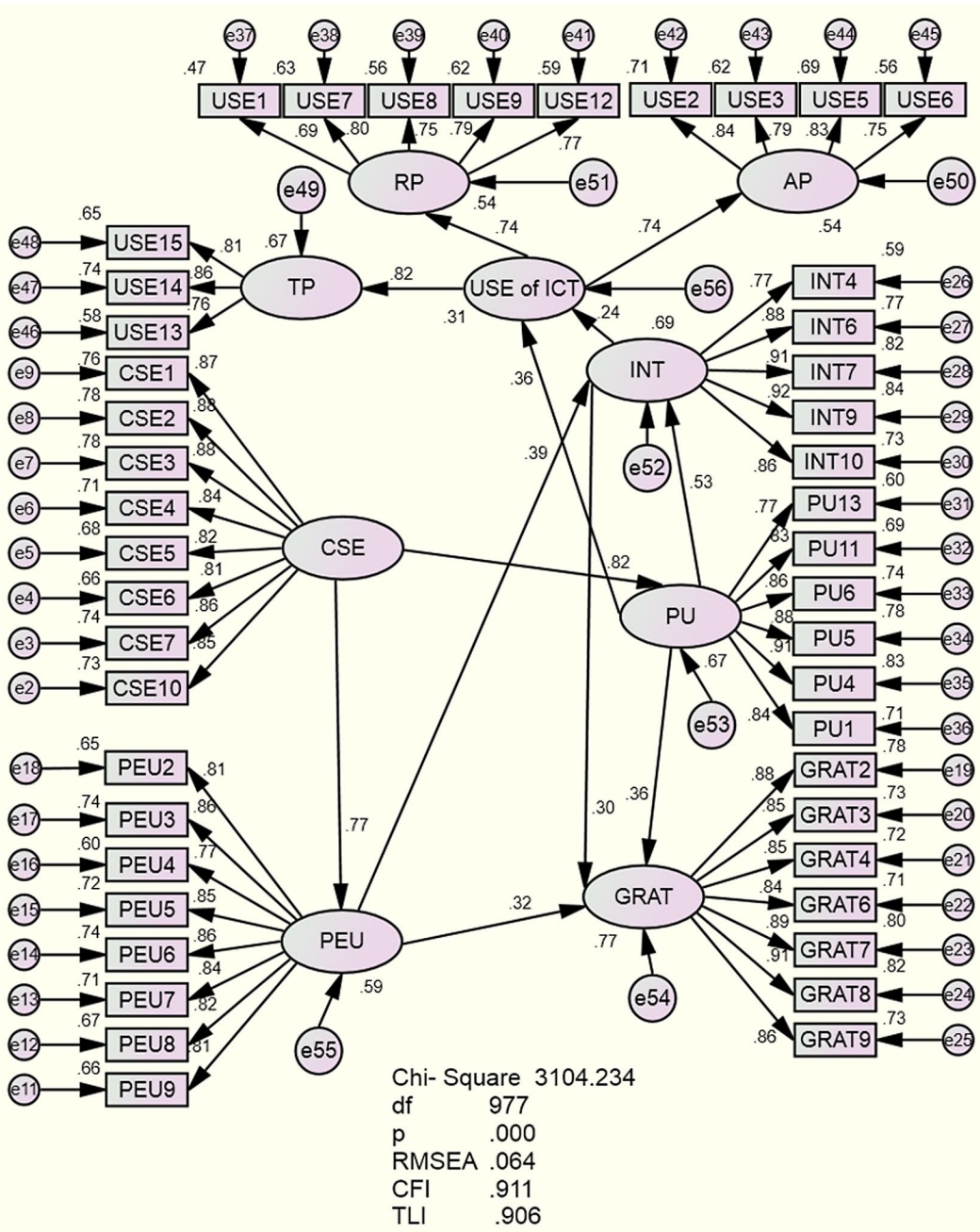
Figure 3: Technology Adoption and Gratification Model. Note: computer self-efficacy (CSE), actual use (USE of ICT), gratification (GRAT), perceived usefulness (PU), intention to use (INT), perceived ease of use (PEU), teaching purpose (TP), research purpose (RA) and academic purpose (AP)

Table 3: The total variance and standardized direct and indirect effect size

Direct effect size		Indirect effect size	
CSE → PU	0.820	CSE → INT	0.733
CSE → PEU	0.769	CSE → USE of ICT	0.464
PU → INT	0.526	CSE → TP	0.379
PU → USE of ICT	0.355	CSE → AP	0.342
PU → GRAT	0.357	CSE → RP	0.342
PEU → INT	0.392	CSE → GRAT	0.759
PEU → GRAT	0.319	PU → USE of ICT	0.124
INT → USE of ICT	0.236	PU → TP	0.392
INT → GRAT	0.301	PU → AP	0.353
USE of ICT → TP	0.817	PU → RP	0.353
USE of ICT → AP	0.736	PU → GRAT	0.158
USE of ICT → RP	0.737	PEU → USE of ICT	0.093
Variables	Variances	PEU → TP	0.076
Endogenous variables		PEU → AP	0.068
USE of ICT	31%	PEU → RP	0.068
GRAT	77%	PEU → GRAT	0.118
Mediating variables		INT → TP	0.193
PEU	59%	INT → AP	0.174
INT	69%	INT → RP	0.174
PU	67%		

by gratification and belief in computer skills. These associations imply that teachers' belief in their abilities are more important in increasing their level of gratification and intensions so that experts should take necessary initiatives to extend teachers' ability to use ICT. On the other hand, teachers' actual use of ICT was indirectly dependent on their abilities and benefits, while teachers' gratification was also relying on their benefits and ease to use ICT through intentions. These results show that to enhance technical and vocational college teachers' gratification and use of ICT, authorities need to ensure that teachers are willing to use ICT for their teaching and research purposes, and they are satisfied due to the convenient and beneficial ICT services as provided through ongoing training programs.

Overall, through extensive analyses, the present study has proven that Chinese technical and vocational college teachers are using new technologies for academic, teaching and research purposes, and their perceptions of the relationships of the various constructs of the TAG model are found to be theoretically and practically important. However, the challenges that technical and vocational teachers confront in using new technologies for their teaching and research purposes could be explored through in-depth qualitative analysis, which was not included in this study.

Conclusion

The quality of teaching, learning and research in technical and vocational education could be enhanced through the application of emerging ICT based on our findings that suggest the use of ICT has three primary determinants: teaching purpose, research purpose and academic purpose. Technical and vocational college teachers' technology adoption and gratification was directly and indirectly predicted by their computer self-efficacy, intention to use, perceived ease of use and usefulness of ICT. Most importantly, the TAG model accounted for 77% of the variance in teachers' gratification using those predictive variables. This research successfully applied the TAG model and it further fosters recommendations for future investigations. This study should contribute to theoretical, methodical and practical understandings of ICT use in technical and vocational

education, which has been much less explored than in K-12 education and university settings. However, our research was performed focusing on only three technical and vocational colleges in China, while there are many colleges that exist within this setting that should be considered by future researchers to enhance the predictive power of the TAG model by including service quality theory and teachers' computer anxiety. This study suggests integrating the moderating variables of the unified theory of acceptance and use of technology (Venkatesh, Morris, Davis, & Davis, 2003) into the TAG model for further studies. By conducting cross-cultural studies, researchers could be able to comprehend the overall scenarios of ICT in technical and vocational education as proposed. In this research, we ignored the qualitative method due to the limited funding as well as time but we recommend integrating mixed method for the future researchers to conduct in-depth analysis in technical and vocational education throughout the world.

Statements on open data, ethics and conflict of interest
If the readers would like to get the data of the instrument used in this paper that had no respondent identifications, they can send a request either to the corresponding author or Faculty of Education, East China Normal University, Shanghai, China.

This research had obtained the ethical endorsement from the Vocational and Technical Colleges and Research Management Centre for Non-Clinical Faculties in the East China Normal University before we distributed the questionnaires among the teachers to collect the data.

There is no conflict of interests between the authors and respondents.

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Appendix A: The loadings of the items of the measurement model

Factors	Indicators	Item measure	Loadings	M	SD	α
AP	USE2	How often do you use the following ICT facilities for academic-related activities?—Laptop or Desktop computers	.84	6.16	1.172	.877
	USE3	How often do you use the following ICT facilities for academic-related activities?—Wireless Internet	.79	6.19	1.202	
	USE5	How often do you use the following ICT facilities for academic-related activities?—search engine, eg, Google, Yahoo, etc	.83	6.27	1.114	
	USE6	How often do you use the following ICT facilities for academic-related activities?—Microsoft Office applications.	.75	6.27	1.076	
RP	USE1	How often do you use the following ICT facilities for research-related activities?—College Online Research Databases/Online library research databases	.69	4.80	2.021	.868
	USE7	How often do you use the following ICT facilities for research-related activities?—software to analyse data.	.80	5.10	1.904	
	USE8	How often do you use the following ICT facilities for research-related activities?—document processing, eg, PDF	.75	5.58	1.690	
	USE9	How often do you use the following ICT facilities for research-related activities?—computer graphics	.79	4.97	2.077	
	USE12	How often do you use the following ICT facilities for research-related activities?—computer labs	.77	4.70	2.156	
TP	USE13	I use multimedia facilities for teaching students (eg, CD-ROM, VCD, DVD etc.)	.76	5.85	1.502	.850
	USE14	I use ICT facilities for preparing course and lecture notes	.86	5.97	1.462	
	USE15	I use ICT facilities for making course presentations	.81	6.00	1.397	
CSE	CSE1	I have the skills required to use computer applications for writing my research papers	.87	5.89	1.235	.956
	CSE2	I have the skills and knowledge required to use computer applications for demonstrating specific concepts in class	.89	5.92	1.191	
	CSE3	I have the skills required to use computer applications for presenting lectures	.88	6.01	1.170	
	CSE4	I have the skills required to communicate electronically with my colleagues and students	.84	6.10	1.099	
	CSE5	I have the ability to e-mail, chat, download teaching, learning and research materials, and search different websites	.83	6.22	1.065	
	CSE6	I have the ability to use the Wireless Internet service provided by the university	.81	6.13	1.220	
	CSE7	I have the skills required to use ICT facilities to enhance the effectiveness of my teaching, learning and research	.86	6.06	1.136	
	CSE10	I have the skills required to use the ICT facilities to enhance the quality of my research work	.85	6.00	1.139	

Appendix A: Continued

Factors	Indicators	Item measure	Loadings	M	SD	α
PEU	PEU2	I find it easy to access the university research databases	.81	5.36	1.570	.945
	PEU3	It is easy for me to become skilful at using university databases for conducting research	.86	5.46	1.567	
	PEU4	Interacting with the research database systems requires minimal effort on my part.	.78	5.19	1.712	
	PEU5	I find it easy to get to the research databases to help facilitate my research	.85	5.59	1.470	
	PEU6	Interacting with the university research databases system is very stimulating for me	.86	5.47	1.519	
	PEU7	I find it easy to select articles/journals of different categories using research data-bases (education/engineering/business, etc.)	.84	5.64	1.366	
	PEU8	With Wireless Internet, I find it easy to access university databases to do research	.82	5.56	1.509	
	PEU9	Wireless Internet allows me to access research and learning materials from Web Browser (WWW)	.81	5.67	1.515	
INT	INT4	I will teach a course that will be delivered totally on the world wide web	.77	5.50	1.554	.936
	INT6	I intend to download research materials from the university databases frequently	.88	5.94	1.307	
	INT7	I will use the university research databases to update myself on the research areas I am pursuing	.91	5.94	1.253	
	INT9	I will use the university research databases to write outstanding journal articles	.92	5.94	1.288	
	INT10	I intend to use research related software to analyse data	.86	5.95	1.268	
PU	PU1	Using the ICT facilities at the university enables me to accomplish tasks more quickly.	.84	5.77	1.346	.939
	PU4	ICT facilities at the university improve the quality of the work I do	.91	5.85	1.301	
	PU5	Using the university ICT facilities enhances my research skills	.88	5.79	1.298	
	PU6	Using the university ICT facilities would make it easier for me to find information	.86	5.78	1.337	
	PU11	Using the university ICT facilities provides me with the latest information on specific areas of research	.83	5.77	1.370	
	PU13	I believe that the use of ICT in the classroom enhances student learning in my discipline	.77	5.91	1.255	
GRAT	GRAT2	I am satisfied with the ICT facilities provided by the university	.89	5.70	1.508	.958
	GRAT3	I am satisfied with the ease of use of the ICT facilities	.86	5.82	1.342	
	GRAT4	The university ICT facilities have greatly affected the way I search for information and conduct my research	.86	5.73	1.389	
	GRAT6	Overall, I am satisfied with the amount of time it takes to complete my tasks	.85	5.72	1.435	
	GRAT7	I am satisfied with the structure of accessible information (available as categories of research domain, or by date of issue—of journals in particular, or as full-texts or abstracts of theses and dissertations) of the university research databases	.90	5.62	1.471	
	GRAT8	I am satisfied with the support information provided by the university's ICT facilities	.91	5.72	1.406	
	GRAT9	I am satisfied when using ICT facilities for teaching, learning and research	.86	5.85	1.318	