

Utilization of online educational resources in teaching: A moderated mediation perspective

Su Iong Kio¹ · Meng Chan Virginia Lau²

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Abstract The study builds on a newly modified Technology Acceptance Model (TAM) to substantiate the motivation and operation of teachers' utilization of online learning resources. A 'Comprehensiveness' construct is proposed in the modified TAM to reflect the breadth and depth of rich online knowledge. This new construct serves as the mediator between 'Usefulness' and 'Behavioral Intention' in the new TAM structure. In addition, the 'Ease of Use' factor in conventional TAM is proposed to moderate the mediation in the modified TAM. Survey data are collected from 301 teachers undertaking certified training in Macau and Structural Equation Model (SEM) technique is used to assess the model. Moderated mediation is evaluated using both multi-group bootstrapping method and moderated path analysis method. Both methods verify the presence of moderated mediation with partial mediation in high Ease of Use values and full mediation in low Ease of Use values. Theoretical implication of the current study extends the coverage of TAM applications and academic implication suggests the strengthening in teachers' professional development and government sponsorship in building repositories of online resources.

Keywords Online educational resources · Structural equation modeling · Media in education · Teaching/learning strategies · Modified technology acceptance model - TAM

1 Introduction

The World Wide Web has virtually unlimited resources abundant in content, structure, form and accessibility. It is a tremendous segment in modern educational methodology (Crook and Harrison 2008). The rich and comprehensive information on the web has

✉ Su Iong Kio
kiosamuel@usj.edu.mo

¹ Department of Psychology and Education, University of Saint Joseph, Rua De Londres, Macau 16, China

² Institute for Tourism Studies, Colina de Mong-Ha, Macau, China

encouraged many to rely on it for deploying educational content and supporting innovative learning style (Jenkinson 2015; Ramaswamy et al. 2015). Even government agents and policy makers have realized this new developing trend and have setup strategies and devise plans to incorporate online learning technology into their educational policies, such as Hong Kong (Curriculum Development Council 2000) and Singapore (Lim 2007). The potency of online educational resources has been growing at an incredible pace.

Yet, while some teachers have embraced the emergence of the online movement readily, others are still relying on conventional means in their teaching (Clements et al. 2015). The utilization of online resources has not always been peachy along the way. Although the benefit of web content is obvious, there are also barriers to hinder its use by teachers (Seyedarabi 2011). Among the most noticeable obstacles are insufficiency in computer knowledge, time consuming and reliability of web content (So et al. 2014). The adoption of online information search has helped some teachers enrich their teaching style. However, it has yet to see its general adaptation at a large scale.

There are various theories behind the integration of technology into teachers' teaching practices, the most prominent of which is the Technology Acceptance Model (TAM) proposed by Davis (1989). Although the model was not initially designed in an academic context, its application has found numerous instances in the teaching and learning field (Liu et al. 2010; Park 2009). Nevertheless, the TAM model is a generalized model that uses behavioral intention as its output. It does not attempt to make specific measurements on performances or outcomes. The structure of the TAM is kept parsimonious so that it can have a broader application. However, its explanatory power is still superior as many studies have demonstrated using the TAM structure as foundation (Lederer and Maupin 2000; Gibson et al. 2008).

This paper focuses on teachers' utilization of online resources as an application to substantiate a modified TAM structure that inserts an element of moderated mediation into the original model. Figure 1a shows the original TAM structure with three constructs: Perceived Usefulness, Perceived Ease of Use and Intention to Use. The 'Usefulness' construct has generally been recognized as the main contributor to the teachers' intention to use technology, but the contribution of the 'Ease of Use' construct does not always yield the same significance (Aypay et al. 2012; Gibson et al. 2008). The weight of the 'Ease of Use' factor on the 'Intention to Use' factor is usually small or the significance of that

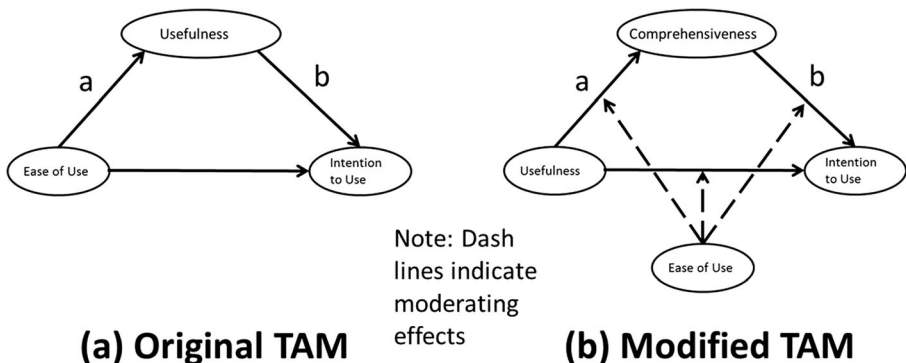


Fig. 1 Original TAM structure and Proposed Modified TAM with moderated mediation

weight is usually weak. This prompts the possibility that the role of the ‘Ease of Use’ construct may be different in the TAM and more consideration has to be taken.

Since the current application of the TAM is online resource utilization, the driving force behind teachers resorting to the internet is usually the comprehensiveness of information on the web (Dringus 2008). There is always something that fits every need of the teachers, no matter what subject, type or form of information the teachers are looking for (Roy et al. 2010). As such the modified TAM structure uses ‘Comprehensiveness’ as a mediator between ‘Usefulness’ and ‘Intention to Use’ to form the basic constructs of the TAM structure. In addition, although the role of the ‘Ease of Use’ construct may not have strong presence in the basic model, its effect cannot be neglected. It is proposed that the ‘Ease of Use’ construct is acting as a moderator for the interactions between the basic constructs such that its effect is manifested in a secondary level, but nevertheless is strong enough to change the relationships among the basic constructs. The proposed modified TAM structure is shown in Fig. 1b. It is necessary to emphasize that although the output in the model is “intention to use”, the more underlying goal should be what students can actually learn from using ICT. Teachers are to convert their intention to utilize online resources into student performances ultimately.

2 Theoretical framework for the proposed model

2.1 Teacher’s utilization of online resources

Despite the diversity of information available on the web that makes searching so much easier for teachers now, the extent to which it is utilized by teachers is still not certain (Moore and Chae 2007; McMartin et al. 2008). Many teachers still heavily depend on textbook information and the auxiliary data that come with the textbook.

However, there is little doubt about the value of online resources that can greatly enhance teachers’ repertoire in their teaching approaches (So and Ching 2012). Students are able to be exposed to knowledge beyond that of the textbooks and receive perspectives from different angles (Zhang 2013; Hughes 2013). Teachers are able to put more variety into their lectures that can appeal more to the students and more effectively draw their focus.

Given the obvious benefit of online resources and the uncertainty of whether they are being fully utilized, the sensible effort to make would be to investigate deeper into the motivation and the mechanism of why and how teachers would use them. The Technology Acceptance Model (TAM) is a very good candidate for that purpose due to its ability to explain behavioral intention in teachers’ acceptance of technology (Teo 2009; Yuen and Ma 2008). It also offers a parsimonious structure that greatly increases its usability and application (Wu et al. 2011). However, since the current study focuses on the specific assessment of utilizing online resources, the ‘Comprehensiveness’ construct is introduced and the ‘Ease of Use’ construct recedes into a moderating role.

2.2 Perceived usefulness of online resources

In a TAM structure, the perceived usefulness of a system is usually the dominant determinant of whether it will be accepted by users or not (Wong et al. 2013; Chen and

Tseng 2012). If people perceive value in performing a task, it would become the dictating factor in their behavioral intention to actually carry out that task. In his original TAM model, Davis (1989) defines perceived usefulness as the extent to which people believe using certain technology would enhance their performance. As long as there is a perceived positive value in that technology, it would be most likely that the technology would be adopted.

The usefulness of online resources has been reflected in their values in various learning topics. Abrams and Walsh (2014) examine students' use of adaptive online resource to assist their language learning and observe that students are more aware of their vocabulary through the online resources. Laetitia and Ghislaine (2009) integrate online material into Math teaching through a 9th grade trigonometry class and are able to reduce students' resistance to Math learning. Indeed, there have been numerous demonstrations that have incorporated the usefulness of online resources to not only help students acquire knowledge easier, but to also help them understand and retain the knowledge in various forms (Cornelius and Gordon 2009; Dhatt and Kaliaperumal 2014; Lazaros and Bormann 2013). As the ultimate goal is enhancing what students can learn, the utilization of online resources by teachers should eventually translate to a better learning performance by the students. The usefulness factor, therefore, plays an essential role in the model.

2.3 Comprehensiveness of online resources

Although the usefulness of the online resources has been largely recognized and its causal relationship with behavioral intention seems assured, the nature of this relationship still needs to be explored. The relationship can be of a direct effect such that the usefulness factor directly causes behavioral intention. Or, the relationship can be of an indirect effect such that the causation goes through some auxiliary factor (Gunzler et al. 2013). There might be an intermediate reason why teachers think online resources are useful. It is this proposition that leads to the inclusion of the comprehensiveness construct serving as a mediator between usefulness and intention in the proposed TAM structure.

The web is a sea of information that encompasses every imaginable content. From arithmetic to astronomy, from alphabet to literature and from geometry to calculus, one can find virtually any subject that fits every degree of sophistication (McClain 2009; Gunderson 2013; Roberts 2015). There are various resources on the web that teachers from every discipline at any grade level can still utilize. The Khan Academy is an online video repository that covers all math topics from kindergarten to college (Muir 2014). Language teachers use online resources to assist them in teaching grammar (Hegelheimer 2006; Angelova and Zhao 2016). Multi-discipline online resources such as WebQuest offer teachers easy and reusable content that can save them precious time in preparing for lessons (Osman 2014; Alias et al. 2014). All these resources are just at the fingertips of those who are willing to apply them.

The essence of searching information online is the belief that it is highly likely that one can probably find what he or she is looking for. This is a direct result of the comprehensiveness of online resources that is due to the information and knowledge buildup on the web over the past three decades. This could be the reason why some teachers think it is useful to search for material online and the current study tests exactly this proposition.

2.4 Perceived ease of use

The Ease of Use construct has been a basic factor in the TAM structure since its inception. It has been included in many applications using the TAM as theoretical framework (Park et al. 2012; Ahmad et al. 2010). However, there are also applications where the Ease of Use construct may not have the same contribution as other factors. Lee and Lehto (2013) apply TAM to procedural learning using YouTube and report that Ease of Use construct does not have significance on behavioral intention. Goh et al. (2014) reveal from their study on faculty Moodle usage that lecturers do not react positively to Ease of Use. Even when Ease of Use is acting as an independent predictor of behavioral intention, without the mediating effect of Usefulness, Tarhini et al. (2014) still find the effect of Ease of Use to be only half of that of Usefulness.

In terms of the current study on utilization of online resources, Ease of Use is characterized to be the degree of effort on attempting to find relevant material online. Although the web offers unlimited opportunities on various types of information, it is not always easy to locate the right material when it is needed (Seyedarabi 2011). Teachers have to sift through hundreds of entries on the return page of a search engine. It takes experience to know the keywords and their combinations for precise returns on searching.

Teachers have to use their professional knowledge to verify the correctness of the online content and whether the content is biased or objective. They have to know if they can utilize the whole content or just part of it. Sometimes online resources can be sporadic, so teachers need to reorganize them for their own use. When the resources are a little advanced and geared toward interested students, teachers have to be able to change them to fit students of all levels. It also takes skill to know which websites contain the right material for the teachers' teaching level such as kindergarten, primary or high school, even college. They have to know where to find exercise problems, lecture examples and quiz questions. All these take a degree of effort for the teachers.

Due to this uneven position of the Ease of Use construct, its implication on the relationships between the basic constructs of Usefulness, Comprehensiveness and Intention in the TAM structure cannot be neglected. It is conceivable that this implication constitutes a moderating effect (Ndubisi 2005) on different paths in the TAM such that the path weights between the basic constructs and their corresponding significances depend on the level of the Ease of Use construct. As such, Ease of Use is incorporated into the current proposed model as a moderator as depicted in Fig. 1b.

3 Methodology and participants

3.1 Research hypotheses

In order to confirm the proposed TAM structure, the following 2 hypotheses guided the design and the analysis of the current study.

1. The Comprehensiveness of online resources mediates the Usefulness and Intention constructs.
2. The ease of use construct moderates the direct path between usefulness and intention; and the indirect path between them through the comprehensiveness construct.

3.2 Evaluation method

Due to the multivariate nature of the proposed model, Structural Equation Modeling (SEM) (Hair et al. 2010) was employed as the analytic instrument to assess the relationships between and contributions among the constructs. Given its capability to simultaneously evaluate multiple relationships between multiple variables (Hancock and Mueller 2006), SEM has gain popularity recently in social science research. Unlike regression, SEM allows researchers to look at complex models with a holistic view that not only indicates the direct effect between adjacent variables but also explores the indirect relationships between variables that are levels apart. It is this powerful feature that enables researchers to make aggressive assumptions and build intricate models that would otherwise be too tedious and too difficult to prove, which in turn would hinder creation and innovation.

Although the current proposed TAM is a rather simple model with 3 basic constructs and 1 moderator, the complex relationship of moderated mediation still warrants the use of SEM to make the interaction between the mediator and the moderator and the whole structure easily observed and conclusion readily drawn. The Statistical Package for Social Science (SPSS) and the AMOS statistics software program were used to evaluate the model.

3.3 Instrumentation

A survey questionnaire was developed borrowing from previous literature (Chen and Tseng 2012; Davis 1989; Thompson et al. 1991 and modified to fit the

Table 1 Proposed TAM constructs and items in each construct

Construct	Items in Construct
Usefulness (USE)	USE1 - Researching material from online resources can also help me learn at the same time. USE2 - Researching material from online resources can also help my work. USE3 - Teaching with web-assisted information can enhance my teaching effectiveness.
Ease of Use (EOU)	EOU1 - It is easy to research for relevant material on the web for my teaching. EOU2 - It is easy for me to prepare my own material from the web material. EOU3 - It is easy to learn how to search for online resources for teaching material.
Comprehensiveness (CMP)	CMP1 - I can find information from the web that textbooks lack. CMP2 - Examples I find on the web are more lively and wide-ranging. CMP3 - Material from the web provides a different perspective to textbook knowledge.
Intention to Use (ITU)	ITU1 - Researching online resources will be a significant element in my teaching. ITU2 - Whenever possible, I intend to search for online resources for teaching purposes. ITU3 - On a whole, I will search for online resources for my teaching methodology.

current application of utilizing online recourses. Table 1 lists the constructs in the proposed TAM and the items in each construct. The questionnaire was translated to Chinese first as most of the target participants are Chinese-speaking. A second translator then translated the Chinese version back to English. Discrepancies between the two versions were readjusted to ensure a genuine reflection between the translations. The Usefulness, Ease of Use and Comprehensiveness items all use a 5-point Likert scale, while the Intention to Use items use a 7-point Likert scale to alleviate some Common Method Variance (Podsakoff et al. 2003).

3.4 Participants

The survey was conducted in Macau, a Special Administrative Region (SAR) of China. Participants were current or prospective teachers undertaking pedagogic training from three Post-Graduate-Certificate-in-Education (PGCE) programs which account for 75 % of such training programs in the region. Approval was first obtained from the institutions offering the programs and the nature of the survey was made clear to be voluntary and anonymous. The survey was given to the teachers at the beginning of a regular class and it took around 15 min to finish. A total of 327 teachers participated in the survey and 301 papers were retained after data cleaning and validating (discussed in section 4.1), resulting in a 92 % retention rate. Table 2 shows the demographic data of the participants. The teaching levels of the participants spread quite evenly. Teachers from all levels can all benefit from online resources, whether they are from kindergarten (Marklund 2015), primary (So et al. 2014) or secondary (Pellerin and Montes 2012) schools. Teachers from the college level are not included in this study since higher education has reached more maturity in online resource utilization already.

Table 2 Demographic data of the participants

Demographic information	Number of participants	Percentage
Gender		
Male	81	26.1 %
Female	229	73.9 %
Age		
Below 20	18	6.0 %
20–29	205	68.1 %
30–39	54	17.9 %
40–49	20	6.6 %
Above 50	4	1.4 %
Teaching level		
Kindergarten	94	31.2 %
Primary	105	34.9 %
Secondary	102	33.9 %

4 Analysis

4.1 Data integrity

Before applying the data to the analytic process, they were first checked for data integrity. Abnormal values, such as out-of-range data, were identified using min-max functions. Missing data were cross-checked against the total in each paper. Skewness and kurtosis of each question were calculated. Their absolute values were all less than 1 indicating that the data were generally concentrating at the center, not steering toward either or both sides. Some participants gave the same answer to all questions resulting in a homogeneous entry line. This was checked by looking at the standard deviation of that line. All participants with the standard deviation less than 0.30 were removed. Together with missing demographic data, 26 out 327 participants were disregarded resulting in 301 valid papers.

4.2 Measurement model

The measurement model assesses how well the collected data fit the proposed model using Confirmatory Factor Analysis (CFA). The assessment comes from a series of fit indices that offer various comparison methods. Different validity and reliability metrics are also evaluated in the measurement model to indicate how well the observed variables form different latent constructs and how the constructs are invariant across groups.

4.2.1 Goodness of fit indices

Generally, the fit of the measured data to the theorized model is not reflected in a single indicator. No single fit index is able to fully describe how well the matching is between the measured and theorized models. The comparison has to go through multiple indices to produce different perspectives of the assessment.

The absolute indices presume the best fitting model to have a fit of zero, thus, indicating how far the measured model is away from a perfect fit. These indices include the χ^2 statistics, the Goodness-of-Fit Index (GFI), Standardized Root Mean Residual (SRMR) and the Root Mean Square Error of Approximation (RMSEA), etc. The RMSEA is sometimes also termed as a parsimony index as it takes into account the complexity of the model by including the Degree of Freedom (DF) and the sample size into its calculation (Kenny and McCoach 2003). The incremental fit indices compare the proposed model to a null model where all variables have no correlation with each other. The null model contains no latent constructs as all variables are uncorrelated. The incremental fit indices measure the improvement of the proposed model to this null model. They include the Comparative Fit Index (CFI) and the Tucker Lewis Index (TLI), etc.

Hair et al. (2010) suggest that researchers should report at least one incremental index and one absolute index, in addition to the χ^2 value and the associated degrees of freedom (DF). The χ^2 value is usually sensitive to large sample size, thus the ratio of χ^2 value to DF is usually reported. For the current study, two indices were reported in each category in addition to the χ^2 /DF ratio. Table 3 lists these indices and their

Table 3 Fit indices of the proposed model

Fit Indices	Values	Recommend values from literature
χ^2	73.0 $p = 0.003$	Significant p value expected
Degree of Freedom (DF)	43	
χ^2/DF	1.70	< 3: Kline (2005);
Absolute Fit Indices		
RMSEA	0.048	< 0.07 (Kenny and McCoach 2003)
SRMR	0.026	< 0.05 (McDonald and Ho 2002)
Incremental Fit Indices		
CFI	0.982	> 0.95 (Hu and Bentler, 1999)
TLI	0.973	> 0.95 (Hu and Bentler, 1999)

recommended values from literature. All the reported indices yielded better scores than the recommended values.

4.2.2 Reliability and convergent validity

Acquiring good indices is just the first step toward a proper measurement model. It still remains to be tested to see how well the observed variables aggregate together to form the latent constructs. Three indicators are usually used to demonstrate this convergence:

Table 4 Convergent validity parameters and internal consistency of the constructs

Construct	Standardized loading	Composite Reliability (CR)	Average Variance Extracted (AVE)	Cronback alpha
Usefulness		0.87	0.70	0.86
USE1	0.87			
USE2	0.90			
USE3	0.72			
Ease of Use		0.76	0.52	0.77
EOU1	0.77			
EOU2	0.73			
EOU3	0.66			
Comprehensiveness		0.83	0.63	0.79
CMP1	0.80			
CMP2	0.73			
CMP3	0.84			
Intention to Use		0.89	0.73	0.88
ITU1	0.87			
ITU2	0.86			
ITU3	0.83			

the factor loading of each variable on their construct; the Composite Reliability (CR) of each construct and the Average Variance Extracted (AVE) of each construct. Table 4 shows the values of these indicators. It also shows the Cronback alpha value of each construct to verify internal consistency of the data within each construct.

It would be preferable for all the standardized loadings to be greater than 0.70. That is the case for most of the variables in Table 4 except for the EOU3 variable. Its loading is 0.66. However, it is quite close to the 0.70 guideline. In addition, the recommended minimum value for the AVE, which is the mean-square of all the loadings in the construct, is 0.50 (Segars 1997). All the AVEs reported are bigger than this minimum value. The Composite Reliability needs a value higher than 0.7, which is satisfied by all the constructs here. Finally, the Cronback alpha also prefers a minimum value of 0.70 to show internal data consistency. The reported values for this parameter are all greater than 0.70.

4.2.3 Discriminant validity

In a measurement model, it is not sufficient to only show that certain variables belong to their respective construct. It is also necessary to establish that these variables probably do not belong to other constructs at the same time. The variance shared by the construct with its variables has to be larger than any variances between this construct and other constructs. The discriminant validity evaluates this distinction by comparing the self-correlation of a construct to the cross-correlation between this construct and any other construct. The self-correlation is just the square-root of the AVE of the construct. Table 5 shows the values of the correlation matrix that allows easy comparison. The diagonal in the table is the self-correlations. By comparing each self-correlation with other cross-correlations vertically and horizontally in the table, it is clear that each self-correlation is larger than its associated cross-correlations. As such, the discriminant validity in the measurement model is deemed adequate.

4.3 Structural model

With a reasonably robust measurement model verified, the subsequent step is to proceed to testing relationships between constructs using the structural model. The primary focus of the structural model is to evaluate the path coefficients between constructs much like the regression coefficients, with consideration of measurement at the same time. Therefore, theorized paths have to be defined in a structural model

Table 5 Discriminant validity

Construct	Usefulness	Ease of Use	Comprehensiveness	Intention to Use
Usefulness	0.834			
Ease of Use	0.509	0.720		
Comprehensiveness	0.453	0.412	0.792	
Intention to Use	0.460	0.416	0.549	0.855

first with arrows indicating exogenous and endogenous constructs, or independent and dependent constructs.

4.3.1 Testing mediation only

Mediation by causal steps procedure The first hypothesis of this study posits that the relationship between Usefulness and Intention to Use is mediated by the Comprehensiveness of online resources. Mediation is typically tested with the causal steps procedure suggested by Baron and Kenny (1986). As shown in Fig. 2a, c is the path coefficient without the presence of the mediator Comprehensiveness, and c' is the coefficient after the mediator is inserted. The causal steps procedure requires that all path coefficients a , b , c be significant and c' be either insignificant or lower than c . Figure 2b shows the magnitudes of the path coefficients along with their significance. As all coefficients are significant and there is a decrease in c , partial mediation is verified by the causal steps procedure.

Mediation by bootstrapping Although Baron and Kenny's (1986) method has been widely applied in mediation testings, the decrease in c to c' is still tested separately. However, the essence of mediation is that the decrease itself has to be significant. The quantity $c - c'$ has to be tested together. Since $c - c'$ is ordinarily equivalent to ab (MacKinnon et al. 1995), the decrease can be tested by looking at the product of a and b . If this product is positively significant, that will imply a significant decrease in c to c' . The product of a and b is usually tested using the bootstrapping technique (Preacher and Hayes 2004; Song et al. 2013) due to the advance in computer speed. The current model was tested for mediation again using a bootstrapping of 2000 resampling. The bias-corrected 99 % confidence interval for the ab product is from 0.13 to 0.51, a range well above 0. This implies that the product is positive with at least 0.01 significance, thus, further verifying the mediating effect of Comprehensiveness on the relationship between Usefulness and teachers' Intention to Use online resources.

4.3.2 Testing moderated mediation

Although mediation exists in the proposed model, the extent of this mediation was postulated to depend on the level of the Ease of Use factor. This is the second

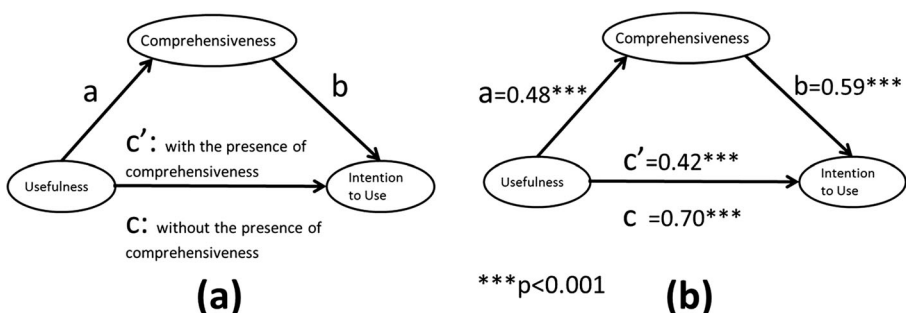


Fig. 2 Path coefficients for mediation

hypothesis of the current study. The testing for this moderation was also carried out by two different methods to provide a degree of complementarity as to improve the robustness of the test. The moderated mediation was first tested by multi-group method, and then, by the moderated path analysis.

4.3.3 Moderated mediation by multi-group method

The multi-group method splits the sample data into groups according to the moderator (Wegener and Fabrigar 2000). In this case, the Ease of Use construct was first summated and dichotomized into high and low values using its median. The high group and low group were then created according to the values of this moderator. Direct and indirect paths were examined between the groups to evaluate the effect of the moderator on the mediation. As shown in Fig. 3, the direct path is the one with path weight c' and the indirect path is the one with path weight ab .

Mediation was tested in each group with bootstrapping of 2000 resampling. As indicated in Fig. 3, the low group exhibits full mediation as the direct path is not significant anymore with the presence of the mediator. The indirect path has a very significant path weight of 0.28. The high group, on the other hand, only exhibits partial mediation as the direct path is still very significant and the indirect path has only a weak path weight of 0.12. In fact, the significance on the indirect path is only 0.04, barely below the 0.05 line. The mediation in the high group is, therefore, very weak. As such, moderation by the Ease of Use construct is evident in the model according to the multi-group method as different groups exhibit different levels of mediation.

4.3.4 Moderated mediation by interaction method

Although multi-group testing for moderated mediation has been widely used in behavioral research, it has been criticized for the sacrifice of statistical power due to the reduction in sample size in each group (MacCallum et al. 2002). The bootstrapping technique, however, compensates for the statistical power by providing a pseudo sampling distribution that is formed from resampling the sampled data many times (Preacher and Hayes 2004). A combination of multi-group and bootstrapping is able to constitute a viable testing method for moderated mediation. Nevertheless, for the current study, moderated path analysis (Edwards and Lambert 2007) was also

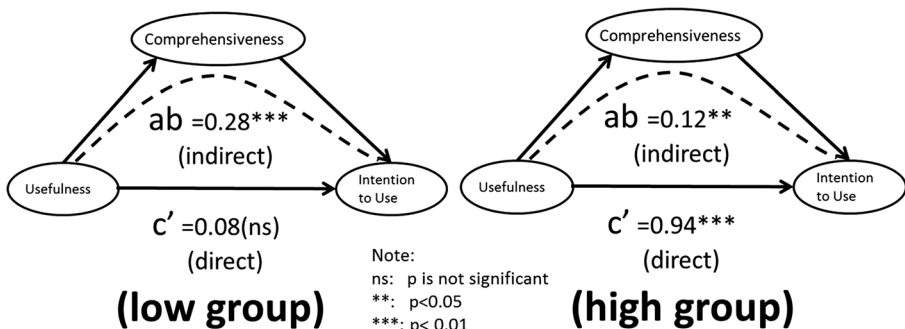


Fig. 3 Direct and indirect paths in multi-group moderation

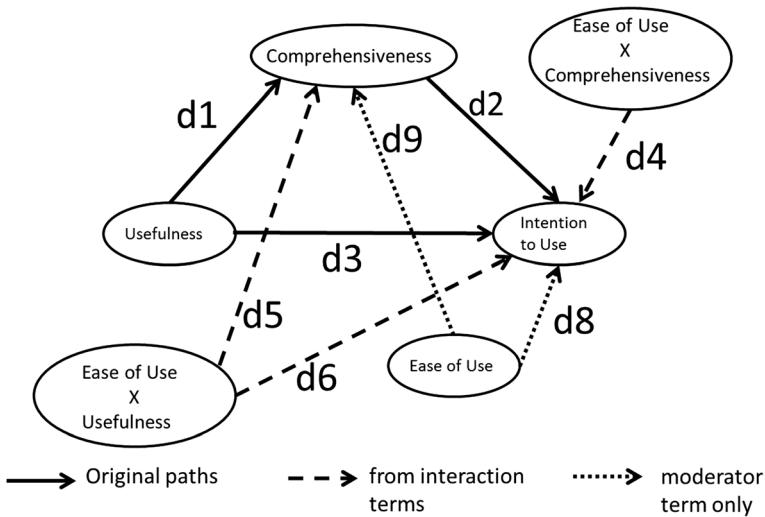


Fig. 4 Various terms for the moderator and its product terms in the moderated path analysis

employed to see if the moderated mediation results are consistent across different testing methods. The moderated path analysis creates a product term between the moderator and the predictor in a simple path. If the coefficient for the product term is significant, moderation can be deduced for the corresponding path. Figure 4 shows the various terms in the proposed model.

The three basic constructs of Usefulness, Comprehensiveness and Intention to Use all have interaction (product) terms pointing to them, representing the possibility of moderation in the three original paths denoted by d1, d2 and d3. Table 6 lists the magnitudes and the significances of the various coefficients. The first column shows the coefficients of interaction terms for each path. The direct path from Usefulness to Intention to Use is moderated by Ease of Use as d6 is significant. The original path denoted by d1 is not moderated as d5 is not significant. The original path denoted by d2 is moderated as d4 is significant. Since d1 and d2 constitutes the indirect effect of the mediation, as long as either path is moderated, the indirect effect is moderated. As a result, the moderated d2 path implies moderation in the indirect effect of the mediation. Together, both the direct and indirect effects of the mediation are being moderated by the Ease of Use construct. To illustrate the degree of moderation, Fig. 5 plots the relationship between the predictor and its predicted construct for each of the three

Table 6 Coefficients in the moderated path analysis model

Coefficients for interaction terms	Values	Original Paths	Values	Coefficients for moderator only	Values
d6	0.17***	d3	0.29***	d9	0.10(ns)
d5	0.03(ns)	d1	0.30***		
d4	-0.15***	d2	0.34***	d8	0.23***

ns: not significant, ***: $p < 0.01$

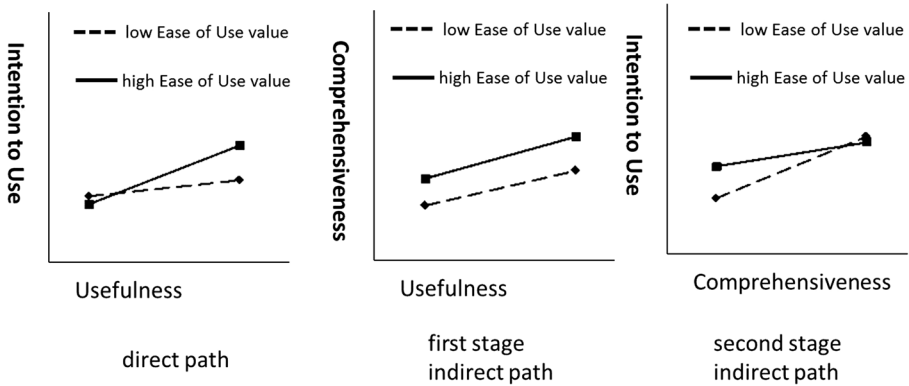


Fig. 5 Simple path relationships across high and low values of the moderator

original paths in the model across prominent values of the moderator (one standard deviation above for high value and one standard deviation below for low value).

It is evident from Fig. 5 that the direct path is strongly moderated as the high value line has a large slope and the low value line has a small slope. This is in agreement with the result from the multi-group testing. The first stage of the indirect path shows no sign of moderation as the slopes of the high and low values are more or less the same. The second stage of the indirect path again displays strong moderation. This time, the low value line has a large slope and the high value line has a small slope. The overall mediation in the indirect path, then, is moderated and in the opposite direction of the direct path. This observation is again aligned with the result from the multi-group testing.

4.4 Hypotheses revisit

The two hypotheses that initiated the current study were verified along the process of the data analysis. The first hypothesis assumes that Comprehensiveness of online resources mediates Usefulness and Intention to Use. The causal steps procedure and bootstrapping method both proved this assumption by demonstrating a partial mediation through the Comprehensiveness construct. The second hypothesis postulates that the mediation effect is moderated by the Ease of Use of online resources. The proof of this hypothesis also undergoes two separate tests, the multi-group test and the moderated path analysis test. Both test results were in agreement that moderated mediation was present such that data with high Ease of Use value exhibit partial mediation and data with low Ease of Use value exhibit full mediation through the direct and indirect paths in the model.

5 Discussion

Although the Technology Acceptance Model (TAM) has been the major theory behind abundant research on teachers' adoption of information and communication technology in their academic practice, the current application of teachers' utilization of online resources demands a closer appraisal of the model. Simple causal relationships and

mediation effects in conventional TAM structures and its variations (Chen 2010) offer insight into the intrinsic and extrinsic factors influencing teachers' decision to accept technology. However, due to the special circumstances surrounding the current topic of online resources, the basic constructs in a TAM structure need to be re-examined and their roles re-evaluated.

5.1 Theoretical implications

The proposed modified TAM structure for this application advocates the importance of the comprehensiveness of online resources in the process of teachers' utilization of such resources. This comprehensiveness construct becomes the mediator in the modified model such that the causal relationship between the usefulness of online resources to its utilization by teachers may be due to the presence of this mediator. This is the first time such construct has been proposed in a TAM structure and the mediation effect is posited in the first hypothesis of this study. The causal steps procedure by Baron and Kenny (1986) verified this hypothesis by reporting a direct effect of 0.70 without the mediator and a direct effect of 0.42 with the mediator. This is a significant drop in the direct effect and the cause of this drop is the indirect effect through the comprehensiveness mediator. The two paths of the indirect effect have path weights of 0.48 and 0.59 respectively.

The bootstrapping method further solidified the first hypothesis by focusing on the indirect path instead of the direct path. The 2000 resampling of the sampled data used in the bootstrapping method resulted in a distribution of the indirect effect. The 99 % confidence interval of this distribution is well above 0 indicating that the indirect effect is significantly positive, which in turn implies a significant drop in the direct effect (MacKinnon et al. 1995), leading to the conclusion of mediation in the first hypothesis.

The insertion of the comprehensiveness construct in the TAM structure extends the literature on the coverage of technology acceptance with regard to online applications. Variations in the TAM research typically explore the external constructs that contribute to the basic constructs of Usefulness, Ease of Use and Intention, but have not scrutinized these core constructs differently as to their roles and functions. This observation led to the second hypothesis of moderated mediation in the proposed model. The Ease of Use construct, although fundamental in conventional TAM, is frequently being deemed as inconsequential or less significant in research articles regarding technology use (Lee and Lehto 2013; Arbaugh 2000). As such, the role of the Ease of Use construct was proposed to be a moderator, altering the relationships in the basic structure, rather than acting as a dominant factor in the model.

The effect of the moderated mediation was confirmed, again by two separate tests. The multi-group method and the moderated path analysis method both provided corroborating results in that the nature and the level of mediation in the core constructs in the modified TAM structure varied across the values of the Ease of Use moderator. When the moderator value is low, the mediation is of a full mediation nature with no direct effect between Usefulness and Intention anymore. Contrarily, when the moderator value is high, the mediation becomes a partial mediation with a strong direct effect still remaining and a weak indirect effect through the Comprehensiveness construct. This moderated mediation characteristic offers a new dimension in TAM research such that various technology acceptance studies now do not have to rely on straight causal

relationships between constructs any more. It opens another potential perspective in explaining conflicting properties in data that would have been difficult to elaborate with causal effects only. The moderating element in the current approach has the capability to reconcile results according to different traits in a construct within various models.

The proposed model has focus on the current 4 constructs of usefulness, ease of use, comprehensiveness and intention to use. There are many other factors that have been identified to be related to the TAM. However, initial simulation in this study has shown that factors such as attitude, facilitation and workload are not significant enough to be included in the current model. Many other factors are either not associated with the current topic of online resource utilization or somehow are incorporated in the 4 constructs within the current model already. As such, the parsimonious model proposed in this study is sufficient for the current application of online resource utilization.

5.2 Academic implications

The expansion and the optimization of the online knowledge base have created a learning paradigm that is shifting the fundamental emphasis of traditional pedagogy. Much like the emergence of the ancient printing technology, online learning resources are revolutionizing the way people learn and acquire information. The usefulness and comprehensiveness of online learning material are gradually but certainly transforming teachers' willingness to adopt online resources to be part of their teaching methodology. The process of this transformation, however, may not be a straight forward transition. Nevertheless, with the ultimate goal of enhancing student performance, the utilization of these online resources by teachers is a sure step forward towards improving the quality of student learning.

Results from the current study recognize the impact of the comprehensiveness of online resources but not without deeper description. Its mediating effect is a function of how well teachers have grasped the skill of online research. Those who are novel to researching online still rely heavily on the breadth and depth of online material even though they agree that the online resources are useful to their teaching. Those teachers with experience researching online would embrace the online resources mostly as an endorsement to their usefulness. The comprehensiveness of online material still plays a role here for the experienced teachers although its mediating effect is not as strong as the case for the novice teachers.

In light of these outcomes, schools must take necessary measures to ensure that a culture of information and communication technology be cultivated from within (Lim 2007). The implication is twofold. First, professional development programs for teachers must include elements in terms of skills to search, identify and apply essential online material for their academic use. They must learn how to overcome the barriers of searching educational material online (Seyedarabi 2011). Strategies have to be discussed on the effectiveness of information search (Henry 2005) and popular resources have to be pinpointed as easy starting point. Once teachers gain confidence and are skillful enough to carry out independent online researching, they will be able to elevate their teaching methodology to the next level.

The second implication from this study is for government education departments to promote, collect and categorize useful online resources themselves. Online repositories can be assembled with contributions from local schools or private institutions such that

teachers can always resort to these repositories first for quick access and reliable information. Resource portals, such as those in Hong Kong (HKedCity 2015) and Macau (*Teacher Corner* 2015), should be further developed and funded by local effort or even international collaborations. The ultimate goal is to create a database of comprehensive resources that is rich in content and diverse in scope, all at the fingertip of those searching for it.

6 Conclusion and future direction

This article explores teachers' utilization of online resources with grounding from the Technology Acceptance Model (TAM). The model was modified to incorporate the complexity of a moderated mediation perspective that reflects the various degrees of acceptance across different skill levels from the teachers in exercising online research. Emphasis was placed on the comprehensiveness of the online resources as a mediator in the modified TAM structure and the ease of use factor as the moderator quantifying those skill levels. Results from the current study reveal the need for further consolidation of this utilization process in that novice teachers should undergo necessary professional training to strengthen their confidence and ability to acquire online material. At the same time, government effort and organizational support are to be reinforced to build up an online infrastructure that can deliver accurate and reusable content to teachers from every corner of the world and from every aspect of the teaching and learning need.

Potential subsequent research effort can be focused on qualitative data that may be integrated with quantitative results from this research to form a mixed-method investigation. The results from both studies can afford triangulation and corroboration with perspectives from both methods. Other potential mediators or moderators may also be examined to determine if a more complicated model has enough explanatory power at the price of parsimony. Finally, a word of alert that the constructs in this model have not explicitly addressed the issues of the validity of online resources. There are plenty of material on the web that lacks verification and authentication. The correctness of online resources is of critical importance in their utilization as well. As such, more attention can be focused on the accuracy of these resources in future studies and the influence of this accuracy, or the lack thereof, can be determined on the utilization of these online resources.

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