The Construction of a Valid and Reliable Instrument to Measure Virtual Learning Environment Success

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Abstract

The Virtual Learning Environment (VLE) technology has become an essential element to support 21st-century teaching and learning approaches. To ensure that this technology can be employed effectively by the teachers, the assessment of VLE success is necessary. However, few measures of VLE success amongst teachers exist. Therefore, this article describes the process of the development and validation of a questionnaire to measure the VLE success from the teacher's point of view. The construction of this questionnaire has been done through a series of procedures, starting by generating the items, conducting face validation and content validation, translating, as well as piloting the questionnaire to a number of selected respondents. As a result, 45 robust items to evaluate VLE success among teachers have been yielded.

Keywords: Instrument Development; Scale Development; Questionnaire; VLE Success, Virtual Learning Environment

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Introduction

By definition, the Virtual Learning Environment (VLE) can be described as a platform that flexibly supports various forms of education and it permits the users to manage educational resources (Al-Busaidi & Al-Shihi, 2012). Since it was first introduced, this platform has gaining quick popularity among teachers worldwide due to the ability to defy the time and location boundaries, which allows the teaching and learning process to happen even without a physical or face-to-face classroom environment (Cavus, 2013).

Most of the time, the implementation of VLE in schools requires a high cost, particularly in terms of licensing and facilities provisions. Thus, to ensure that the investment is profitable, it is necessary for teachers to fully utilize and grasp the maximum benefits offered by various VLE platforms such as Frog VLE, Moodle, and Blackboard. However, in reality, this desired phenomenon never happens, especially in developed countries. Recently, several issues related to the problem of low usage, including among teachers, are consistently raised, indicating that the platform is disoriented from its success direction.

Therefore, to ensure that it can be used effectively by teachers, there should be a way of measuring the success of the VLE platform. Indeed, the success evaluation has been accepted as a crucial process of all types of information systems (IS), including VLE (Alsabawy et al., 2013). Strong justification is required to rationalize the costly investments in implementing VLE in schools. In light of this, the aspects of the platform (VLE Quality, Information Quality and Service Quality), as well as the user (Continuous Intention, VLE Usage, Teacher Satisfaction and VLE Benefits), can be used to measure VLE success among teachers. Therefore, this article aimed at producing a robust and empirically validated questionnaire to evaluate VLE success among teachers that is ready-to-use for researchers and professionals (Y. Wang et al., 2007).

Theoretical Background

From the literature, it is found that the evaluation of the VLE success could be engaged using the updated DeLone and McLean IS Success Model (D&M) (DeLone & McLean, 2003), as evidenced by much prior research (Mohammadi, 2015; Zhu et al., 2013). To measure IS success, the D&M comprehensively elaborates on the inter-relationships between six critical indicators: (i) Information Quality, (ii) System Quality, (iii) Service Quality, (iv) Use, (v) User Satisfaction and (vi) Net Benefits. Unfortunately, most of the available research has neglected this concept of comprehensiveness and inter-relationship success dimensions proposed by the D&M. Some research adopted certain selected parts of the model for measurement and assessment (Urbach & Müller, 2012), for instance, User Satisfaction (Chang et al., 2009; Dai et al., 2011) and IS Usage (Jurisch et al., 2015; Park, 2009). According to DeLone and McLean (2003), IS success involves interrelated dimensions that should not be measured separately. This notion indicates that the preceding research practice is insufficient in the perspective of IS success and against the original idea of D&M.

The entire six dimensions should be attempted to present a holistic approach and to extend the overall validity of the D&M Model (Urbach & Müller, 2012). In addition, another important consideration when applying the D&M in research is the context of IS under investigation. Therefore, instead of eliminating some elements of IS success in D&M, future researchers should continuously enhance and refine the model to increase its validity and to match various contexts of IS studies. Consistent with the stance, the questionnaire to measure VLE success among teachers retains all dimensions in D&M.

Furthermore, the successful implementation of IS is critically determined by the continuous usage during the post-implementation stage (Bhattacherjee, 2001). In the updated D&M, the construct of Intention to Use was presented as a substitution for Use, to tackle the issue of voluntary versus mandatory IS usage. In other words, Intention to Use is a substitute measurement for the mandatory type of IS. Nevertheless, the Use is still a better option as no IS is totally compulsory to use (DeLone & McLean, 2003). In addition, the Intention to Use (attitude) and its relationship to Use (behavior) is challenging to measure. Hence, many researchers prefer to stick with Use in measuring the IS usage (Davarpanah & Mohamed, 2013; Eom, 2012).

However, Use and continuous Intention to Use could also be two distinct dimensions that are related to each other. In other words, the current Use is hypothesized to influence the future intention to use IS (Agarwal & Prasad, 1997). Consequently, this would create repetitive and recursive relationships, whereby the excellent

first encounter with the IS would probably cause satisfaction, thus triggering the user's continuous intention to use it in the future, and finally the actual Use will also increase. Based on the preceding discussion, this article proposes the separation of these two dimensions to enable future researchers to examine the issue of VLE continuous usage and increase the explanatory power of the D&M (Agarwal & Prasad, 1997; Awang, Wan Rozaini, et al., 2018; Mardiana et al., 2015). Figure 1 illustrates the proposed framework for VLE Success amongst teachers.
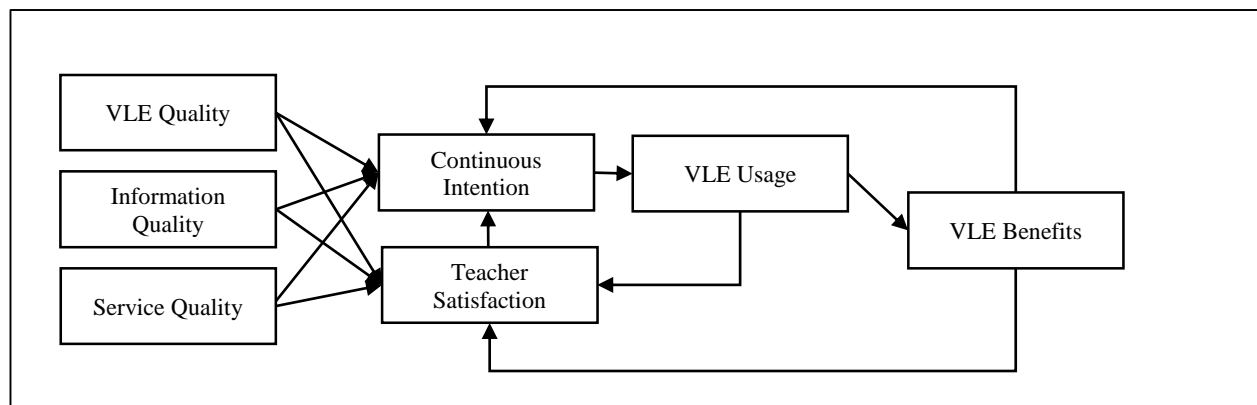

Figure 1. Framework for VLE Success Among Teachers

Methods

Definition of Constructs

Seven constructs to model the determinants of VLE success among teachers were proposed in this article. The operational definition of these constructs is shown in Table 1.

Table 1
The Definition of Constructs for VLE Success Among Teachers

Construct	Definition	Sources
VLE Quality	The extent of VLE quality in terms of technical performance from the perspective of the teachers.	(DeLone & McLean, 1992, 2003)
Information Quality	The extent of output or information quality produced by VLE from the perspective of the teachers.	(DeLone & McLean, 1992, 2003)
Service Quality	The extent of services, supports and encouraging environments provided by the VLE system and service provider for the teachers.	(DeLone & McLean, 1992, 2003)
Continuous Intention	The extent of intention for future use, after the initial use of VLE among the teachers.	(Agarwal & Prasad, 1997; DeLone & McLean, 2003)
VLE Usage	The utilization of VLE among the teachers (individual level).	(DeLone & McLean, 1992, 2003)
Teacher Satisfaction	The perception of pleasure or displeasure caused by the teachers' level of belief that the VLE system has fulfilled their needs or expectations.	(DeLone & McLean, 1992, 2003)
VLE Benefits	The expected and the actual impacts or benefits at the individual level, attributed to the use of VLE among the teachers.	(DeLone & McLean, 1992, 2003)

Generation of Scale Items

There is an abundance of available items to measure VLE success. Thus, in order to find and retrieve the most suited items from the literature, a comprehensive revision has been conducted on the related subject areas, including IS Usage, E-Learning Satisfaction and IS Success. As a result, a question for seven constructs comprising of 78 items has been generated, as shown in Table 2. To suit the context of the study, these items have been modified accordingly.

Table 2
The Constructs' Measurements for VLE Success

Construct	Measurements	Sources
VLE Quality	Usability, Availability, Reliability and Accessibility	(Eom, 2012; Lwoga, 2013; Zhou, 2013)
Information Quality	Relevance, Sufficiency, Accuracy, Currency, Format, Reliability and Timeliness	(Eom et al., 2012; Teo et al., 2009; Wixom & Todd, 2005)
Service Quality	Empathy, Assurance, Responsiveness and Tangibility	(Chang et al., 2009; Kettinger & Lee, 1994; Pitt et al., 1995)
Continuous Intention	Intention to Reuse in Future	(Alharbi & Drew, 2014; Teo et al., 2009)
VLE Usage	Nature of Use and Regularity of Use	(Agarwal & Prasad, 1997; Eom, 2012)
Teacher Satisfaction	Enjoyment, User Survey and Overall Satisfaction	(Eom et al., 2012; Y. S. Wang, 2008; Zhou, 2013)
VLE Benefits	Productivity Improvement, Time-Saving and Personal Valuation	(Chen et al., 2015; Y. Wang et al., 2007)

Measurement Scale

The questionnaire uses a seven-point Likert Scale, ranging from '1' [extremely disagree] to '7' [extremely agree], as it provides more comprehensive scale values compared to the five-point Likert Scale. This should decrease the possibility of respondent's bias by avoiding a neutral value and straight-line answers (Dwivedi et al., 2010). In fact, the seven-point Likert Scale has also been adopted by many prominent IS researchers (Agarwal & Prasad, 1997; Venkatesh et al., 2012).

Instrument Translation

The items of the instrument were adapted from various sources and translated from English to Malay by a translator from the Language Center, Universiti Utara Malaysia. Nevertheless, the original English version was also provided in a smaller font size so that the respondents will be able to cross-check specific terms that might be confusing.

Pilot Study

The sample size for a pilot study must be at least 30 respondents (Hunt et al., 1982). However, the 'Rule of 100' stressed that the sample should be at least 100 to conduct factor analysis (Gorsuch, 1974). Therefore, 150 questionnaires were distributed to the primary and secondary teachers across the state of Pahang, which represent the homogenous characters of the study population. Out of this number, only 119 were usable after the data cleaning, representing 79% of the response rate. The characteristics of respondents for the pilot study are shown in Table 3.

Table 3
The Demographics of Respondents for Pilot Study

Characteristic/Value/Percentage		
Age	Min: 20, Max: 57, Mean: 34.76	
Gender	Male: 42.9%	Female: 57.1%
School Location	Urban: 49.6 %	Rural: 50.4 %
School Level	Primary: 53.8%	Secondary: 46.2%

In the initial stage of pilot study analysis, the Skewness and Kurtosis values were used for the normality test. The result has shown that the values of Skewness and Kurtosis for each variable in the study were between -2 and +2 (see Table 4), which are considered to be normally distributed (Garson, 2012). The test for normality assumption in the pilot data is vital, especially to minimize the error during reliability analysis based on internal consistency (Sheng & Sheng, 2012). Apart from that, the pilot data was also being used for factor analysis.

Table 4
Skewness and Kurtosis Values of the Pilot Data

Dimension	Skewness	Kurtosis
VLE Quality	0.132	-0.478
Information Quality	-0.026	-0.710
Service Quality	0.269	-0.180
Continuous Intention	0.070	-0.220
VLE Usage	0.119	-0.641
Teacher Satisfaction	-0.018	-0.666
VLE Benefits	-0.131	-0.414

Scale Purification

Face Validation

The general practice allows face validation to be conducted either using experts or prospect respondents (Devon et al., 2007). However, to maximize the face validation of this questionnaire, the procedure has been performed in two phases. Phase one started by retrieving and creating the pool of related items from the literature. This was followed by the evaluation of six experts, consisting of (i) one language expert to check the language accuracy, structure and grammar, (ii) three E-Learning and IS experts to examine the items' accuracy, in terms of double-barreled, ambiguity, leading questions and other related issues, and (iii) two statisticians to verify the measurements and scale. Next, in phase two, the focus discussion using 16 respondents has been implemented to pretest the questionnaire. The sampling procedure to choose the participants has been systematically planned to make sure that they represent all characteristics of real respondents, as illustrated by Figure 2. Furthermore, the average time taken to complete the questionnaire was also recorded, which is 19.75 minutes. This average time which is below 20 minutes, is considered good, as expected by the typical respondent (Henning, 2013). Later, a discussion session was organized with the aim of finding the consensus of each item among the participants. Subsequently, a few issues and suggestions to improve the questionnaire has been captured, including bilingual appropriateness, sentence structure, number of items and scales. In sum, both phases of face validation were successfully conducted, whereby all the experts in phase one and respondents in phase two were contented with the face validity of the VLE success questionnaire.
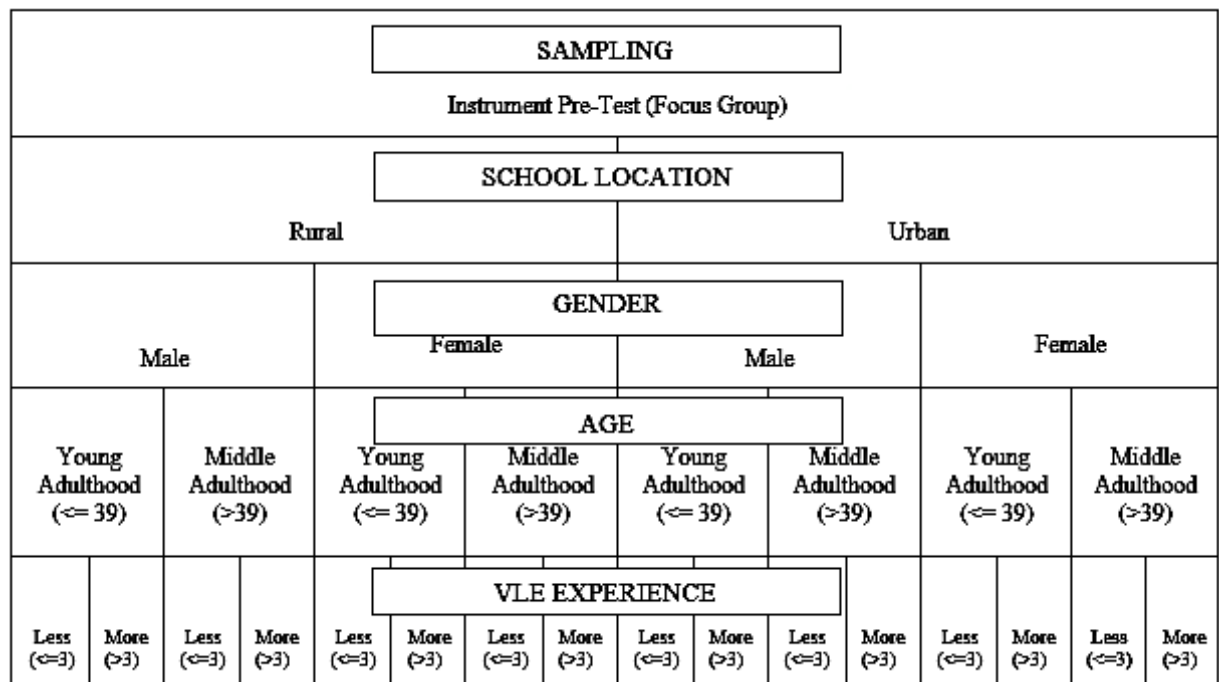
Figure 2. Sampling Procedures for Face Validation

Content Validation

To skim the items in the pool, the analysis of content validity using a group of experts was performed (Awang, Zahurin, et al., 2018). In this case, the Content Validity Index (CVI) was applied to determine the consensus among them. The CVI is used to examine the item's appropriateness to measure the respective construct (Polit et al., 2007). Usually, the content must be validated by three to ten experts. However, at least six experts are needed to balance the disagreement among them (Lynn, 1986). As for this study, seven experts in IS, E-Learning and ICT in Education took part in the content validation procedure. To assist them, the necessary information was provided, including the research framework and instructions for CVI rating. Then, four rating scales (1 = Not Relevant, 2 = Somewhat Relevant, 3 = Quite Relevant, 4 = Highly Relevant) were used by the experts to rate each item (Davis, 1992). The CVI values are calculated based on each item (i-CVI) and the overall scale (s-CVI) (Polit et al., 2007). The acceptable threshold value for i-CVI, using seven experts, is 0.78 (Lynn, 1986). On the other hand, s-CVI can be calculated either using the Universal Agreement method (s-CVI/UA) or the Averaging method (s-CVI/Ave) (Polit et al., 2007). As for the current study, the s-CVI/Ave, with the threshold value of 0.8, was chosen (Davis, 1992). Table 5 summarizes the CVI analysis of this study.

Table 5
CVI Analysis of Content Validity

Construct	Initial Items	Eliminated Items	Final Items	s-CVI/Ave
VLE Quality	19	12 [SyQ4, SyQ5, SyQ6, SyQ7, SyQ9, SyQ10, SyQ13, SyQ14, SyQ15, SyQ16, SyQ17, SyQ19]	7	0.81
Information Quality	10	3 [IQ5, IQ6, IQ10]	7	0.86
Service Quality	18	9 [SeQ1, SeQ2, SeQ4, SeQ5, SeQ10, SeQ11, SeQ12, SeQ13, SeQ18]	9	0.81
Continuous Intention	6	2 [ITU3, ITU4]	4	0.81

Construct							
VLE Usage	12	3 [U2, U3, U5]			9	0.88	
Teacher Satisfaction	7	3 [US1, US2, US7]			4	0.82	
VLE Benefits	6	1 [NB6]			5	0.93	

Identifying the Factor Structure of the Constructs

To identify and confirm the factor structure of constructs, the Exploratory Factor Analysis (EFA) has been performed using the pilot data. Besides exploring data structure, the EFA is also applicable to confirm the consistency of the extracted factors from the real data and the theoretical perspective (Hair et al., 2010). Thus, in this study, the EFA procedure was performed on each construct. The justification for this is that the items were adapted from various sources that have already been used to measure the respective construct. In this case, this procedure is only being used to confirm the consistency of constructs' items. Hair et al. (2010) recommend the following cut-off values when conducting EFA; Sphericity Bartlett Test < 0.5, Kaiser-Meyer-Olkin (KMO) > 0.8, Factor Loading $\geq$ 0.5, Communalities $\geq$ 0.3, and Eigenvalue $\geq$ 1.0. As for this study, no deletion of the item was performed because all the items in the questionnaire exceed these values (refer to Table 6).

Table 6
Summary of EFA Result

Construct	KMO	EV	BT	Item	FL	Com.	Del
Information Quality	0.93	5.94	0.00	IQ1	0.81	0.81	-
				IQ2	0.91	0.91	-
				IQ3	0.87	0.87	-
				IQ4	0.85	0.85	-
				IQ7	0.86	0.86	-
				IQ8	0.88	0.88	-
				IQ9	0.77	0.77	-
VLE Quality	0.89	5.49	0.00	SyQ1	0.85	0.72	-
				SyQ2	0.91	0.83	-
				SyQ3	0.84	0.71	-
				SyQ8	0.92	0.85	-
				SyQ11	0.88	0.78	-
				SyQ12	0.89	0.80	-
				SyQ18	0.90	0.81	-
Service Quality	0.93	7.46	0.00	SeQ3	0.94	0.81	-
				SeQ6	0.93	0.87	-
				SeQ7	0.93	0.87	-
				SeQ8	0.92	0.88	-
				SeQ9	0.92	0.85	-
				SeQ14	0.90	0.76	-
				SeQ15	0.89	0.85	-
				SeQ16	0.88	0.79	-
				SeQ17	0.87	0.77	-
Continuous Intention	0.86	3.57	0.00	ITU1	0.95	0.90	-
				ITU2	0.95	0.90	-
				ITU5	0.94	0.89	-
				ITU6	0.94	0.88	-
VLE Usage	0.91	7.36	0.00	U1	0.91	0.83	-
				U4	0.78	0.62	-
				U6	0.88	0.78	-
				U7	0.94	0.88	-
				U8	0.93	0.88	-
				U9	0.92	0.85	-
				U10	0.93	0.87	-
				U11	0.92	0.84	-

Construct		EV	BT	VAR	FL	Com.	Del.
				U12	0.92	0.84	-
Teacher Satisfaction		0.81	3.68	0.00	US3	0.96	0.93	-
				US4	0.98	0.96	-
				US5	0.96	0.91	-
				US6	0.94	0.88	-
VLE Benefits		0.87	4.53	0.00	NB1	0.93	0.86	-
				NB2	0.95	0.90	-
				NB3	0.97	0.94	-
				NB4	0.96	0.92	-
				NB5	0.95	0.91	-

*VAR=Variables, EV=Eigen Value, BT= Sphericity Bartlett Test, FL=Factor Loading, Com. = Communalities, Del. = Deleted Item

Reliability Analysis

The reliability analysis of each construct in the questionnaire was measured based on internal consistency, as indicated by Cronbach Alpha (α) value. To ensure the reliability coefficient of an item, the threshold value for α is 0.7, but 0.6 is acceptable for the exploratory type of studies (Hair et al., 2010). The procedure of reliability analysis requires the deletion of items that did not contribute to the increment of α. Nevertheless, this procedure is discarded since no item is below the threshold value. Indeed, the α values are within 0.95 to 0.97, which indicated that the questionnaire achieved a high level of construct reliability. Table 7 summarizes the result of the reliability analysis in this study.

Table 7
Result of Reliability Analysis

Construct	Initial No of Items	Initial α	Final No of Items	Final α
VLE Quality	7	0.95	7	0.95
Information Quality	7	0.97	7	0.97
Service Quality	9	0.97	9	0.97
Continuous Intention	4	0.96	4	0.96
VLE Usage	9	0.97	9	0.97
Teacher Satisfaction	4	0.97	4	0.97
VLE Benefits	5	0.97	5	0.97

Result

After went through a series of systematic procedures, this study has produced a substantial, robust, valid and reliable questionnaire to measure VLE success among teachers, as shown in Table 8. From 78 items in the pool at the beginning, only 45 items were retained, which are ready to be used for real studies.

Table 8
Measurement Items to Measure VLE Success Among Teachers

Construct	Measurement Items
VLE Quality	1. The VLE is always available. 2. The VLE is user-friendly. 3. The VLE has attractive features that appeal to me. 4. The VLE enables me to accomplish tasks quicker. 5. The VLE is easy to navigate. 6. The VLE provides high-speed information access. 7. The VLE functions accurately most of the time.
Information Quality	1. The VLE provides information that is exactly what I need. 2. The VLE provides information that is relevant to teaching. 3. The VLE provides sufficient information. 4. The VLE provides information that is easy to understand. 5. The VLE provides up-to-date information. 6. Through VLE, I get the information I need in time. 7. The information provided by VLE is reliable.

Service Quality	1. The VLE helpdesk is prompt in responding to my queries.
	2. The VLE helpdesk is available in case I have a technical problem.
	3. The VLE helpdesk is willing to help whenever I need support.
	4. The VLE helpdesk gives users individual attention.
	5. The VLE helpdesk is highly knowledgeable.
	6. The VLE helpdesk dedicates enough time to resolve my specific technical concerns.
	7. The helpdesk shows a sincere interest in solving technical problems related to VLE.
	8. The VLE has up-to-date equipment.
	9. The VLE's physical facilities are visually appealing.
Continuous Intention	1. I intend to continue using the VLE.
	2. I will regularly use the VLE in the future.
	3. Assuming that I have access to the VLE, I intend to use it.
	4. I intend to be a heavy user of VLE.
VLE Usage	1. I frequently use the VLE.
	2. I use the VLE whenever appropriate.
	3. I use VLE voluntarily.
	4. I use VLE for teaching.
	5. I use VLE to give tests to my students.
	6. I use VLE to communicate with students.
	7. I use VLE to collaborate with other teachers.
	8. I use VLE to retrieve educational information.
	9. I use VLE to retrieve teaching resources.
Teacher Satisfaction	1. I feel contented using VLE.
	2. I feel pleased using VLE.
	3. I think the VLE is very helpful.
	4. I think the VLE is successful.
VLE Benefits	1. The VLE is timesaving.
	2. The VLE enhances my teaching skills.
	3. The VLE helps me improve my job performance.
	4. The VLE empowers me.
	5. The VLE contributes to my career success.

Implications of the Study

Practical Implications

The preceding analyses have successfully produced a questionnaire that consists of 45 items with desired psychometric attributes. This questionnaire that is developed based on the updated D&M IS Success Model is now ready to be used to evaluate VLE, e-learning applications or Learning Management Systems (LMS) from teachers' perspectives. Practically, the questionnaire produced by this study could be valuable for VLE implementation in schools. An evaluation has been proved as a vital step in managing any type of IS, including VLE (Awang et al., 2019; Awang, Wan Rozaini, et al., 2018). However, holisticness is one aspect that has always been ignored when conducting an evaluation. Congruent to the suggestion by DeLone and McLean (2003), the evaluation of VLE success should be conducted from all perspectives, including technical-semantic level and effectiveness level. Therefore, the proposed validated questionnaire should be appropriate to support this kind of evaluation. Additionally, it can be concluded that the main advantage of this questionnaire is to allow the stakeholders to examine the success of VLE implementation from the teachers' perspective. This evaluation will provide fast feedback that is useful for further improvement of the system.

Theoretical Implications

IS success involves interdependent and multi-dimensions constructs. Hence, to maintain its comprehensiveness, it should not be measured based on a single indicator, such as usage or user satisfaction

(DeLone & McLean, 2003). Based on this premise, Continuous Intention is included as a companion to the construct of VLE Usage, which will allow the researchers to examine the VLE continuous usage. Therefore, it is hoped that this questionnaire will provide a more accurate interpretation of VLE success. The questionnaire is also suitable for researchers to analyze hypotheses related to VLE success. For example, using this questionnaire as a measurement tool, it is possible for researchers to examine the relationships between VLE success constructs, or to compare the strength of those relationships between specific groups of teachers.

Summary

The key contribution of this study is creating an initial effort to investigate the success of VLE. Notwithstanding researchers' growing interest in VLE, little attention has been paid to evaluating VLE success. This study, therefore, created a validated questionnaire that is ready for subsequent studies. Nevertheless, it cannot be implemented easily without revision, in particular for other settings with different cultures and environments. Since this questionnaire has been developed within the Malaysian educational environment, its applicability to other settings may be limited. Future studies should, therefore, attempt to investigate other external factors that reflect local features of VLE implementation. For example, teachers' heavy workload has been identified as the main issue in Malaysian education, which could probably hinder them from using the VLE system. Yet, the empirical evidence is unavailable thus far, which calls for the attention of future researchers. Nevertheless, the seven main constructs of the VLE Success Model (Information Quality, VLE Quality, Service Quality, Continuous Intention, VLE Usage, Teacher Satisfaction and VLE Benefits) are relevant across different contexts regardless of culture, economic and political disparities. In like manner, the creativity and rationale of the researchers are necessary to integrate the external factors into the existing constructs of VLE success.

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