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Understanding cloud-based VLE from the SDT and CET perspectives: Development and validation of a measurement instrument

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ABSTRACT

With the emergence of the cloud computing technology, virtual learning environment (VLE) may play an imperative role in promoting instructional effectiveness of ubiquitous learning. However, the existing literature on VLE has been mostly based on the acceptance of VLE from the perspective of the undergraduate students. There is a dearth in studies on the VLE instructional effectiveness from the K-12 teachers' perspective, the effects of Self Determination Theory and Channel Expansion Theory. Existing VLE instruments have not been rigorously validated and do not consider the importance of cultural differences. This research aims at creating and rigorously validating an instrument to study the cloud-based Frog VLE's instructional effectiveness in the Malaysian cultural setting. The robustness of the instrument was validated using structural equation modeling, expert panel, Q-sort, pre-test, pilot-test and fieldwork study. This research may offer a parsimonious instrument to evaluate the instructional effectiveness of the Frog VLE for subsequent studies contributing to theory building in the IS literature.

1. Introduction

Government of Malaysia has introduced the 1BestariNet (*i.e. 1SmartNet*) initiative which involves 10,000 schools nation wide with 5 million students, 4.5 million parents, 500,000 teachers and 1 platform. The Ministry of Education (MoE), Malaysia is cooperating with YTL Communications to bring high-speed wireless 4G Internets along with the cloud-based Frog VLE to all schools nationwide. With this project, FrogAsia will bring the cloud-based VLE to all Malaysian students, teachers and parents through the integration of the high-speed 4G Internet connection with the Frog VLE platform. Malaysia is the first nation in the globe to gather its whole education community together on a sole converged network tailored exclusively to meet the requirements of teaching and learning (1BestriNet, 2015).

The Frog VLE (Fig. 1) is a cloud-based virtual learning environment that resembles normal school teaching and learning environment which incorporates virtual equivalents of traditional education concepts. For example, instructors can deliver lessons virtually, conduct online teaching and tests; mark students' assignments and announce their marks, whereas learners

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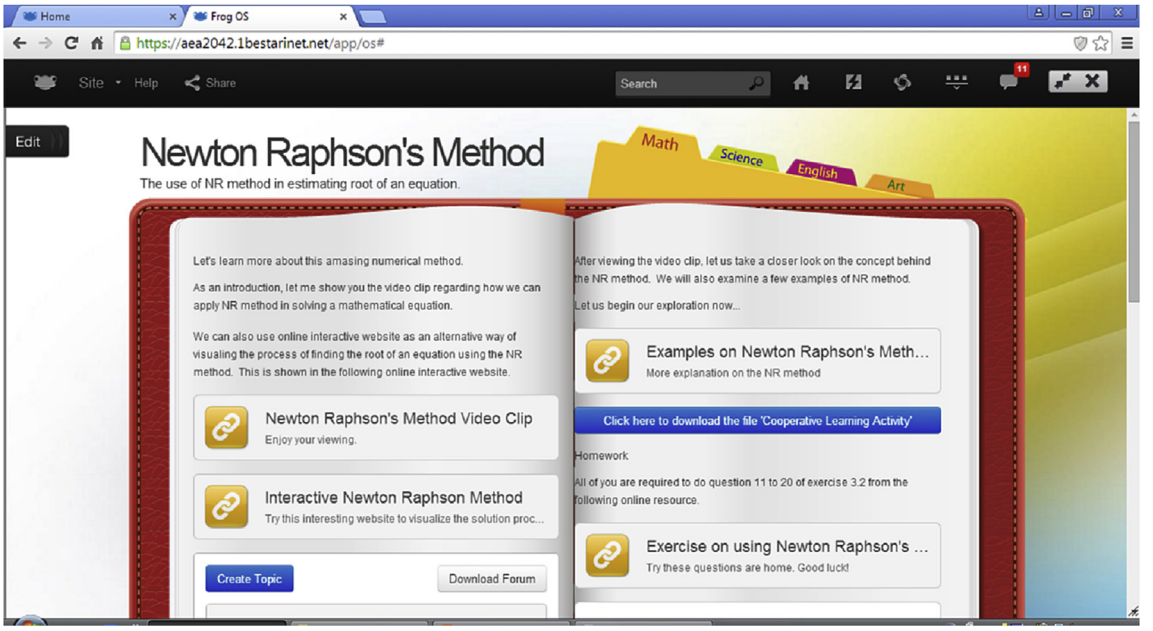


Fig. 1. The Frog VLE interface.

can participate in online learning activities, discussion forums and quizzes or hand-in assignments and check their scores through the VLE. It also allows communication between parents and the schools whilst administrators of school can manage the school calendars and make school announcements via the Internet. Frog VLE is a user-friendly platform that enables instructors and learners to seek for teaching and learning resources such as animations, images, video clips and other resources and assemble them within a filtered and safe environment without requiring any technical know-how (1BestriNet, 2015a).

Even after an era of VLEs in higher education, "many teachers are still using only a minimum of its affordances" (Rienties, Giesbers, Lygo-Baker, Ma, & Rees, 2014, p.1). Majority of teachers use VLEs as a simple repository for students to obtain materials like PowerPoint slides and reading lists (Rienties et al., 2014). Even though there is increase in use of VLEs, however, there is no widespread evidence of transformation in pedagogic practice (Kinchin, 2012). In fact, the number of studies on the reception and adoption of VLE is diminutive but growing (Van Raaij & Schepers, 2008). Examples of VLEs are Blackboard, Moodle, Sakai, Claroline and WebCT (Berns, Gonzalez-Pardo, & Camacho, 2013). Nevertheless, the conversion from conventional instruction to ICT-enhanced environments is not apparent and a lot of instructors remain diffident or reluctant to use instructional technology (Al-Senaidi, Lin, & Poirot, 2009).

Prior studies have been focusing primarily on the web-based or online learning platforms like Blackboard, Moodle, WBLS, e-LMS and etc. which uses grid computing technology that does not come with the facilities of unlimited storage space, on the cloud network access that is location- and device-independent as well as on-demand, configurable and scalable teaching and learning resource materials (Wyld, 2009) compared to the facilities available in the cloud computing technology. Cloud computing provides "an opportunity of flexibility and adaptability to use the computing resources on-demand" (Ercan, 2010, p. 939). Thorsteinsson, Page, and Niculescu (2010) opined that cloud computing may support socially oriented theories of learning and cooperative learning through collaborative methods of instruction. With the cloud-based high speed Frog VLE systems, teachers and students are able to save their work and share them with the colleagues and peers, anytime and anywhere. Due to these differences, it would be interesting to examine whether there are differences between the acceptances and instructional effectiveness of the grid computing web-based instructional systems and the cloud computing based Frog VLE system.

Even though there are several studies on online or e-learning which have examined students' intrinsic motivations (Shroff & Vogel, 2009; Sarnoff, Vogel, & Coombes, 2008, 2007; Xie, Debacker, & Ferguson, 2006) or both intrinsic and extrinsic motivations (Hartnett, George, & Dron, 2011), however the existing grid-based VLE-related researches have been focusing mainly on the students' extrinsic motivations and utilitarian factors such as TAM and ISSM (Motaghian, Hassanzadeh, & Moghadam, 2013), TAM (Sánchez & Hueros, 2010), TAM2 (Van Raaij & Schepers, 2008) or UTAUT (Sumak, Polancic, & Hericko, 2010) instead of the teachers' intrinsic motivational factors like teachers' self determination and motivations towards adoption of the VLE. Besides, none of these researches have investigated the impacts of media rich attributes of the VLE systems on its acceptance and effectiveness. Since the Frog VLE entails a rich media environment with numerous graphics, video, animation, sound, hyperlinks and other multimedia features, the impacts of these media are worth studying. Thus, it is exciting to investigate whether Self Determination Theory (SDT) and Channel Expansion Theory (CET) play significant roles in

affecting teachers to adopt the VLE. Furthermore, the task specific characteristics of interactivity and content design of the VLE were overlooked in the existing studies. Because the VLE system provides various teaching and learning contents like teaching sites, Frogstore online resources, teaching community, assignment modules, forums, emails, quizzes and etc., the effects of content designs require further study. Likewise, since the VLE encompasses interactivity between the teachers and the system, the influence of interactivity towards behavioral intention and perceived instructional effectiveness may warrant a study to be conducted. Therefore, in this study, SDT and CET are integrated with the VLE-related constructs (i.e. content design and interactivity) in predicting the acceptance and instructional effectiveness of the Frog VLE.

Thus far, most of the VLE related studies have used adapted items from existing literature without a rigorous instrument development and validation process. As studies have shown that culture plays an imperative role in IS adoption, thus we argue that it is vital and necessary to conduct rigorous instrument development and validation before the instrument can be used in other cultural contexts. Since there are significant cultural differences (The Hofstede Center, http://geert-hofstede.com/, 2015) between Malaysia and US (Fig. 2), the existing instruments in the original English versions may not be applicable and effective for the Malaysian cultural setting. Thus this study is aimed at developing and validating a measurement instrument to study the acceptance as well as instructional effectiveness of the Frog VLE from the context of Malaysia. This study makes several contributions. First and most importantly, the rigorously developed and validated instrument can be used to study the adoption and instructional effectiveness from the perspectives of SDT and CET in the Malaysian context. Secondly, future researchers may utilize the similar instrument development and validation procedures as a practical guide in different cultural contexts.

The remaining of this research paper is presented as follows. In the subsequent part, we will elucidate the concept of VLE and the existing instruments. This is followed by a brief description on the SDT and CET theories. Then, we will expound the instrument development and validation processes followed by the data collection procedures and data analyses. Finally, discussion of research findings, theoretical and practical contributions will be presented followed by the limitations and future research direction.

2. VLE: definitions and existing instruments

In this section, we first present the definition of VLE. This is followed by a review of the existing VLE related instruments.

2.1. Defining VLE

VLE is a cloud-based platform of communications which enables learners, with no location and time limitations, to obtain various learning tools, for instance course content, course information, discussion boards, instructor assistance, document sharing applications, as well as other instructional resources (Ngai, Poon, & Chan, 2007).

2.2. Existing VLE related measurement instruments

To avoid re-inventing the wheel, we have performed a comprehensive literature review to find instruments that measure instructional effectiveness of the cloud-based VLE especially from the Malaysian context but to no avail. Nevertheless, we were able to locate some relevant instruments that measure the acceptance of other web-based learning platforms like Moodle, Blackboard, *e*-LMS, WBLS and etc. Even though there have been studies on grid-based online or e-learning that used SDT from the students' perspective (Hartnett et al., 2011; Shroff & Vogel, 2009; Shroff et al. 2008, 2007; Xie et al. 2006), however there are hardly any of the grid-based VLE related studies which have examined the effects of SDT and CET on the acceptance and instructional effectiveness of the VLE especially from the viewpoint of the K12 teachers or instructors. All of

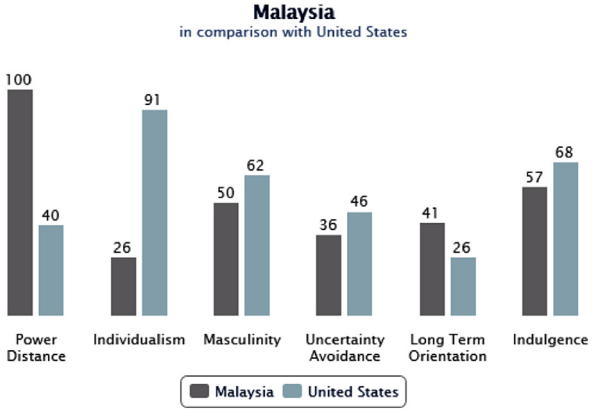


Fig. 2. Cultural differences between Malaysia and US.

these studies did not engage rigorous instrument development and validating processes even though the instruments were administered in different cultural contexts. In fact, none of the studies has engaged any translation processes to the dominant language of the local cultural contexts such as English to Chinese, Iranian, Slovenian, Spanish or Malay back-translations. Hence, the reliability and accuracy of the research findings may be affected. Table 1 shows a summary of the existing grid-based VLE related studies.

3. Theoretical underpinnings

The following section will explicate the theories which are used in the current study.

3.1. Self Determination Theory (SDT)

SDT (Deci & Ryan, 2002) is a macro theory of personality and motivation, pertaining to individuals' inborn growth propensities and the inherent psychological needs. It talks about the motivation behind the options which individuals choose with no external interference and influence. SDT concerns the level to which a person's act is self-motivated and self-determined. Deci and Ryan (1985) assert that 3 psychological needs stimulate a person to instigate behavior and specify nutriments which are crucial for psychological fitness and comfort. These needs comprise of the need for autonomy, competence, and psychological relatedness and are believed to be innate, universal, and psychological. Autonomy focuses the need to self-organize a person's behaviors, whenever the person can pursue the activity freely and attain the volitional feeling by acting so (Deci & Ryan, 1987). The need for competence indicates that individual tends to be effectual in their interactions with the surroundings and when the individuals accomplish an act (Deci & Ryan, 1985) and it is similar but not analogous to the self-efficacy concept as both are distinctly different constructs (Bandura, 1986). The need for relatedness (Baumeister & Leary, 1995) refers to the need to feel linked and supported by significant individuals, for instance a supervisor, teachers, friends or colleagues.

3.2. Channel Expansion Theory (CET)

CET (Carlson & Zmud, 1999) evolves from a range of theoretical contexts which deals with media channel perceptions. It unites constructs from social influence model and the media richness theory and assumes media richness as a vital factor in media choice and use. CET claims that knowledge-building experiences affect media richness perception. These experiences include experiences with the channel, communication partner, subject and organization context (Carlson & Zmud, 1999). A communication channel experience will enable a user to learn about the attributes, choices, limitations and uses of the channel thus enabling the user to use more efficiently the communication channel and adapt its adoption to the attributes of the task as well as increasing its perceived richness (Fernandez, Simo, Sallan, & Enache, 2013). The experience with communication partners through mutual learning and interactions such as language patterns as well as expectations in message building will enable the application of a richer language in communications. The application of symbols and shared cultural references enables for a richer communication language through the media as a result from the rise in the enhancement of the organization's knowledge base (Timmerman & Madhavapeddi, 2008).

Table 1
Definition of construct.

Construct	Definition	Literature
Perceived Relatedness (PR)	The degree of the desire to feel connected to others.	Sørebø, Halvari, Gulli, and Kristiansen (2009)
Perceived Autonomy (PA)	The degree of the desire to self-initiate and self-regulate own behavior.	Sørebø et al. (2009)
Perceived Competence (PC)	The degree of the desire to feel effective in attaining valued outcomes.	Sørebø et al. (2009)
Perceived Media Richness (PMR)	The degree to which a teacher believes that VLE is capable of carrying a wide variety of media based on the criteria of capacity in immediate feedback, personal focus, multiple cues and language variety.	Fernandez et al. (2013)
VLE Content Design (VCD)	The degree to which learning contents are designed and developed to fit students' needs.	Lee, Yoon, and Lee (2009)
VLE Interactivity (VI)	The degree of interaction that a teacher perceives as having with the VLE system, and the extent to which the VLE system is perceived to be responsive to his/her needs.	Chen, Chen, and Kazman (2007)
School Support (SS)	The degree to which a teacher believes that his/her school is committed to successful VLE implementation and use.	Lai and Chen (2011)
Attitude toward knowledge sharing (AT)	The degree of a teacher having positive feelings about sharing ideas and resources with those with whom they have developed a close relationship.	Chow and Chan (2008)
Trust in Website (TW)	The degree of the belief resulting from the reliability and reliance of the VLE website.	Hsu, Chang, Chu, and Lee (2014)
Behavioral Intention (BI)	The degree to which a teacher has formulated conscious plans to perform or not perform some specified future behavior.	Venkatesh, Morris, Davis, and Davis (2003)
Perceived Instructional Effectiveness (PIE)	The degree a teacher believes that using VLE is able to enhance his or her instructional effectiveness.	Limniou and Smith (2010)

4. Methods

4.1. Instrument development and validation

It is vital that for effective instrument to be developed, it must be able to cover the content domain of every construct (Nunnally, 1978). Items that measure a construct ought to congregate with each other while items of a construct should discriminate themselves with items of other constructs. Every construct must be reliable and valid. We have further enhanced the parallel approach used by Li, Rao, Ragu-Nathan, and Ragu-Nathan (2005) in developing and validating the measurement instrument by integrating an English-Malay back-translation process. This approach consists of two phases that starts with construct definitions and the relevant items. The first phase involves item selection, pre-test, item translation and pilot test. In subsequent phase, we further validated and refined the instrument using a large scale fieldwork study.

4.2. Measurement scales

In this study, 7-point Likert scales were used to measure the level of agreement to a given statement as they are able to generate higher degree of dispersion as well as minimizing neutral responses. The response ranges from (1) strong disagree to (7) strong agree for agreement type of scale.

4.3. Operational definitions

Table 2 contains the operational definitions and corresponding sources of every constructs engaged in this study. These constructs will be further discussed in section 6. The original English versions of measurement scales are listed in Appendix A at the end of this paper.

4.4. Target population and sample

The population of teachers as of 31 December 2014 is 419,820. The sampling frame is the list of 351 Champion Schools attained from MoE. Champion Schools are selected primary and secondary schools that are given prioritized training by FrogAsia and act as the benchmarks for other schools nationwide. The unit of analysis is primary and secondary school teacher in Malaysia.

4.5. Data collection procedures

In order to conduct this research, approval has been acquired from the Educational Planning and Research Division, Ministry of Education, Malaysia. Further approvals have also been obtained from all State Education Departments. Questionnaires were posted to the selected Champion Schools which have implemented the Frog VLE system using self-addressed envelopes based on simple random sampling technique. The data collection has been conducted in two phases using a gestation period of four months (Venkatesh, Thong, & Xu, 2012). Phase one (T1) is used to gather data on the demographics and independent variables while phase two (T2) is meant for gathering the data on the dependent variables. The aim of using two different surveys (i.e. T1 & T2) to gather the independent and dependent variables is to reduce common method bias. To trace the respondents on the two phases, the last three digits of the national identity card and mobile phone are collected in both surveys. In the first phase, a total of 800 questionnaires were administered and 575 were gathered back. Therefore, the response rate is 71.8%. In the second phase, 575 questionnaires were mailed and 398 were collected back yielding a 69.2% response rate.

4.6. Pre-test

In the pre-test stage, measurement scales were developed based on face validity and content validity of the instrument. These involve reviews by expert panel and practitioners as well as Q-sort procedure to assess the Content Validity Index (CVI) and construct validity inter-rater reliability (Cohen's Kappa) respectively.

4.7. Scale development and expert panel

The scales in the instrument were adapted from previous studies through an extensive literature review. These scales were then reviewed for face validity and content validity by an expert panel consisting of three Malaysian professors in the field of Information Systems (IS) who are Editor-in-Chief or guest editor of IS related journals and published numerous ISI-ranked journal papers. These panel experts are born and raised in Malaysia and are therefore very familiar with the Malaysian culture and hence will be able to provide accurate recommendations from the Malaysian cultural setting. The Harzing's *H*-index of these professors ranges from 20 to 35. The full biographies of these panel experts can be obtained upon request to the authors. The other members of the expert panel are three experienced practitioners. These practitioners consist of Frog Champion teacher, Frog VLE coordinator and master teacher who are able to provide practical recommendations from the

Table 2
A review of existing VLE related instruments.

Author(s)	Instrument to study	Sampling procedure & target respondent	What is measured	Type of scale	Validation
Sumak et al. (2010)	Moodle acceptance in Slovenia	Online survey using convenient sample of 235 undergraduate students at the Faculty of Electrical Engineering and Computer Science in Maribor, Slovenia	UTAUT	7-point Likert scale	Pre-test, Pilot test
Van Raaij and Schepers (2008)	CassLearn acceptance in China	A convenient sample of 40 Chinese managers enrolled in Executive MBA program	TAM2, SN, PIIT and Computer Anxiety	7-point Likert scale	No validation. All items were adapted from published studies.
Sánchez and Hueros (2010)	Moodle acceptance in Spain	A convenient sample of 226 students of the Faculty of Business Sciences and the Faculty of Educational Science at the University of Huelva, Spain	TAM, technical support and perceived self-efficacy	7-point Likert scale	Pre-test No pilot test
Chou and Liu (2005)	Technology-mediated VLE (TVLE) in Taiwan	A convenient sample of 210 Hsing-Kuo High School students	Learner control, Learning performance, Self efficacy, Satisfaction and Climate	5-point Likert scale	No validation. All items were adapted from validated studies.
Eom (2012)	e-Learning Management System (e-LMS) in US	A convenient sample of 674 university students in Midwest USA using online survey.	E-learning System Success (ELSS)	7-point Likert scale	No validation. All items were adopted from Wang, Wang, and Shee (2007)
Motaghian et al. (2013)	Web-based Learning System (WBLS) in Iran	115 university instructors from two Iranian universities were selected using cluster sampling	TAM, ISSM, Self-efficacy and SN	7-point Likert scale	No validation. All items were adopted from Wang and Wang (2009)
Sun and Hsu (2013)	Web-based Instruction (Moodle) in Taiwan	A convenient sample of 42 undergraduate students using experimental setting	Perceived interactivity, ATT, Satisfaction and Perceived learning	5-point Likert scale	Pre-test, Pilot test
Liaw (2008)	Blackboard system in Taiwan	A convenient sample of 424 university students	Three-tier Use Model (3-TUM)	7-point Likert scale	No validation. All items were developed by the authors.
Lee, Hong, and Ling (2001)	Experience and attitude towards computer and awareness on PU, PEOU of ICT in Malaysia	330 private college students	TAM	4-point Likert scale	No validation. All items were adopted from existing instruments.

Note: SN = Social Norm, PIIT = Personal Innovativeness in IT, ATT = Attitude, UTAUT = Unified Theory of Acceptance and Use of Technology, TAM2 = Technology Acceptance Model 2, ISSM = Information Systems Success Model.

perspective of the teachers as the dominant Frog VLE users. Their biographic information can be obtained upon request to the authors.

4.8. Face validity

Face validity is different from content validity in the sense that it refers to the condition when items ought to imply what they are meant to measure whereas content validity refers to the condition that items ought to represent an appropriate sample of the construct's domain (Hardesty & Bearden, 2004). In order to warrant face validity, expert panel was engaged whereby members of this panel were tasked to review whether the measures in the instrument really measure what they are presumed to measure. Based on the feedbacks from the expert panel, the members were generally satisfied with the face validity of the instrument and suggested minor amendments and formatting of the instrument.

4.9. Content validity index (CVI)

The most fundamental prerequisite for a good and reliable measure is content validity. Content validity is referred as the level to which the items denote the construct being measured and it is mainly assured by using the formerly published measurement items for the construct and an item-by-item review by the practitioners and experts during pre-test and after the pilot test (Dinev, Xu, Smith, & Hart, 2013). The most extensively used measure of content validity is the CVI (Lynn, 1986).

Two types of CVIs were examined, namely the item-level CVI (I-CVI) and the scale-level CVI (S-CVI). By tradition, 4-point ordinal scale is used to evade from having an ambivalent and neutral midpoint. The scale ranges from (1) not relevant, (2) somewhat relevant, (3) quite relevant to (4) highly relevant. Items that are rated as 3 or 4 are considered as relevant items whereas those rated 1 or 2 are not relevant to the construct.

4.9.1. Item-level CVI

The I-CVI is calculated as the proportion of the number of panel experts who give either 3 or 4 rating (which dichotomize the ordinal scale into either relevant or not relevant). Lynn (1986) recommended that for a panel with six experts, the I-CVI should be not less than 0.83. The results of the I-CVIs of the items in the instrument based on the reviews from the six panel experts are shown in Table 3. Since all I-CVIs are at least 0.83, we concluded that all items have adequate content validity and therefore no items were dropped from the instrument.

4.9.2. Scale-level CVI

The S-CVI is referred as the ratio of items which are rated as 3 or 4 by both raters involved. There are two types of S-CVI based on universal agreement (S-CVI/UA) and average value (S-CVI/Ave). S-CVI/UA is the proportion of items that are rated 3 or 4 by all panel experts where as S-CVI/Ave is the mean proportion of items which are rated 3 or 4 by the panel experts. S-CVI/UA is too stringent if there are many experts and a 100% agreement would deem excessively conservative, hence S-CVI/AVE is preferable (Polit & Beck, 2006). Therefore, we decided to use S-CVI/Ave as the criteria for scale content validity acceptance. Lynn (1986) recommended that the minimum value for S-CVI/Ave should be 0.90. As indicated in Table 3, all S-CVIs are at least 0.90, hence we conclude that all scales have adequate content validity and no scales were discarded from the instrument.

4.10. Instrument translation

As the instrument needs to be administered in Malay, the local language predominantly used by the teachers in Malaysia and also the Malaysia's official language, the instrument has been translated from English to Malay and then back to English to ensure translation equivalence (Venkatesh et al., 2012). Three rounds of translation processes were engaged. In the preliminary round, the original English version was translated into Malay by an English subject matter expert and in the second round it was then translated back to English by another English subject matter expert. In the third round, the translated versions were double-checked by several other independent subject matter experts for equivalence and consistency until both versions converged (Al-Gahtani, Hubona, & Wang, 2007). The subject matter experts engaged are very experienced and well versed in both English and Malay languages. After going through careful and rigorous checking, the subject matter experts in the last round satisfied that there were no differences in terms of meanings or interpretations or words or phrases between the English and Malay versions of the measurement instruments. Both versions were justified to be equivalent in its contents, meaning and interpretation.

4.11. Construct validity

To evaluate the construct validity and reliability of the scales in the measurement instrument at the pre-testing stage, a classifying method similar to the Q-sort method was engaged (Moore & Benbasat, 1991). Two rounds of classification procedures with four practitioners for each round were conducted to obtain the overall hit ratios in order to assess the construct validity (i.e. convergent validity and discriminant validity) and the inter-rater reliability was evaluated based on Cohen's Kappa values (Warren, Sulaiman, & Jaafar, 2015). The practitioners or judges were required to sort the items to its respective construct based on the constructs' definitions. Based on the item's hit ratio in the first round, items that are too ambiguous will be dropped and the less ambiguous items were examined, modified and reworded before second round of Q-sort classification commenced (Warren, Sulaiman, & Jaafar, 2014). The overall hit ratio for each items as well as the overall hit ratio of the instrument for the first and second round of Q-sort procedure are presented in Tables 4 and 5 respectively. It can be seen that the hit ratio for items ranges from 68% to 100% and 83%–100% for round one and two respectively. The overall hit ratio of the instrument also improved from 89% in round one to 94% in round two. On the other hand, the inter-rater reliability (Cohen's Kappa) has improved from 0.71 in round one to 0.80 in round two. Since the Kappa values are above the suggested threshold of 0.65 (Warren et al., 2015), we concluded that the instrument possesses high level of construct validity.

After examining the face, content and construct validity in the pre-test stage, we then moved on to assess the construct reliability according to the Cronbach's alpha obtained from a pilot test. The next section will describe the pilot test and its outcomes.

4.12. Pilot test

The instrument was pilot tested among teachers from one primary and one secondary school who were excluded from the main survey. The pilot test's sample size may range between 25 and 100 but does not need to be statistically chosen (Cooper & Schindler, 2003). Rossi, Wright, and Anderson (1983) opined that 20 to 50 respondents in a pilot test are adequate in finding questionnaire errors. Therefore, in this research, 100 respondents were selected. Out of this, 75 samples were usable

Table 3
I-CVI and S-CVI analysis.

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Agreement	I-CVI	S-CVI/Ave
PR1	X	X	X	X	X	X	6	1.00	0.98
PR2	X	X	X	X	X	X	6	1.00	
PR3	X		X	X	X	X	5	0.83	
PR4	X	X	X	X	X	X	6	1.00	
PR5	X	X	X	X	X	X	6	1.00	
PR6	X	X	X	X	X	X	6	1.00	
PR7	X	X	X	X	X	X	6	1.00	
PR8	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	0.88	1.00	1.00	1.00	1.00			
PA1	X	X	X	X	X	X	6	1.00	0.95
PA2	X	X	X	X	X	X	6	1.00	
PA3	X	X	X	X	X	X	6	1.00	
PA4	X		X	X	X	X	5	0.83	
PA5		X	X	X	X	X	5	0.83	
PA6	X	X	X	X	X	X	6	1.00	
PA7	X	X	X	X	X	X	6	1.00	
Proportion relevant	0.86	0.86	1.00	1.00	1.00	1.00			
PC1	X	X	X	X	X	X	6	1.00	0.97
PC2	X	X	X	X	X	X	6	1.00	
PC3	X	X	X	X	X	X	6	1.00	
PC4	X	X	X	X	X	X	6	1.00	
PC5		X	X	X	X	X	5	0.83	
PC6	X	X	X	X	X	X	6	1.00	
Proportion relevant	0.83	1.00	1.00	1.00	1.00	1.00			
PMR1	X	X	X	X	X	X	6	1.00	1.00
PMR2	X	X	X	X	X	X	6	1.00	
PMR3	X	X	X	X	X	X	6	1.00	
PMR4	X	X	X	X	X	X	6	1.00	
PMR5	X	X	X	X	X	X	6	1.00	
PMR6	X	X	X	X	X	X	6	1.00	
PMR7	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
VCD1	X	X	X	X	X	X	6	1.00	1.00
VCD2	X	X	X	X	X	X	6	1.00	
VCD3	X	X	X	X	X	X	6	1.00	
VCD4	X	X	X	X	X	X	6	1.00	
VCD5	X	X	X	X	X	X	6	1.00	
VCD6	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
VI1	X	X	X	X	X	X	6	1.00	0.97
VI2	X	X	X	X	X	X	6	1.00	
VI3	X	X	X	X	X	X	6	1.00	
VI4	X		X	X	X	X	5	0.83	
VI5	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	0.80	1.00	1.00	1.00	1.00			
SS1	X	X	X	X	X	X	6	1.00	1.00
SS2	X	X	X	X	X	X	6	1.00	
SS3	X	X	X	X	X	X	6	1.00	
SS4	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
AT1	X	X	X	X	X	X	6	1.00	1.00
AT2	X	X	X	X	X	X	6	1.00	
AT3	X	X	X	X	X	X	6	1.00	
AT4	X	X	X	X	X	X	6	1.00	
AT5	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
TW1	X	X	X	X	X	X	6	1.00	1.00
TW2	X	X	X	X	X	X	6	1.00	
TW3	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
BI1	X	X	X	X	X	X	6	1.00	1.00
BI2	X	X	X	X	X	X	6	1.00	

(*continued on next page*)

Table 3 (*continued*)

Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Agreement	I-CVI	S-CVI/Ave
BI3	X	X	X	X	X	X	6	1.00	
Proportion relevant	1.00	1.00	1.00	1.00	1.00	1.00			
PIE1	X	X	X	X	X	X	6	1.00	1.00
PIE2	X	X	X	X	X	X	6	1.00	
PIE3	X	X	X	X	X	X	6	1.00	
PIE4	X	X	X	X	X	X	6	1.00	
PIE5	X	X	X	X	X	X	6	1.00	
PIE6	X	X	X	X	X	X	6	1.00	
Proportion Relevant	1.00	1.00	1.00	1.00	1.00	1.00			

Note: X indicated item is rated 3 or 4 by the expert; I-CVI = Item level content validity index; S-CVI/Ave = Average scale level content validity index; PR = Perceived Relatedness; PA = Perceived Autonomy; PC = Perceived Competency; PMR = Perceived Media Richness; VCD = VLE Content Design; VI = VLE Interactivity; SS = School Support; AT = Attitude toward knowledge sharing; TW = Trust in Website; BI = Behavioral Intention; PIE = Perceived Instructional Effectiveness.

Table 4
Q-sort classification result (round one).

		Actual											N/A	Total	Hit ratio (%)
		PMR	VCD	VI	PR	PA	PC	SS	AT	TW	BI	PIE			
Theoretical	PMR	23		3			1							27	85%
	VCD	1	21								1			23	91%
	VI			19				1						20	95%
	PR				28				2		1			31	90%
	PA				1	15	2	1		1			1	21	71%
	PC					2	13				1	2	1	19	68%
	SS							16						16	100%
	AT								19					19	100%
	TW									12				12	100%
	BI										12			12	100%
	PIE					2						21		23	91%

Note: N/A = Not Applicable.
Item placements:223, Hits: 199, Overall Hit Ratio: 89%.

Table 5
Q-sort classification result (round two).

		Actual											N/A	Total	Hit ratio (%)
		PMR	VCD	VI	PR	PA	PC	SS	AT	TW	BI	PIE			
Theoretical	PMR	27												27	100%
	VCD		24											24	100%
	VI		2	16	1				1					20	80%
	PR				31	1								32	97%
	PA		1		2	20					1			24	83%
	PC		1			1	16	1						19	84%
	SS							16						16	100%
	AT								20					20	100%
	TW									12				12	100%
	BI										12			12	100%
	PIE			1								23		24	96%

Note: N/A = Not Applicable.
Item placements: 230, Hits: 217, Overall Hit Ratio: 94%.

producing a 75% response rate. The objective of the pilot test is to evaluate construct reliability and clarity of the instrument. Minor modifications and amendments have been carried out according to the comments and feedbacks from the respondents of the pilot test study before the instrument is finally ready for use in the fieldwork study.

4.13. Construct reliability

Construct reliability means that "a scale should always reflect the construct it is measuring" (Leong, Ooi, Chong, & Lin, 2011, p. 506). Using SPSS version 21, we have performed a reliability test and obtained the Cronbach's alpha for each of the constructs (Hew, Lee, Leong, Hew, & Ooi, 2016). Through an iterative procedure, items which did not contribute to the alpha value were discarded. The initial alpha values from pilot test are shown in Table 6. Since all alpha values (0.713–0.976)

Table 6
Construct reliability (Cronbach's alpha).

Construct	Initial number of items	Initial Cronbach's alpha	Final number of items	Final Cronbach's alpha
PR	8	0.792	8	0.792
PA	7	0.713	7	0.713
PC	6	0.526	3	0.730
PMR	7	0.940	7	0.940
VCD	6	0.932	6	0.932
VI	4	0.902	4	0.902
SS	4	0.943	4	0.943
AT	5	0.976	5	0.976
TW	3	0.946	3	0.946
BI	3	0.962	3	0.962
PIE	6	0.968	6	0.968

Note: N = 75; PR = Perceived Relatedness, PA = Perceived Autonomy, PC = Perceived Competence, PMR = Perceived Media Richness, VCD = VLE Content Design, VI = VLE Interactivity, SS = School Support, AT = Attitude toward knowledge sharing, TW = Trust in Website, BI = Behavioral Intention, PIE = Perceived Instructional Effectiveness.

superseded the threshold of 0.70 (Hair, William, Barry, & Rolph, 2010), we concluded that the instrument possess high level of construct validity.

4.14. Fieldwork

We continue to validate the final Malay version of the instrument by conducting a fieldwork study administered to 800 respondents selected using a simple random sampling technique from the sampling frame of 351 Frog VLE champion schools nationwide and 575 and 398 questionnaire were returned in T1 and T2 respectively. Questionnaires were dropped if the last three digits of identity card and mobile phone number did not match as some of the respondents did not take part in both phases of the survey. Finally, after further elimination of incomplete and double-entry questionnaires, we were able to gather 327 usable samples for further statistical data analyses.

5. Data analysis

5.1. Demographic profile of respondents

The respondents' demographic profile is shown in the self-explained Table 7.

5.2. Common method bias (CMB)

To minimize CMB, data were collected using two separate instruments with a gestation period of 4 months (Venkatesh et al., 2012). Nevertheless, to further validate this issue, we have engaged Harman's single factor test via principal component analysis (PCA) with no rotation (Tan, Ooi, Leong, & Lin. 2014; Tan, Siah, Ooi, Hew, & Chong, 2014). The result showed that a single factor is able to provide 38.26% of the total variance explained which is below 50% indicating no dominant factor that can lead to CMB (Wong, Tan, Hew, & Ooi, 2016).

5.3. Non-response bias

We then examined non-response bias by conducting t-tests on all the key constructs except for school support based on early and late respondents (Leong, Hew, Lee, & Ooi, 2015). School support was not included as there will be different levels of school support from the various headmasters and principals. The result (Table 8) confirmed that there are no significant differences for all constructs between the early and late respondents. Hence, we concluded that non-response bias is insignificant in the research.

5.4. Test of multivariate assumptions

Prior to the Confirmatory Factor Analysis (CFA) using Structural Equation Modeling (SEM), several multivariate assumptions need to be satisfied. First of all, the sample size of 327 is more than the minimum size of 200 required for SEM analysis (Kline, 2005). We also examined the normality of the data distribution with skewness and kurtosis. All skewness and kurtosis are less than 3 and 10 respectively (Teo, Tan, Ooi, Hew, & Yew, 2015). Hence, we concluded that the data is normally distributed. Next, we assessed the homoscedasticity based on scatter plots of dependent variable and the standardized residuals. Fig. 3 shows that the standardized residuals is evenly scattered about a straight line indicating no issue of homoscedasticity.

Table 7
Respondents' profile of demographic.

	Description	Frequency	Percent
Category of teachers	Primary School	149	45.6
	Secondary School	178	54.4
Gender	Male	60	18.3
	Female	267	81.7
Age (years)	20–25	11	3.4
	21–30	51	15.6
	31–35	63	19.3
	36–40	65	19.9
	41–45	57	17.4
	46–50	46	14.1
	51–55	27	8.3
	56–60	7	2.1
Highest education level	SPM (equivalent to O-level)	16	4.9
	STPM (equivalent to A-level)	12	3.7
	Diploma	25	7.6
	Advanced Diploma	1	0.3
	Bachelor Degree	255	78.0
	Master Degree	17	5.2
	PhD or Doctoral Degree	1	0.3
Teaching experience (years)	1–5	63	19.3
	6–10	78	23.9
	11–15	48	14.7
	16–20	65	19.9
	21–25	28	8.6
	26–30	32	9.8
	31–35	11	3.4
	36–40	2	0.6
Purpose of using VLE	Teaching	245	35.3
	Evaluation and Assessment	70	10.1
	Communication/Discussion	129	18.6
	Collaboration/Sharing Ideas	176	25.4
	Guidance and Counselling	20	2.9
	Entertainment/Leisure/Past Times	54	7.8

Linearity of the distribution was examined based on the *p*-value of the deviation from linearity and Ordinary Least Square (OLS). All constructs demonstrated linearity with *p*-value more than 0.05 in deviation from linearity and for those that did not meet this requirement, further analysis with OLS confirmed that the *p*-value is less than 0.05. Thus, linearity of relationships was validated. Finally, the issue of multicollinearity was eliminated as the VIF is smaller than ten and tolerance greater than 0.10 (Tan, Ooi, Chong, & Hew, 2014a). This was further verified based on the Pearson's correlation coefficients not exceeding 0.80 between the constructs (Hair et al., 2010).

6. Evaluation of construct reliability and validity

To assess the measurement properties, the covariance-based SEM with AMOS 18 was engaged. We did not engage variance-based SEM such as SmartPLS because the objective of our study is to examine how fit the instrument is able to measure the intended constructs and not to maximize prediction and percentage of variance explained. Furthermore, the distribution of data is normal and the study is not exploratory but confirmatory in its nature. The next section will describe the unidimensionality, goodness-of-fit indices, convergent and discriminant validity as well as the construct reliability.

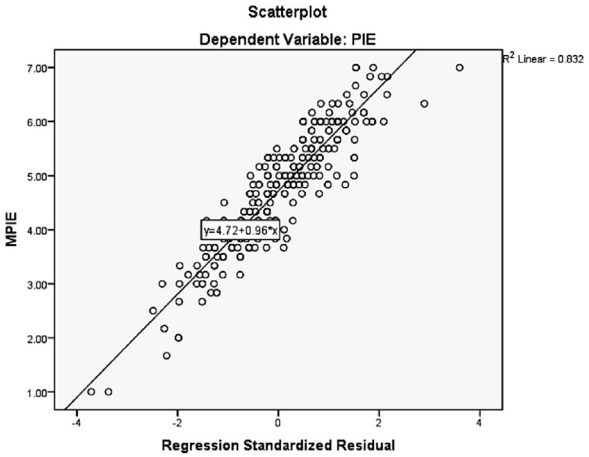
6.1. Unidimensionality and goodness-of-fit indices

Unidimensionality ensures that all items measure only a sole theoretical construct. To assess unidimensionality and minimize measuring biases inherited from different measures, GFI, NFI, RMR and SRMR indices were used (Leong, Hew, Ooi, & Lin, 2012). The recommended threshold for GFI and NFI is at least 0.90 (Tosuntaş, Karadağ, & Orhan, 2015) and RMR and SRMR should be less than 0.05 (Hair et al., 2010). Similar to Li et al. (2005), iterative modifications of construct were carried out based on the coefficients and modification indices in order to obtain fit indices. In the case where there are less than four items for a construct, a 2-factor model was examined by integrating items from another construct (Li et al., 2005). Table 9 indicates no evidence of deficiency in unidimensionality of the constructs.

Table 8
Non response bias using t-test.

Construct	*t*-value	*df*	*p*-value
PR	−0.168	325	0.867
PA	−1.666	309.918	0.097
PC	−0.884	325	0.377
PMR	−0.708	325	0.479
VCD	0.307	325	0.759
VI	0.423	325	0.672
AT	0.683	324.997	0.495
TW	−1.003	319.525	0.316
BI	0.940	325	0.348
PIE	0.441	324	0.660

Note: PR = Perceived Relatedness, PA = Perceived Autonomy, PC = Perceived Competence, PMR = Perceived Media Richness, VCD = VLE Content Design, VI = VLE Interactivity, SS = School Support, AT = Attitude toward knowledge sharing, TW = Trust in Website, BI = Behavioral Intention, PIE = Perceived Instructional Effectiveness.



Note: PIE = Perceived Instructional Effectiveness

Fig. 3. Homoscedasticity analysis.

6.2. Convergent validity, discriminant validity and construct reliability

To validate the quality of the items in the instrument, we have evaluated the convergent validity of the constructs based on the AVE above 0.50 (Chuang, Weng, & Huang, 2015). The construct reliability was evaluated using composite reliability (CR) and Cronbach's alpha (Shih & Chuang, 2013). The Cronbach's alpha and CR values have exceeded 0.70 indicating high level of reliability (Hair et al., 2010). Table 10 indicates that all of these criteria were fulfilled. Construct reliability is further verified since all CRs are larger than their AVEs (Table 11). Using Fornell-Larcker's (1981) criterion, we found that every square root of AVE is more than their respective correlation coefficients thus confirming the discriminant validity (Table 11). Discriminant validity is also confirmed since AVE is larger than the ASV and MSV (Chong, 2013). This is further supported by the Fornell-Larcker's ratio (i.e. less than one). Therefore, we concluded that the measures in the instrument possess adequate convergent validity, discriminant validity and construct reliability.

7. Discussions

Based on the rigorous instrument development processes, we have successfully developed an instrument to measure the instructional effectiveness of using the VLE to be used in the cultural setting of Malaysia. The findings support our argument that cultural dimensions play a substantial influence on the perception of IS adoption. This is evidenced by the final Malay version of the instrument which is significantly different from the original English version as several measures or items have been dropped due to cultural differences. We therefore recommend that a cultural-based instrument should be utilized for non-English native speaking nations as there are significant differences in the interpretation of meanings and terms between different cultures and languages. Fig. 4 summarizes the steps involved in validating the robustness of an existing instrument for implementation in the Malaysian cultural setting. This practical guideline may be used for developing and validating the robustness of other existing instruments in different cultural settings. Given the importance of having effective instruction in

Table 9
Assessment of unidimensionality with goodness-of-fit indices.

Construct	Indicators	Chi-square (χ^2)	*p*-value	GFI	NFI	RMR	SRMR
PR	5	1.695	0.429	0.998	0.999	0.007	0.0050
PA*	3	10.602	0.304	0.990	0.993	0.022	0.0149
PC*	3	13.175	0.155	0.988	0.991	0.026	0.0170
PMR	7	6.612	0.470	0.994	0.997	0.011	0.0086
VCD	6	10.287	0.113	0.990	0.995	0.015	0.0118
VI	4	5.776	0.056	0.991	0.994	0.020	0.0132
SS	4	3.053	0.139	0.994	0.997	0.011	0.0061
AT	5	5.831	0.120	0.993	0.998	0.007	0.0053
TW*	3	12.761	0.120	0.989	0.994	0.029	0.0188
BI*	3	12.114	0.146	0.990	0.995	0.016	0.0100
PIE	6	8.034	0.154	0.992	0.996	0.012	0.0086

Note: *The items from VI were added to form a two-factor model for construct with less than 4 items; The following reverse-worded items were dropped due to low standardized regression weights: PR3_R, PR6_R, PR7_R, PA2_R, PA4_R, PA7_R, PC1_R, PC5_R and PC6_R; PR = Perceived Relatedness, PA = Perceived Autonomy, PC = Perceived Competence, PMR = Perceived Media Richness, VCD = VLE Content Design, VI = VLE Interactivity, SS = School Support, AT = Attitude toward knowledge sharing, TW = Trust in Website, BI = Behavioral Intention, PIE = Perceived Instructional Effectiveness.

the classroom and the uniqueness of this instrument that is specifically developed from the teachers' perspective with the application of SDT and CET, the development of this instrument may further advance the existing body of knowledge pertaining to the instructional effectiveness of VLE specifically and the IS theory generally.

8. Theoretical and practical contributions

The study has several theoretical contributions. Firstly, the most significant contribution is the creation of an effective measurement instrument to gauge the adoption and instructional effectiveness of using VLE from the perspective of SDT and CET in the non-English cultural setting. Through the rigorous instrument development processes, the findings from this study may provide theoretical contribution in terms of confirming the influence of cultural differences towards the effectiveness of an instrument. It is now confirmed that adapted items from existing instruments should go through rigorous validation before they can be applied in different cultural settings. It is hoped that the findings from using this instrument may contribute theoretical to the integration of the CET and SDT in predicting intention to use and the instructional effectiveness of VLE. Currently there has been scarcity in understanding the effects of SDT and CET towards teachers' behavioral intention as well as its indirect effects on the instructional effectiveness. Therefore, this study may further extend the literature in IS field thus filling the existing research gaps.

Secondly, since the study has engaged additional effort to corroborate instrumentation for established theoretical constructs, it is able to assess the robustness of the constructs and theoretical relationships to the measurement change or method thus may represent substantial contribution to the scientific practices in the technology adoption literature (Dwivedi, Choudrie, & Brinkman, 2006). The rigorously validated instrument may be used for further empirical studies aimed at understanding why teachers are engaged in VLE as well as how the use of VLE may affect its instructional effectiveness.

Besides the theoretical contributions, the study also has several practical contributions. First of all, the method used in developing and validating the instrument which includes item selection, face validity and content validity index by expert panel members, English back-translation, Q-sort procedure by practitioners, pre-test, pilot test, fieldwork, test of multivariate assumptions (i.e. normality, multicollinearity, linearity, homoscedasticity), convergent validity, discriminant validity, unidimensionality and construct reliability (i.e. composite reliability, Cronbach's alpha) may provide a useful practical guideline for developing new instruments in other cultural settings.

Secondly, the policy and decision makers such as Ministry of Education, Malaysia, YTL Communications and FrogAsia as well as other educational stakeholders in Malaysia may use the findings from the use of this instrument to further strengthen and motivate the adoption rate of the Frog VLE. These stakeholders may use the instrument to evaluate intention to use the Frog VLE as well as its instructional effectiveness. For examples, by measuring the level of teachers' perception in SDT, CET and VLE-related factors as well as the behavioral intention and instructional effectiveness, Critical Success Factors (CSFs) may be identified. From the identified CSFs, new policies, strategies and measures may be taken to further address the weaknesses that exist in the current practices.

Next, teachers and instructors can also increase the level of instructional effectiveness based on the findings from the use of this instrument. For examples, the instrument may be used to measure the effects of VLE-related factors like VLE content design, interactivity, trust-in-website, knowledge sharing attitude and school support on teachers' behavioral intention to use the Frog VLE. From the findings of the survey, teachers and instructors will be able to ascertain the most prominent drivers that motivate teachers to use the VLE which may further affect the instructional effectiveness of the VLE. Hence, appropriate measures may be taken to further address the weaknesses in areas that need further improvements.

Last but not the least, VLE content and service providers such as YTL Communications and FrogAsia may incorporate the findings of subsequent studies that use this instrument in raising the quality of the VLE content and services. For examples,

Table 10
Convergent validity and construct reliability analysis.

Construct	Indicator	Factor loadings	AVE	CR	Cronbach's alpha
PA	PA1	0.701	0.532	0.772	0.811
	PA3	0.698			
	PA6	0.785			
PC	PC2	0.693	0.533	0.774	0.818
	PC3	0.735			
	PC4	0.760			
PR	PR1	0.824	0.714	0.926	0.930
	PR2	0.869			
	PR4	0.919			
	PR5	0.825			
	PR8	0.782			
PMR	PMR1	0.817	0.727	0.949	0.950
	PMR2	0.859			
	PMR3	0.840			
	PMR4	0.850			
	PMR5	0.880			
	PMR6	0.876			
	PMR7	0.844			
VCD	VCD1	0.860	0.754	0.948	0.949
	VCD2	0.903			
	VCD3	0.894			
	VCD4	0.905			
	VCD5	0.810			
	VCD6	0.832			
VI	VI1	0.837	0.747	0.922	0.918
	VI2	0.875			
	VI3	0.921			
	VI4	0.821			
AT	AT1	0.890	0.877	0.973	0.975
	AT2	0.937			
	AT3	0.935			
	AT4	0.985			
	AT5	0.932			
TW	TW1	0.915	0.892	0.961	0.961
	TW2	0.946			
	TW3	0.971			
SS	SS1	0.952	0.841	0.955	0.954
	SS2	0.935			
	SS3	0.935			
	SS4	0.841			
BI	BI1	0.932	0.912	0.969	0.968
	BI2	0.976			
	BI3	0.956			
PIE	PIE1	0.831	0.779	0.955	0.957
	PIE2	0.911			
	PIE3	0.910			
	PIE4	0.887			
	PIE5	0.846			
	PIE6	0.908			

Note: N = 327; PR = Perceived Relatedness, PA = Perceived Autonomy, PC = Perceived Competence, PMR = Perceived Media Richness, VCD = VLE Content Design, VI = VLE Interactivity, SS = School Support, AT = Attitude toward knowledge sharing, TW = Trust in Website, BI = Behavioral Intention, PIE = Perceived Instructional Effectiveness.

YTL Communications through its subsidiary, FrogAsia, may conduct a survey using this instrument to measure the effects of VLE content design, interactivity, perceived media richness, trust-in-website, perceived competency, perceived autonomy and perceived relatedness on teachers' intention to use the Frog VLE as well as its instructional effectiveness. From the findings of the study, FrogAsia will be able to measure teachers' perceptions on each factor and thus identify the areas that require further improvements.

9. Limitations and future research direction

Since the instrument was developed in the Malaysian cultural setting, it may not be applicable to other cultural settings. As the perception and behavior of teachers may be influenced by changes in cultural, political, economical and environmental settings, the instrument should be evaluated after a general election and when new educational policies emerge. Future studies should focus on using this instrument to identify the antecedents of adoption and effectiveness of the Frog VLE. We

Table 11
Discriminant validity analysis.

	PMR	VCD	VI	SS	AT	TW	PR	MA	PC	BI	PIE	CR	AVE	MSV	ASV
PMR	0.975											0.949	0.727	0.604	0.304
VCD	0.777**	0.974										0.948	0.754	0.576	0.305
VI	0.759**	0.736**	0.958									0.922	0.747	0.370	0.194
SS	0.453**	0.506**	0.403**	0.977								0.969	0.912	0.335	0.162
AT	0.377**	0.394**	0.309**	0.491**	0.987							0.973	0.877	0.321	0.206
TW	0.552**	0.567**	0.517**	0.479**	0.468**	0.980						0.961	0.892	0.383	0.151
PR	0.239**	0.266**	0.151**	0.413**	0.537**	0.350**	0.964					0.926	0.714	0.324	0.145
PA	0.569**	0.545**	0.513**	0.300**	0.252**	0.388**	0.212**	0.901				0.772	0.532	0.419	0.166
PC	0.422**	0.435**	0.333**	0.253**	0.247**	0.362**	0.264**	0.647**	0.904			0.774	0.533	0.438	0.286
BI	0.648**	0.662**	0.608**	0.579**	0.489**	0.619**	0.340**	0.539**	0.429**	0.984		0.969	0.912	0.438	0.294
PIE	0.477**	0.451**	0.436**	0.314**	0.257**	0.333**	0.177**	0.378**	0.291**	0.409**	0.978	0.955	0.779	0.228	0.132
FLR	0.831	0.764	0.495	0.367	0.366	0.429	0.454	0.788	0.822	0.480	0.293				

Note: $^{**}p < 0.01$; CR = Composite Reliability; AVE = Average Variance Explained; MSV = Maximum Shared Variance; ASV = Average Shared Variance; FLR = Fornell-Larcker's Ratio; Diagonal cells show the square root of the construct's AVE; PR = Perceived Relatedness, PA = Perceived Autonomy, PC = Perceived Competence, PMR = Perceived Media Richness, VCD = VLE Content Design, VI = VLE Interactivity, SS = School Support, AT = Attitude toward knowledge sharing, TW = Trust in Website, BI = Behavioral Intention, PIE = Perceived Instructional Effectiveness.

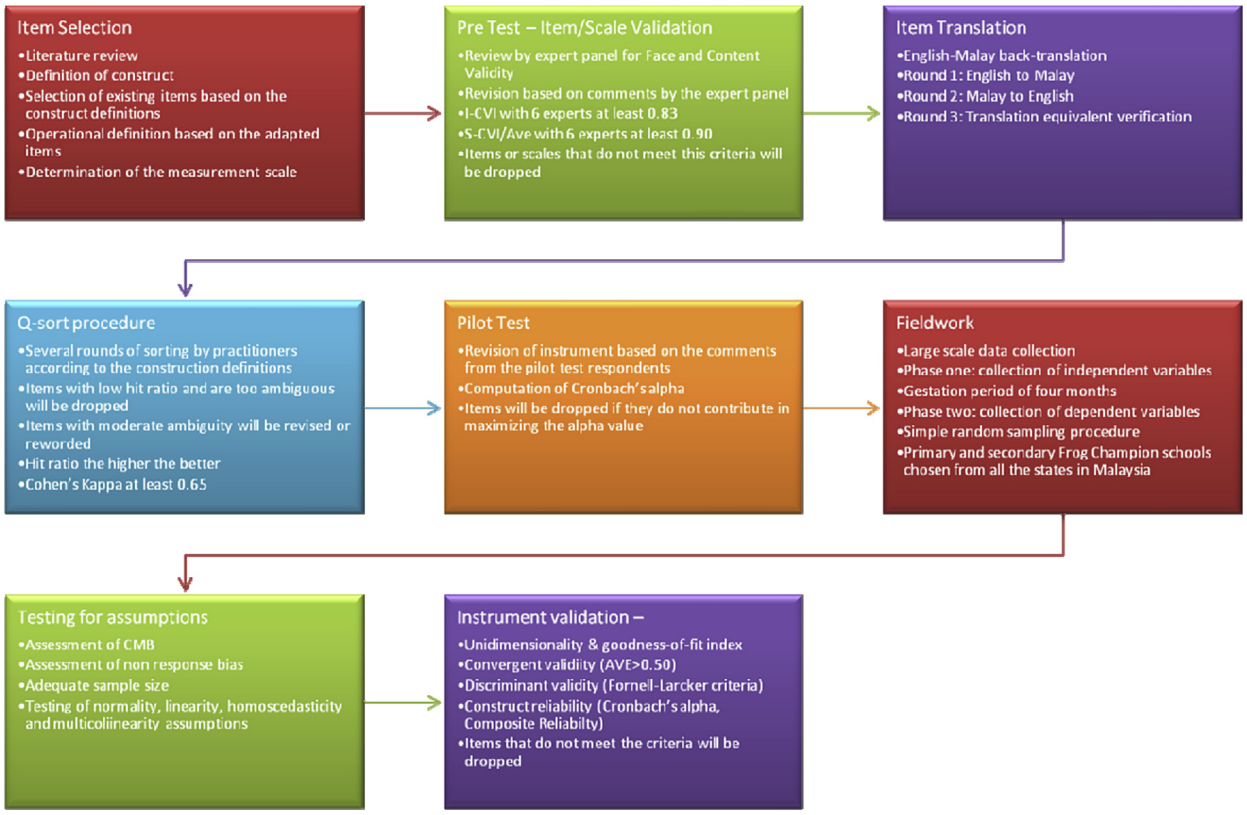


Fig. 4. Steps in developing and validating a measurement instrument.

have since proceeded to conduct subsequent studies to look into this direction. We will report the findings from these studies in separate papers.

10. Conclusions

Through this paper, we reported our efforts in developing and validating an effective measurement instrument to measure the adoption and instructional effectiveness of using the Frog VLE in Malaysia. This instrument is now ready for subsequent studies which we will conduct in the near future. The findings from these studies will be submitted to the Malaysian Ministry of Education so that effective measures and strategies may be drawn up to further improve the standard of education in Malaysia.

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Appendix A. List of English items used in developing the measurement instrument

Construct	Items or indicators
Perceived Relatedness (PR)	PR1: I really like the people I work with.
	PR2: I get along with people at work.
	PR3_R: I pretty much keep to myself when I am at work.
	PR4: I consider the people I work with to be my friends.
	PR5: People at work care about me.
	PR6_R: There are not many people at work whom I am close to.
	PR7_R: The people I work with do not seem to like me much.
	PR8: People at work are pretty friendly towards me.
Perceived Autonomy (PA)	PA1: I feel like I can make a lot of inputs in deciding how I use VLE in my teaching profession.
	PA2_R: I feel pressured at using VLE in my teaching profession.
	PA3: I am free to express my ideas and opinions on using VLE in my teaching profession.
	PA4_R: When I am using VLE, I have to do what I am told.
	PA5: My feelings toward VLE are taken into consideration at work.
	PA6: I feel like I can pretty much use VLE as I want to at work.
	PA7_R: There is not much opportunity for me to decide for myself how to use VLE in my teaching profession.
Perceived Competence (PC)	PC1_R: I do not feel very competent when I use VLE in my teaching profession.
	PC2: The other colleagues tell me I am good at using VLE in my teaching profession.
	PC3: I have been able to learn interesting new skills in VLE through my profession.
	PC4: Most days I feel a sense of accomplishment from working with VLE.
	PC5_R: As a teacher I do not get much of a chance to show how capable I am in VLE.
	PC6_R: When I am using VLE I often do not feel very capable.
Perceived Media Richness (PMR)	PMR1: The VLE features allow me to give and receive timely feedback.
	PMR2: The VLE features allow me to tailor my teaching to my own personal requirements.
	PMR3: The VLE features allow me to communicate a variety of different cues (such as emotional tone, attitude, or formality) in my teaching.
	PMR4: The VLE features allow me to use a rich and varied language in my teaching.
	PMR5: I could easily explain concepts using the VLE features.
	PMR6: The VLE features help me to communicate quickly.
	PMR7: The VLE features help me to better understand others.
VLE Content Design (VCD)	VCD1: The level of difficulty of the learning contents is appropriate.
	VCD2: The content of assignments is easy to understand.
	VCD3: The amount of learning contents is appropriate.
	VCD4: The delivery schedule of learning contents is flexible.
	VCD5: VLE provides individualized learning management.
	VCD6: VLE provides a variety of learning methods.
VLE Interactivity (VI)	VI1: Interacting with VLE is like having a conversation with a sociable, knowledgeable and warm representative from my school.
	VI2: I feel as if VLE talked back to me while I was navigating the VLE.
	VI3: I perceive the VLE to be sensitive to my needs for information.
	VI4: My interaction level with the VLE was high.
	VI5: I don't interact with the VLE much.
School Support (SS)	SS1: My school is committed to a vision of using VLE in teaching.
	SS2: My school is committed to supporting my efforts in using VLE for teaching.
	SS3: The school strongly encourages the use of VLE for teaching.
	SS4: My school will recognize my efforts in using VLE for teaching.
Attitude toward knowledge sharing (AT)	AT1: Sharing of my knowledge with other teachers is always good.

(*continued on next page*)

(*continued*)

Construct	Items or indicators
	AT2: Sharing of my knowledge with other teachers is always beneficial. AT3: Sharing of my knowledge with other teachers is always an enjoyable experience. AT4: Sharing of my knowledge with other teachers is always valuable to me. AT5: Sharing of my knowledge with other teachers is always a wise move.
Trust in Website (TW)	TW1: I think the VLE website is secure. TW2: I think the VLE website is reliable. TW3: I think the VLE website is trustworthy.
Behavioral Intention (BI)	BI1. I intend to use VLE in the coming months. BI2. I predict I would use VLE in the future. BI3. I plan to use VLE in the future.
Perceived Instructional Effectiveness (PIE)	PIE1: I believe that I could improve my teaching by using the VLE. PIE2: I believe that I could improve students' performance by using the VLE. PIE3: I believe that the students could better understand the content of their subjects through the use of VLE. PIE4: I believe that I have control of teaching by using the VLE. PIE5: I believe that the VLE is the best way for teaching and learning. PIE6: Overall, I believe that students will be more self-motivated if they have access to the VLE.

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