The Quality of a USB-based Learning Management System

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This paper empirically evaluates the quality of the developed USB-based learning management system, called PLMS. The PLMS is a handy learning management system that can run on USB flash drives. It organizes classroom information and learning activities even without internet connectivity. Specifically, this article presents the levels of functionality, reliability, usability, efficiency, portability, and pedagogical characteristics of the portable learning management system. Likewise, this article also describes the relationship between the respondent's profiles and quality level. Respondents of the study are teacher educators in higher education institutions in the five provinces in the Visayas Region, Philippines. The study utilized ISO 9126 Software Quality Model as the basis of the survey questionnaire. Results show that all quality statements—functionality ($\bar{x}$ = 3.62), reliability ($\bar{x}$ = 3.46), usability ($\bar{x}$= 3.39), efficiency ($\bar{x}$ = 3.49), portability ($\bar{x}$ = 3.71), and pedagogical characteristic ($\bar{x}$ = 3.61)—are rated with a description 'strongly agree' with an overall mean of 3.56. The result also shows that age and number of years in teaching are significantly related to the quality of PLMS. The results also indicate that none of the technologic variables is having a significant relationship with any of the six quality components. The study concludes that PLMS is a fully-operational portable learning management system. It recommends the maximum utilization of PLMS in higher education institutions.

Keywords: Learning Management System, Mobile Learning, Portable Learning Management System, Software Quality Testing

INTRODUCTION

Quality refers to the degree of excellence and a characteristic or feature that something has (Merriam-Webster). In software engineering, "quality is the properties of compliance and modifiability, qualification of either leading to concomitant reservation on software quality" (Macro, 1990). In software design, quality is associated with measurement (Budgen, 2003). According to Pressman (2001), software measurements have two categories. These categories include the direct measures and indirect measures. Accordingly, direct measures include cost and effort applied to the product like lines code produced, execution speed, memory size, and defects reported over some set period. On the other hand, indirect measures include functionality, quality, complexity, efficiency, reliability, and maintainability. "Software quality is the conformance to explicitly stated functional and performance requirements, explicitly documented development standards, and implicit characteristics that are expected of all professionally developed software" (Pressman, 2001). A software quality plan should explicitly identify the quality attributes that are most significant to a particular project and should set out how these attributes can be assessed (Sommerville, 1997). Thus, software testing plays a critical role in the implementation phase of the software development life cycle.

Software testing is an analysis performed to provide stakeholders with information about the quality of the software (Kaner, 2006). It is a critical component of software quality assurance and characterizes the final appraisal of the specification, design, and code generation (Pfleeger, 2002). There are several approaches that software engineering books mentioned. Sommerville (1997) said that diverse types of testing used different forms of test data. These test data include statistical testing and defect testing. Macro (1990) summarized six categories of testing practices. These are author, adversary, static, dynamic, top-down, and bottom-up. He said that the basic methods of enhancing confidence in software quality are conducting quality control and inspection and performing quality assurance and the role of black-box and white-box testing. Moreover, most of the said books specified two particular steps: these are black-box testing and the white-box testing. In large-scale systems development, testing involves several stages (Pfleeger, 2002). This testing includes module testing, component testing, and unit testing. Pressman (2001) and Budgen (2003) suggest conducting formal technical reviews as a mean to ensure software quality. According to Sommerville (1997) and

Pressman (2001), statistical testing can be used to test the system's performance and reliability.

With the aim to provide innovative teaching in higher education institutions in the Philippines, a portable learning management system was developed. The system is called PLMS, a handy learning management system that can run on USB flash drives. The PLMS organizes classroom information and learning activities, even without internet connectivity. It is a kind of information system that is transferable to multiple environments and manageable to a variety of infrastructure specifications using a USB flash drive. The PLMS was designed using pedagogical principles embedded in Moodle to help teachers develop innovative teaching and learning practices even being challenged with internet connectivity.

This paper aimed to measure the quality level of PLMS statistically as perceived by teacher educators in higher education institutions in the Philippines. It is part of a larger research entitled "ICT in Teacher Education in Region 7, Philippines". Specifically, this article presents the levels of functionality, reliability, usability, efficiency, portability, and pedagogical characteristics of the portable learning management system. Likewise, this article also describes the association between the quality levels and the profiles of the respondents.

RELATED LITERATURE

Among the longstanding popular models of software quality includes Boehm's model, McCall's model, Dromey's model, and ISO 9126 (Pfleeger, 2002). Boehm's model listed seven quality factors, namely: portability, reliability, efficiency, usability, testability, understandability, and flexibility (see Figure 1). "Boehm's model asserts that quality software is software that satisfies the needs of the users and programmers involved with it" (Pfleeger, 2002). On the other hand, McCall's model identified 11 quality factors. These are maintainability, flexibility, testability, portability, reusability, interoperability, correctness, reliability, efficiency, integrity, and usability (see Figure 2). These factors, according to McCall and Cavano (1979), as cited in Pressman (2001), assess software from three distinct points of view: product operation, product revision, and product transition. For Dromey, "product quality is largely determined by the choice of components that comprise the product, the tangible properties of components, and the tangible properties of component

composition" (Pfleeger, 2002). Dromey's quality model uses four properties. These are correctness, internal, contextual, and descriptive (see Figure 3). Last but not the least is the ISO 9126 (see Figure 4). The ISO 9126 is a worldwide software quality standard. Table 1 shows the six major attributes of the hierarchical model contributing to quality (ISO, 1991, cited in Pfleeger, 2002).

Table 1. ISO 9126 Quality Characteristics (Pfleeger, 2002, p. 525).

Quality Characteristic	Definition
Functionality	This is Aa set of attributes that bear on the existence of a set of functions and its their specified properties. The functions are those that satisfy stated or implied needs.
Reliability	This is aA set of attributes that bear on the capability of software to maintain its performance level under stated conditions for a stated period.
Usability	This is aA set of attributes that bear on the effort needed for use and on the individual assessment of such use by a stated or implied set of users.
Efficiency	This is a A set of attributes that bear on the relationship between the software"s performance and some resources used under stated conditions.
Maintainability	This is a A set of attributes that bear on the effort needed to make specified modifications (which may include corrections, improvements, or adaptations of software to environmental changes and the changes in the requirements and functional specifications).
Portability	This is a A set of attributes that bear on the ability of software to be transferred from one environment to another (including the organizational, hardware, or software environment).

According to Pfleeger (2002), one major difference between the ISO model and those of McGall and Boehm is that the ISO hierarchy is strict. Pfleeger (2002) means that "the right-hand characteristics are related to the user view of the software, rather than to an internal, developer view". It is in this context that this study employed ISO 9126. The ISO 9192 has three extensions, and these include ISO/IEC 9126-1: Quality characteristics and subcharacteristics; ISO/IEC 9126-2: External metrics; and ISO/IEC 9126-3: Internal metrics (Veenendaal & McMullan, 2003). It is a surprise that the factors that defined software quality in the 1970s are the same factors that continue to define software quality in the first decade of this century (Pressman, 2001).

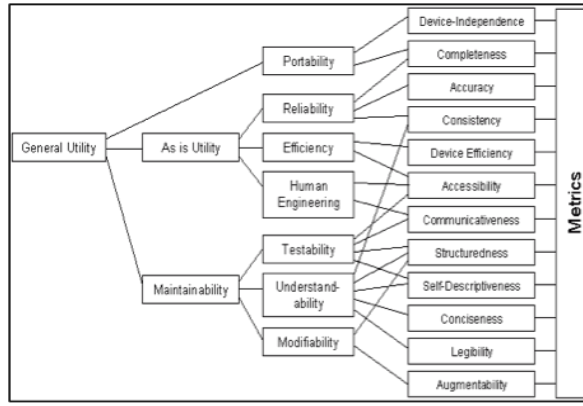

Figure 1. Boehm's model, Quality Model (www.sce2.umkc.edu)

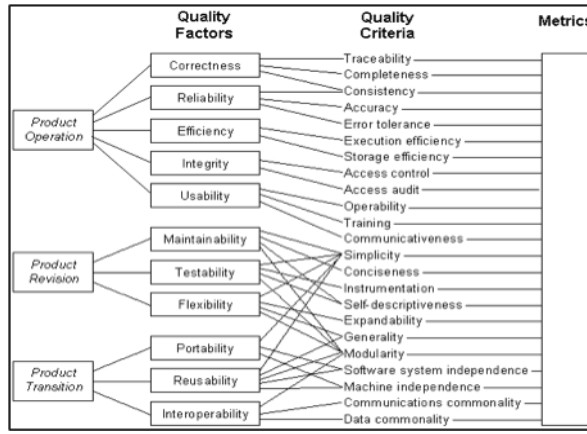

Figure 2. McCall's Quality Model (www.sce2.umkc.edu)

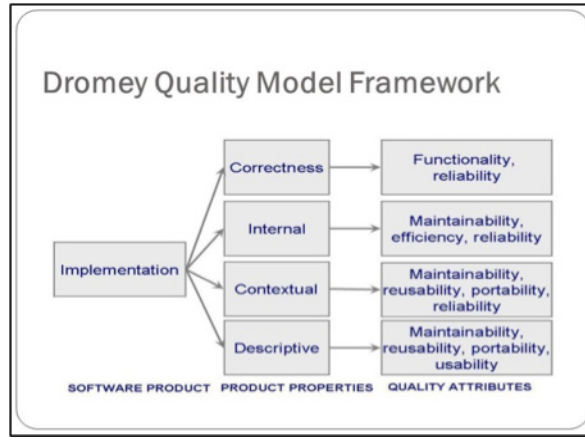

Figure 3. Dromey''s Model (www.slideplayer.com)

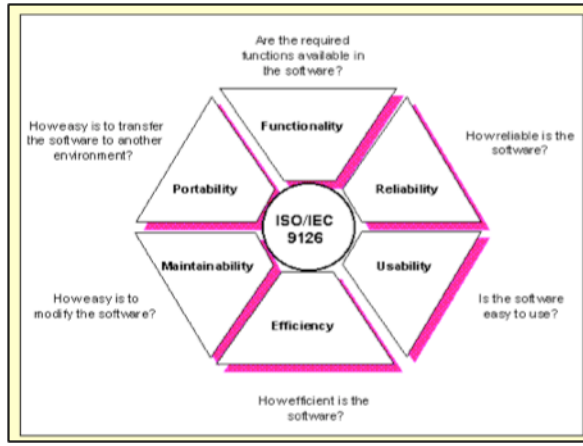

Figure 4. ISO/IEC 9126: The six quality characteristics of a software (http://www.cse.dcu.ie/essiscope/sm2/9126ref.html)

Studies have shown that ISO 9126 is the best quality model for e-learning-related systems like learning management systems. Chua and Dyson (2004) validated that ISO 9126 was a useful tool for evaluating learning management systems. They asserted that the said quality model was helpful in detecting design flaws and faults. The study of Djouab and Bari (2016) proposed a unique quality characteristic of evaluating e-learning software products. The ISO 9126 standard was the basis of their assessment. On the other hand, Fahmy, Haslinda, Roslina, and Fariha (2012) proposed an empirical method for identifying characteristics of software quality of e-book materials based on ISO 9126. Further, Titthasiri (2014) asserted that ISO 9126 model proposed the idea of 'error prevention,' instead of 'error correction.' The author argued that "ISO 9126 model is used to be a standard specification for having a software engine with high quality before implementation."

Numerous factors influence the quality and several techniques for assessing it. Pressman (2001) emphasized that software requirements are the foundation for measuring quality. Lack of conformance to requirements is a lack of quality. Second, specified standards define a set of development criteria that guide the manner in which software is engineered. If the criteria are not followed, lack of quality will almost surely result. Lastly, a set of implicit requirements often goes unmentioned. If software conforms to its explicit requirements but fails to meet implicit requirements, software quality is suspect. Likewise, Sommerville (1997) identified four principal factors that affect quality. These were process quality, development technology, people quality, and cost, time,

and schedule. He also argued that quality was likely high if the development team has a great ability and experience. "The quality of a system is only as good as the requirements that describe the problem, the design that models the solution, the code that leads to an executable program, and the tests that exercise the software to uncover errors" (Pressman, 2001).

METHOD

Research Design

The study implemented a descriptive–correlative and utilized a survey method. It described the quality level of PLMS. Likewise, this study employed a correlation of two variables specifically the demographic and technological profiles and the usability level.

Research Environment

The study was conducted in higher education institutions (HEIs) offering any teacher education programs in the four provinces of Central Visayas, Philippines. Likewise, the study was also undertaken in Dipolog City, Province of Zamboanga del Norte. See Figure 1 for the map of the Philippines illustrating the study sites. The teacher education program refers to recognized degree programs such as Bachelor of Science in Secondary Education and Bachelor of Science in Elementary Education offered in public and private HEIs. The HEIs include private, public, and community colleges and universities in Bohol, Cebu, Negros Oriental, and Siquijor.

Respondents

The respondents of the study were trainees of the regionwide user training on the use and classroom integration of PLMS. These trainees were full-time faculty teaching any professional or specialization courses of the teacher education program. Also, a few student-teachers joined the training. Selection of trainee-participants depended on the participating HEIs. The HEIs involved during Year 1 of the project received the training invitation. The trainee's willingness to use and integrate PLMS into their classroom instruction was the only explicit qualification to participate during the end-user training. There

were 152 participants in all five batches of training. A total enumeration of respondents was employed. Of the 152, 123 participants participated in the survey, and the analysis included responses from 116 participants.

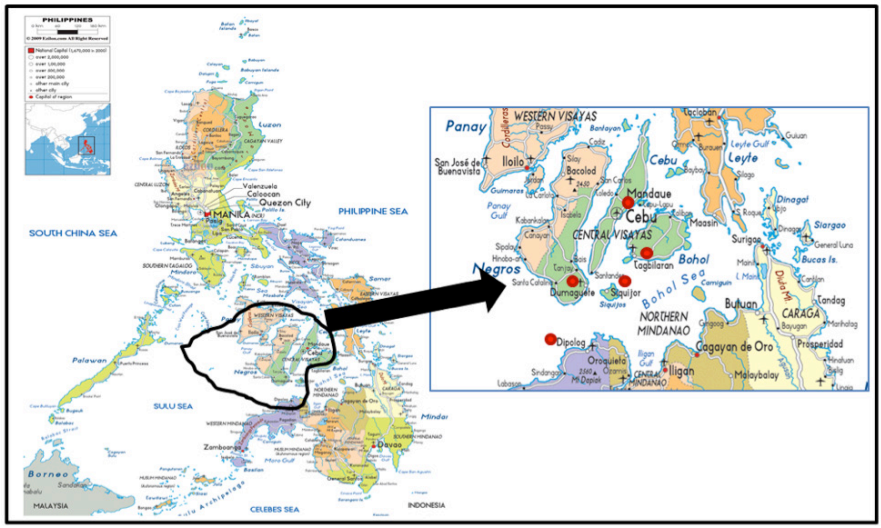

Figure 5. Map of the Philippines illustrating the study sites
(Map is downloaded from http://www.ezilon.com/maps/asia/philippines-maps.html)

Instrument

The instrument used in data gathering to undertake the usability of PLMS was a survey questionnaire. The statements in the survey were based on the ISO 9126. These statements were categorized into six quality factors in the ISO Software Quality Model. These were functionality, reliability, usability, efficiency, portability, and the pedagogical characteristic of PLMS. Each factor was composed of at least three specific statements. Respondents were asked to rate their level of agreement with the quality statements according to four-point scale choices: 4 — strongly agree; 3 — agree; 2 — disagree; and 1 — strongly disagree. Further, the survey questionnaire also included the demographic and technologic profile of the five batches of trainees. These profiles were used in measuring relationships with the usability components.

Data Collection

There were five different settings during the data collection. The collection was during the end-user training batches of PLMS. The training was face-to-face,

and it aimed to demonstrate, practice, and do hands-on activities with the use and classroom integration of the newly developed PLMS. The three batches of training are provincial-based where it was attended by participants from many institutions. On the other hand, the last two batches were school-based where participants are coming only from the host institution. The first group of the end-user training was composed of HEIs in Negros Oriental and Siquijor. It was held on October 26–27, 2015 at Silliman University, Dumaguete City, Negros Oriental. The second batch of training was attended by HEIs in Cebu province. It was held on October 28–29, 2015 at the University of Cebu — Main Campus, Cebu City. The third batch was attended by HEIs in Bohol province. It was held on October 30–31, 2015 at Holy Name University, Tagbilaran City. The fourth batch of training was participated by teachers and student-teachers in Bohol Island State University — Calape Campus, a satellite campus of a state university in the Province of Bohol. The training was held on November 12–13, 2015. The last batch of end-user training was participated by teachers in Dipolog Medical Center College Foundation, a private school in Dipolog City, Zamboanga de Norte. The training was held on December 8–9, 2015. The survey questionnaire was distributed to all participants during the last hour of the training. Respondents were given the option to either respond to the survey using the printed copy or online through Google Form.

In total, 116 responses were included in the analysis. Filled-out questionnaires from unqualified respondents were deleted. Particularly, responses from participants who did not come from HEIs were removed. Double entries were also checked in the case of online responses. In this case, seven responses were rejected because these responses were from respondents who did not come from HEIs.

Data Analysis

The statistical tools employed in the data processing were frequency and percentage for the demographic profile as well as the technology ownership profile of the respondents. Also, the weighted mean was used for measuring the quality level. The chi-square was used to determine if there are significant relationships that exist between the quality level and sex, status, and technology ownerships among the respondents. The Spearman's Rank-Order Correlation computation was used to determine if there were significant relationships that existed between the quality level and age, highest educational attainment,

and number of years of teaching among the respondents. Lastly, the ANOVA analysis was used in determining whether or not the quality level across the five batches significantly differed.

RESULTS

Demographic Profile of the Respondents

As shown in Table 2, 43 (37.07%) were male, and 73 (62.93%) were females. There were 89 (76.72%) aged 18–40 and 25 (21.55%) aged 41–65. No one was over 65 years old, and two (1.73%) opted not to answer. More than a majority of the respondents were teaching for less than eight years. A little higher than the majority were single respondents (69, 59.48%). Regarding the respondents' highest educational attainment, 43 (37.07%) had a master's degree, 42 (36.21%) had a bachelor's degree, 22 (18.97%) were undergraduates who were student-teachers, and 9 (7.76%) had doctorate degrees. As for batches of training, there were 31 (26.70%) participants in the first batch, 16 (13.80%) in the second batch, 29 (25%) in the third batch, 21 (18.1%) in the fourth batch, and another 19 (16.4%) in the fifth batch. There were more (67, 63.81%) respondents coming from the private HEI than the public.

Table 2. Demographic Profile of the Respondents.

PROFILE	Total	
	f	%
Sex		
Male	43	37.07
Female	73	62.93
Total	116	100.00
Age		
18–- 40	89	76.72
41 – 65	25	21.55
> 65	0	0.00
No Answer	2	1.73
Total	116	100.00
Number of Years In Teaching		
0–-7	72	62.07
8–-14	12	10.35

15--21	11	9.48
22--28	4	3.45
29--35	0	0.00
36--43	1	0.86
No Answer	16	13.79
Total	116	100.00
Status		
Single	69	59.48
Married	46	39.66
Others	1	0.86
Total	116	100.00
Highest Educational Attainment		
Undergraduate	22	18.97
Bachelor"s Degree	42	36.21
Master"s Degree	43	37.07
Doctoral/PhD	9	7.76
Total	116	100.00
Type of HEI		
Public	33	36.19
Private	67	63.81
Total	116	100.00
Batches of Training		
First Batch	31	26.70
Second Batch	16	13.80
Third Batch	29	25.00
Fourth Batch	21	18.10
Fifth	19	16.40
Total	116	100.00

Technologic Profile of the Respondents in Central Visayas

Table 3 shows the technological ownership of the respondents presented according to batches of trainees. The data only presents the ownership of the respondents in the Central Visayas region. Of the 70 respondents, more than half (46, 64.71%) did not have an Android-based tablet. Likewise, 63 (90%) respondents said that they did not have an iPad tablet computer. Surprisingly, no one in Bohol had an iPad computer. On the contrary, more than the majority (61, 87.14%) owned a laptop computer, but a little more than half of

the respondents (41, 58.67%) had no desktop computers. The data shows that there were more respondents from Negros Oriental and Siquijor (15, 62.50%) who possessed a desktop computer than those from Cebu (7, 25%) and Bohol (7, 38.89%). The results also show that about 75% of the respondents had Smartphones.

Table 3. Technologic Ownership of the Respondents by Training Batch in Central Visayas.

Profile	Batch of Trainees						Total	
	Negros Oriental & Siquijor		Cebu		Bohol			
	f	%	f	%	f	%	f	%
Android Tablet								
Yes	8	33.33	7	25.00	9	50.00	24	34.29
No	16	66.67	21	75.00	9	50.00	46	64.71
Total	24	100.00	28	100.00	18	100.00	70	100.00
iPad Computer								
Yes	5	20.83	2	7.14	0	0.00	7	10.00
No	19	79.17	26	92.86	18	100.00	63	90.00
Total	24	100.00	28	100.00	18	100.00	70	100.00
Laptop Computer								
Yes	23	95.83	23	82.14	15	83.33	61	87.14
No	1	4.17	5	17.86	3	16.67	9	12.86
Total	24	100.00	28	100.00	18	100.00	70	100.00
Desktop Computer								
Yes	15	62.50	7	25.00	7	38.89	29	41.43
No	9	37.50	21	75.00	11	61.11	41	58.67
Total	24	100.00	28	100.00	18	100.00	70	100.00
Smartphone								
Yes	18	75.00	20	71.43	14	77.78	52	74.29
No	6	25.00	8	28.57	4	22.22	18	25.71
Total	24	100.00	28	100.00	18	100.00	70	100.00

Quality Level

Table 4 shows the quality level of PLMS. In terms of quality level, the table reveals a means of 3.56, which corresponds to 'strongly agree'. Unexpectedly, all quality components—functionality ($\bar{x}$= 3.62), reliability ($\bar{x}$= 3.46), usability ($\bar{x}$=

3.39), efficiency ($\bar{x}$ = 3.49), portability ($\bar{x}$ = 3.71), and pedagogical characteristic ($\bar{x}$= 3.61)—were given a rating that corresponds to 'strongly agree'. Specifically, all statements, except one, were described as 'strongly agree'. The table shows that the portability component was rated highest in terms of the overall mean value, followed by the functionality component level. The highest overall mean was equal to 3.78 belonging to the functionality component which was "PLMS performs the assigned tasks." On the contrary, the statement "PLMS is operated with minimal effort" got the lowest mean level of 3.27, described as 'agree.'

Table 4. Quality Level

Functionality Statements		Total	
		Mean	Description
1.	PLMS performs the assigned tasks.	3.78	Strongly Agree
2.	PLMS produces the expected results.	3.73	Strongly Agree
3.	PLMS interacts with another computer system.	3.47	Strongly Agree
4.	PLMS is equipped with the acceptable security measure.	3.51	Strongly Agree
	Overall Mean	3.62	Strongly Agree
Reliability Statements			
5.	PLMS responds to my teaching requirements.	3.64	Strongly Agree
6.	Most of the faults in PLMS can be eliminated over time.	3.41	Strongly Agree
7.	PLMS can handle errors.	3.38	Strongly Agree
8.	PLMS can resume working and restore data after a failure.	3.39	Strongly Agree
9.	PLMS complies with my reliability requirements.	3.48	Strongly Agree
	Overall Mean	3.46	Strongly Agree
Usability Statements			
10.	PLMS is easy to understand.	3.40	Strongly Agree
11.	PLMS is easy to learn.	3.46	Strongly Agree
12.	PLMS is operated with minimal effort.	3.27	Agree
13.	The interface of PLMS is appealing.	3.36	Strongly Agree
14.	PLMS complies with my usability requirements.	3.48	Strongly Agree

	Overall Mean	3.39	Strongly Agree
Efficiency Statements			
15.	PLMS behaves promptly.	3.42	Strongly Agree
16.	PLMS complies with my efficiency requirements.	3.45	Strongly Agree
17.	PLMS utilizes resources efficiently.	3.56	Strongly Agree
	Overall Mean	3.49	Strongly Agree
Portability Statements			
18.	PLMS can be moved to another computer environment.	3.71	Strongly Agree
19.	PLMS is easy to install.	3.73	Strongly Agree
20.	PLMS complies with my portability requirement.	3.71	Strongly Agree
	Overall Mean	3.71	Strongly Agree
Pedagogical Characteristic Statement			
21.	PLMS complies with a pedagogical approach in the classroom.	3.61	Strongly Agree
	Mean of Means	3.56	Strongly Agree

The lowest mean (strongly agree) of the functionality statements is on the interaction of PLMS with another computer system. The statement about compliance with teaching requirements has the highest weighted mean of 3.64 in terms of the reliability component, while the lowest mean is on error-handling. The highest mean level in the usability component is in the statement "PLMS complies with usability requirement" with an average of 3.48. Regarding the efficiency level, the highest mean (3.56) is the statement "PLMS utilizes resources efficiently." The highest mean under portability is on the statement about easy installation of PLMS ($\bar{x}$= 3.73).

Test of Relationship between the Profiles and Usability

Tables 5 and 6 show the results of the analysis done so as to establish whether or not a significant association existed between the respondents' profile and their agreement level of the quality of PLMS. As shown in Table 5, age and number of years in teaching are significantly related to the quality of PLMS. Specifically, the table shows that age has a significant relationship with reliability ($r_s = 0.2566$, $p < 0.01$), usability ($r_s = 0.2872$, $p < 0.01$), and efficiency ($r_s = 0.3795$, $p < 0.01$). Shown also in Table 5 is the number of years in teaching,

which has significant correlations with functionality (r_s = 0.2327, $p < 0.05$), reliability (r_s = 0.2571, $p < 0.01$), usability (r_s = 0.2407, $p < 0.05$), and efficiency (r_s = 0.3808, $p < 0.01$). There was a nonsignificant correlation of 0.1721 (p = n.s), 0.1508 (p = n.s), and 0.1221 (p = n.s) between age and functionality, between age and portability, and between age and pedagogical characteristic of PLMS, respectively. In the same way, there is a nonsignificant correlation of 0.1953 (p = n.s) between number of years of teaching and portability as well as of 0.1503 (p = n.s) between number of years of teaching and pedagogical characteristic of PLMS.

Table 5. Test of relationship between Age and No. of Years of Teaching and usability.

Variables	**r_s value**	**p - Value**	**D*f***	**Remarks**
Age and				
Functionality	0.1721	0.0684	111	Not Significant
Reliability	0.2566	0.0060	111	Significant
Usability	0.2872	0.0020	111	Significant
Efficiency	0.3795	‹0.0001	111	Significant
Portability	0.1508	0.1102	111	Not Significant
Pedagogical	0.1221	0.1963	111	Not Significant
No. of Years in Teaching and				
Functionality	0.2327	0.0197	98	Significant
Reliability	0.2571	0.0099	98	Significant
Usability	0.2407	0.0161	98	Significant
Efficiency	0.3808	‹0.0001	98	Significant
Portability	0.1953	0.0529	97	Not Significant
Pedagogical	0.1503	0.1368	98	Not Significant

Table 6 shows that only the variable, highest educational attainment, has a significant association with the quality level of PLMS. Specifically, the study indicates that there is an evidence of a significant relationship between highest educational attainment and usability of PLMS (x^2 (1, N = 116) = 7.760, $p <$ 0.05). Likewise, highest educational attainment is significantly related with to efficiency level (x^2 (1, N = 116) = 4.520, $p < 0.05$).

Table 6. Test of Relationship between Sex, Status, Highest Educational Attainment, and Type of Institution and Usability.

Variables	x^2	*p* - Value	*Df*	Remarks
Sex and				
Functionality	0.850	0.357	1	Not Significant
Reliability	0.660	0.4166	1	Not Significant
Usability	0.050	0.8231	1	Not Significant
Efficiency	3.040	0.081	1	Not Significant
Portability	2.260	0.1328	1	Not Significant
Pedagogical	0.210	0.6468	1	Not Significant
Status and				
Functionality	0.010	0.920	1	Not Significant
Reliability	2.300	0.129	1	Not Significant
Usability	0.430	0.512	1	Not Significant
Efficiency	3.230	0.072	1	Not Significant
Portability	0.570	0.450	1	Not Significant
Pedagogical	0.020	0.888	1	Not Significant
Highest Educational Attainment and				
Functionality	0.040	0.842	1	Not Significant
Reliability	0.07	0.791	1	Not Significant
Usability	7.760	0.021	1	Significant
Efficiency	4.520	0.034	1	Significant
Portability	3.440	0.064	1	Not Significant
Pedagogical	0.010	0.920	1	Not Significant
Type of Institution and				
Functionality	0.000	1.000	1	Not Significant
Reliability	0.350	0.554	1	Not Significant
Usability	1.23	0.267	1	Not Significant
Efficiency	0.210	0.647	1	Not Significant
Portability	0.050	0.823	1	Not Significant
Pedagogical	1.190	0.275	1	Not Significant

Test of relationship between the Technology Ownerships and Usability

The results of the chi-square analysis indicate that none of the technologic variables has a significant association with any of the six quality components ($p > 0.05$). The result implies that having mobile technologies like Android tablet, iPad, laptop, desktop computer, and Smartphone does not guarantee the improvement of the quality of PLMS with regard to functionality, reliability, usability, efficiency, portability, and pedagogy.

Test of Difference between the Quality Level and Training Batches

With the six ANOVA analyses, not one came out to be significantly different. There were no statistically significant differences between batch means and functionality level ($F(4,111) = 1.52$, $p = 0.201$), reliability level ($F(4,111) = 0.99$, $p = 0.416$), usability level ($F(4,111) = 0.66$, $p = 0.621$), efficiency level ($F(4,111) = 0.41$, $p = 0.801$), portability level ($F(4,110) = 1.33$, $p = 0.263$), and pedagogical characteristic ($F(4,111) = 1.48$, $p = 0.213$).

DISCUSSION

PLMS Functionality

The PLMS is perceived as a functional teaching tool. The results imply that PLMS can perform any assigned classroom activities quickly. The results mean that PLMS easily produces the expected outcomes, and it interacts with another computer system. Moreover, the results suggest that PLMS is embedded with extremely acceptable security measures to protect the teaching resources and learning activities saved.

PLMS Reliability

The PLMS is deemed a complete, consistent, and robust (Budgen, 2003) learning management platform. The results suggest that PLMS can handle all combinations of classroom events and activities in the system. Likewise, the findings also imply that PLMS is repeatable regardless of the overall system loading. The results mean that most of the faults in PLMS can be

eliminated over time. The PLMS runs properly for very extended periods of time without failure (Pfleeger, 2002). When errors are encountered, PLMS can resume working and restore classroom data and information. In reference to Boehm's model, PLMS has integrity and consistency characteristics. This means that PLMS complies with the respondent's reliability requirements. Most importantly, the results connote that PLMS responds to the respondent's teaching requirements.

PLMS Usability

Teacher educators evaluated PLMS as having high usability attributes. The results show that PLMS is user-friendly technology. This means that PLMS is easy to understand and learn not just for the digital natives but as well as for the digital immigrants. The interface of PLMS is deemed appealing. The results suggest that teachers have the physical or intellectual skill essential to learn the PLMS (Pressman, 2001). There is minimal time required to become moderately efficient in the use of PLMS. Therefore, PLMS can be operated with minimal effort without any apprehensions and fear.

PLMS Efficiency

The PLMS is efficient as perceived by the teachers. Although the efficiency of a system can be measured through its use of resources such as processor time, memory, network access, system facilities, and disk space (Budgen, 2003), the respondents strongly believe that PLMS behaves promptly and utilizes classroom resources efficiently.

PLMS Portability

The PLMS can be moved from one computer to another without disturbing the functionality of the system (Pfleeger, 2002). This means that PLMS is easy to install. It is portable and handy as perceived by the teachers. The PLMS is self-contained, which means that the installer of PLMS does not require any remote files or utilities (What is a portable app?, 2016).

PLMS Pedagogical Characteristic

The PLMS has the necessary pedagogical characteristic. The results imply

that PLMS embeds a pedagogical approach that can help achieve innovative teaching. The results suggest that the teachers have a positive attitude towards the full integration of PLMS into their teaching job.

Relationships and Differences of the Variables

The test of the relationship between age and quality signifies that a teacher's age affects the quality of PLMS. Specifically, the results show that age has something to do with quality aspects of reliability, usability, and efficiency but not with functionality, portability, and pedagogical characteristic. Xenos and Christodoulakis (1995) posits that the "user's age has to do with his ability to adopt new technologies." Likewise, number of years of teaching is also a factor in the quality of PLMS particularly in the aspect of functionality, reliability, usability, and efficiency. The results also mean that teaching experience does not affect the quality of PLMS regarding portability and pedagogical characteristic. Further, highest educational attainment is found to be a factor in the quality of PLMS specifically on the aspects of usability and efficiency but not with functionality, reliability, portability and pedagogical characteristic. The data revealed that teachers with master's degree were better in learning and understanding PLMS easily. The data also disclosed that teachers with a doctorate degree had a better ability to perform PLMS well than those with other educational attainments. This result is explained by Xenos and Christodoulakis (1995) who said that a user's education helps in expressing serious critique in software quality. On the contrary, sex, civil status, and type of institution did not affect the quality of PLMS. This result goes to show that being male and female does not matter in the quality of PLMS. Further, it is interesting to note that ownership of Android tablet, iPad, laptop, desktop, and Smartphone did not affect the quality of PLMS. The results imply that the degree of excellence in using PLMS can still be achieved even if users do not personally own the said technologies.

The test of differences among batches showed that all the five batches were the same in all those six factors or areas of quality. The result may suggest that the quality level of PLMS will be similar in the next batches of training, provided that there will be similar training conditions.

CONCLUSIONS

The PLMS is a quality teaching tool to support reforms in managing learning resources and activities under the limited technological access. The PLMS is a fully-operational portable learning management system. It has the properties that comply with teaching requirements in higher education institutions. It conforms to the expected functional and nonfunctional requirements of a learning management system. It is very functional and highly usable, especially in managing resources and conducting activities offline. Further, PLMS is a highly efficient tool for teaching. It is optimized for use on removable drives that do not interfere with software installed on personal computers (What is a portable app?, 2016).

Achieving quality in any learning management systems is a shared responsibility. It is a responsibility between the teachers—who provide the requirements and the developers—who design the features. However, strict observance of software development standards must bridge between the two important entities.

RECOMMENDATIONS

The study recommends the maximum utilization of PLMS. To do this, teachers must regularly practice all aspects of the learning management system. The development team should conduct regular trainings on the use and classroom integration of PLMS. More batches of training should be done not only in Central Visayas, Philippines but also in other regions.

There must be a follow-up quality testing among the respondents after the full integration of PLMS in their classes. The study also recommends performing quality testing from the students' perspective. In the same manner, the study recommends exploring other methods of quality testing as mentioned at the beginning of this article. Data sets of the quality testing results may be used to describe, predict, and derive teaching patterns and behaviors of teachers to support educational reform in learning management.

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