An Inspection of Learning Management Systems on Persuasiveness of Interfaces and Persuasive Design: A Case in a Higher Learning Institution

Wan Nooraishya Wan Ahmad[1], Mohamad Hidir Mhd Salim[2], Ahmad Rizal Ahmad Rodzuan[3]

Faculty of Computing and Informatics, University Malaysia Sabah, Labuan, Malaysia[1, 3]

Institute of IR4.0, Universiti Kebangsaan Malaysia, Selangor, Malaysia[2]

Abstract—An effective Learning Management System (LMS) is an essential factor that can increase e-learning persuasiveness. One of the components that need to be addressed to design an effective LMS is design interfaces. Instead of developing a new LMS that requires a high cost, evaluating and improving the existing LMS is the best option. Issues like low completion rates and procrastination are common issues related to e-learning usage. These issues can be solved if academic institutions provide a proper LMS for students to change their learning behaviors positively. Many previous studies claimed they managed to implement persuasive technology into e-learning platforms to encourage positive learning behaviors. However, the claims can be questionable if the persuasive e-learning systems are not gone through a proper evaluation phase. This study will use the heuristic evaluation method to assess the persuasiveness level of LMS interfaces. The persuasive Systems Design Model (PSD), on the other hand, is used to evaluate persuasive strategies in LMS. The assessment involves students' perspectives as the primary users to identify potentially behavior change factors, especially on engagement. Thus, the objectives of this study are i) to investigate the persuasiveness of LMS interfaces and ii) to identify persuasive strategies in the LMS design. Apart from that, this study also produces a) recommendations on design examples to increase the persuasiveness of LMS interfaces and b) the mapping of LMS interfaces to PSD framework that can be utilized by higher learning institutions.

Keywords—Learning management system; e-learning; persuasive design; persuasiveness; interface design

I. Introduction

E-learning or electronic learning is a learning medium which involves processes of delivering learning materials, communicating knowledge, tasks and learning instructions through online mediums [1]. Some examples of the commonly used tools for e-learning include video conferencing solutions, virtual tutoring, and digital libraries [2]. Previous studies reported that the effectiveness of e-learning is high, up to 60% of retaining learning materials compared to a traditional classroom which is up to only 8% to 10% of retention [3]. Because of the potential of e-learning as a platform for future learning, this study focuses on one of the e-learning technologies, which is Learning Management Systems (LMS).

LMS is a platform or medium used to provide learning features such as distributing learning materials and training activities while tracking students' progress [4]. One of the famous examples of LMS is Moodle. An effective LMS can connect students with instructors outside of traditional classrooms via technology. Other than that, students can also be involved in online discussions through LMS. It even allows asynchronous conversation and facilitates problem-solving to improve the understanding of their enrolled subjects [4]. According to [5], incorporating LMS technology into teaching and learning enhances the accuracy of teaching attempts, student performance, and learning effectiveness. Thus, the LMS interface should be designed by considering students' perspectives as the end-users to prevent students from becoming discontent.

Almost every tertiary education institution worldwide uses LMS in its learning process [6]. Some tertiary education institutions in Malaysia use Moodle as their LMS platform due to its flexibility and versatility in fulfilling learning functions. On the other hand, some institutions develop their own LMS platforms for different reasons, such as cost and other preferences [7]. Despite the benefits that e-learning technologies offer to the learning process, some educational experts argue that there are flaws in e-learning because a significant percentage of students reported dissatisfaction with how technology is used in education [8]. They claimed that the lack of direct interaction between students and teachers is an important issue that needs to be solved to increase the effectiveness of the technology, or else it is worth noting. User acceptability and use are important indicators of the system's success. As a result, student admission must be considered; otherwise, information systems are prone to failure [8]. Persuasive technology is a technology developed that aims at users' behavior change without coercion [9]. A low completion rate due to procrastination is one of the issues related to e-learning that require changing students' behaviors [10]. A previous study claimed they integrated persuasive technology into e-learning platforms to encourage positive learning behaviors [11]. However, the claim can be questionable if the persuasive systems are not going through the proper evaluation phase. Students' evaluation is crucial since they are the primary users of e-learning technology.

This research study used the heuristic of persuasion in interface [12] to assess the persuasiveness of LMS interface and Persuasive Systems Design Model (PSD) [9] to evaluate persuasive strategy in LMS of a higher learning institution. The assessment is made from students' perspective as the primary entity potentially related to behavior changes on engagement. Thus, the objectives of this present study are i) to investigate

the persuasiveness of interface of a learning management system and ii) to identify persuasive strategy in the design of a learning management system. This study contributes to the following: a) recommendation on design examples to increase persuasiveness of LMS interface, and b) the mapping of LMS interface to PSD framework for LMS that can be utilized by higher learning institution particularly to the six most visited interface in the LMS.

The rest of the study is followed by Section II, which provides an outline of the background study and explains past related works. Section III describes the method, materials, and data collection and analysis procedures. Section IV presents two parts of the result and Section V is the discussion to describe the observed scenario. Lastly is the conclusion.

II. BACKGROUND STUDY

A. Persuasion

Persuasion is a form of influence as the technique tries to convince the persuadee of something [9]. There are two forms of persuasion: indirect and direct persuasion [13]. Indirect persuasion is a method that does not make persuasive intent clear. The intent is not expressed clearly without condemning or confronting a person's attitude or endorsing another person who has already accepted the offered message or notion. Direct persuasion is where persuasion has apparent intentions. It provides clear direction to a person with goal setting, including the process and clear instructions to achieve their goal despite their agreement. The LMS is supposed to have direct persuasion because the use of LMS in learning will eventually modify a student's learning habit [14].

Persuasion is the core process of persuasive technologies that modify users' behavior and perceptions through various techniques [15]. Therefore, it has been studied in various domains such as education [14], tourism [16], and health [17]. In addition, the Persuasive Systems Design Model (PSD) [9] has served as the guideline in designing and evaluating persuasive systems. The PSD framework is composed of four types of persuasive design principles: (i) primary task support, (ii) dialogue support, (iii) credibility support, and (iv) social support. The primary task principles are concerned with assisting the user's principal actions and goals. Dialogue support principles relate to human-computer dialogue aid in reaching the system's aim. The credibility support principles address how to design a more credible and convincing system. Finally, the design principles of social support utilize various components of social influence to ensure that the build system inspires the users.

Apart from becoming the core process in persuasive technology, persuasion has become one of the critical user experience attributes in interface design [18]. The potential persuasive impact of these dynamic interfaces is much more significant than a static information display where no interaction is possible. Interface properties are necessary but insufficient to change behaviors and attitudes since change can be constructed by considering user specifications [12]. Although we can enhance efficiency by applying traditional usability techniques, just because people can do something does not guarantee that they will. They must get motivated and

persuaded. A user will become more emotionally involved through repetitive interactions with an interface. Thus, [12] constructed a persuasiveness criteria grid to evaluate the persuasiveness of interfaces. The grid consists of static and dynamic criteria. Static criteria are the features required to start user acceptance and confidence to develop user engagement. The four static components are credibility, privacy, personalization, and attractiveness. Dynamic criteria incorporate substantial temporal factors where the interface elements encourage the user to commit to higher degrees of engagement. The dynamic components comprise solicitation, priming, commitment and ascendency.

B. Related Works

The two main concerns of persuasiveness studies in human-computer were on persuasive technology [15, 17, 20-23] and interface design [12, 19, 24]. Thus, the focus of persuasiveness is either on a system's perceived persuasiveness [15, 17, 20-22] or the receptiveness of a system's persuasion strategy [12, 19, 23-24]. Persuasiveness or perceived persuasiveness has been defined differently based on the context of the study. The persuasiveness of persuasive technology is defined as persuasive systems' ability to persuade or encourage users to modify their behavior in a good direction [21, 22], while the persuasiveness of interfaces refers to the perceived persuasive design of multimedia interfaces [24].

The following studies explained the previous works related to a system's perceived persuasiveness. Ref [15] concerned about the factors that affect perceived persuasiveness. Survey items were developed based on the construct of PSD framework that measured primary task support, dialogue support, perceived credibility, unobtrusiveness, and design aesthetics. The study conducted on a web-based health program found that the persuasive system categories of the PSD framework affect the perceived persuasiveness of a system. On the other hand, [20] investigated factors influencing the perceived persuasiveness of a web-based health program and whether perceived persuasiveness predicts intention to utilize the intervention and actual system use. The report also indicated that the PSD categories [9] influence perceived persuasiveness and system usage. The study developed survey items to measure perceived persuasiveness and the categories in the PSD framework. After that, the items were used in several studies to assess perceived persuasiveness [21-23]. In addition, [17] adapted the Perceived Persuasiveness Questionnaire [15] to evaluate the perceived persuasiveness of a Nurse Antibiotic Information App (NAIA) using user tests and expert assessments. The expert assessment approach discovered primary task support, credibility, unobtrusiveness, perceived persuasiveness, perceived effort, and perceived effectiveness in the app. A similar outcome was obtained using the user test approach, with good remarks on primary task support, perceived persuasiveness, and unobtrusiveness. Ref [21] studied the impact of perceived persuasiveness of behavior model design on self-efficacy, self-regulation, and result expectancy. The study adopted [20] questionnaire items to measure the perceived persuasiveness of a fitness app. The findings revealed that the perceived persuasiveness of a behavior model design increased users' outcome expectations positively for their engagement in the target exercise behavior.

The study [22] investigated if integrating perceived persuasiveness in the TAM will result in a better model and the moderating effect of culture. According to the findings, individuals in individualist cultures were more likely to recognize the persuasiveness of a fitness app. As a result, incorporating a persuasive construct into the TAM is likely to be relevant compared to collectivist culture. Individualist group involving perceived persuasiveness are more likely to result in long-term persuasive system adoption than the collectivist group with no perceived persuasiveness. The author [23] studied users' susceptibility to the perceived persuasiveness of the fitness app and each persuasive element. The study developed a model to understand better the relationship between perceived UX design traits (such as perceived usefulness, credibility, and aesthetics) and users' susceptibility to persuasive features included in persuasive technologies. Persuasive features from the PSD framework [9], such as Goal setting/Self-Monitoring, Reward, Cooperation, Competition, Social Comparison, and Social Learning, were evaluated, and survey items from [20] were used to assess the fitness app's perceived persuasiveness. According to the findings of the study, perceived usefulness, followed by perceived aesthetics, has the most significant association with users' susceptibility to the persuasive elements.

Meanwhile, the persuasiveness of interfaces lacks attention from HCI researchers except those listed in the first paragraph in Section B. In [19] the authors have developed a set of guidelines to assess the persuasiveness of interfaces. The study examined 15 website and application interfaces to provide a criteria-based approach to classifying and evaluating the persuasive power of interfaces. Eight criteria were established and identified from the 15 interfaces. The criteria were divided into a static and dynamic category; each consisted of four criteria. The static category, which consists of credibility, privacy, personalization, and attractiveness, are related to the content impact to engender user adoption and engagement experience. Static criteria are all the interface elements required to kickstart a process of user engagement. The dynamic category consists of solicitation, priming, commitment and ascendency. The dynamic criteria serve as an approach to immerse the users in an interactive process that gradually engages them with the interface to motivate users to change their behavior. The criteria for interactive persuasion emphasize the social and emotional aspects of interfaces, complementing the traditional inspection criteria (e.g., clarity, consistency, homogeneity, compatibility, and usability). These criteria involved the temporal aspects of the interface. The study [12] used a set of instructions [20] from an existing e-learning program for self-regulated middle school mathematics learning to conduct a persuasiveness assessment. The findings demonstrated that personalization, attractiveness, solicitation, initiation, and commitment criteria explained the low engagement when using the e-learning program. In addition, the ascendency criteria were found to be irrelevant for educational interfaces. Credibility and privacy criteria dominated the user engagement with the e-learning program. The author [24] conducted a study based on user time spent to assess the usability and persuasion of social networking mobile applications such as YouTube and Facebook. The analysis on persuasion reveals that Facebook and YouTube utilize a series of persuasion strategies to engage the user in an engaging cycle and keep them online for a longer time. Using the persuasion criteria [19], the study discovered some criteria emphasize being subtle and obtrusive. The subtle strategies rely on targeted suggestions to distract the user's attention and prompt engagement. In contrast, an obtrusive mechanism, such as a notification system, was used even when the user was not linked to the software.

In summary, health seems to be the domain concern of the previous works investigating persuasive technology's perceived persuasiveness. The persuasiveness of interfaces has been studied diversely, including websites, mobile apps, an e-learning system, and social networking applications. However, this present study focused on the LMS used in a higher learning institution since persuasive learning has become a concern among HCI researchers [14, 25]. Compared to the previous works, this study will conduct an integration study on the persuasiveness of interfaces and persuasion design strategy. Both perspectives are essential in determining user engagement towards using the LMS [14, 25].

III. METHODOLOGY

The methodology approaches in performing the study are described in this section, which includes (a) participant, (b) material, (c) measures and analysis, and (d) procedure. The following are the subsections:

A. Participant

Two experts in Human-Computer Interaction (HCI) and one expert in E-learning were recruited for the evaluation study. They were picked based on their five years of expertise in those research fields, as well as their consistent journal publications in the field. To prevent bias, the hired experts were chosen not among the system's users.

B. Material

SMART2 and SMARTv3 were the two versions of the learning management system from Universiti Malaysia Sabah used as the case study (refer Fig. 1). The SMART2 refers to an older version of the LMS, whilst the SMARTv3 refers to the most recent version. Both system versions have comparable capabilities, although the SMARTv3 has a modest upgrade in the interface design. SMART2 has been used for ten years in UMS before the ICT Department came out with SMARTv3 in the year 2020 on Semester 2. For the last ten years, SMART2 has received complaints from the students and lecturers regarding functionality and interface design. These have made some of the lecturers switch to other platforms for their blended learning.

Six interfaces of both LMS versions were selected based on the frequency of students visiting or using the interface. The interfaces are the homepage before login, course page, assignment view, assignment submit view, forum, and quiz. Fig. 2 illustrates the six selected interfaces of the LMS versions.
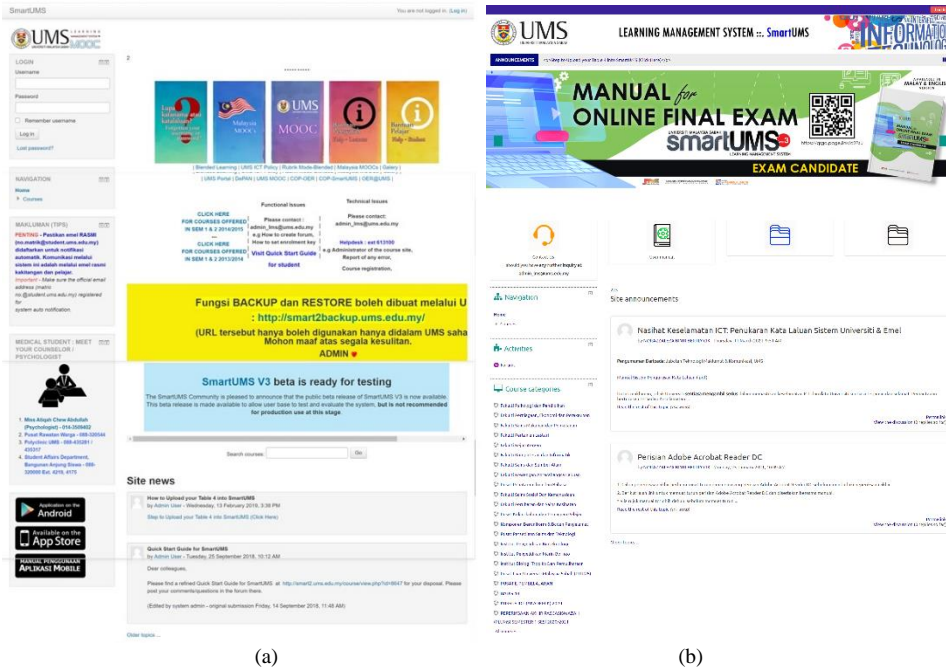
(a)   (b)

Fig. 1.   Learning Management System: (a) SMART2; (b) SMARTv3.

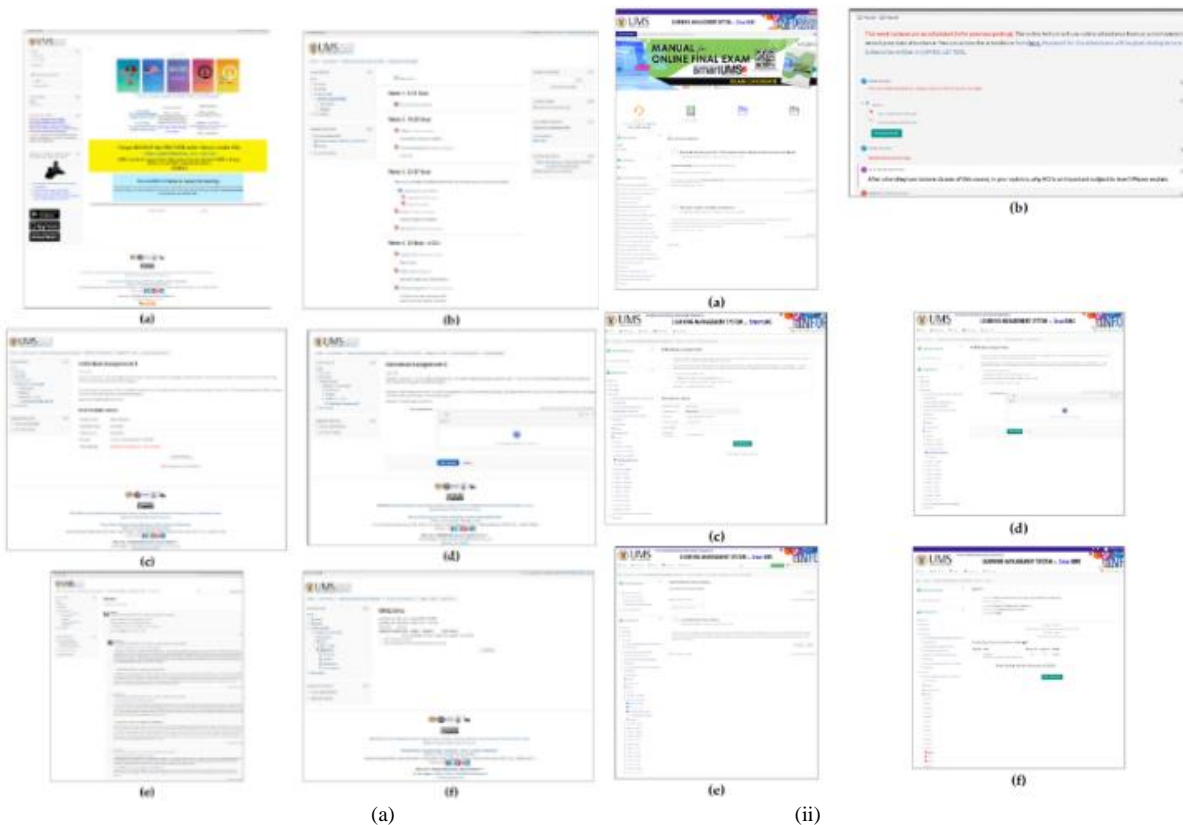(a)   (ii)

Fig. 2.   Interfaces of (i) SMART2; (ii) SMARTv3. The Interfaces are (a) Homepage; (b) Course Page; (c) Assignment View; (d) Assignment Submission; (e) Forum; (f) Quiz.

C. Measures and Analysis

In the evaluation study, a heuristic inspection is performed to assess both persuasiveness of interface and persuasive strategy design to obtain insight from professionals in an independent walkthrough using established persuasive grid criteria [12] and PSD model [9]. The grid contains eight criteria and 23 sub-criteria. In addition, the experts examined the six selected interfaces of both LMS versions using evaluation

checklists. The checklist required the experts to rate "Yes" and "No" answers, with the "Yes" answer was provided with two options, "Yes Low" and "Yes High" answers. Different from [12], the findings are divided into three types of answer that later grouped as "Satisfied", "Dissatisfied" and "Unsatisfied". The responses "yes high" and "yes" were classified as "Satisfied," whereas the response "yes low" was classified as "Unsatisfied." The "Dissatisfied" term came from the response "no" provided by the experts. The term "Unsatisfied" refers to the need for more interface elements relevant to the criterion, whereas "Dissatisfied" refers to the absence of interface components linked to the criteria. The analysis on PSD principles for six screen is classified as "yes" and "no" answers according to the type of LMS and interfaces. The response "yes" indicates that PSD principles were present in the LMS, whereas the answer "no" indicates that PSD principles were not applied in the LMS. Both the heuristic inspections are analyzed using descriptive analysis.

D. Procedure

All three experts were given a printed version of the interfaces so that they may annotate them. Each interface was evaluated according to the qualities of persuasive grid criteria [12] and persuasive strategy design [9]. The experts were also given definitions of the attributes and criteria to use as references. Experts were required to rate each criterion and strategy and make comments or proposals for improving the interface.

IV. RESULTS

This section presented the results on persuasiveness of interface and criteria of persuasive system design.

A. Persuasiveness of Interface

Fig. 3 reported the six screens' inspections of both systems. The results are illustrated according to the persuasive criteria and interfaces for each LMS evaluated according to the qualities of persuasive grid criteria [12] and persuasive strategy design [9]. Fig. 4 and Fig. 5 illustrated the compilation of eight persuasiveness criteria for both LMS according to the answers group. The results show that Smart2 and Smartv3 managed to meet the solicitation criteria successfully. The system is expected to create relationship and initiate user action. However, ascendency, personalization and privacy are found to be the critical persuasive criteria in Smart2. The Smart2 system is also found to lack in providing interfaces that engaged students to commit in the process, the user interface is not aesthetically appealing, and not have enough of elements to instill trust. Due to the lack of commitment criteria, this has resulted in the equal percentage for the initiation criteria in those three types of answers group.

Meanwhile, like Smart2 system, the result shows that Smartv3 system is also lacking in credibility elements that could instill trust apart from just having the university logo and license statement from the authority. The result discovered critical persuasive criteria in the Smartv3's interface namely attractiveness, personalization, commitment, ascendency, privacy, and initiation. Although in the context of educational interface, ascendency is irrelevant [12], the criteria existed in both system in this present study with both systems scored the same percentage in three answers group (satisfied=17%, unsatisfied=22%, dissatisfied=61%). It can be presumed that the compulsory use of LMS in learning has made students develop emotional attachment with both systems through interfaces such as course page, assignment view, assignment submit and forum.

Those four interfaces were successful in instilling a degree of repetition and regularity in students' visits to them, and failing to visit the interfaces will result in students falling behind in their learning.

			INTERFACES ACCORDING LMS TYPE												TOTAL CRITERION PER LMS							
			Homepage		Course page		Assignment view		Assignment submit		Forum		Quiz		SMART2				Smartv3			
			Smart2	Smartv3	Smart2	Smartv3	Smart2	Smartv3	Smart2	Smartv3	Smart2	Smartv3	Smart2	Smartv3	Yes H (+)	Yes	Yes L	No (-)	Yes H (+)	Yes	Yes L	No (-)
Static criteria	Credibility	Trustworthiness	Yes high	Yes high	Yes low	Yes low	Yes	Yes	Yes low	Yes low	Yes low	Yes low	Yes low	Yes low	1	1	4	0	1	1	4	0
		Expertise	Yes	Yes	Yes low	Yes low	Yes low	Yes low	No	No	Yes low	Yes low	Yes low	Yes low	0	1	4	1	0	1	4	1
		Fidelity	Yes low	Yes low	Yes	Yes low	Yes high	Yes high	Yes low	Yes low	Yes low	No	Yes	Yes	1	2	3	0	1	1	3	1
		Legitimacy	Yes low	Yes low	Yes low	Yes low	Yes	Yes low	Yes	Yes	Yes	Yes low	Yes	Yes	0	4	2	0	0	2	4	0
	Privacy	Safeness	Yes	Yes	Yes low	Yes low	Yes low	Yes	Yes low	Yes low	Yes low	Yes low	Yes low	Yes low	0	1	5	0	0	2	4	0
		Law respect feeling	Yes	Yes	No	No	No	No	No	No	No	No	No	No	0	1	0	5	0	1	0	5
		Confidentiality	Yes	Yes	Yes low	Yes low	No	No	No	No	No	No	Yes low	Yes low	0	1	2	3	0	1	2	3
	Personalisation	Individualization	No	No	Yes	Yes	Yes low	No	Yes low	Yes low	Yes low	Yes	No	No	0	1	3	2	2	2	2	2
		Group membership	No	No	Yes low	No	No	No	No	No	No	No	No	No	0	0	1	5	0	0	0	6
	Attractiveness	Emotional attraction	No	No	Yes low	No	No	No	No	No	Yes low	No	No	No	0	0	2	4	0	0	0	6
		Call to action	Yes low	Yes low	Yes	Yes	No	No	Yes low	Yes low	Yes	Yes low	Yes low	Yes low	0	2	3	1	0	1	4	1
		Tunelling design	No	No	No	No	No	No	No	No	Yes low	No	No	No	0	0	5	1	0	0	0	6
Dynamic criteria	Solicitation	Allusion	Yes	Yes	Yes high	Yes high	Yes	Yes low	No	No	Yes	Yes	Yes	Yes	1	4	0	1	1	3	1	1
		Suggestion	Yes low	Yes low	Yes high	Yes high	Yes low	Yes low	No	No	No	No	Yes	Yes	1	1	2	2	0	2	2	2
		Teasing	No	No	Yes	Yes low	No	No	No	No	Yes low	Yes low	Yes	Yes	0	2	1	3	0	1	2	3
	Initiation	Priming	No	No	Yes	Yes low	Yes low	Yes low	No	No	Yes low	No	Yes	Yes	0	2	2	2	0	1	2	3
		First action guidance	No	No	Yes high	Yes high	No	No	Yes low	Yes low	Yes	Yes	Yes low	Yes low	1	1	2	2	1	1	2	2
	Commitment	Repeated request	Yes low	Yes low	Yes high	Yes high	No	No	No	No	Yes low	Yes low	No	No	1	0	2	3	1	0	2	3
		External negative factor avoidance	No	No	Yes	No	No	No	No	No	Yes low	Yes low	No	No	0	1	1	4	0	0	1	5
		Increased cost	No	No	Yes low	Yes low	No	No	No	No	Yes	Yes	No	No	0	1	1	4	0	1	1	4
	Ascendency	Prescription of repetition	No	No	No	No	No	No	No	No	Yes low	Yes low	No	No	0	0	1	5	0	1	1	4
		No-limit interaction	No	No	No	No	Yes	Yes low	Yes low	Yes low	Yes	Yes	No	No	0	2	1	3	0	1	2	3
		Presseure released	No	No	No	No	Yes low	No	Yes low	Yes low	Yes	Yes	No	No	0	1	2	3	0	1	1	4
TOTAL INTERFACES PER LMS		Yes High (+)	1	1	4	3	1	1	0	0	0	0	0	0								
		Yes (+)	5	6	6	2	4	2	1	1	7	6	6	6								
		Yes Low	5	4	8	10	6	6	8	8	12	9	6	6								
		No (-)	12	12	5	8	12	14	14	14	4	8	11	11								

Fig. 3. Results of the Experts Analysis with Eight Persuasive Criteria on Both Smart2 and Smartv3 LMS.
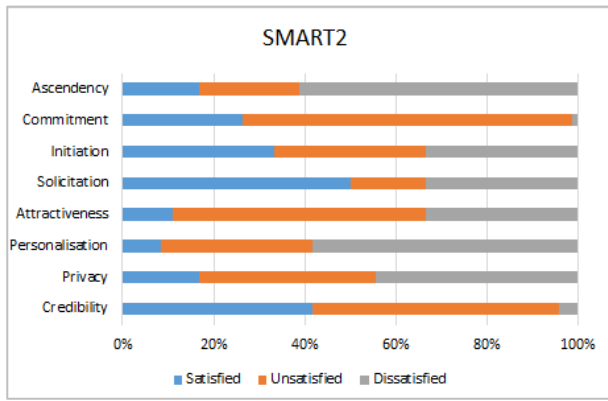
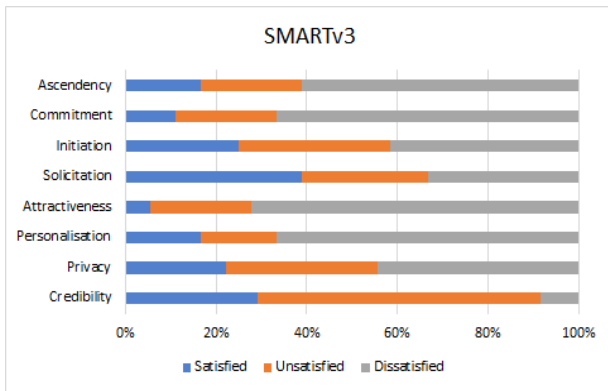Fig. 4. Compilation of Persuasive Interface Criteria for Smart2.

Fig. 5. Compilation of Persuasive Interface Criteria for Smartv3.

Table I outlines some of the critical concerns from both systems that were discovered during the inspection, as well as the corrective suggestions that were made as a result of the findings.

TABLE I.   CRITICAL CONCERNS FROM PERSUASIVENESS INSPECTION

Persuasion Interface Criteria	General Comments	Design Examples
Credibility	- Improve the surface design of the interface in terms of layout and navigation to increase trustworhiness and legitimacy on user perception towards the system - Allow for various searching apporach based on the course code and name, lecturer and course program and faculty	Use UI elements such as dropdown menu to list the courses users have taken instead of listing everything on the page
Privacy	Make the privacy elements immediately visible to the user without making them to scroll until the end of the page or having them to click on a link.	Use a banner or images that symbolises user's data privacy and security is protected.
Personalisation	- Should allow users to tailor the interface according to the their needs to create the sense of belonging. - Lack in mechanism to provide a personalise	- Personalise message that welcome or praise user will attract and engage user to use system.
	message that compliment students progress or achievement - Recommend system to provide a personalised suggestion that can enhaced learning based on student's past activities	-Screen customisation that allow users to change screen display or information layout of their preferences. -Compliment message that show personalise encouragement to students on progression and achievement. -Personalised proposal that reflect from past activities achievement.
Attractiveness	Make use of different color or color themes for emotional design elements such as images, font, icons and emoticons to attract user graphically.	- Using attractive colors or color themes for font and backgroud color. - Pictures, icons, and various emoticons that attract user to initiate actions.
Initiation	Make use of multimedia elements that can persuasively trigger and initiate user to start first action.	- Using blinking graphic to emphasis importance on such links or tasks. - Use motivational element such as reward, badges that encourage user to complete tasks.
Commitment	Improve the interaction by utilising tunelling appraoch to make the user involved and engaged with the whole process in order to access the next task and able to invite or remind their coursemates who have not yet completing the task.	-Regularly create tasks to let the user get involved frequently. - Propose a pop-up list to invite or remind other user to complete the next course material.
Ascendency	- Improve UI by applying emotional design elements to create emotional attachment and trigger positive emotion among user. - Should adopt social network design to create immersive interaction and repetative use.	- Utilise emotional design elements such as images, graphic, animation, video, text, navigation and layout to trigger positive emotion. - User profile page should be design according to social network that allow connection with other user.

B. Persuasive System Design

The result on the inspection of PSD categories is presented in Fig. 6. Finding shows that all four PSD categories; primary task support, dialogue support, system credibility and social support were found in Smartv3, while for Smart2 LMS, social support category were not found from the six screen interfaces, making only three PSD categories namely primary task support, dialogue support, system credibility existed. Both LMSs scored high in implementing system credibility principles, while social support principles were the least PSD implemented.
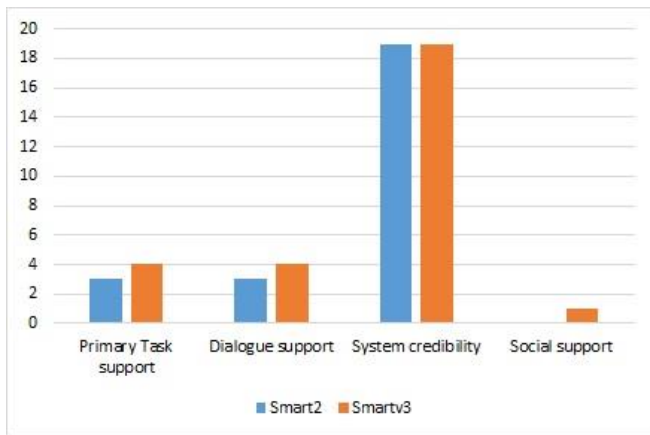
Fig. 6.   Summary of PSD in Smart2 and Smartv3.

Fig. 7 illustrated the number of PSD principles implemented in six screen interfaces. It is found that PSD principles were merely implemented in the course page interface compared to others for both LMSs.
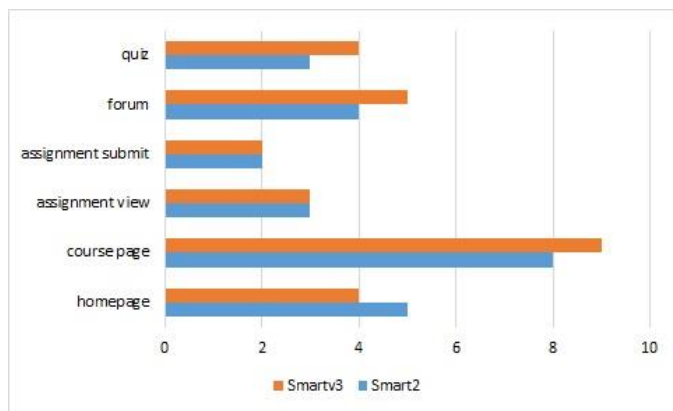

Fig. 7.   Numbers of PSD Principles in Smart2 and Smartv3.

A summary of PSD principles found in both systems during the experts' evaluation study is presented in Table II. The findings show that PSD principles are not necessarily implemented in every interface. The implementation of PSD principles depends on the purpose of interface and activities conducted in it. The homepage interface applied system credibility principles in both Smart2 and Smartv3 system according to its function as the introductory interface. The principles are mainly Surface credibility, Real-world feel, Authority, and Third-party endorsement. All four PSD categories were implemented in the course page interface for Smartv3 system, except for Smart2 where none of social support principles is implemented. The course page interface is an instructional component in LMS where it allows for the instructor to create various learning tasks implemented using various forms and deliverables such as animation, games, or video [25]. The interface of assignment view enables student to view and read the assignment provided by the course instructor. The dialogue support and system credibility principles were found in this interface. Those principles are Reminder, Trustworthiness and Surface credibility. The assignment summit's interface consists of two system credibility principles which are Trustworthiness and Surface credibility. Meanwhile,

the forum interface applied PSD principles of primary task support, dialogue support and system credibility, except for Smart2 system where none of primary task support principles are found. The principles consist of Self-monitoring, Liking, Surface Credibility, Real-world feel, and Authority. The same PSD categories were also found in quiz interface where principles of dialogue support and system credibility were implemented in both systems except for Smart2 system only implemented system credibility principles. The applied principles were Reminder, Surface Credibility, and Real-world feel.

TABLE II.   PSD PRINCIPLES IN SMART2 AND SMARTV3

Interfaces	PSD Principles		PSD Category
	Smart2	Smartv3	
Homepage	Surface credibility, Real-world feel, Authority, Third-party endorsement	Surface credibility, Real-world feel, Authority, Third-party endorsement	System Credibility
Course page	Reduction, Tailoring, Self-monitoring	Reduction, Tailoring, Self-monitoring	Primary Task Support
	Reminder	Reminder	Dialogue Support
	Trustworthiness, Surface credibility, Real-world feel, Authority	Trustworthiness, Surface credibility, Real-world feel, Authority	System Credibility
	n/a	Social learning	Social support
Assignment view	Reminder	Reminder	Dialogue Support
	Trustworthiness, Surface credibility	Trustworthiness, Surface credibility	System Credibility
Assignment submit	Trustworthiness, Surface credibility	Trustworthiness, Surface credibility	System Credibility
Forum	n/a	Self-monitoring	Primary Task Support
	Liking	Liking	Dialogue Support
	Surface credibility, Real-world feel, Authority	Surface credibility, Real-world feel, Authority	System Credibility
Quiz	n/a	Reminder	Dialogue Support
	Surface credibility, Real-world feel	Surface credibility, Real-world feel	System Credibility

Persuasive design and learning generally have a positive impact to motivate students to learn [25, 26]. The principles of reduction, tailoring and self-monitoring are used in course page to enable course development and implementation. These principles were found to excite students by stimulating intrinsic motivation, assisting students in completing tasks, and encouraging a continuous cycle of online learning [26]. Even though the social learning principle is implemented in both systems, social learning should be the least important concept to adopt in supporting students' learning progress [27] and in promoting student learning engagement [28]. Trustworthiness depicts a reliable system that gives accurate, impartial, and fair information to accomplish the desired behavior [9]. It specifies

an approach for allowing a user to trust the system such as using logo of the organization to show that the system is owned or prepare a list of references or information sources connected to the course material [25]. Generally, the surface credibility is more on the firsthand look of an interface that makes a system looks credible to use. The inspection result shows that all the six-screen managed to portray a surface credibility to its users.

V. Discussion

This study shows that persuasive designs have been implemented in the LMS for higher education. However, the effectiveness of persuasive design principles applied in the interfaces may be argued. Therefore, we mapped a persuasive design framework for LMS that consist of 13 strategies based on the LMS components and activities comprises the four dimensions of PSD. Further reading on the framework can be found in [25]. Table III summarizes the mapping of six screen LMS interfaces with the framework we have previously developed by aligning the interfaces to LMS components and activities.

The study's drawback is limited to one higher learning institution and the five most viewed websites by students. Having two separate versions of an LMS, on the other hand, is sufficient to disclose insights regarding LMS design in a higher learning institution. Nonetheless, future research might be broadened to investigate additional LMS design in different higher education institutions.

TABLE III.   MAPPING OF SIX SCREEN INTERFACES WITH PSD FOR LMS

| Interfaces | PSD Framework for LMS | | |
	LMS components	Activities	PSD Principles
Homepage	Administrative	Student enrolment	Praise
	Visual	Interface design	Liking, Trustworthiness, Personalization
Course page	Administrative	Monitor learning progress	Self-monitoring, Reward, Competition, Social comparison
	Instructional	Course development	Tailoring
	Instructional	Course implementation	Reduction, Self-monitoring
	Support	Tracking learning process	Suggestion, Tunnelling, Self-monitoring
	Visual	Interface design	Liking, Trustworthiness, Personalization
Assignment view	Instructional	Course implementation	Reduction, Self-monitoring
Assignment submit	Instructional	Course implementation	Reduction, Self-monitoring
Forum	Interactive	Communication	Social role, Praise
Quiz	Instructional	Course implementation	Reduction, Self-monitoring
	Interactive	Communication	Social role, Praise

Despite those limitations, this study contributes to the establishment of design recommendations to increase persuasiveness of LMS interfaces in order to ensure that the LMS can capture and engage its users. Furthermore, this study also proposes a framework that can be utilized by higher learning institution, specifically in designing the six most visited interfaces in the LMS by mapping LMS interfaces to PSD.

VI. Conclusion

This study examined the persuasiveness of interface and the application of persuasive design in the case of higher learning institution with two versions of learning management system: Smart2 and Smartv3. The results show that both system versions successfully meet the solicitation criteria that managed to establish relationship and prompt user action through its interface design. However, both system versions are lacking in other persuasiveness of interface criteria such as credibility, privacy, personalization, attractiveness, initiation, commitment, and ascendency. The ascendency criteria which supposed irrelevant in educational interface happened to be found in both system versions making previous literature and our finding contradict. This study discovered that minimal persuasive design principles have been utilized in LMS for higher education. This has contributed to the development of persuasive LMS framework which can be used as a guideline to design an effective persuasive LMS. In the future, development of a prototype based on the developed framework can be used to assess the framework empirically. The study contributes to the body of knowledge in human-computer interaction in the educational area where the framework can be used to improve the LMS design in encouraging positive learning behavior.

References

[1] M. O. Alassafi, "E-learning intention material using TAM: A case study," Mater Today Proc, vol. 61, pp. 873–877, Jan. 2022.

[2] "Five facts on e-learning that can be applied to COVID-19 - Institute for Environment and Human Security." https://ehs.unu.edu/news/news/five-facts-on-e-learning-that-can-be-applied-to-covid-19.html (accessed Sep. 26, 2022).

[3] "The rise of online learning during the COVID-19 pandemic | World Economic Forum." https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/ (accessed Sep. 26, 2022).

[4] F. Bousbahi and M. S. Alrazgan, "Investigating IT faculty resistance to learning management system adoption using latent variables in an acceptance technology model," Scientific World Journal, vol. 2015, 2015.

[5] H. Fung and A. Yuen, "Factors Affecting Students' and Teachers' Use of LMS – Towards a Holistic Framework," in international conference on hybrid learning, 2012, vol. 7411, pp. 306–316.

[6] N. Phongphaew and A. Jiamsanguanwong, "Usability evaluation on learning management system," in Advances in Intelligent Systems and Computing, 2018, vol. 607, pp. 39–48.

[7] H. Ming Chee, C. Wou Onn, and S. Pei Hwa, "Implementation of LMS among Private Higher Learning Institutions in Malaysia," in Proceedings of Knowledge Management International Conference, 2010, pp. 157–163. [Online]. Available: http://mmlscyber.mmu.edu.my/.

[8]   Y. H. S. Al-Mamary, "Understanding the use of learning management systems by undergraduate university students using the UTAUT model: Credible evidence from Saudi Arabia," International Journal of Information Management Data Insights, vol. 2, no. 2, Nov. 2022.

[9]   H. Oinas-kukkonen and M. Harjumaa, "Communications of the Association for Information Systems Persuasive Systems Design: Key Issues , Process Model , and System Features Persuasive Systems Design : Key Issues , Process Model , and System Features," Communications of the Association for Information Systems, vol. 24, no. 28, pp. 485–500, 2009.

[10]   N. Huang, J. Zhang, G. Burtch, X. Li, and P. Chen, "Combating Procrastination on MOOCs via Optimal Calls-to-Action: Evidence from a Field Experiment," Academy of Management Proceedings, vol. 2018, no. 1, p. 14171, 2018, doi: 10.5465/ambpp.2018.14171abstract.

[11]   M. H. Mhd Salim, N. M. N. M. Ali, and M. T. M. T. Ijab, "Understanding students' motivation and learning strategies to redesign massive open online courses based on persuasive system development," International Journal of Advanced Computer Science and Applications, vol. 10, no. 12, pp. 234–241, 2019.

[12]   E. Brangier, M.C. Desmarais, "Heuristic inspection to assess persuasiveness: A case study of a mathematics e-learning program," in: International Conference of Design, User Experience, and Usability (DUXU 2014). Lecture Notes in Computer Science, vol 8517, A. Marcus, Eds. Springer, Cham. 2014, pp. 425–436.

[13]   T. Aleahmad, A. D. Balakrishnan, J. Wong, S. R. Fussell, and S. Kiesler, "Fishing for sustainability: the effects of indirect and direct persuasion," in CHI EA '08: CHI '08 Extended Abstracts on Human Factors in Computing Systems, pp. 3021-3026, April 2008.

[14]   F.A. Orji, J. Vassileva, and J. Greer, "Personalised persuasion for promoting students' engagement and learning," in Proceedings of the Personalisation in Persuasive Technology Workshop, Persuasive Technology 2018, Waterloo, ON, Canada, pp.77–87, April 2018.

[15]   T. Lehto, H. Oinas-Kukkonen, Harri, and F. Drozd, "Factors affecting perceived persuasiveness of a behavior change support system", in Thirty Third International Conference on Information Systems (ICIS 2012) Proceedings, Orlando, US, pp. 1-15, December 2012.

[16]   N. Ibrahim, M. F. Shiratuddin, K. Wong, "Persuasion techniques for tourism website design," in The International Conference on E-Technologies and Business on the Web (EBW2013), Bangkok, Thailand, pp. 175-180, May 2013.

[17]   N. de Jong, J. Wentzel, S. Kelders, H. Oinas-Kukkonen, J. van Gemert-Pijnen, " "Perceived persuasiveness questionnaire; Evaluation of perceived persuasiveness constructs by combining user tests and expert assessments," in Proceedings of the Second International Workshop on Behavior Change Support Systems 2014. A. Öörni, S. Kelders, L. van Gemert-Pijnen, H. Oinas-Kukkonen (Eds.), CEUR-WS.org, Padua, Italy. 2014, pp. 7-15, May 2014.

[18]   L. S. Platt, H. Li, C. E. Bass, and K. Yu, "Validating persuasive experience (PX) theory: Preliminary results of a case study on a corporate wellness program's web-based learning interfaces," in Proceedings of the 2018 International Symposium on Human Factors and Ergonomics in Health Care, Boston, Massachusetts, USA pp. 56-63, March 2018.

[19]   A. Nemery, E. Brangier, "Set of guidelines for persuasive interfaces: organization and validation of the criteria," Journal of Usability Studies, vol. 9, no. 1, pp 105–128, 2014.

[20]   F. Drozd, T. Lehto, H. Oinas-Kukkonen, "Exploring perceived persuasiveness of a behavior change support system: A structural model," in: International Conference on Persuasive Technology, PERSUASIVE 2012. Lecture Notes in Computer Science, vol. 7284, M. Bang, E. L. Ragnemalm (Eds.) Springer, Sweden. 2012, pp. 157-168.

[21]   K. Oyibo, I. Adaji, R. Orji, B. Olabenjo, M. Azizi, J. Vassileva, "Perceived persuasive effect of behavior model design in fitness apps", in Proceedings of ACM UMAP Conference, Singapore, July 2018 , pp. 219-228.

[22]   K. Oyibo and J. Vassileva, "HOMEX: Persuasive technology acceptance model and the moderating effect of culture", Frontiers in Computer Science, vol. 2, no. 10, pp. 1-17, 2020.

[23]   K. Oyibo, and J. Vassileva, "Relationship between perceived UX design attributes and persuasive features: A case study of fitness application ", Information, vol. 12, no. 365, 2021.

[24]   M. Bedjaoui, N. Elouali, and S. M. Benslimane, "User time spent between persuasiveness and usability of social networking mobile applications: A case study of Facebook and YouTube", in MoMM2018: Proceedings of the 16th International Conference on Advances in Mobile Computing and Multimedia, Yogyakarta, Indonesia, pp. 15–24, Nov. 2018.

[25]   W. N. Wan Ahmad, A. R. Ahmad Rodzuan, and C. Salimun, "Mapping learning management system features of persuasive design strategies to inform the design of persuasive learning management system", International Journal of Learning Technology, vol. 16, no. 3, pp. 246-263, 2021.

[26]   M. M. J. Engelbertink, S. M. Kelders, K. M. Woudt-Mittendorff, and G. J. Westerhof, 2, "Participatory design of persuasive technology in a blended learning course: a qualitative study", Education and Information Technologies, vol. 25, pp. 4115–4138, 2020.

[27]   F.A. Orji, K. Oyibo, R. Orji, J. Greer, and J. Vassileva, "Personalisation of persuasive technology in higher education I, in ACM UMAP 2019 – Proceedings of the 27th ACM Conference on User Modeling, Adaptation and Personalisation, New York, USA, pp.336–340, June 2019.

[28]   H. H. Selassie, and J. Vassileva, "Susceptibility of graduate assistants to social influence persuasive strategies', in CRIWG 2017. Lecture Notes in Computer Science vol. 10391, C. Gutwin, S. Ochoa, J. Vassileva, T. Inoue, Eds. Springer, Cham, 2017, pp.118–131.