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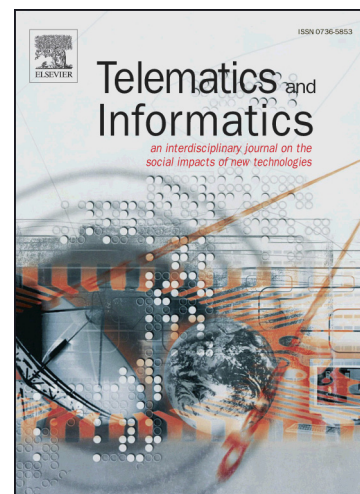
Blended learning: Investigating the influence of engagement in multiple learning delivery modes on students' performance

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Blended learning: Investigating the influence of engagement in multiple learning delivery modes on students' performance

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Abstract

The current reliance on different modes for delivering learning materials and establishing connections among peers can be significantly attributed to the teaching and learning practices in higher education. Here, the possible effects of students' engagement in multiple learning delivery modes on their academic performance were examined. This study specifically examined the effects of students' engagement in three learning delivery modes—face-to-face (F2F) learning, learning management system (LMS)-based learning, and web-based learning (WBL)—on their learning experience and performance. A total of 196 questionnaires were administered to university students (104 male; 92 female) to assess their perception of the three modes. Log records were also obtained to investigate the mediation effect of students' learning experience in LMS-based learning (by access, time spent, tools usage) and WBL (by web tools usage and self-learning time) on their learning performance. Results of a partial least-squares structural equation modeling (PLS-SEM) analysis revealed that students' engagement in the F2F mode had a significant positive effect

on their engagement in the LMS and WBL modes. Moreover, LMS time and tools usage had a positive influence on students' learning performance in the blended learning environment. Thus, the study results evince the effectiveness of multiple learning delivery modes on the learning development of students in higher education.

Keywords: blended learning; engagement; web-based learning; LMS-based learning; life-long learning, higher education

1. Introduction

The literature has emphasized that a blended learning environment typically involves face-to-face (F2F) and other complementary online learning delivery modes (Garrison & Kanuka, 2004; Oliver & Trigwell, 2005; Heirdsfield, Walker, Tambyah, & Beutel, 2011). Typically, students attend conventional instructor-directed F2F classes with synchronous communication (Graham, 2006), and use advanced online learning technologies (Iiyoshi & Kumar, 2008), including an online learning management system (LMS) (e.g., Blackboard (BB)), to create a blended learning environment (Black, Beck, Dawson, Jinks, & DiPietro, 2007; Jain, Abhyankar, & Venugopal, 2013). The experiences gained from using these tools not only support learning communities but also promote students' learning engagement (Baragash, & Al-Samarraie, 2018; Coates, 2005) and success in higher education (Álvarez, Martín, Fernández-Castro, & Urretavizcaya, 2013; Islam, 2013).

With the recent development of information and communication technologies (ICTs), university students must be familiar with different learning delivery modes to effectively learn in the online environment (Gros, Garcia, & Escofet, 2012). This has become more apparent with the development of online learning and the recent emergence of Open Educational Resources (OER) and Massive Open Online Courses (MOOCs), as well as with the increase in the use of social networks that provide multiple options to students (Al-Samarraie, & Saeed, 2018; Santally, 2011). Students generally capitalize on these open digital and networked technologies that are beyond the LMS to satisfy their learning interests and needs; they employ different web tools to seek learning resources and for peer interaction (Tu, Sujo-Montes, Yen, Chan, & Blocher, 2012). According to Franklin and Peat (2001), different learning delivery modes may yield different learning outcomes; however, the effects of the outcomes on students' learning experience, particularly when accessing synchronous and

asynchronous communications, are not adequately emphasized. Therefore, it is assumed that students' ability to engage in different online delivery modes and its effect on their learning performance in the context of higher education has not been investigated sufficiently.

Similarly, inadequate attention has been paid to students' preferences and motivation to use certain learning delivery modes, regardless of their learning abilities and styles (Klein, Noe, & Wang, 2006; Buch & Bartley, 2002). Nevertheless, most previous studies have suggested that students' participation in certain learning delivery modes may create promising interaction opportunities, which may subsequently influence their learning outcomes (Zacharis, 2015; Olczak, 2014; Tess, 2013; Orenstein, 2014). Therefore, we investigated the effects of students' engagement in three key learning delivery modes—F2F, LMS, and WBL—on their performance. To understand how students might engage in a blended learning environment, their participation in online activities must be considered. The review of the literature highlights that a combination of data from LMS logs and survey instruments can help in modeling individuals' participation in certain situations (Macfadyen & Dawson, 2010; Tempelaar, Rienties, & Giesbers, 2015). However, few studies have used these types of data in the context of higher education (Papamitsiou & Economides, 2014a; 2014b) or the combination of two measures to examine learning in online learning environments (Henrie, Bodily, Manwaring, & Graham, 2015; Tempelaar et al., 2015). Therefore, in this study, a framework that covers three learning delivery modes to explore how students' engagement in certain modes facilitates their online learning performance was proposed. This study was interested in determining the direct and indirect effects of these modes on students' learning performance in blended learning environments. Furthermore, other mediated effects on learning performance (login frequency; LMS time, LMS and web tools usage frequency, and self-learning time (LT)) were examined. This paper is organized as follows. Section 2 describes the research framework constructed to understand the three distinct learning delivery modes. Section 3 introduces the proposed research model with the development of hypotheses examined in this study. Sections 4 describes the study method which include: participants, instrument, data collection procedure and analysis. Sections 5 presents the results of the assessment of the structural model. Section 6 discusses the findings of this study. Section 7 presents the limitations and future works. Finally, section 8 presents the conclusion.

2. Research Framework

Investigation of engagement in both F2F learning (25%) and online learning (75%) can help identify the main antecedents of blended environments to facilitate learners' online learning experience (McDonald, 2012). In this study, the blended learning experience was supported by Anderson's (2008) well-established pedagogical framework that provides an in-depth understanding of dimensions for life-long online learning. The model distinguishes between collaborative, community of inquiry, and independent learning in online environments. It consists of two major human actors—learners and teachers—and their interaction with each other and the content. It also includes collaborative learning practices for promoting social skills when both learners and teachers interact with each other and the content using various synchronous or asynchronous web tools, such as videos, virtual classes, or chats. The independent learning elements are associated with structured learning resources such as computer-assisted tutorials, tests, drills, and simulations. Thus, based on this model, we investigated three distinct learning delivery modes (F2F, LMS, and WB).

2.1 Face-to-Face Learning (F2F)

F2F is the traditional mode of communication between students and instructors that usually take place in formal classroom settings. This mode of communication facilitates what is called instructor-led learning (F2F-ILL) (Smith, Sheppard, Johnson, & Johnson, 2005) that allow students to understand and to discuss learning tasks. It is also considered as the main medium for providing immediate feedback and opportunity for a synchronous physical interaction among students and between students and instructor (Smyth, Houghton, Cooney, & Casey, 2012; Thai, Wever, & Valcke, 2015; Wong, 2005). In addition, F2F mode involves workplace colleagues, local peers, as well as formal and informal groups of students meet with one another and collaborate in course-related activities (F2F-CL) (Krause, 2007). F2F-CL is believed to create high levels of interaction among students which can increase both the quality of learning experiences and the effectiveness of learning delivery (Curtis & Lawson, 2001). Self-learning or independent learning (F2F-IL) has also been characterized as an effective approach that involves learners' interaction with friends and family members (Anderson, 2008), which provide the source of support and assistance essential for facilitating interpersonal learning practices (Ma, 2001). Based

on these, the mode of F2F was categorized into three types: F2F-ILL; F2F-CL; and F2F-IL.

2.2 LMS-based Learning

An LMS is an online platform widely used in universities to help teachers deliver lessons, make course announcements, give assignments and grades, upload lecture notes and tutorials, and collaborate with students (Bradford, Margaret Porciello, & Balkon, 2007; Heirdsfield et al., 2011; Monsakul, 2007). In the LMS mode, students can individually engage in active learning activities by using the available resources and materials in the form of interactive e-books, videos, and weekly instructions. In this mode, some students may tend to use LMS independently (LMS-IL), as a more academically and less socially oriented approach to study. Students may also tend to seek challenging learning experiences and use feedback to help them learn more effectively (Jain et al. 2013; Coates, 2007). In addition, students in the LMS platform can practice and perform self-evaluation and assessment (LMS-ILE) provided in the form of instant feedback, step-by-step tutorials, and examples to solve certain problems (Lenz, 2010; Gok, 2011; Mestre et al., 2002). The students can also use the synchronous virtual classroom in order to meet and interact with their instructors directly via the chat room and other asynchronous tools such as e-mail or discussion boards. This type of interaction in the LMS environment is referred as instructor led learning (LMS-ILL) in which the more instructors communicate to students, the more engagement students will experience (Beer et al., 2010). Furthermore, learning in the LMS environment may also allow students to use synchronous and asynchronous tools, particularly to enable individual group member to collaborate and interact with peers (LMS-CL) (Al-Drees et al., 2014; Jain et al., 2013). Therefore, this study categorized the LMS mode into four types: LMS-IL; LMS-ILE, LMS-ILL; and LMS-CL.

2.3 Web-based Learning (WBL)

Web-based learning is the practice that allows students to learn using online contents delivered through a web browser over the public Internet, private intranet or extranet. In this mode, students can individually (WBL-IL) and freely access any content in multiple formats on the web, as well as searching for online resources and materials that can support their learning (Coiro & Fogleman, 2011). For example,

students can use instructional websites, such as Khan-academy, or instructional videos, such as those in YouTube, which develop formal and informal learning spaces by enabling individual students to gain more knowledge about the subject matter (Bonk, Lee, Kou, Xu, & Sheu, 2015; Chtouki, Harroud, Khalidi & Bennani, 2012; Dias & Diniz, 2014). Also, WBL can enable students to evaluate and discuss learning materials relevant to the course (WBL-ILE). This include participating in online quizzes, sharing online supplementary materials, and receiving immediate feedback which helps to improve student understanding (Leong & Alexander, 2014). When the use of WBL incorporates social elements such as the use of social networks (Facebook, Twitter, and WhatsApp), discussion boards, and send personal e-mail on the web, it could then be used to facilitate online collaboration practices (WBL-CL) (Olczak, 2014). This is because, an informal community is an open environment that has a rich amount of resources for students to learn social skills, collaborate with one another, develop personal relationships with their peers (Rennie & Morrison, 2013; Stollak, Vandenberg, Burklund, & Weiss, 2011). It is believed that students' engagement in this mode of learning can help them improve their communication skills, supporting student participation and interaction, and provide opportunities for knowledge construction (Akyol & Garrison, 2011; Serdyukov & Serdyukova, 2012). Therefore, WBL in this study was classified into three main learning types: WBL-IL; WBL-ILE; and WBL-CL.

Based on these observations, the study framework was constructed to show the associations between the three modes of learning delivery (see Figure 1). In the blended learning environment, students may engage in different modes of learning delivery such as F2F, LMS or WBL to achieve their course goals. For example, students learning in the F2F mode may create new knowledge through direct interaction and acquiring information from others, which can be further extended and improved with the use of other modes of delivery. More precisely, students can make a good use of LMS tools in order to exchange ideas and thoughts with others, thus reducing ambiguity in new situations (Ryser, Beeler, & McKenzie, 1995). Yet, LMS provides limited access to learning resources, whereas WBL provides open access to a learning environment. Hence, students can potentially use WBL along with LMS to help them find alternative ways or solutions to solve certain learning problems (Deng & Tavares, 2015; McCarthy, 2010; Picciano, 2009; Rose & Ray, 2011). Since students' learning experiences emerged from engaging in F2F, LMS, and WB modes

have been rarely investigated in the literature, this study investigated the influence of students' engagement in these distinct modes of learning delivery on their learning experience and performance in a blended environment.

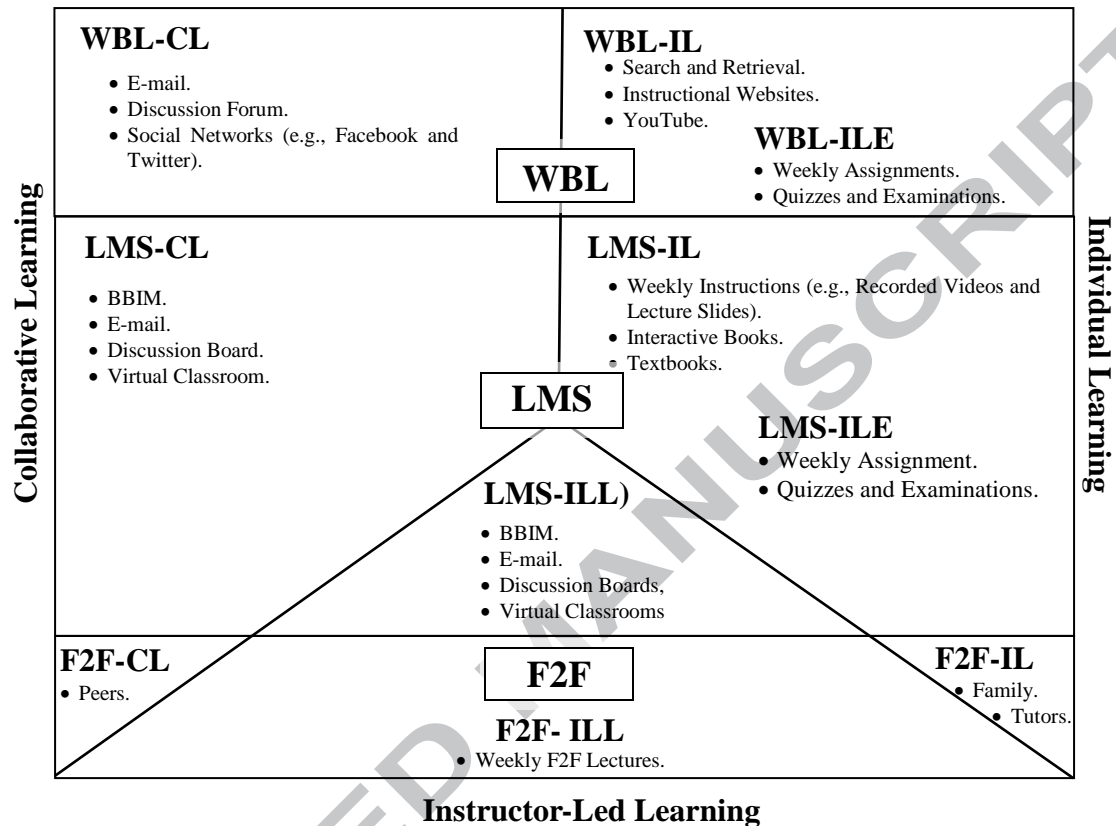


Figure 1. A framework of learning delivery modes in a blended learning environment

3. Research Model

The study model was developed based on Carroll's (1963) model of school learning and the activity theory (Engeström, 1987). Carroll's model suggests that engagement time is typically related to students' performance. Most previous studies (e.g., Bos & Brand-Gruwel, 2016; Gromada & Shewbridg, 2016) have supported this assumption and agreed that student learning can be stimulated based on the amount of time students spend actively engaged in an instruction. Raspopovic, Jankulovic, Runic, and Lucic (2014) argued that time spent on learning is one of the crucial factors in the engagement and success of a blended learning environment.

The activity theory, however, provides a deeper understanding of the learning processes facilitated by technology (Gedera, 2014). It suggests that for individuals to reach an *outcome*, it is necessary to produce certain *objects*, such as knowledge (Engeström, 1987). In this study, we suggest that students' outcomes from different

learning delivery modes create different learning experiences, which subsequently have significant influence on their performance. The proposed hypotheses and sub-hypotheses are presented in Figure 2. The first set of hypotheses was related to examining the effects of students' engagement in the F2F mode on their engagement in the LMS and WBL modes and learning performance. Many studies have addressed the important role of F2F interaction in facilitating online learning through the LMS mode (Akanbi, 2013) and the WBL mode (Zainuddin, 2016) as well as its effects on learners' performance in a blended environment (Brown, 2009; Orenstein, 2014). The specific hypotheses related to students' engagement in F2F learning are as follows:

- H1a: Engagement in F2F learning has a significant positive influence on engagement in LMS-based learning.
- H1b: Engagement in F2F learning has a significant positive influence on engagement in WBL.
- H1c: Engagement in F2F learning has a significant positive influence on performance.

The second set of hypotheses was related to the influence of students' engagement in the LMS mode on their learning performance. Most of the previous studies on the LMS mode have argued that it promotes learning engagement and improves learning performance (Beer, Clark, & Jones, 2010; McBrien et al., 2009). Moreover, most LMS-related studies have investigated the role of LMS access, time spent, and tools usage in facilitating learners' learning development and performance. For example, the frequency of participation and the time spent in LMS activities are considered important antecedents for successful online and blended learning (Kang, Kim, & Park, 2009). Furthermore, LMS access (Siemens & Long, 2011) and time spent in LMS (Calafiore & Damianov, 2011; Cortés & Barberà, 2013) are considered important predictors of online performance in the context of higher education. In addition, the use of different types of LMS tools and materials can facilitate students' engagement and outcomes (Venugopal & Jain, 2015). The relationship between the use of learning materials, interaction tools, and final scores can facilitate effective learning practices (Falakmasir & Habibi, 2010). Based on these observations, we developed the following set of hypotheses:

- H2a: Engagement in LMS-based learning has a significant positive influence on LMS access.
- H2b: Engagement in LMS-based learning has a significant positive influence on LMS time spent.
- H2c: Engagement in LMS-based learning has a significant positive influence on LMS tools usage.
- H2d: Engagement in LMS-based learning has a significant positive influence on performance.
- H2e: LMS access has a significant positive influence on performance.

H2f: LMS time has a significant positive influence on performance.

H2g: LMS tools usage has a significant positive influence on performance.

H2h: LMS access significantly mediates LMS-based learning and performance

H2i: LMS time significantly mediates LMS-based learning and performance.

H2j: LMS tools usage significantly mediates LMS-based learning and performance.

The third set of hypotheses was developed to determine the influence of students' engagement in the WBL mode on their learning performance. Many studies have discussed the role of learners' engagement in the WBL mode in promoting positive learning performance (Al-Rahmi & Othman, 2013; Olczak, 2014). Moreover, some studies have indicated a strong relationship between total time spent in learning and performance (Stewart, Stewart, & Taylor, 2012); the effects of using WBL tools to predict students' performance have also been highlighted (Al-Rahmi & Othman, 2013; Mosharraf & Taghiyareh, 2016). Therefore, we developed the following hypotheses:

H3a: Engagement in WBL has a significant positive influence on web tools usage.

H3b: Engagement in WBL has a significant positive influence on self-LT.

H3c: Engagement in WBL has a significant positive influence on performance.

H3d: Self-LT has a significant positive influence on performance.

H3e: Web tools usage has a significant positive influence on performance.

H3f: Self-LT significantly mediates WBL and performance.

H3g: Web tools usage significantly mediates WBL and performance.

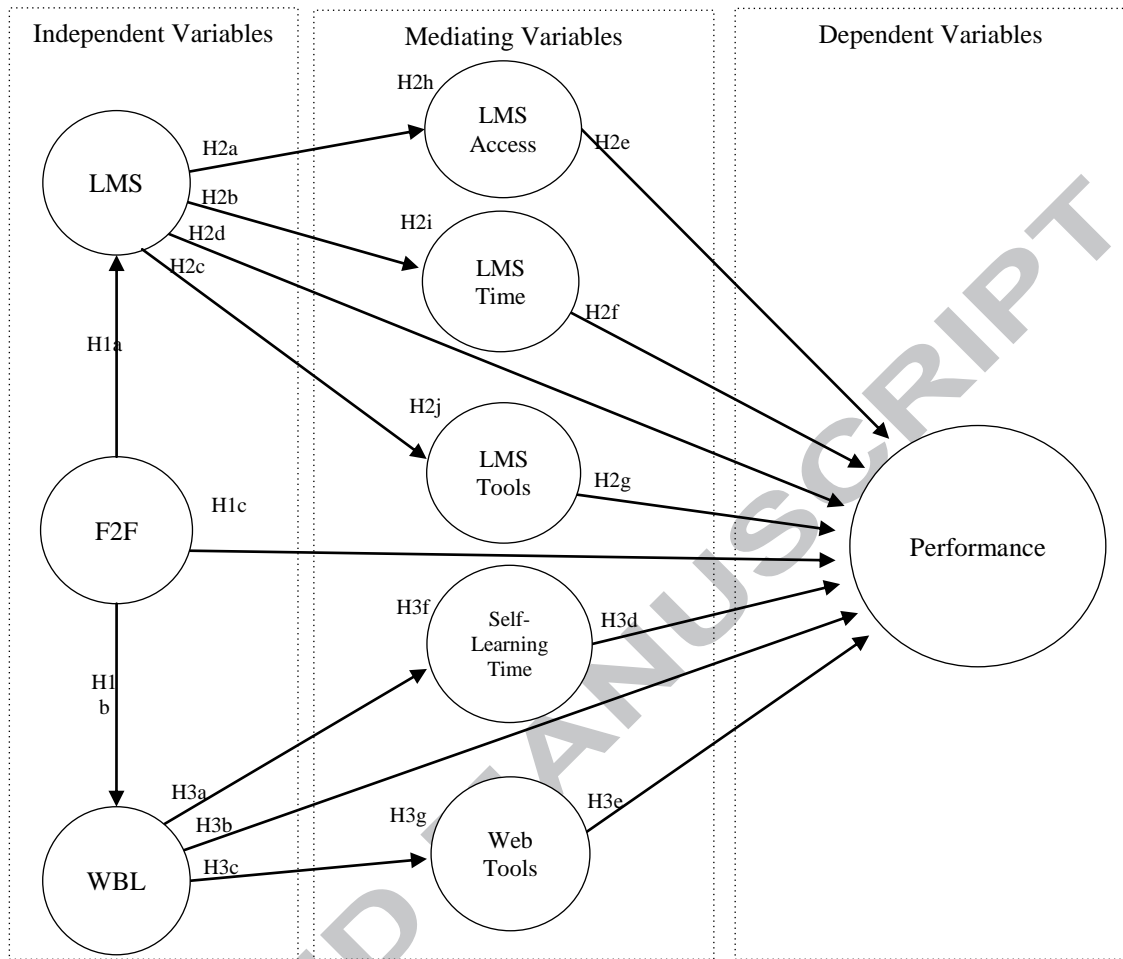


Figure 2. Proposed research model

4. Method

For this study, a quantitative correlational research design was used to determine the nature and strength of the influence of students' engagement in the three modes of learning delivery on their performance in a blended learning environment. The survey research method was used to collect data from respondents.

4.1 Participants

We invited 250 undergraduate students from a key university in a developing country to respond to the questionnaires. All students actively participated in F2F and online learning activities. An examination and sorting of the data revealed 24 incomplete and 30 irrelevant responses; thus, we obtained 196 responses for data analysis. A stratified sampling strategy was used to select the participants, the strata included information about gender as well as about the type of courses students enrolled in (see Table 1).

Table 1. Students distribution using the stratified sampling method

Course	Population	Female	Representative size	Male	Representative size
Math	560	210	44	350	73
Computer science	640	300	62	340	71
Total	1200	510	106	690	144

4.2 Instrument and Data Collection Procedure

We used a correlational research design-based online survey to collect data from university students. The data collection employed two instruments. First, a web-based questionnaire with ten constructs that reflect students' engagement in the three learning delivery modes in a blended learning environment. The questionnaire consists of 67 items for measuring students' engagement in the three modes: F2F, LMS, and WBL. Most items in the questionnaire were principally adapted from prior studies, with some modifications in wording to reflect the blended context under investigation. For example, to assess students' engagement in the F2F mode, we adapted 6 items on students' F2F engagement and interaction with the instructor (F2F-ILL) from Barnard et al. (2009) and Hamlett (2006); 5 items for assessing students' F2F learning and collaborative interaction with peers (F2F-CL) were adapted from Barnard et al. (2009); and 6 items for assessing students' F2F individual learning with family and friends (F2F-IL) were adapted from Barnard et al. (2009). To assess students' engagement in the LMS mode, 16 items were adapted from Hamlett (2006) and Liaw (2008) to examine students' learning and interaction with content (LMS-IL and LMS-ILE); 7 items for assessing students' collaborative interaction with peers (LMS-CL) were adapted from Hamlett (2006) and Barnard, Lan, To, Paton and Lai (2009); and 7 items adapted from Arbaugh et al., (2008) and Hamlett (2006) were used to assess students' learning and interaction with the instructor (LMS-ILL). To assess students' engagement in the WBL mode, a total of 10 items were adapted from Hamlett (2006) and Liaw (2008) to capture students' individual learning and interaction with the online content (WBL-IL and WBL-ILE); and 10 items for examining students' learning and collaborative interaction with peers (WBL-CL) were adapted from Barnard et al. (2009) and Hamlett (2006). All the students were asked to answer the questions using a five-point Likert scale, ranging from 1 for strongly disagree to 5 for strongly agree.

The second instrument consisted of the LMS analytics data that included access frequency, time spent in online activities, and tools usage. In addition, students' learning performance consists of weekly assignments scores, midterm, and final exams scores. A total of 17 lecturers were asked to assist in the data collection by encouraging students in their classes to participate in this study. The lecturers were asked to post a link of the online questionnaire on the LMS main page at the end of the semester. In addition, email notifications were sent to the selected respondents. After receiving the students' responses, the lecturers were asked to provide the LMS data on their students. Student IDs were used in both the questionnaire and LMS data to ensure data consistency and integrity across classes.

4.3 Data Analysis

We used partial least-squares structural equation modeling (PLS-SEM) for data analysis because it is considered a comprehensive statistical approach that allows for the simultaneous evaluation and modification of a conceptual model, including the relationships among the latent variables (LVs) (Anderson & Gerbing, 1988). The SmartPLS version 3.0 was used to perform the PLS-SEM data analysis.

5. Results and Discussion

5.1 Descriptive Statistics

Table 2 presents the distribution of the respondents by gender, age, background, employment, and course. Of the total 196 respondents, 53% ($n = 104$) were male and 47% ($n = 92$) were female. In the age category, the respondents were distributed as follows: 30.8% were aged older than 30 years, 22.4% were aged between 21 and 23 years, and 19.9%, 13.8%, and 13.8% were in the age groups of 18–20 years, 24–26 years, and 27–29 years, respectively. Of the total respondents, 48.0% ($n = 94$) were enrolled in a computer basics course, while 51.0% ($n = 100$) were pursuing a mathematics principles course. Since computer science and mathematics are applied courses, it was assumed that these courses would have to participate in in-depth discussions and collaboration practices. In addition, both courses have the same contact hours and scores distribution in which each student must spend four contact hours attending weekly lectures for a minimum of 12 weeks. 76.5% ($n = 150$) of the respondents were unemployed, while the remaining 23.5% ($n = 46$) were employed.

The results also indicated that 68.9% (n = 135) of the respondents had a scientific background.

Table 2. Demographic background

Classification	Frequencies	Percentage
<i>Gender</i>		
Female	92	53.1%
Male	104	46.9%
<i>Age</i>		
18-20 years	39	19.9%
21-23 years	44	22.4%
24-26 years	27	13.8%
27-29 years	27	13.8%
More than 30 years	59	30.1%
<i>Background</i>		
Scientific	135	68.9%
Literary	51	26.0%
Other	10	5.1%
<i>Employment</i>		
Employed	46	23.5%
Unemployed	150	76.5%
<i>Course</i>		
Computer Basics	94	48.0%
Math Principles	100	51.0%

According to Table 3, the most notable F2F support for learning received by the students in this mode were from the lecturer (52.95%), fellow classmates (49.62%), family (17.90%), graduate students (14.67%), and tutors (12.00%).

In addition, the most notable LMS-BB resources used by students for learning were lecture slides (54.48%), the virtual classroom (50.19%), the interactive e-book (43.38%), recorded lectures (40.71%), and the printed book (23.05%). Furthermore, the most notable tools used by students for interaction were the virtual classroom (60.19%), emails (44.57%), the discussion board (36.52%), and the Blackboard Instant Messenger (BBIM) (17.71%).

Table 3 also indicates that the most notable WBL resources used by students were YouTube videos provided by the university (49.76%), general YouTube videos (48.95%), the Webopedia website (33.24%), the Khan-academy website (30.76%), and the WolframAlpha website (31.24%). The most used tools for interaction were WhatsApp (60.19%), the formal discussion board (40.76%), the informal discussion board (30.52%), Twitter (27.90%), and Facebook (20.86%).

Table 3. Frequency of resources and tools used in F2F, LMS, and WBL modes

F2F	Percentage
Lecturer	52.95%
Fellow classmate	49.62%
Family	17.90%
Graduate students	14.67%
Private tutors	12.00%
Other	9.71%
LMS	Percentage
<u>Resources</u>	
Lecture slides	54.48%
Virtual classroom	50.19%
The Interactive e-book	43.38%
Recorded Lectures	40.71%
Printed Textbook	23.05%
Others	8.19%
<u>Interaction tools</u>	
Virtual Classroom	60.19%
Email	44.57%
Discussion Board	36.52%
BBIM	17.71%
Others	6.48%
WBL	Percentage
<u>Resources</u>	
University YouTube channel	49.76%
Other YouTube channels	48.95%
Webopedia.com	33.24%
Khan-academy.com	32.76%
WolframAlpha.com	31.24%
Other	7.81%
<u>Interaction tools</u>	
WhatsApp	57.52%
Formal discussion board	40.76%
Informal discussion board	30.52%
Twitter	27.90%
Facebook	20.86%
Other	6.86%

5.2 Inferential Statistics

The assessment of a model using PLS is typically a two-step process in which the measurement model is assessed first, followed by the assessment of the structural model (Chin, 1998; Hair, Hult, Ringle, & Sarstedt, 2016). In the first step, the loadings of the indicators that contribute to the validity and reliability of the LVs are analyzed; the second step involves the examination of the relationships between the constructs (Chin, 1998; Hair et al., 2016).

5.3 Assessment of the Measurement Model

We used a reflective measurement model, it required the use of different criteria and methods to determine its quality (Hair et al., 2016). To assess the measurement model, we conducted a reliability and validity analysis. The internal consistency reliability and indicator loadings were assessed to determine the reliability of the reflective measurement model for SEM evaluation. However, the validity assessment involved two main types: convergent and discriminant (Chin, 1998; Hair et al., 2016). The study model consisted of 10 first-order reflective constructs: LMS-IL, LMS-ILE, LMS-CL, LMS-ILL, Web-IL, Web-ILE, Web-CL, F2F-IL, F2F-CL, and F2F-ILL. In addition, the model had seven second-order constructs: LMS-IL, LMS-ILE, LMS-CL, LMS-ILL, Web-IL, Web-ILE, and Web-CL (see Figure 3).

The measurement model analysis was conducted in two phases. In the first phase, all first-order constructs were assessed simultaneously. In the second phase, which began after the second-order constructs were generated, the three second-order constructs of F2F, LMS-based learning, and WBL were assessed in relation to students' learning performance.

5.4 Convergent Validity

To assess indicator reliability, we evaluated the loading of each indicator on its associated latent construct; a greater than 0.7 loading was considered acceptable in terms of indicator reliability (Hair et al., 2016). In this study, we considered deleting indicators with loadings between 0.4 and 0.7, only if the deletions would result in an increase in the composite reliability (CR) or average variance extracted (AVE) above the indicated threshold value (Hair et al., 2016). Table 3 indicates the loading of the indicators on their associated LVs before creating the second-order LVs. It also indicates that loadings with less than the recommended value of 0.70 were dropped from the model. The items dropped from the model were LMS_IL_1, LMS_IL_7, LMS_IL_EV_7, Web_CL_1, Web_CL_6, Web_CL_10, and IL_F2F_6 (see Figure 3).

We also used AVE to estimate the amount of variance in LVs (as contributed by its indicators (Chin, 1998)). The literature has suggested that the AVE requires a greater than 0.5 convergent validity to be acceptable (Chin, 1998; Hair et al., 2016). According to Table 3, the AVE values of the constructs in the measurement model

ranged between 0.60–0.98; the 0.60 AVE value of LMS-IL increased to 0.55 after removing LMS_IL_1, LMS_IL_7. In addition, the AVE value of LMS-ILE increased to 0.64 after removing LMS-LMS_IL_EV_7. However, the 0.52 AVE value of Web-CL increased to 0.63 after removing Web_CL_1, Web_CL_6, and Web_CL_10, and the 0.64 AVE value of F2F-IL increased to 0.73 after removing F2F_IL_6. Therefore, the convergent validity of the measurement model was acceptable; Table 4 presents that the AVE value for each of the latent constructs was greater than 0.5.

5.5 Internal Consistency Reliability

Typically, to assess the internal consistency reliability, the composite reliability (CR) coefficient and the more common Cronbach's alpha (CA) coefficient are considered (Chin, 1998; Götz, Liehr-Gobbers, & Krafft, 2010). Due to CA's limitations in the population, the CR is assumed to be more suitable for PLS-SEM (Hair et al., 2016). Table 4 indicates that the CR and CA for all constructs in the measurement model were greater than 0.7. Therefore, the measurement model has internal consistency and is reliable.

Table 4. Results of the assessment of the measurement model for first-order constructs

Construct	Indicators	Convergent Validity		Internal Consistency Reliability		Source
		Loadings	AVE	CR	α	
LMS_IL	LMS_IL_2	0.72	0.60	0.90	0.88	Adapted from Hamlett (2006) & Liaw (2008)
	LMS_IL_3	0.72				
	LMS_IL_4	0.74				
	LMS_IL_5	0.73				
	LMS_IL_6	0.75				
	LMS_IL_8	0.73				
	LMS_IL_9	0.77				
LMS_ILE	LMS_IL_EV_1	0.76	0.68	0.93	0.90	Adapted from Hamlett (2006)
	LMS_IL_EV_2	0.88				
	LMS_IL_EV_3	0.87				
	LMS_IL_EV_4	0.73				
	LMS_IL_EV_5	0.81				
	LMS_IL_EV_6	0.74				
LMS_ILL	LSM_ILL_1	0.78	0.71	0.94	0.93	Adapted from Hamlett (2006) & Arbaugh et al., (2008)
	LSM_ILL_2	0.78				
	LMS_ILL_3	0.91				
	LMS_ILL_4	0.85				
	LMS_ILL_5	0.82				
	LMS_ILL_6	0.89				
	LMS_ILL_7	0.85				
LMS_CI	LMS_CI_1	0.72	0.66	0.93	0.92	Adapted from Hamlett (2006) & Barnard, Lan, To, Paton, & Lai (2009)
	LMS_CI_2	0.80				
	LMS_CI_3	0.86				
	LMS_CI_4	0.80				
	LMS_CI_5	0.84				
	LMS_CI_6	0.87				
	LMS_CI_7	0.82				
LMS_Access	Activity_logs	0.98	0.70	0.82	0.65	LMS logs
	Content_logs	0.67				
LMS_Time	Activity_time	0.98	0.96	0.98	0.96	LMS logs
	Ebook_time	0.98				
LMS_Tools	BB_Inter_tools	0.99	0.98	0.99	0.98	LMS logs
	BB_res.	0.99				
Web-IL	Web_IL_1	0.85	0.70	0.93	0.91	Adapted from Hamlett (2006)
	Web_IL_2	0.82				
	Web_IL_3	0.87				
	Web_IL_4	0.88				
	Web_IL_5	0.85				
	Web_IL_6	0.84				
Web-ILE	Web_IL_ev_1	0.90	0.64	0.88	0.81	Adapted from Hamlett (2006) & Liaw (2008)
	Web_IL_ev_2	0.90				
	Web_IL_ev_3	0.86				
	Web_IL_ev_4	0.80				
Web-CL	Web_CL_2	0.80	0.63	0.92	0.90	Adapted from Hamlett (2006) & Barnard et al. (2009)
	Web_CL_3	0.77				
	Web_CL_4	0.80				
	Web_CL_5	0.78				
	Web_CL_7	0.82				
	Web_CL_8	0.80				
Web-Tools	Web_Inter_Tools	0.86	0.79	0.89	0.75	Students' inputs
	Web_Res	0.92				
Self-LT	HW_Hours	0.79	0.61	0.82	0.70	Students' inputs
	MID_Hours	0.82				
	Final_Hours	0.73				

F2F-IL	F2F_IL_1	0.90	0.73	0.93	0.91	Adapted from Barnard et al. (2009)
	F2F_IL_2	0.90				
	F2F_IL_3	0.85				
	F2F_IL_4	0.84				
	F2F_IL_5	0.75				
F2F-CL	F2F_CL_1	0.85	0.72	0.93	0.90	Adapted from Barnard et al. (2009)
	F2F_CL_2	0.92				
	F2F_CL_3	0.86				
	F2F_CL_4	0.74				
	F2F_CL_5	0.87				
F2F-ILL	F2F-ILL_1	0.70	0.73	0.94	0.92	Adapted from Barnard et al. (2009) & Hamlett (2006)
	F2F-ILL_2	0.76				
	F2F-ILL_3	0.91				
	F2F-ILL_4	0.92				
	F2F-ILL_5	0.89				
	F2F-ILL_6	0.91				
Performance	Final exam	0.86	0.60	0.82	0.66	LMS logs
	Midterm exam	0.83				
	Weekly_assign	0.62				

The second phase of the measurement model analysis involved the generation of three second-order constructs: F2F, LMS-based learning, and WBL. The results of the measurement model after the generation of the second-order constructs are presented in Table 5. To estimate the criteria for the second-order constructs, we employed a two-stage approach suggested by Hair et al. (2016). Moreover, the CR of LMS-based learning, F2F learning, and WBL was higher than 0.93 and the associated AVE was greater than 0.62. Therefore, both the reliability and convergent validity of the model's second-order constructs were acceptable.

Table 5. Results of the measurement model for the second-order constructs

Constructs	Indicators	Convergent Validity		Internal Consistency	
		Loadings	AVE	CR	CA
F2F learning	F2F-CL	0.89	0.62	0.93	0.91
	F2F-IL	0.69			
	F2F-ILL	0.76			
LMS-based learning	LMS-CL	0.79	0.80	0.94	0.94
	LMS-IL	0.60			
	LMS-ILE	0.85			
	LMS-LL	0.83			
WBL	Web-CL	0.77	0.66	0.94	0.93
	Web-IL	0.87			
	Web-ILE	0.80			

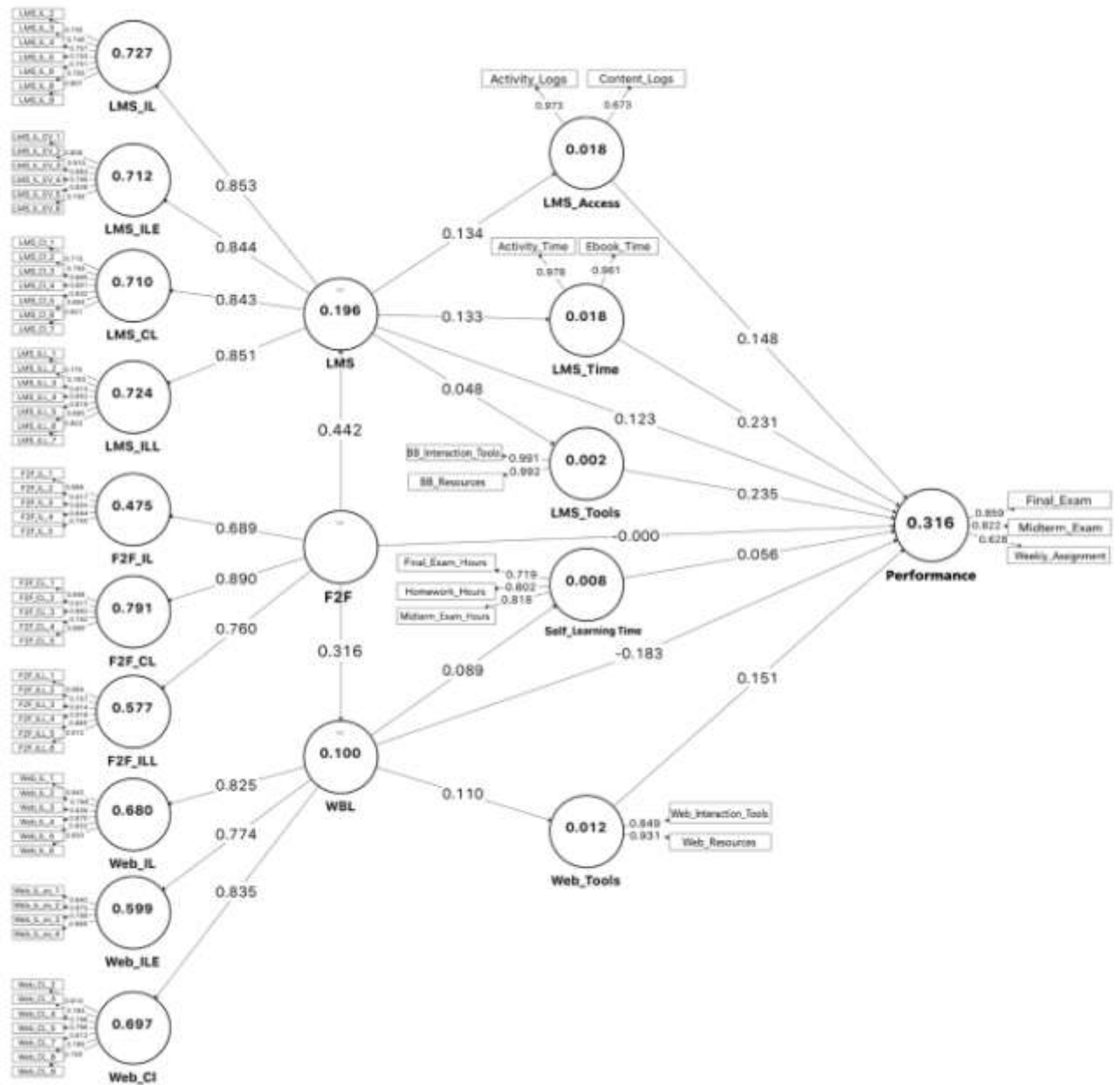


Figure 3. The model after removing unacceptable loadings

5.6 Discriminant Validity

Discriminant validity, in general, assesses how the construct is truly distinct from other constructs in the model (Chin, 1998; Hair et al., 2016). The literature review revealed that a comparison between the square-root of AVEs for any two constructs and the correlation estimate between the same constructs is the most common way to assess the discriminant validity (Hair et al., 2016). Thus, Table 6 presents a comparison of the square root of the AVE for each construct with the correlation of the other constructs. The comparison demonstrates that for the first-order constructs,

the discriminant validity was acceptable and the square root of AVE was greater than the correlation between these and the other constructs.

Table 6. Discriminant validity for first-order constructs

	F2F_CL	F2F_IL	F2F_ILL	LMS_CL	LMS_IL	LMS_ILE	LMS_IL L	Web_CI	Web_IL	Web_ILE
F2F_CL	0.849									
F2F_IL	0.532	0.855								
F2F_ILL	0.534	0.177	0.851							
LMS_CL	0.419	0.384	0.299	0.815						
LMS_IL	0.288	0.216	0.246	0.572	0.742					
LMS_ILE	0.139	0.054	0.165	0.348	0.406	0.799				
LMS_IL L	0.285	0.136	0.520	0.625	0.474	0.342	0.841			
Web_CI	0.279	0.407	0.181	0.434	0.371	0.253	0.227	0.793		
Web_IL	0.153	0.190	0.057	0.264	0.381	0.357	0.209	0.447	0.854	
Web_ILE	0.220	0.318	-0.032	0.333	0.343	0.194	0.131	0.415	0.644	0.865

Diagonals (in bold) represent square root of the AVE.

In addition, Table 7 indicates the discriminant validity for the second-order constructs. The square root for each construct was higher than the correlation of that construct with the other LVs. Thus, findings from the first-order and second-order constructs indicate that the hypothesized model, as expressed by the measurement model, fit the data and was valid.

Table 7. Discriminant validity for the second-order constructs

	F2F	LMS	LMS_access	LMS_Time	LMS_Tools	Perf	Self_LT	WBL	Web_Tools
F2F	0.664								
LMS	0.466	0.624							
LMS_access	0.063	0.144	0.836						
LMS_Time	0.096	0.122	0.603	0.979					
LMS_Tools	0.029	0.048	0.102	0.170	0.992				
Perf	0.062	0.114	0.345	0.387	0.377	0.777			
Self_LT	0.114	-0.056	0.227	0.115	0.041	0.097	0.783		
WBL	0.298	0.452	0.090	0.053	-0.019	-0.137	0.063	0.680	
Web_Tools	0.141	0.104	0.159	0.116	0.437	0.291	-0.013	0.181	0.892

Diagonals (in bold) represent square root of the AVE.

5.7 Assessment of the Structural Model

We assessed the structural model by estimating the predictive power of the model and analyzing the hypothesized relationships among the latent constructs proposed in the research model. Based on the recommendations of Hair et al. (2016), we followed the main steps to assess the structural model; namely, we assessed the significance

and relevance of the model relationships, the level of R-square (R^2), the effect of f^2 , and the q^2 effect sizes.

5.8 Coefficient of Determination (R^2)

The predictive accuracy of the structural model was estimated based on the magnitude of the coefficients of determination given by the R^2 values. A preliminary assessment of the structural model (i.e., inner model) was performed by evaluating the R^2 measure of the endogenous constructs and the path coefficients (Chin, 1998; Hair et al., 2010). The literature review (e.g., Chin, 1998) suggested that R^2 values of 0.67, 0.33, and 0.19 were considered substantial, moderate, and weak, respectively. In this study, the R^2 value of the endogenous construct was 0.316 for performance in the moderate range. Thus, approximately 31.6% of the variance was explained by the independent variables.

Table 8. Path coefficient and hypothesis testing (direct and indirect effects)

H	Relationship	β	STD	T Statistics	P Values	Support
<u>Direct Effects</u>						
H1a	F2F \rightarrow LMS	0.442	0.072	6.014**	0.000	Yes
H1b	F2F \rightarrow WBL	0.316	0.093	3.181**	0.001	Yes
H1c	F2F \rightarrow Performance	-0.001	0.070	0.005	0.996	No
<u>Direct Effects</u>						
H2a	LMS \rightarrow LMS_access	0.134	0.067	1.956*	0.046	Yes
H2b	LMS \rightarrow LMS_Time	0.133	0.066	2.097*	0.045	Yes
H2c	LMS \rightarrow LMS_Tool	0.048	0.061	0.787	0.431	No
H2d	LMS \rightarrow Performance	0.123	0.080	1.532	0.126	No
H2e	LMS_access \rightarrow Performance	0.148	0.073	2.031*	0.043	Yes
H2f	LMS_Time \rightarrow Performance	0.231	0.072	3.904**	0.001	Yes
H2g	LMS_Tools \rightarrow Performance	0.235	0.066	3.633**	0.000	Yes
<u>Indirect Effects</u>						
H2h	LMS \rightarrow LMS_access \rightarrow Performance	0.020	0.014	1.384	0.167	No
H2i	LMS \rightarrow LMS_Time \rightarrow Performance	0.031	0.018	1.706	0.089	No
H2j	LMS \rightarrow LMS_Tool \rightarrow Performance	0.011	0.015	0.764	0.445	No
<u>Direct Effects</u>						
H3a	WBL \rightarrow Web_tools	0.110	0.071	1.547	0.122	No
H3b	WBL \rightarrow Self-LT	0.063	0.101	0.627	0.531	No
H3c	WBL \rightarrow Performance	-0.183	0.071	2.610*	0.010	Yes
H3d	Self-LT \rightarrow Performance	0.056	0.074	0.757	0.450	No
H3e	Web_Tools \rightarrow Performance	0.151	0.066	2.458*	0.017	Yes
<u>Indirect Effects</u>						
H3f	Web \rightarrow Self-LT \rightarrow Performance	0.005	0.011	0.458	0.647	No
H3g	Web \rightarrow Web_tool \rightarrow Performance	0.017	0.012	1.387	0.166	No

Beta = regression weight, t values are computed through bootstrapping procedure with 242 cases and 500 samples; * $p < 0.05$, ** $p < 0.01$

The results presented in Table 8 and Figure 4 reveal that F2F learning had a significant positive influence on LMS-based learning ($\beta = 0.422$; $t = 6.014$) and WBL ($\beta = 0.316$; $t = 3.181$). However, it had no significant influence on students' learning performance ($\beta = -0.001$; $t = 0.005$). In addition, learning performance was not mediated by WBL, Web tools, by WBL, self-learning time, or by WBL where $p > 0.05$.

Students' engagement in LMS-based learning mode had a positive influence on LMS access ($\beta = 0.134$; $t = 1.956$) and LMS time ($\beta = 0.133$; $t = 2.097$). Furthermore, engagement in LMS-based learning had no significant influence on LMS tools usage ($\beta = 0.048$; t value = 0.43). In addition, LMS-based learning had no significant influence on learning performance ($\beta = 0.123$; $t = 1.532$). However, it had a significant influence on LMS access ($\beta = 0.148$; $t = 2.031$), LMS time ($\beta = 0.231$; $t = 3.194$), and LMS tools ($\beta = 0.235$; $t = 3.551$). For LMS-based learning and performance, no mediation influence was observed by LMS access ($\beta = 0.020$; $t = 1.384$), LMS time ($\beta = 0.031$; $t = 1.706$), or LMS tools ($\beta = 0.011$; $t = 0.764$).

Students' engagement in WBL had no significant influence on students' usage of Web tools ($\beta = 0.110$; $t = 1.547$) and Self-LT ($\beta = 0.063$; $t = 0.627$). However, WBL had a significant negative influence on students' learning performance ($\beta = -0.183$; $t = 2.579$). In addition, web engagement and performance were not mediated by web tools usage and Self-LT. Thus, nine hypotheses, comprising nine direct effects, namely H1a, H1b, H2a, H2b, H2e, H2f, H2g, H3c and H3e, were supported, whereas the remaining 11 hypotheses of H1c, H2c, H2d, H2h, H2i, H2j, H3a, H3b, H3d, H3f, and H3g were not supported.

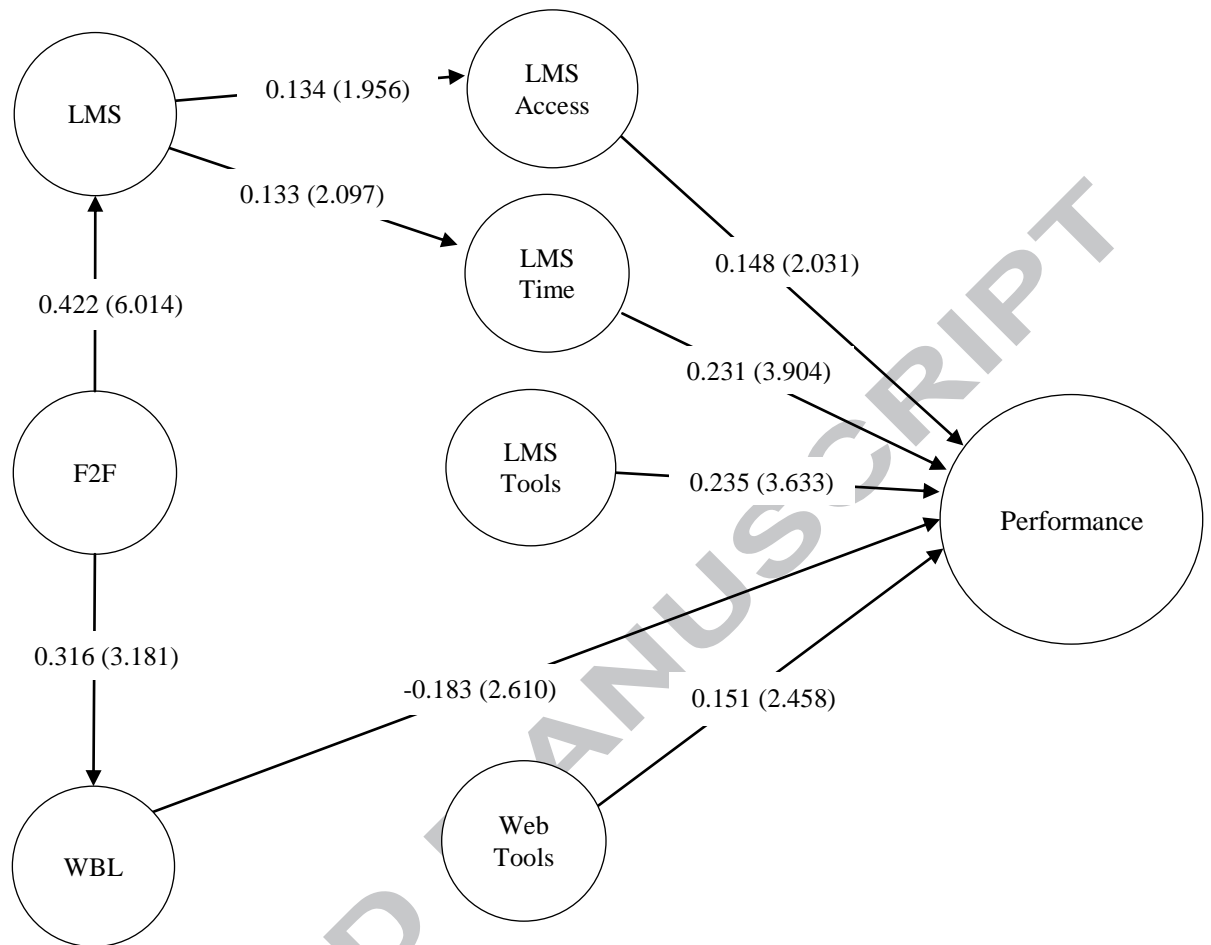


Figure 4. The structural model with significant relationships

6. Discussion

The purpose of this study was to determine whether any relationships exist between students' engagement in different learning delivery modes in a blended learning environment, their learning time, their frequency of use of various learning tools, and their learning performance. The results indicated that the F2F learning mode produced a significant positive direct influence on the LMS-based learning and WBL modes, but not on students' learning performance. Woods et al. (2007) and Gros et al. (2012) have reported that F2F learning initially drives the use of LMS among students who engage in sessions with their instructors and then proceed to complete their remaining coursework remotely in the LMS. The cycle continues with subsequent F2F sessions that involve feedback regarding the general mastery of topical objectives as well as the use of the LMS and the accompanying learning strategies. Akanbi (2013) asserted that the LMS promotes F2F learning because the

latter strongly influences subsequent learning activities and direction with the provision of feedback and learning guidance. The findings of this study are consistent with those of the previous studies: F2F learning has a significant influence on engagement in the LMS (Akanbi, 2013; Collopy & Arnold, 2009; Deperlioglu & Kose, 2013). The influence of F2F learning on WBL can be attributed to the fact that university students are generally considered internet savvy, with access to freely available internet resources and social media (Coiro & Fogleman, 2011; Revere & Kovach, 2011). Students are constantly seeking shortcuts to learning and knowledge acquisition, and the internet is their immediate tool (Dunlap & Lowenthal, 2011). For serious learning, students can also access instructional websites for similar courses, such as Khan Academy or other OER or OpenCourseWare (OCW) sites (Zainuddin, 2016). Since the use of the web is encouraged among university students, instructors believe that such a practice can profoundly enhance the student learning experience by providing a wider range of materials and resources, such as YouTube and other instructional websites, such as Webopedia, Khan-academy, and WolframAlpha (Chtouki et al., 2012; Dias & Diniz, 2014; Lee & McLoughlin, 2007; Rhode, 2009). Theoretically, such resources may offer students unlimited informal content interaction that may correspondingly enhance their engagement with the environment (Bonk et al., 2015; Revere & Kovach, 2011). Furthermore, easier access to other web-based resources or social networks can encourage students to capitalize on the pedagogical affordances of several synchronous and asynchronous tools in the social network, such as discussion forums, WhatsApp chats, Twitter exchanges, and Facebook discussion groups, to find relevant information or to interact with colleagues (Hotrum, 2005; Sclater, 2008; van Coiro & Fogleman, 2011; Rennie & Morrison, 2013). Our findings related to the F2F mode influence on WBL were consistent with those of the previous research on the role of the F2F mode in promoting students' engagement in the web mode by providing them not only the freedom to choose when and where to study (Dunlap & Lowenthal, 2011; Zainuddin, 2016) but also the opportunity to further elaborate and contextualize lesson contents.

Furthermore, this study elucidates that LMS time and LMS access can be considered as the main indicators of students' engagement in the LMS, which is supported by many previous studies (e.g., Beer et al., 2010; Cruz-Benito, Therón, García-Peñalvo, & Lucas, 2015) that have suggested students who spend more time in the LMS tend to be more engaged with the learning activity based on the available

online resources and tools. Mogus, Djurdjevic, and Suvak (2012) and Fritz (2011) have examined students' online activity from the LMS database to determine whether their activity logs correlated with their final marks; they observed a strong correlation between students' activity logs and their final marks.

The result of LMS time influence on students' learning performance is consistent with that of Carroll's (1963), who proposed that time on task is a strong measure that contributes to an individual's overall academic achievement. It is also consistent with previous studies observations that time spent to solve a learning task is a factor in students' success (Raspopovic et al., 2014; Halabi et al., 2014). Similarly, Zimmerman (2012) found a significant positive relationship between the time students spent online on LMS content and weekly quiz scores.

In addition, we observed that students' use of LMS tools had a significant influence on their performance. This result is in line with the significant positive results reported by many studies that have examined the direct relationships between LMS tools usage and student academic achievement. For example, Zacharis (2015) and Gašević, Dawson, Rogers, and Gasevic (2016) have suggested that LMS tools, such as a discussion forum, email, and chat, stimulate students' educational outcomes in blended learning courses; Johnson and McKenzie (2013) believed that such outcomes are contributed to LMS tools being used to reduce students' efforts in seeking course-related information.

Our results reveal that e-books and recorded lectures were used by 43.38% and 40.71% of the students, respectively. The e-books were used mainly as an online homework system for self-assessment and practice, which students found to be helpful because of the instant feedback, immediate step-by-step instructions, additional examples they can review to solve given problems, and ability to track their progress (Lenz, 2010; Gok, 2011; Mestre et al., 2002). Moreover, it is assumed that students use recorded lectures because they allow them to review contents asynchronously, thereby enhancing their understanding and learning (Martin & Parker, 2014; Wieling & Hofman, 2010; Williams, Birch, & Hancock, 2012). Students' interaction with each other and with the instructor using several tools (e.g., virtual classroom chat (60.19%), email (44.57%), and discussion board (36.52%)) can enhance their engagement with the learning task (Martin & Parker, 2014; Mokoena, 2013; Paulus, 2005; Vaughan & Garrison, 2005). The virtual classroom text-based chat was the most popular tool because it facilitated live interaction among students

and helped students receive immediate feedback from the instructor and their classmates (Martin & Parker, 2014; Bradford et al., 2007); moreover, the written nature of communication provided a greater opportunity to reflect and express ideas more freely than in the F2F oral learning mode. This result was supported by Vu and Fadde (2013), who revealed that in blended courses, students' preferred way of interaction was a text-based chat in which they asked questions or made comments in the virtual classroom during the instructor's lectures. However, the asynchronous tools interaction, such as email and discussion boards within the LMS, were the least used, which was contrary to the previous findings that have highlighted discussion boards as the most popular tool in the LMS (Mokoena, 2013; Kurkovsky & Whitehead, 2005; Macfadyen & Dawson, 2010).

In the WBL mode, the major finding was that students' engagement in WBL mode had a significant negative influence on their performance; this result is consistent with those of many previous studies that have examined the use of web tools and its negative effects on academic performance. For example, Hazelhurst, Johnson, and Sanders (2011) revealed that the extensive use of web tools can be associated with negative behaviors and outcomes among students due to distractions and time-wasting on browsing to understand a concept. Alwagait, Shahzad, and Alim (2015) also reported that the use of social media among university students may negatively drive their performance in the course. However, we believe that the negative influence of WBL on performance can be associated with students' limited experience in browsing web resources and social networks to extract the required information, and that students' use of YouTube videos or Google notes has increased their learning engagement and the time spent by them on a task to build understanding. However, the outcomes from such usage may not necessarily fulfill the lesson objectives. We observed that the WBL tools usage frequency influenced students' academic performance. This finding is supported by some studies that examined the role of web tools usage in stimulating learners' academic performance (Chtouki et al., 2012; Karpinski & Duberstein, 2009). Nevertheless, we believe that the usage of web tools can provide students with adequate support and practice in completing and assessing their weekly assignments to prepare for mid-term and final examinations.

7. Limitations and Future Research

This study has several limitations that must be considered in future research. First, the study was conducted on narrow sample (from a developing country university); more research can be conducted in other geographically distant populations from developing and developed countries to improve the generalization of the findings. Second, the sample was taken from two courses only which may imply different behaviors and different preferred styles of learning. In future research, a sampling frame that combines individuals from different disciplines such as education, finance and management should be used. Third, this study is cross-sectional in which future research may consider a longitudinal study design to better assess the influence of F2F, LMS, and WBL modes on students' learning, thus increasing the ability of making causal inferences. Fourth, whereas this study evaluated students' engagement in the three modes of learning delivery, the moderator effects on the associations between students' learning experiences and performance was not considered. Thus, future research designs should assess the potential moderator effects of gender, task complexity, age, etc. on students' learning in these modes. Finally, future work may also investigate the causes of the negative influence resulted from using WBL on students' performance. This type of study would help to establish an understanding of web usage in the blended learning.

8. Conclusion

This study revealed that in a blended learning environment of an e-university, the F2F mode was a managerial factor that drove other learning activities in the LMS and WBL modes. The brief, but regular F2F sessions facilitated students' learning by encouraging them to engage in LMS-based learning activities, for which the resources in the LMS were perceived to be sufficient to promote learning and enhance performance after the initial F2F interaction. In addition, we observed that students over-valued web resources and tools to obtain quick and easy information to assist in their mastery of the course content. Therefore, it is important for universities to advise students to consider the learning materials provided in the LMS because of the risk that the more time they spend on the web, the lower will be their performance in the course. This study provides necessary insights on how certain learning delivery modes are major factors in sustaining students' learning performance and promoting lifelong

learning. It also provides a more accurate demonstration (based on the examination of direct and indirect effects) of the nature and extent of relationships among F2F learning, LMS-based learning, WBL, and learning performance.

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Highlights

- The effects of students' engagement in three learning delivery modes on their online learning performance was examined.
- The mediation between students' learning experience and their learning performance was investigated.
- Certain modes of delivery can influence students' learning experience, thus influencing their performance.

ACCEPTED MANUSCRIPT