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Non-repository Uses of Learning Management System through Mobile Access

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Abstract: *Learning Management Systems (LMSs) have been widely adopted in higher education worldwide, but predominately used as repositories of learning materials. Mobile access to LMSs enables greater mobility and flexible learning, and thus may help boosting non-repository uses of LMSs, maximizing their educational affordance. This study examined the extent to which mobile access to an LMS, Moodle, was used for various learning activities, with a focus on those beyond storing and retrieving learning materials, as well as the factors influencing students' non-repository uses of LMS via mobile access. A mixed-method approach was applied, with survey responses collected from 316 students and interviews with 26 students and five instructors across nine courses in a comprehensive university in Hong Kong. The results showed that mobile access to non-repository uses of Moodle was significantly less frequent than that to repository uses across all courses, and students viewed mobile access to the Moodle platform largely as a backup to supplement computer access. Findings suggested four inter-related factors influencing mobile access to LMS for non-repository uses, including course LMS activity design, instructors' attitudes towards LMS, the nature of tasks conducted with LMS, and situational contexts.*

Keywords: Learning management system, Moodle, mobile access, non-repository uses, higher education

1. Introduction

As technology becomes more integrated into modern life, educators have, and will continue to, face calls for improving the quality of technology-assisted learning. This is particularly true for mobile-based technologies (Ko et al, 2015; Papamitsiou & Economides, 2014), which have become ubiquitous in today's society, especially for younger users. However, there is still a wide gap in the level of research and understanding about how best to implement the current technological tools

into learning environments to maximize the impact for students and educators (Murphy, 2012). One of the most significant tools currently being used in higher education is the learning management system (LMS), an online suite of systems and functions designed to automate and augment the delivery of course material using the Internet. Previous research has suggested, however, that the current methods for implementing these systems are lacking in effectiveness and are largely used merely as repositories for teaching materials; greatly reducing their potential efficacy as a

learning tool (Cho, Jung, & Im, 2014; Olmos, Mena, Torrecilla, & Iglesias, 2015; Hu et al., 2016). Based on the research by Hu et al. (2016), this study seeks to further explore how students engaged with the LMS through mobile devices, with a specific emphasis on the non-repository uses, in order to gauge the current implementation levels across courses within the Hong Kong higher education system.

1.1 Learning Management Systems

Learning Management Systems (LMSs) (e.g. Moodle, Desire2Learn, Blackboard, etc.) have been defined differently in the literature, as systems that “integrate a wide range of pedagogical and course administration tools” (Coates et al., 2005, p.19), an infrastructure that “delivers and manages instructional content, identifies and assesses individual and organizational learning or training goals, tracks the progress towards meeting those goals, and collects and presents data for supervising the learning process of organization as a whole” (Szabo & Flesher, 2002, as cited in Watson & Watson, 2007, p.28), and “allowing instructors and students to share instructional materials, make class announcements, submit and return course assignments, and communicate with each other online” (Lonn & Teasley, 2007, p.686). Among these definitions, the management and sharing of teaching and learning resources seem to precede other uses of LMSs. Moodle, an open-source LMS, has been registered in over 1,800 sites, is present in more than 193 countries, and available in 60 languages around the world (Çelik, 2010; Hajjar, 2014). LMSs have been used by these institutions to support three types of instruction, namely face-to-face learning, online learning, and blended learning (e.g., Black et al., 2007; Novo-Corti et al., 2013). Despite the increasing use of Moodle around the globe, scholars have expressed concern

that the current usage of Moodle is failing to realize the full benefits of an LMS in improving student engagement and facilitating teaching and learning (Mullinix & McCurry, 2003; Olmos et al., 2015).

1.2 LMS Usage

Prior research describing and analyzing the use of LMSs have classified these uses into different levels and categories. Francis and Raftery (2005) defined three levels of LMS usage. The first level is for depositing materials and distributing information. The second is for enhancing teaching and learning by using various tools in the LMS for assessment, communication, and collaboration. The third and highest level is for supporting fully fledged online courses where much of the learning takes place on the LMS itself. Carvalho, Areal and Silva (2011) surveyed around 15,000 students on their usage of two LMSs: Blackboard and Moodle, finding that the use of the LMSs for the majority of students was still at the lowest level, i.e., for accessing learning materials and checking course announcements. It was shown that participating in course forums, course chatrooms, and taking tests were less frequently used functions. Olmos et al. (2015) concluded that LMSs have been primarily used as repositories of content, assignments, and other online resources shared by students and instructors. In short, LMSs are likely not being exploited effectively. Nichols (2008) indicated that even when an e-learning platform is available, institutions might not make full use of it. Recent studies (e.g., Cho, et al., 2014; Olmos et al., 2015, etc.) have therefore been advocating using LMSs beyond being merely as a repository, i.e., utilizing their potential for supporting interactions, collaborations, and developing a learning community. This study regards those LMS uses or functionalities not related to reposition as the non-repository uses,

which will be the focus of this study. Adopting the categorization of Moodle activities from the recent literature (e.g., Gogan et al., 2015; Hu et al., 2016) and the official website of

Moodle (<https://moodle.org/>), Table 1 shows the grouping and description of various functionalities of Moodle.

Table 1. Moodle activities in categories

	Uses	Activities	Description
Repository	News and Announcements	Announcements	Broadcasting current, time-critical information
		News	Displaying news and updates from online sources
	Accessing resources	Resources	Accessing documents, URLs or other websites
		Search	Searching content within course or across courses
	Submitting assignment	Assignments	Viewing, posting, and submitting assignments
	Taking tests	Tests and quizzes	Taking online tests/quizzes
Non-repository	Interactions	Forums (e.g. Q&A Forums)	Asynchronous discussions
		Messages / Quickmail	Exchange of messages with course participants
		Feedback	Anonymous polls or voting
	Collaboration	Choice	Responding to teacher-initiated multiple-choice questions
		Wiki	Collaborative construction, and editing of pages and content
		Glossary	Collaborative contribution of lists of definitions; like a dictionary

1.3 Mobile Access to LMS

Following the growing popularity of handheld mobile devices, most staff and students in higher education are in possession of mobile devices such as smartphones. A survey of mobile devices in academic libraries in Hong Kong and Singapore revealed that 93.4% of Hong Kong university students owned a mobile phone, while 61.9% used smartphones to access the Internet (Ang et al., 2012). Students' use of mobile devices to engage with materials online has become more and more common (Peters, 2007), and previous studies on mobile learning (m-learning) have offered reassuring results on the use of mobile devices for supporting teaching and learning (e.g., Kennedy et al., 2008, Rath, 2015). M-learning has also been shown to provide opportunities for building a learning community, interactions and collaboration among students (Donaldson, 2011), aligning with the general non-repository uses of LMSs. Despite this, students' mobile access to the non-repository functions of LMSs has remained under-researched among studies on LMS usage.

Other studies (e.g. Lonn & Teasley, 2009) have focused on students' experience and perceptions with using LMSs in terms of usage and interfaces, without directing attention to mobile access. Ivanc et al. (2012) proposed a framework for testing an LMS's mobile web interface, albeit from the usability perspective. Hu and colleagues (2016) investigated students' Moodle usage and their perceptions towards Moodle through mobile access, showing that mobile access to Moodle was not optimally utilized, owing to usability and reliability issues. This theme is also reflected in other studies (e.g. Cho et al., 2014). Antonenko, et al. (2013) explored students' usage of mobile LMSs and their perceptions, putting forward that

Announcements/News and Content were two of the more popular features of a mobile LMS. The most common usage of mobile access to Moodle by students in Hu et al. (2016) was as a repository for teaching materials, which suggests that the platform was under-used as a tool for facilitating teaching and learning. This theme was echoed by Wilcox and colleagues (2017) who commented that instructors did not "design their courses for the target platform used by students' smartphones" (p.1167). Therefore, this study was designed to more closely explore students' non-repository uses of LMSs through mobile access.

To the authors' best knowledge, no empirical research has been conducted focusing on the non-repository uses of LMSs through mobile access for facilitating teaching and learning. This study will build upon a previous study (Hu et al., 2016) and further add to the body of knowledge by narrowing the focus to measure only those functions which give a more accurate reading of student engagement with LMS, given that Hu et al. (2016) focused only on the general uses of LMSs via mobile access and lacked solid explanation of and reflections on the observed usage patterns. The present study therefore aims to bridge this gap by exploring and reflecting on students' non-repository usage of LMS through mobile access. Through understanding non-repository uses of LMS via mobile access, instructors can take advantage of mobile access to LMS in their practices by considering not only its repository but also non-repository uses, in order to reap the benefits offered by the pedagogical affordances of both mobile learning and LMS usage.

2. Theoretical Framework

This study is guided by two theories that support the development and evaluation

of LMS. The epistemological foundation of Moodle as an LMS is related to social constructivism (Palincsar, 1998), such that a collaborative discourse enables the co-construction of meaning through students' sharing of texts and other devices (e.g., graphics) (Olmos et al., 2015). This can be operationalized as collaboration as a use of LMS. For facilitating research on LMS, Malikowski and colleagues (2007) proposed a model that integrates technology with learning theories. The model categorizes LMS features into five categories, including (1) transmitting course content, (2) creating class discussions, (3) evaluating students, (4) evaluating courses and instructors, and (5) creating computer-based instruction. Evaluation of courses and instructors as a use of LMS and creation of online instruction are out of the scope of this study. Transmission of course content can be operationalized as the repository use of LMS whereas the creation of class discussion can be operationalized as interaction as an LMS use, and evaluation of students can be operationalized as assignment submission and taking tests.

3. Research Design and Method

3.1 Research Questions

This study aims to address the following research questions:

1. How often do students use mobile phones to access Moodle for non-repository activities, in comparison to repository activities?
2. What are the factors that affect students' mobile access to Moodle for non-repository uses?

3.2 The LMS and the Context of Study

This study was conducted in a large, comprehensive university in Hong Kong. Moodle (version 2.8) was the LMS used in the courses involved. It should be noted that the university supported the use of virtual learning environments (VLE) including LMSs, despite no university regulations being imposed to mandate its use. In spite of the availability of a mobile app for Moodle, it could not be integrated into the Moodle installation at the university where this study was conducted, owing to the university's policy on information security. As an alternative, the Moodle installation offered a Mobile Theme, a customized display for browser screens of smartphones. Except for the display, all functions in Moodle could be accessed through the Mobile Theme. In other words, students could use the Mobile Theme to view course content, submit assignments, and access various Moodle activities including Forums, Choice, Feedback, Quizzes, Wikis, and so on.

3.3 Sampling

There were several criteria based on which a course was selected for participating in this study. First, the instructor of a course was willing to improve the use of Moodle in their courses. Second, the instructor should have participated in a one-hour workshop on various mobile-friendly Moodle functions and features. Next, the instructor needed to intend for their students to access Moodle via mobile phones. Finally, at least one non-repository Moodle activity should have been implemented in the course.

3.4 Procedures and Instruments

This study employed a mixed method

approach, collecting both survey and interview data. Ethical consent was sought prior to data collection which was conducted towards the end of the fall semester of the academic year 2015/16. All questionnaires were administered by the same researcher for the sake of consistency. This study used a questionnaire (Appendix 1) that asked about students' experience of using Moodle of the selected courses via mobile access. Prior to filling in the questionnaire, students were reminded that they should base their responses on the use of Moodle in the particular course. It asked students to report their frequency of using different categories of Moodle activities through mobile access, with multiple-choice responses on a 7-point Likert scale, from 1 (never) to 7 (several times a day). After collecting the survey data, emails, and course Moodle announcements were used to invite survey respondents to participate in follow-up interviews. A semi-structured interview protocol (Appendix 2) was designed to elicit students' further elaboration on their Moodle usage experience and opinions. It contained questions such as "Why would you access Moodle of this course with your mobile phone?". Each student interviewee was paid HK\$25 for their participation. In addition, after the end of every participating course, instructors involved in this study also took part in an interview for the purposes of learning more about their Moodle activity design, and their attitudes towards Moodle and instructors' roles. For these instructor interviews, another semi-structured interview protocol (Appendix 3) was developed, comprising questions such as "What non-repository activities did you implement in the course Moodle and why?", and "What did you do to encourage or facilitate your students to use mobile access to the Moodle of your courses".

4. Results

4.1 Participating Courses and Course Moodle Activities

Nine courses from four different disciplines in this university were selected for this study. There were three elective language courses (ART1, ART2, ART3) in Humanities and Arts, taught by the same instructor (Instructor ART). Four courses were from Education, including two undergraduate major courses (EDU1 and EDU2) taught by an instructor (Instructor EDU12), and two postgraduate-level courses (EDU3 and EDU4) taught by another instructor (Instructor EDU34). One course was from Social Sciences. It was a large-size foundation course (SOC1) taught by one instructor (Instructor SOC), with students from different years of study. The last course was in Engineering (ENG1) which was a large-size general education course co-taught by a professor and five teaching assistants, with students from different disciplines. The chief teaching assistant (Instructor ENG) actively participated in this study. A document analysis of the Moodle page of each participating course was also conducted and Table 2 displays the distribution of Moodle activities of each category of Moodle usage. Thus, this study intends to build on previous research by exploring the level 2, non-repository uses of mobile access to the Moodle platform and present the findings through comparisons across usage categories.

Table 2. Distribution of Moodle activities across courses

Moodle usage categories	Humanities and Arts			Education				Social Sciences	Engineering	All
	ART1	ART2	ART3	EDU1	EDU2	EDU3	EDU4	SOC1	ENG1	
accessing resources	175 (92.6%)	136 (87.7%)	68 (87.2%)	27 (54%)	37 (67.3%)	62 (74.7%)	38 (64.4%)	72 (98.6%)	83 (69.7%)	698 (87.1%)
submitting assignments	5 (2.6%)	1 (0.6%)	0	3 (6%)	1 (1.8%)	4 (4.8%)	3 (5.1%)	0	18 (15.1%)	35 (4.1%)
taking tests	0	15 (9.7%)	0	2 (4%)	9 (16.4%)	3 (3.6%)	1 (1.7%)	0	13 (10.9%)	43 (5%)
interaction	8 (4.2%)	3 (1.9%)	1 (1.3%)	13 (26%)	5 (9.1%)	14 (16.9%)	11 (18.6%)	1 (1.4%)	4 (3.4%)	60 (7%)
collaboration	1 (0.5%)	0	9 (11.5%)	5 (10%)	3 (5.5%)	0	6 (10.2%)	0	1 (0.8%)	25 (2.9%)
Total of non-repository	14 (7.4%)	19 (12.3%)	10 (12.8%)	23 (46%)	18 (32.7%)	21 (25.3%)	21 (35.6%)	1 (1.4%)	36 (30.3%)	163 (18.9%)
Total	189	155	78	50	55	83	59	73	119	861

4.2 Questionnaire Responses

A total of 316 valid responses were collected from students from the nine courses. These questionnaire responses were mostly collected on paper (245) and a few collected online (71). Table 3 shows the statistics of students' self-reported usage of Moodle via mobile phones. The sample size for each usage category is limited to students in the courses where Moodle activities of this category were implemented. Access to learning resources was the most frequent activity, while interacting with other students was the least

frequent. Accessing resources is regarded as a repository use of Moodle in this study, while the remaining four uses are then the non-repository uses. As the data are in the ordinal scale, the non-parametric Kruskal-Wallis test was used to compare the usage frequencies of mobile access to Moodle across usage categories, yielding statistically significant differences ($p = .000^{**}$). Follow-up pairwise comparisons show that students accessed Moodle via mobile access significantly more frequently for the repository use than any of the non-repository uses.

Table 3. Descriptive statistics of frequency of Moodle usage via mobile phones

Moodle Usage Category	N	Minimum	Maximum	Mean	Standard Deviation
accessing resources	316	1	7	3.86	1.586
submitting assignments	234	1	7	2.53	1.778
taking tests	210	1	7	2.68	1.699
Interaction	315	1	7	2.26	1.583
collaboration	199	1	6	2.42	1.571

(1 –never, 2 – Once a month or less, 3 – Once every 2 weeks, 4 – 1-2 times a week, 5 – 3-6 times a week, 6 – Once every day, and 7 – Several times a day)

Table 4 shows the percentages of students in each course with regard to their self-reported usages of Moodle via their mobile phones. Overall, 91.1% of all surveyed students reported to have accessed Moodle via their mobile phones, where 89.6% accessed the course Moodle for the repository use. Around two-third (62.3%) accessed the course Moodle for at least one of the non-repository uses, leaving about one-third (37.7%) of the students that never accessed any of the non-repository uses via their mobile phones. The majority of students in each course, ranging

from 82.6% to 100%, used their mobile phones to access the course Moodle for the repository use. The portion of students who reported at least one of the non-repository uses in each course was smaller. In particular, for all courses except ENG1, the portion of students using Moodle via their mobile phones for interaction was at least relatively higher than other, if not the highest among the non-repository uses. Also, a minority of students in each course never accessed Moodle of the course using their mobile phones.

Table 4. Percentages of students w.r.t. Moodle usage via mobile phones

	ART1	ART2	ART3	EDU1	EDU2	EDU3	EDU4	SOC1	ENG1	Total
No. of Students	24	22	10	40	23	23	8	72	94	316
Repository uses (%)	91.7	100.0	90.0	92.5	82.6	91.3	87.5	84.7	90.4	89.6
Submitting assignments	41.7	45.5	NA	45.0	43.5	26.1	25	NA	70.2	45.9
Taking tests	NA	40.9	NA	65.0	39.1	39.1	25	NA	81.9	50.8
Interaction	54.2	50.0	50.0	52.5	65.2	39.1	37.5	22.2	67.7	49.5
Collaboration	54.2	NA	50.0	40.0	56.5	NA	37.5	NA	67.0	45.9
Non-repository uses (%)	66.7	54.5	50.0	85	69.6	56.5	50.0	22.2	86.2	62.3
Never via mobile access (%)	8.3	0.0	10.0	0	17.4	8.7	12.5	15.3	7.4	8.9

Statistics of usage frequencies across courses are presented in Table 5. In each course, similar to overall results, resource access was still the most frequent Moodle use. In other words, students from all courses involved in this study used their mobile phones mostly for obtaining learning resources rather than for non-repository uses. The Kruskal-Wallis test yielded statistically significant differences across Moodle usage categories in all but one course, i.e., EDU4 (Table 5). A follow-up pairwise comparison revealed that accessing resources was the most frequent usage of Moodle via mobile phones in all but one course (EDU4). In particular, its usage frequency outweighed that of submitting assignments in most courses,

including ART1, ART2, EDU1, EDU2, EDU3 and ENG1 ($p \leq .003$). Also, for five out of six courses with test or quiz activities on Moodle (ART2, EDU1, EDU2, EDU3, ENG1; $p \leq .017$), students used mobile phones to access Moodle for test-taking significantly less frequently than for the repository use. Using Moodle via mobile phones for interaction was significantly less frequent in ART1, ART2, EDU1, EDU3, SOC1 and ENG1 among all courses ($p \leq .013$). Collaboration on Moodle via mobile phones was also a significantly less accessed usage in four out of six courses that implemented collaborative activities on Moodle (e.g., Wiki), including ART1, ART3, EDU1 and ENG1 ($p \leq .030$).

Table 5. Statistics of frequency of Moodle usage via mobile phones across courses of different courses

Moodle usage categories		ART1	ART2	ART3	EDU1	EDU2	EDU3	EDU4	SOC1	ENG1
accessing resources	N	24	22	10	40	23	23	8	72	94
	Mean	4.25	4.27	3.60	4.08	4.04	3.91	3.88	3.15	4.09
	Median	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	4.00
	SD	1.67	1.32	1.43	1.70	2.01	1.68	1.89	1.37	1.46
submitting assignments	N	24	22		40	23	23	8		94
	Mean	2.08	2.64	NA	2.20	2.13	1.83	2.13	NA	3.06
	Median	1.00	1.00		1.00	1.00	1.00	1.00		3.00
	SD	1.64	2.17		1.70	1.63	1.67	2.10		1.67
taking tests	N		22		40	23	23	8		94
	Mean	NA	2.55	NA	2.15	2.17	1.87	1.63	NA	3.35
	Median		1.00		2.00	1.00	1.00	1.00		4.00
	SD		2.18		1.25	1.80	1.60	1.41		1.53
interaction	N	24	22	10	40	23	23	8	72	93
	Mean	2.00	2.55	2.20	2.43	2.35	2.04	2.25	1.54	2.78
	Median	2.00	1.50	1.50	2.00	2.00	1.00	1.00	1.00	2.00
	SD	1.29	2.06	1.40	1.60	1.40	1.61	1.83	1.20	1.64
collaboration	N	24		10	40	23		8		94
	Mean	2.17	NA	1.90	2.08	2.48	NA	2.00	NA	2.70
	Median	2.00		1.50	1.00	2.00		1.00		2.00
	SD	1.55		1.10	1.51	1.78		1.60		1.57
Sig. KW		.000**	.003**	.021*	.000**	.003**	.000**	.114	.000**	.000**

* indicates significance level at $0.01 < p < 0.05$ and ** indicates significance level at $p < 0.01$.

Hu et al. (2016) discussed that the Moodle usage patterns could be attributed by the distribution of Moodle activities in their participating courses. This study take a further step to validate this relationship through a correlation analysis. The result shows that there is a significantly strong correlation (correlation coefficient = .767, $p = .000^{**}$; Ratner, 2013) between the percentage of Moodle activities for the particular usage (e.g., interaction) and students' mean frequency of using Moodle via mobile phones for that purpose. For instance, when the percentage of Moodle activities for resource access was higher across courses (Table 2), students also accessed those activities more frequently via their mobile phones accordingly (Tables 4 and 5).

4.3 Themes from Student Interviews

Twenty-six students attended the interviews among which 12 were conducted face-to-face and 14 of them through phone calls. Twenty-three out of the 26 (88.5%) interviewed students reported that they used

their mobile phones to access the Moodle page of courses. Table 6 presents representative quotes from students' responses in interviews, categorized by three main themes regarding the repository and non-repository uses of Moodle through mobile access. Students tended to opt for the repository uses of Moodle when they accessed it with their mobile phones, where they usually viewed certain general information (e.g., announcements posted by the instructor, course syllabus) or retrieved learning materials (e.g. lecture handout). As for non-repository uses, participation in forums, and conducting online quizzes were the two frequently mentioned Moodle activities via mobile access. However, some students did not prefer using mobile access to Moodle, mainly due to the limited screen size or difficulty in "typing words". Also, when asked about suggestions for improving Moodle, some students responded that a mobile application of Moodle should be developed so that its interface and functionality (e.g., instant notifications) can be improved for a more convenient mobile access.

Table 6. Themes from interviews with students (Note: Emphases added by researchers)

Themes	Quotes from interviewees
Repository use(s) of Moodle via mobile access	<p>"[I would use mobile access to Moodle] when I need to have a quick look [of some information], but not browsing for a long time." (Interviewee 1, EDU1)</p> <p>"[I used Moodle via my mobile phone] for downloading notes, and to see if there are any notes being uploaded or new information being posted. Mostly just viewing [information]." (Interviewee 1, EDU1)</p> <p>"When I suddenly want to know the deadline of an assignment, then I will go to Moodle using [my] mobile phone." (Interviewee 17, ART2)</p> <p>"Sometimes, when I received a text message [from a friend] that the teacher has posted new announcements about assignments and I would then use my [mobile] phone to access Moodle." (Interviewee 2, EDU1)</p> <p>"It is not always convenient to take out my computer, ..., I will then use my mobile phone to access Moodle." (Interviewee 12, ENG1)</p> <p>"I would use the mobile phone to access Moodle when I am going to school or going home, for reviewing the lecture content or preparing for class." (Interviewee 5, EDU2)</p> <p>"Usually when I want to check the test coverage, I will use my mobile phone [to access Moodle]." (Interviewee 16, ART1)</p>

Table 6. Themes from interviews with students (Note: Emphases added by researchers)

Themes	Quotes from interviewees
	<p>"When we needed to look at each other's work or to check the course syllabus, [we would use mobile access to Moodle]. These tasks were fast." (Interviewee 6, EDU2)</p> <p>"Normally, I would use mobile access [to Moodle] for viewing information but not for working." (Interviewee 10, EDU2)</p> <p>"When I do not have a computer at hand, I'd use my mobile to check things on Moodle. The mobile device is more like a back-up [device] for me to access Moodle." (Interviewee 14, ENG1)</p>
Non-repository use(s) of Moodle via mobile access	<p>"I have attempted online quizzes [using my mobile phone] once or twice. Usually, I worked on a quiz after class, during the lunch break." (Interviewee 5, EDU2)</p> <p>"[I would seldom use mobile access to work on an assessment task on Moodle] unless the task is simple, for example, doing an online MC quiz." (Interviewee 8, EDU2)</p> <p>"I was able to do [online] quizzes [using mobile access to Moodle] and it was really time-efficient." (Interviewee 3, ENG1)</p> <p>"When there is a forum task and there is not enough time, my classmates would work on it using their mobile during transportation." (Interviewee 4, EDU2)</p> <p>"I was on the streets when it was the [tutorial] registration timeslot. Then, I could only use [my] mobile phone to do so." (Interviewee 18, SOC1)</p>
Against non-repository use(s) of Moodle via mobile access	<p>"[Mobile access to Moodle is] a little bit hard [to use] because I cannot read and write (type) as conveniently as using computer." (Interviewee 21, SOC1)</p> <p>"Even when the [online] quiz might require me to add some comments by typing words, I normally wouldn't do it because I find it troublesome to do so." (Interviewee 15, ENG1)</p> <p>"It is easy to have typos [when using mobile access to Moodle] as the keyboard is very small." (Interviewee 4, EDU2)</p> <p>"[I would not use mobile access for tasks that involve typing because] it is slow for typing using mobile phones." (Interviewee 2, EDU1)</p> <p>"It's not convenient to type many words using mobile Moodle." (Interviewee 25, EDU3)</p> <p>"That time, [Instructor EDU34] asked us to log in to Moodle to write a brief comment. It felt strange as the mobile [web] browser would squeeze the whole Moodle page into the [mobile] screen size." (Interviewee 26, EDU3)</p> <p>"If I use mobile access [to do an exercise], when I close the window [of the mobile web browser], then everything I've done will be gone. That makes it inconvenient." (Interviewee 1, EDU1)</p>

Students were divided as to their preference towards using mobile access to Moodle for non-repository uses. Nonetheless, most of them in general expressed negative opinions about using mobile phones when

accessing Moodle. Table 7 displays various aspects of limitations brought about by mobile access to Moodle, generalized from students' comments.

Table 7. Limitations of mobile access to Moodle

Aspects of Limitations	Issues reflected in students' comments
Moodle display	<ul style="list-style-type: none"> • Low reliability of access due to mobile display of Moodle page (i.e., Mobile Theme of Moodle) • Too many columns on Moodle page
Device	<ul style="list-style-type: none"> • Limited mobile storage for downloading large-size files (e.g. notes, PowerPoint Slides, etc.)
Usability	<ul style="list-style-type: none"> • Small phone screen leading to difficulty of pressing buttons • Small keyboard increasing risk of accidentally quitting Moodle
Functionality	<ul style="list-style-type: none"> • Browser version causing inconvenience compared to native App • Failure of command execution in certain Moodle activities (e.g. posting a comment on a forum) • Need to log-in repeatedly after refreshing

When asked the circumstances under which mobile access to Moodle would be used, the majority of students opined that they would use their mobile phones to access Moodle when computer access was not available. For instance, when they did not have their laptop computer for various reasons (e.g., too heavy to bring along), they would resort to mobile access since they usually carried their mobile devices with them. In some circumstances even when they brought their laptop, it was cumbersome, not feasible, or even impossible to use it (e.g., during travel), they would then find mobile access to Moodle more useful and convenient. Desktop computers were available for temporary usage on different locations on-campus, such as the library and some classrooms. According to the interviewed students, mobile access to Moodle would be needed when these on-campus computers were occupied or otherwise not available. Generally, students treated mobile access to Moodle as a back-up option to computer access. To summarize these interview responses, whether students would use mobile access to Moodle or not was related to the *non-availability of computers* and the *inconvenience brought about by the mobile interface*.

4.4 Themes from Instructor Interviews

In terms of Moodle activity design, the five instructors shared similar practices in uploading materials such as lecture slides to the course Moodle on a weekly basis and posting course announcements though the course Moodle. However, their implementations for non-repository uses of Moodle varied.

According to Instructor ART, ART3 received different Moodle activity implementations compared with ART1 and ART2 as she was the sole instructor for ART3 and a co-instructor for the other two. She regarded the course Moodle of ART3 as an online learning community for both the instructor and the students. Besides using Forum for question answering, so that “everybody sees the question and receives the answer”, an “Online Users” block was also added to the course Moodle which showed which members of the course were on the course Moodle at any given time. This enabled her to scaffold interacting with students by initiating conversations with them upon seeing them online. Instructor ART observed that students were later proactive in this kind

of interactions. Instructor ART emphasized that instructors themselves should use the implemented Moodle activities in order to prompt students to follow suit, instead of only informing them about the activities on the course Moodle.

Instructor EDU12 included a range of Moodle activities on EDU1 and EDU2, namely weekly Quizzes, question/answering Forums, Feedback for in-class polling, Questionnaire for peer evaluation in group projects, and Wikis for student collaboration. Instructor EDU12 was the only instructor among the five to have actively promoted mobile access to the course Moodle through verbal encouragement. To improve student experience in mobile access to Moodle, she also added a Section Links block on the top of the course Moodle page for easier navigation to different sections of the page, as she was aware that “students have small-screen devices, and it is difficult to scroll to [different] sections”.

Instructor EDU34 adopted a reverse chronological display of sections on each course Moodle page, where the latest section was at the top and the oldest at the bottom, so that students “would not need to scroll all the way down” to arrive at the current topic. He also created a Forum in each of the sections for students to demonstrate and discuss the knowledge learned in the class. Exclusive to implementations in EDU3 was the OUWiki intended for the group project assignment, though students had the freedom to choose any alternative platforms such as Google Doc. Instructor EDU34 pointed out that the usefulness of Moodle lay in making resources available for students to download and reported that he tended to follow implementations from the course Moodle in a previous year due to time constraints.

Instructor SOC, teaching SOC1, added a

Section Links block for convenient navigation to different sections of the course Moodle. He also implemented a Forum for students to give comments on presentations voluntarily given by students. He also expressed his original intention to implement the Feedback function for in-class polling so that students could use their mobile phones to participate. The function was eventually not implemented due to temporal constraints from the limited class time to “in-class announcements from the Faculty”.

Besides weekly short quizzes, Instructor ENG also implemented “Feedback” towards the end of the course for students to do self-reflection, but observed that few students participated as this activity was “not counted towards the final grade” of the course. He considered it important that instructors should be aware of students’ incentives of using Moodle.

5. Discussion

Findings from both the survey and interviews indicate that more students used their mobile phones to access Moodle for repository uses (i.e., accessing learning resources) than those for non-repository uses (e.g., interaction, collaboration) (Table 4), and their usage frequencies for repository uses were also higher than those for non-repository uses (Table 3). This reflects the use of mobile access to Moodle remained at the lowest level of LMS usage as suggested by Francis and Raftery (2005), corroborating with previous studies on students’ perception of what Moodle is used for (Kennedy, 2005; Carvalho et al., 2011; Antonenko et al., 2013; Ssekakubo et al., 2013). This suggests a possible overestimation of the power of mobile access in expanding LMS’s support for teaching and learning. On the other hand, interviewees repetitively mentioned the ubiquity of mobile

devices that enabled them to access Moodle at any time in need (e.g., during travel or waiting time) and the types of tasks they used mobile access to perform, suggesting there is potential of mobile access in enhancing non-repository use of Moodle. However, this potential would depend on the nature of tasks, as mobile access was mostly mentioned to have been used for quick and small tasks while computers were strongly preferred for serious work (Lai & Zheng, 2017; Liu, Kuo, Shi & Chen, 2015).

Results of the correlation analysis indicate that the distribution of Moodle activities in each course (Table 2) could partially explain students' self-reported Moodle usage frequencies via mobile phones across usage categories, as reported in Tables 4 and 5. Despite the varying distributions of non-repository LMS activities across courses, those for resource access were still predominant. This denotes that participating courses in this study implemented similar LMS activity designs, causing an unbalanced distribution between activities for repository and non-repository uses. Consequently, students' usage of LMS via mobile access was unsurprisingly inclined to the repository use. These imply that students' usage of LMS via mobile access was likely influenced by the Moodle activity design, which in turn might have been influenced by the attitude of instructors towards their roles and those of LMS (Arvan, 2009; Mott, 2010).

Interviews with the instructors revealed their fairly different attitudes towards the role of LMS in facilitating teaching and learning and the influence of instructors on students' use of LMS. The level of LMS usage revealed in this study to some extent matched the beliefs of instructors, which were generally in line with the literature on teachers' roles in technology adoption in education (Teo, 2009; Steel, 2009). Instructors who took LMS

mainly as a place for storing learning materials and a venue for announcements, would create fewer non-repository activities in Moodle, and thus limited the possibility of students' non-repository usage. In contrast, some instructors believed that LMS could help creating a learning community among students, and thus added Moodle activities in the interaction and collaboration categories. However, making non-repository activities available on Moodle did not necessarily improve students' non-repository usage, since there were considerably more repository than non-repository activities. In this study, instructors played a crucial role in scaffolding and encouraging students' use of these activities. Sometimes, for demonstrating the benefits of non-repository uses of Moodle, instructors even played a modeling role in participating in the non-repository activities. With all these efforts, instructors could help create an atmosphere of active use of Moodle, encouraging interactions among students. Such a desirable social environment has been recognized as a significant predictor of mobile technology adoption in general (Sanakulov & Karjaluoto, 2015). Given the importance of instructors in promoting and facilitating non-repository usage of LMS, institutions need to provide more opportunities for technology-related professional training and development to instructors (Samarawickrema & Stacey, 2007; Jorgensen et al., 2017), helping them understand more about the benefits of non-repository usage of LMS and concrete teaching cases of using these functions.

As shown results of this study, the impact of instructors' scaffolding and participation in the non-repository LMS activities was not strong enough for promoting students' usage through mobile access. This would be related to the nature of tasks devised by instructors for implementation on LMS. As suggested from the student interviews, non-repository uses of LMS for small, quick, and interactive tasks

open more opportunities for mobile access (Hu et al., 2016). A distinct example was taking online quizzes. Albeit reporting a low usage frequency, students complimented the efficiency resulting from using their mobile devices to do quizzes on Moodle. In-class polls were also conveniently conducted with mobile phones. Due to the usability constraints of mobile devices, as reported in student interviews (Table 7), task nature is thus an important factor for promoting mobile access to LMS. Tasks that can be fully displayed on mobile phones, can be quickly completed, and being low-stakes (e.g., without harming GPAs) would be suitable for mobile access. In fact, the use of mobile devices has been found to contribute to a higher academic performance in recent research (e.g., Shyshkanova et al., 2017). This implies the potential of mobile access to LMS in improving students' academic performance. This adds to the pool of motivators for students' mobile access to non-repository uses in addition to instructors' efforts. Furthermore, interactive tasks with immediate feedback, either from system (e.g., quiz) or other users (e.g., peer students' evaluation) could help attract students to access LMS using mobile phones. This is also supported by the relatively high portions of students using Moodle for interactive purposes across the courses in this study.

Contextual factors are also important for realizing the potential of mobile access to LMS. Student interviewees specifically remarked that the convenience of mobile access lay in its immediate availability regardless of the place (e.g., in transportation, in canteens or waiting in queues) and when they were under time constraints. Such results echoed those from Mödritscher et al. (2012) that users used mobile access to LMSs in a more "efficient and targeted" way. Even though there was a comparable number of online quizzes in both EDU2 and ENG1 (9 vs.

13, Table 2), students in EDU2 used mobile access to take tests less than those in ENG1 (Table 6), while the portion of students using mobile access for taking tests in EDU2 (39.1%) was also lower than that in ENG1 (81.9%). They commented that having computer access in their classrooms discouraged them from using mobile access when performing quizzes, evidencing again the influence of situational contexts. This also implies that even quick and low-stakes tasks on LMS would be subject to contextual constraints in terms of mobile access. These findings suggest that when enhancing students' adoption of mobile access to non-repository use of LMS, greater attention should be paid to environmental and contextual factors.

The aforementioned factors are interrelated as task nature is limited by environmental factors (e.g., small tasks are suitable for on-the-go situations), and Moodle activity design is evidently affected by instructor's attitude. To fully exploit the potential of mobile access to LMS on facilitating non-repository aspects of learning, all these factors must be considered in a holistic manner.

6. Conclusion

This study explored university students' usage of Moodle via mobile access, with a focus on non-repository purposes. Although non-repository Moodle activities (e.g., Forums, Quizzes) were less frequently accessed than learning materials (e.g., Powerpoint Slides), the advantage of mobile access to non-repository Moodle usage was shown to fulfil an instantaneous need regardless of time and location. This study also identifies the factors that influenced students' mobile access to LMS for non-repository uses. Mobile access to Moodle often served as a back-up option

to the primary means, computer access, but it came in handy for simple, quick tasks to be done in contexts where computer access was not available or convenient. With a cross-usage comparison, this study also attributed students' usage frequencies of mobile access to Moodle to the unbalanced distribution of Moodle activities stemming from the course Moodle activity design, which was in turn influenced by the instructors' attitudes towards Moodle as an LMS for teaching and learning, as well as the role of instructors. This determines the task nature that could be constrained by situational contexts. Findings of this study therefore call for special attention to the four interrelated factors of enhancing non-repository use of LMS via mobile access: instructors' attitude, Moodle activity design, task nature, and situational contexts.

Further research could be done to quantify the relationships between these factors and student engagement and utilization of LMSs. This study investigated a limited cohort of students at a Hong Kong university. Further studies are needed to verify the applicability of findings of this study to other learning contexts.

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Appendix 1: Items of the Questionnaire

Note: Each item elicited responses on a 7-point Likert scale, where 1 = “Never”, 2 = “Once a month or less”, 3 = “Once every 2 weeks”, 4 = “1-2 times a week”, 5 = “3-6 times a week”, 6 = “Once every day”, and 7 = “Several times a day”.

Experience with using Moodle of this course:

1. I used Moodle of this course via mobile phones to access learning materials (e.g., slides, notes, readings, assignments).
2. I used Moodle of this course via mobile phones for submitting assignments.
3. I used Moodle of this course via mobile phones for taking tests/quizzes/exams.
4. I used Moodle of this course via mobile phones for interacting with instructors/classmates (e.g., replying to posts, sending messages, chatting, etc.).
5. I used Moodle of this course via mobile phones for collaborating with classmates (e.g., editing wikis, contributing to glossary, discussing group projects, etc.).

Appendix 2: Protocol for Student Interviews

1. What did you usually use Moodle of this course for? Why and why not use it for other purposes?
2. Did you use mobile phone to access Moodle of this course? If yes, at which circumstances? If no, why?
3. What did you do on Moodle of this course when you used mobile phone to access it?

Why didn't you use it for other purposes?

4. Did you encounter any difficulties in using Moodle of this course via either computers or mobile phones?
5. Do you think using mobile phone to access Moodle helped you achieve goals / expectations of (taking) this course? If yes, how? If no, why?
6. Compared with computer access to Moodle, how different the two ways of access helped you achieve those goals?
7. Do you have any suggestions for the improvement of Moodle in general?

Appendix 3: Protocol for Instructor Interviews

1. What non-repository activities did you implement in the Moodle of your course? Why?
2. How is Moodle helpful in your teaching?
3. Did you do anything to encourage or facilitate [mobile] access to Moodle? Why or why not?
4. Did you find students' engagement with Moodle enhanced?
5. Did you encounter any difficulties in using Moodle of this course?