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Do Mobile Learning Experiences Affect College Students' Online Learning Readiness?

RESEARCH ARTICLE

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INTERNATIONAL COUNCIL FOR OPEN AND DISTANCE EDUCATION

ABSTRACT

This study examines how mobile learning experiences influence college students' readiness for online learning. The abrupt shift to online learning due to the COVID-19 pandemic posed challenges, including reduced student engagement and interaction. Previous research has indicated that the degree of students' learning readiness is crucial to derive the greatest advantage from virtual learning. Also, a variety of Information & Communication Technology (ICT) such as computers, laptops, and smartphones, could play a key role in facilitating effective online learning. However, little research examines the effects of mobile learning on online learning readiness (OLR). The study explores how mobile learning affects key components of online learning readiness: computer & internet self-efficacy, online communication self-efficacy, motivation for learning, learner control, and self-directed learning. Two research questions guide the study: 1) To what extent do mobile learning experiences affect college students' online learning readiness? and 2) In what ways do mobile learning experiences influence college students' online learning readiness? Using a mixed-methods approach, data was collected from 73 survey participants and 11 interviewees. Quantitative analysis using a two-tailed t-test showed a positive impact of mobile learning on all factors of online learning readiness. Qualitative content analysis revealed key themes such as getting acquainted with learning technologies, access to related technologies/resources, awareness development, app features, motivation for searching information, learning environment, and limit on access.

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KEYWORDS:
mobile learning experiences; college students; educational technologies; online learning readiness; higher education; computer & internet self-efficacy; online communication self-efficacy; motivation for learning; learner control; self-directed learning

TO CITE THIS ARTICLE:
Li, S., & Huang, W. (2025). Do Mobile Learning Experiences Affect College Students' Online Learning Readiness? *Open Praxis*, *17*(4), pp. 785–802. DOI: https://doi.org/10.55982/openpraxis.17.4.894

INTRODUCTION

COVID-19 rapidly spread worldwide in 2020 and affected nearly every aspect of daily life. The global closure of educational institutions pushed all institutions to transform courses to online platforms. Thus, all universities across the world were required to use Information & Communication Technology (ICT) as an online learning medium (Dwiyanti et al., 2020). Benefits of online learning include flexibility across time and place, and overall convenience for learners (Muthuprasad et al., 2021; Turan et al., 2022). Thus, online learning is defined as a learning environment where students learn and interact with their instructors and peers through the Internet and computer technologies (Ramazanoğlu et al., 2022). Recent work mapping digital transformation highlights mobile learning reshaped distance education, underscoring access, interaction, and equity as central design priorities (Boztaş et al., 2025).

The post-pandemic period has promoted the acceleration of learning technological transformation and reshapes the education service, which brings two main trends: the expansion of distance education and the development of educational technologies (Kang, 2021). Rasmitadila et al. (2020) suggested enhancing technology readiness to address the challenges and problems of online learning during the COVID-19 period, by facilitating easier and more widespread access to the Internet and providing Internet services. Dhawan (2020) demonstrated that learning applications can assist students in overcoming challenges during difficult times, with the goal of offering a wide range of free online courses and reducing the digital divide. For example, Zoom could deliver live online lectures, webinars, and live meetings, which help people stay connected while studying from home. Ho et al. (2021) highlighted that students' technological competency and their perceptions of online learning were critical factors in determining satisfaction levels. Furthermore, self-efficacy—the belief in one's ability to successfully perform tasks or engage with educational technologies—was shown to be significantly related to student satisfaction (Wang & Degol, 2014). Additionally, prior research established that technology readiness significantly enhances learning motivation within blended learning environments in higher education (Geng et al., 2019). Similarly, another study investigated the impact of self-efficacy on students' acceptance of online learning, particularly focusing on perceived ease of use and usefulness during the COVID-19 pandemic in Poland (Rizun & Strzelecki, 2020). Their study highlighted key factors such as accessibility and students' readiness, with self-efficacy emerging as a crucial element influencing the effectiveness of emergency online learning.

On the other hand, the transition to a new learning format has faced some challenges for various stakeholders (Donitsa-Schmidt & Ramot, 2020). For instance, the dropout rates of college students increased because of economic, psychological, and academic factors. Specifically, it was academically difficult for courses that required face-to-face interactions to be delivered online (Franchi, 2020). There are many studies related to the new transformation caused by COVID-19 in education. Fawaz et al. (2022) stated that students had issues with learning and evaluation methods, technical challenges, and confinement during the pandemic. Also, Adarkwah (2021) concluded that students' online learning experience was ineffective during the pandemic because of lacking social interaction, communication, and ICT resources, which led to unsatisfying learning outcomes.

To address these challenges, studies have proposed strategies to improve the effectiveness of online learning. For instance, some studies recommended on improving equity and access in online learning (Martin et al., 2023). Recent studies show that students' attitudes toward online learning and instructors' teaching factors strongly shape engagement and satisfaction—key markers of successful online courses (Li et al., 2023). An Open Distance Learning case study proposes an awareness' framework—institutional, instructor, and student awareness—to deliberately curate online learning for engagement and support (Gani & van den Berg, 2024). Thus, educational institutions should implant in students' readiness to read, discuss, and debate. Additionally, prior studies indicated that the effectiveness of online learning could be related to students' attitudes to the online learning environment (Sivo et al., 2007), attitudes to computers (Pillay et al., 2007), and perspectives on the usefulness of online learning environments (Arbaugh, 2000). Also, student readiness is a key predictor of success and persistence in online courses (Joosten & Cusatis, 2020). Therefore, online learning readiness (OLR) could affect students' online learning effectiveness and outcomes.

The following research questions will be explored:

- To what extent do mobile learning experiences influence college students' online learning readiness levels (computer & internet self-efficacy, learner control, online communication self-efficacy, motivation for learning, self-directed learning)? (RQ1)
- In what ways do mobile learning experiences influence college students' online learning readiness levels (computer & internet self-efficacy, learner control, online communication self-efficacy, motivation for learning, self-directed learning)? (RQ2)

LITERATURE

MOBILE LEARNING

Mobile learning is the subset of online learning using mobile computational devices, which allows learners to access learning resources when they are far away from their normal place of learning environments (Kumar Basak et al., 2018). In this research, mobile learning refers to the use of mobile applications on mobile devices to facilitate students' learning activities and provide access to educational materials such as courses, lectures, assignments, and tests. Mobile learning supports various forms of education and is particularly well-suited for higher education due to the widespread presence of mobile devices on campuses. Multiple mobile learning designs are employed in higher educational institutions. For example, instructors provide college students with formative assessments and feedback through mobile devices (Cheung & Hew, 2009). In-person classes utilize Quick Response (QR) codes to offer online links to additional learning resources (Gikas & Grant, 2013). Mobile devices can also efficiently handle administrative tasks such as tracking attendance through a software Application (Chiang et al., 2022). However, implementing mobile learning in higher education remains challenging due to social, cultural, and organizational factors (Traxler, 2018). Therefore, the perceptions of students and instructors towards mobile learning are crucial for its effective use in higher educational institutions (Cheon et al., 2012).

ONLINE LEARNING READINESS

OLR is framed as learners' preparedness to participate effectively in online environments, encompassing technical competency and confidence, online communication, self-directed learning, learner control, and motivation (Rafique et al., 2021). In this study, we critically examine the model proposed by Hung et al. (2010) for assessing students' readiness for online learning. This model encompasses elements like computer and Internet self-efficacy (CSE and ISE), online communication self-efficacy (OCS), learner control (LC), self-directed learning (SDL), and motivation for learning (MFL).

Constructs of OLR

Computer/Internet self-efficacy is composed of learners' technology-related knowledge, skills, attitudes, and capabilities in using technologies to achieve educational objectives and expectations in higher education (Chung et al., 2020). Ong et al. (2004) find that CSE plays an important role in a learner's decision to use computers, as well as how comfortable learners are with learning skills to be more effective. Similarly, Internet self-efficacy (ISE) does not only help implement any Internet-related tasks but also represents individuals' ability to apply higher-level skills, like troubleshooting (Eastin & LaRose, 2000).

Introverted students are more likely to prefer online courses over traditional face-to-face courses (Harrington & Loffredo, 2010). Moreover, students could escape from burning out or losing interest in online learning contexts when they work with other classmates online and utilize encouragement and feedback to stay motivated. Thus, OCS is believed to be a necessary factor for overcoming the limitations of online communication in the online learning environment (Hung et al., 2010).

Fisher et al. (2010) define learner control as the extent to which a learner is given control over characteristics of instructional design elements, including pace, content, sequence, and guidance. LC should involve guiding the learner's progress, maintaining focus on learning without distractions from other online activities, and repeating online materials according to the learners' learning needs (Chung et al., 2020).

Self-Directed Learning (SDL) is commonly described as a process in which learners actively take the initiative to identify their learning needs, set learning objectives, locate resources, develop and implement appropriate learning strategies, and evaluate their learning outcomes (Murad et al., 2010; Song & Hill, 2007). According to Geng et al. (2019), SDL is characterized by two primary traits: learners' genuine control over most decisions and their ability to effectively access resources. Consequently, self-directed learners tend to be more proactive in engaging with learning activities, such as reading materials, completing academic tasks, and planning and assessing their learning goals (Chung et al., 2020). MOOC research shows self-directed learning positively relates to intrinsic motivation, reinforcing SDL's role in online success (Altinpulluk, et al., 2023).

Motivation has great effects on the learning activeness of students. Logically, students with high motivation for learning may be more willing to participate in the learning process. In contrast, students with low motivation to learn may spend less time learning (Everaert et al., 2017). In online learning contexts, motivation is proven to be positively associated with how learners perceive each other's presence in online courses (Chung et al., 2020). Similarly, Lee and Pang (2014) found that motivation could influence students' perspectives, attitudes, and determination for their academic success.

Effects of Mobile Learning on Constructs of OLR

Despite the extensive empirical research on mobile learning, the correlation between mobile learning and readiness to learn online remains largely underexplored. Some studies have examined the relationship between mobile learning and certain online learning readiness (OLR) variables. For instance, Razzaq et al. (2018) found that college students with high self-efficacy are more inclined to use mobile learning to support their online education. Mobile interactions via smartphones in mobile learning can enhance students' confidence and deepen their understanding of both internal and external factors. Internal factors, such as confidence, personal beliefs, habits, individual literacy, and clarity, may influence self-efficacy. The more frequently students engage with mobile learning, the better their performance and the more achievements they realize. Regarding external factors, students can leverage smartphones to search for information online, submit assignments through email or learning management systems, organize their work in folders, and easily exchange information with classmates or teachers. To summarize, through mobile learning, students interpret their performance, accomplishments, and experiences to develop beliefs about their competencies, thereby encouraging continued participation in similar learning activities.

Regarding the motivation factor of OLR, a prior study investigated the use of mobile learning applications to teach practical techniques in material synthesis, finding that these applications significantly enhanced students' motivation for online learning and improved their online learning performance (Jou et al., 2015). Similarly, it was demonstrated that mobile augmented-reality vocabulary learning yields higher motivation and better vocabulary performance than traditional instruction (Lai & Chang, 2021). In an experimental study, Sari and Nurcahyo (2018) also found that mobile learning could effectively increase students' motivation for online learning. Furthermore, researchers explored the impact of mobile learning applications on the learning motivation, social engagement, and academic achievement of nursing students, revealing that the flexibility and interactivity of mobile applications led to higher levels of online learning motivation (Li et al., 2018).

Learner control empowers individuals to determine the approach and scope of their inquiries. Mobile devices play a pivotal role in supporting these inquiries by offering resources such as built-in cameras that facilitate identification and photo sharing. Furthermore, mobile learning enhances communication between learners and instructors, and its inherent mobility enables inquiries across diverse contexts (Jones et al., 2013). Despite these benefits, the relationship between mobile learning and self-directed learning remains contentious. Research by Boticki et al. (2015) indicates that mobile social learning platforms can foster self-directed and collaborative learning, provided that the learning environment is effectively structured by educators. Additionally, Fok et al. (2018) assessed the impact of a mobile learning technology, "iClass" (https://www.iclasspro.com/), which supports real-time interactive classes via a cloud-based platform. Their findings suggest that self-directed language learning becomes more effective when it incorporates interactive mobile learning. Similarly, another study explored how mobile learning affects the self-directed acquisition of academic English vocabulary,

demonstrating the potential of mobile applications to support autonomous learning (Xodabande & Atai, 2020). Conversely, Bartholomew et al. (2017) examined the relationship between mobile device access, self-directed learning, and academic achievement, finding that access to mobile devices did not significantly influence students' self-directed learning outcomes.

METHODS

RESEARCH METHOD

A mixed methods approach was implemented to compare participants' responses to the OLR scale and interview questions between the group with prior mobile learning experiences and the group without. Within the mixed methods approach, an explanatory sequential design was chosen. Quantitative data collection and analysis were conducted first, followed by qualitative data collection and analysis. The qualitative analysis results would explain or expand on the quantitative results (Maforah & Leburu-Masigo, 2018). As to the research questions in this study, the quantitative data was analyzed to answer the first research question: *To what extent do mobile learning experiences influence college students' online learning readiness levels?* The qualitative data was analyzed to answer the second research question: *In what ways do mobile learning experiences influence college students' online learning readiness levels?*

RESEARCH DESIGN

Data Collection and Participants

Students taking an introductory course in liberal arts and sciences at a Midwestern public university in the U.S. were the sampling pool for this study. All necessary ethical approvals were obtained from the appropriate Institutional Review Board (IRB). All participants provided written or verbal informed consent to conduct the survey and interviews.

For the quantitative data collection, an online survey was sent to 431 potential participants through email. Of these, 99 participants responded and 73 completed all questions, indicating a 16.94% response rate. The sample size was designed to be 60, including 30 participants in Group 1 (without any mobile learning experiences) and 30 participants in Group 2 (with mobile learning experiences). The participants were identified by their responses to the question about whether they had mobile learning experiences or not, which referred to whether they had learned anything knowledge or skills through mobile applications on their smartphones or tablets. Lai & Hwang (2014) demonstrate that the students who learned on their smartphones for a longer time had better conceptions of communication, complex problem-solving, and creativity than others. The participants in that study spent at least two hours on mobile learning activities per week. Thus, to be eligible for the experimental group, this pro-posed study required participants to spend at least two hours per week on mobile learning. As a result, 30 of 35 participants without any mobile learning experiences and 10 participants with less than 2 hours of weekly mobile learning were randomly selected into Group 1. As to Group 2, 30 of 38 participants with more than 2 hours of weekly mobile learning were chosen randomly. The respondents for this study were characterized by four variables: gender, age, GPA, and major (see Table 1).

As to the qualitative data collection, participants choosing to engage in an interview were taken to a separate web page (from the online survey) to collect personal information (i.e., name, department, phone, and email). The inclusion criteria for this study were: (1) participants have filled out the survey; and (2) participants have mobile learning experiences. As a result, 11 participants with mobile learning experiences chose to attend the interview. As the gold standard of qualitative inquiry, data saturation was reached well before the eleventh interview, indicating that no new codes or themes meaningfully emerged from additional interviews (Fusch & Ness, 2015). The participants were characterized by gender, age, GPA, major, and mobile learning experiences (see Table 2).

RESEARCH PROCEDURES

This study began by analyzing the demographic characteristics of participants, including their gender, age, self-reported GPA, and academic major (see Table 1). RStudio (Version 1.2.5033) was used to conduct the quantitative data analysis. A two-tailed independent samples t-test

	DEMOGRAPHIC	FREQUENCY (PERCENT OF RESPONDENTS)	NUMBER
Gender (N = 60)	Female	56.66%	34
	Male	41.67%	25
	Non-Binary	1.67%	1
Age (N = 60)	19–21	93.33%	56
	Above 21	6.67%	4
GPA (N = 60)	Lower than 2.0	0	0
	2.01 ~ 2.49	0	0
	2.50 ~ 2.99	0	0
	3.00 ~ 3.49	13.33%	8
	3.50 and above	86.67%	52
Major (N = 60)	Astrophysics	8.33%	5
	Biochemistry	8.33%	5
	Chemistry	10%	6
	Communication	5%	3
	Economics	5%	3
	Math	16.67%	10
	Political Science	5%	3
	Psychology	16.67%	10
	Sociology	8.33%	5
	Others	16.67%	10

Table 1 Demographic information for online survey participants (N = 60).

PARTICIPANTS	GENDER	AGE	GPA	MAJOR	MOBILE LEARNING EXPERIENCE
Participant 1	Female	19–21	3.50 and above	Computer science & philosophy	Learning languages from Duolingo
Participant 2	Female	19–21	3.50 and above	Biology	Learning languages from Duolingo
Participant 3	Female	19–21	3.50 and above	Math	Using Apps required by courses to finish coursework
Participant 4	Female	19–21	3.50 and above	Psychology	Taking courses on smartphones, such as Coursera
Participant 5	Female	19–21	3.50 and above	Psychology	Learning TOEFL from an App for the TOEFL exam
Participant 6	Female	19–21	3.50 and above	Linguistics	Learning extracurricular knowledge on multiple Apps, such as Duolingo
Participant 7	Male	19–21	3.00 ~ 3.49	Astrophysics	Taking online college-level courses
Participant 8	Female	19–21	3.50 and above	Earth, society, & environmental sustainability	Learning video editing and taking courses required by high school
Participant 9	Female	19–21	3.50 and above	Statistics, & accountancy	Learning math from YouTube App
Participant 10	Female	19–21	3.50 and above	Life sciences	Taking online courses
Participant 11	Female	19–21	3.50 and above	Spanish	Learning languages from Duolingo

Table 2 Demographic Information for Interview Participants.

was applied to address the five sub-research questions related to RQ1. This analysis explored whether there were significant differences between the two groups in their use of learning applications across five dimensions: computer/internet self-efficacy, motivation for learning, online communication self-efficacy, learner control, and self-directed learning.

This study utilized deductive Qualitative Content Analysis (QCA) to analyze the qualitative data. Deductive QCA is not data-driven, and researchers define the coding categories and themes before collecting the qualitative data. During the process of qualitative data analysis, additional codes are developed, and the initial coding scheme will be revised and refined (Hsieh & Shannon, 2005). Firstly, the researcher started with identifying key concepts or variables as a preliminary coding scheme based on the OLR theory, and operational definitions for each category were determined by the OLR theory (Potter & Levine-Donnerstein, 1999). This research's subsequent steps of data analysis were led by categories (Elo & Kyngäs, 2008). The second step was organizing and preparing the qualitative data, including transcribing the recordings of the interview (Ortiz, 2007). Then the researcher and another experienced coder read and understood the scripts of the interview and determined the credibility. During that time researchers re-examined materials interpretatively and reflexively to organize the data. In this part, researchers assigned the coded data into categories (Bengtsson, 2016). This process also allowed researchers to refine the definitions of each category so that the code was clearly operationalized. The final step was interpreting data. Researchers also made the hidden obvious, generated meaning, made references, and went deeper into the data. Table 3 includes the description of each theme based on the OLR theory.

Table 3 Preliminary Codebook based on the OLR Theory (Hung, 2010).

THEME	DESCRIPTION
Computer/Internet self-efficacy	Evaluate learners' confidence and ability to effectively use computer and internet technologies for online learning.
	Perception of the ability to use computers and software for online tasks.
	Perception of the ability to perform internet-related tasks and troubleshoot issues.
Self-directed learning	Assess learners' capacity for self-directed learning, including goal-setting, resource identification, and self-regulation.
	Independence in planning, monitoring, and evaluating their learning process
	Ability to adapt time management skills from in-person to online learning.
Learner control	Measure the extent to which learners can direct and manage their own online learning experiences.
	Autonomy in choosing learning objectives, pace, and resources.
	Ability to focus on learning and minimize distractions in the online environment.
Motivation for learning	Examine learners' motivation, both intrinsic and extrinsic, and its impact on their engagement and persistence in online courses.
	Intrinsic motivation: The inherent interest in acquiring knowledge and skills.
	Extrinsic motivation: Performing behaviors for specific rewards, such as grades or prizes.
Online communication self-efficacy	Assess learners' confidence and skills in effectively communicating and collaborating with others in the online learning environment.
	Proficiency in participating in online discussions and group work.
	Ability to facilitate meaningful interactions in online courses.

RELIABILITY

Reliability Of OLR Survey

While Rafique et al. (2021) and Chung et al. (2020) validated the OLR instrument using composite reliability (CR), this study needs to assess CR within the U.S. context, as Hung et al. (2010) originally tested the OLR in Taiwan. Table 4 presents the comparative CR values for the five dimensions, showing that all five subscales demonstrated adequate internal reliability (above .7) after the item 'LC2' was removed from one subscale.

Inter-rater Reliability

To enhance the inter-rater reliability (IRR) in the coding process, two coders were needed (Armstrong et al., 1997). IRR is a measure of the level of agreement between coders when evaluating qualitative data and its significance (Cole, 2023). To reduce necessary training for the co-coder, the codebook (Table 3) was developed and provided by the primary coder which

SCALE	ITEMS	RAFIQUE ET AL. (2021)	CHUNG ET AL. (2020)	PRESENT STUDY
Computer/Internet self-efficacy	3	.81	.88	.82
Self-directed learning	5	.76	.89	.82
Learner control	3	.50	.84	.70
Motivation for learning	4	.77	.91	.81
Online communication self-efficacy	3	.75	.89	.72

Table 4 Reliabilities of OLR.

Note. The Cronbach's alpha of LC was .62 before removing LC2, which was not reliable enough for the constructs.

identified categories and definitions. Once the primary coder had finished coding, 40% of the dataset was sent to the co-coder for review. After several meetings to discuss the differences in interpreting the codes, an IRR of 0.92 based on Cohen's kappa was reached, indicating a high level of reliability in coding the qualitative data.

FINDINGS AND DISCUSSION

FINDINGS OF QUANTITATIVE DATA

We conducted a two-tailed t-test on independent samples to assess differences in online learning readiness levels between the two groups across five dimensions: computer/internet self-efficacy, motivation for learning, online communication self-efficacy, self-directed learning, and learner control. Results indicated a significant difference in CIS between Group 1 and Group 2, $t(48.38) = -3.41$, $p = .001$, showing that college students with mobile learning experiences have different levels of computer and internet self-efficacy than those without. In SDL, a significant difference was also found, $t(51.53) = -4.23$, $p < .001$, indicating that students with mobile learning experiences demonstrate higher self-directed learning. Similarly, MFL showed a significant difference, $t(52.28) = -4.89$, $p < .001$, suggesting that mobile learning experiences affect learning motivation. The online communication self-efficacy dimension also displayed significant variation, $t(56.27) = -3.93$, $p < .001$, reinforcing that mobile learning experiences influences this aspect of online readiness. Lastly, in LC, a significant difference was found between students with and without mobile learning experiences, $t(49.25) = -3.62$, $p < .001$, showing that mobile learning experiences impact learner control. Table 5 presents the *t*-values for each item, alongside the *t*-values and *p*-values for each dimension based on the quantitative data. We also reported effect sizes (Cohen's d) in Table 5. All five dimensions showed large effects by conventional benchmarks (0.80).

ITEM	*t* OF EACH ITEM	*t* AND *p* OF DIMENSION	COHEN'S d
CIS1	−2.54	$t = -3.41$	*0.88*
CIS2	−3.88	$p = .001$*	
CIS3	−2.29		
SDL1	−3.02	$t = -4.23$	*1.09*
SDL2	−2.43		
SDL3	−2.94		
SDL4	−3.80	$p < .001$*	
SDL5	−2.99		
MFL1	−4.40	$t = -4.89$	*1.26*
MFL2	−3.56		
MFL3	−5.20		
MFL4	−2.14	$p < .001$*	
OCS1	−2.40	$t = -3.93$	*1.01*
OCS2	−4.92	$p < .001$*	
OCS3	−2.18		
LC1	−2.67	$t = -3.62$	*0.93*
LC3	−3.55	$p < .001$*	

Table 5 Results of quantitative data comparison (group 1 minus group 2)*.

Note. Group 1 includes participants without any mobile learning experiences and less than 2 hours of weekly mobile learning; Group 2 includes participants with more than 2 hours of weekly mobile learning.

FINDINGS OF QUALITATIVE DATA

The categories of the content analysis were coded based on the theoretical model for this study: computer self-efficacy, Internet self-efficacy, self-directed learning, motivation for learning, online communication self-efficacy, and learner control, which were theoretical categories. The sub-categories were extracted from the qualitative data, referring to certain topics or arguments as thematic categories. Since sub-categories were created from participants' mobile learning experiences by key-words-in-contexts technique (Ryan & Bernard, 2003), there were some repetitive or similar sub-categories from the parallel categories. Each of them further explained the relationship between the categories and mobile learning experiences.

Computer self-efficacy. Some respondents believed that their mobile learning experiences made them get acquainted with learning technologies since they had more opportunities to use some learning technologies when they learned some knowledge or skills on their smartphones. Thus, their mobile learning experiences improved their confidence in using software for online learning. Participant 6 responded, "After experiencing mobile learning for a while and getting familiar with how the platforms work, I would say I can get more knowledge in using those tools and that helps my later learning in college." Some participants believed that their mobile learning experiences provided them with more access to related technologies or resources and those technologies and resources improved their confidence in knowledge and skills of using software for online learning. Participant 11 reported, "I think I used a smartphone to learn how to use Excel efficiently, like shortcuts, which will improve my confidence in using it a lot." Some participants did not think their mobile learning experiences influenced their computer self-efficacy at all. Participant 5 commented, "My phone and the computer are basically two separate things for me. So, I can't say that my smartphone really did lead to more confidence in using Microsoft Office."

Internet self-efficacy. Some participants believed that their mobile learning experiences motivated them to search for information on the internet since they needed support for their assignments required by mobile learning courses. Therefore, their confidence in searching for information on the internet was improved by their mobile learning experiences. Participant 10 commented, "I would search for related information to solve some problems in the homework. When you find the information you searched helping your study or improve your grades, you will be more confident in searching." Some participants suggested that their mobile learning experiences provided them with more access to related technologies or resources, which improved their confidence in searching for information on the internet since their skills and knowledge of searching online developed. Participant 7 believed that mobile learning offered more resources to search for, "These resources are like ads and other links that relate to the resource that I am looking at. I just click on those extra resources, so I eventually come up with a database of everything that I have." Some participants believed that their mobile learning experiences made them get acquainted with searching technologies since they had more opportunities to use searching technologies when they learned some knowledge or skills on their smartphones. Thus, their mobile learning experiences improved their confidence in using software for online learning searching. For example, Participant 4 commented, "I think it affects how I become more understanding of how the internet works, and what kind of keywords I must use when I want to search for something." Some participants did not think their internet self-efficacy was influenced by their mobile learning experiences at all. Participant 11 explained, "As to searching for information, I don't think mobile learning can really improve my confidence in searching for information since it really depends on my motivation to research."

Self-directed learning. Some of the participants believed that mobile learning developed a habit or awareness of leading their learning by themselves, which positively affected their self-directed learning. Participant 2 stated,

> I've like developed that sense of responsibility or it is just self-awareness. If I do it or if I don't do it, it is not going to affect me, and I should be the one to do it rather than skipping classes. It would be very easy to skip through all the tutorials and videos and just show that the assignment is over on the app. But if I do it, it's going to help me. So, I would say that it has given me a sense of self-responsibility and just being structured and more organized and just like making sure I do everything on time.

Some participants believed that their mobile learning experiences provided them with more access to related technologies or resources for self-directed learning. For instance, Participant 1 stated that there were some apps on smartphones helping her learn independently,

> There are also certain apps that I had downloaded, like the focus apps from Google Play Store, which make it very interactive in achieving your goals. It makes it sort of like a game, when you achieve certain tasks, it really encourages you to keep going. So those kinds of intuition really help you work better. All those things really help me plan out my week and I know that I'm making progress with whatever goals I've set for myself. Of course, they do help me with planning my time because it does give you an overview of how much you've done so far.

Only Participant 8 did not connect her mobile learning experiences to her self-directed learning,

> To be honest, I am particularly bad with time. The reason online learning does not work for me is because it provides a lot of freedom. It's designed to provide you with a lot of freedom of time. I think the freedom of online learning is good for some people who already have full-time jobs or older people who are trying to learn something while also doing everything else in their lives.

Motivation for learning. Some participants thought that some features of learning applications could improve their motivation for learning. For instance, Participant 1 mentioned,

> Mobile applications have very encouraging systems, such as giving you a progress bar of how much you have finished. They have regular tests to help you understand that you've absorbed this much. They are built in such a way that they focus on your weak points and give you more practice for those points.

Some participants mentioned that their mobile learning experiences gave them more opportunities to access related technologies or resources that improved their motivation for learning. For example, Participant 3 stated,

> Online classes can be difficult, and they may not provide all the information. I suppose mobile learning would help fill the gap. If I don't understand the lesson material and don't have access to research about it, I may give up the course. Some Apps can be a supplement to the course.

Some participants disagreed with the influence of mobile learning experiences on motivation for learning. Participant 5 commented, "I don't think so. I'm an in-person course person. I like taking in-person classes. I'm not good at technology stuff. You may face technology problems when taking classes on Zoom."

Online communication self-efficacy. Some participants stated that their mobile learning experiences made them acquainted with online communication since they had more opportunities to communicate with their peers on their smartphones. Thus, their online communication self-efficacy was positively affected. Participant 8 commented,

> The more you use something, the more you get used to it. When you have a lot of mobile learning experiences, you become more confident in that environment. At the beginning of online learning, we didn't know how to ask questions, whether they would be answered, and how to communicate. Over time it has definitely improved.

Some participants talked about how their mobile learning offered them more access to related technologies or resources and they became more confident in communicating online because of the positive feedback they received. Participant 9 responded, "I will also share my questions and give some feedback. I think it's positively influenced. I will ask questions or answer others' questions in the comment channel on my smartphone, which will make me clear about the concept." Some participants believed that mobile learning provided them with a learning environment for online communication. For instance, Participant 1 stated,

> Most of us do hesitate to ask questions in class because you're in person or you're afraid of being judged. But when it's online, when it's for your phone, you're more likely to reach out because it's across the screen, right? And of course, while that's

> not the best thing for your social skills, it definitely helps you learn better because you are not as hesitant about asking questions. You will ask questions through email, through live chat through all of those systems because you do not have that thing holding you back that you will be judged, that people are going to wonder whether or not you know something.

Only Participant 2 did not confirm the relationship between mobile learning experiences and their confidence in online communication because she was quite familiar with online communication before mobile learning.

Learner control. Some participants thought that their mobile learning experiences developed an awareness that their smartphones could be used for learning. Thus, they became more focused on their learning while taking online courses. Participant 5 shared her experience,

> Using a device to learn something or do something makes it harder for you to get distracted because we've been using our devices since grade 5. So, the fact that I am surrounded by a laptop or an iPad or a phone for the majority of my life makes it more difficult for me to get distracted because I'm just used to studying on a device or a phone in general. My mobile learning experiences kind of helps me build up a sense that my cell phone is not just for fun, and it can also be used for learning.

Some participants believed that their mobile learning experiences limited their access to social media on smartphones when they learned on their smartphones, leading to focusing on learning while learning online. For instance, Participant 1 responded, "When you're joining a class through your phone, you are less likely to use social media because it is very inconvenient to join a class and use social media at the same time." On the other hand, some participants did not feel there was any connection between mobile learning experiences and learner control. For example, Participant 3 commented, "But it depends on the learning materials. If it is interesting, then I will be less distracted by social media."

After grouping by the sub-categories above, the critical themes were identified, including getting acquainted with learning technologies, access to related technologies/resources, awareness development, App features, motivation for searching information, learning environment, and limit on access, which explained the quantitative analysis results. Table 6 includes the interview results which were grouped by sub-category, the frequency, and the quantitative findings these sub-categories further explained.

Table 6 Interview Results Grouped by Sub-Category.

SUB-CATEGORY	FREQUENCY	QUANTITATIVE FINDINGS EXPLAINED
Access to Related Technologies/ Resources	20	CSE, ISE, SDL, MFL, OCS
Awareness Development	9	SDL, LC
Getting Acquainted with Learning Technologies	9	CSE, OCS
App Features	4	MFL
Motivation for Searching Information	3	ISE
Learning Environment	3	OCS
Limit on Access	3	LC
No Influence	19	CSE, ISE, SDL, MFL, OCS, LC
	Total: 70	

DISCUSSION

Considering the results of two-tailed t-tests, participants in Group 2 reported significantly higher levels of computer & internet self-efficacy, self-directed learning, motivation for learning, online communication self-efficacy, and learner control than the students in Group 1. Beyond statistical significance, all effects were large, indicating practically meaningful differences in OLR associated with prior mobile learning experiences—especially for SDL and MFL—consistent

with our qualitative mechanisms. Thus, it is concluded that mobile learning experiences significantly affect college students' online learning readiness. This finding was also proved by some prior studies. Razzaq et al. (2018) stated that mobile learning via smartphones could improve students' confidence and understanding of both internal and external factors. Also, prior research found that some mobile learning platforms, such as SamEx and "iClass", had positive effects on the effectiveness and efficiency of students' self-directed learning (Boticki et al., 2015; Fok et al., 2018; Xodabande & Atai, 2020). Sari and Nurcahyo (2018) discovered the effects of mobile learning on students' motivation for learning. Moreover, Arain et al. (2017) examine that a mobile learning application has a positive influence on the learning outcomes of a Communication Skills course, which is also consistent with the findings related to how mobile learning experiences influence online communication self-efficacy. What's more, prior research found that m-learning improved learning by making learners control learning processes, and become independent, self-motivated learners (Chien, 2016), which confirmed the findings of this study related to learner control.

Eight critical themes are identified to explain how mobile learning experiences will affect college students' online learning readiness. For access to related technologies/resources, 20 responses stated that mobile learning experiences improved their OLR, including computer self-efficacy, internet self-efficacy, self-directed learning, motivation for learning, and online communication self-efficacy, by providing more access to related technologies or resources for them. CSE, ISE, and OCS, as constructs of self-efficacy, are key elements of social cognitive theory (He & Freeman, 2010). According to social cognitive theory, CSE, ISE, and OCS are affected by social influences in the environment, which is consistent with the findings of RQ2 in this study. The prior study suggests that a mobile learning application for delivering educational resources empowers students to self-pace their learning, and its automated methods as well as the affordances of distribution could improve student engagement with learning resources (Boyinbode et al., 2012). Rashid & Asghar (2016) prove that access and usage of technologies have a direct positive effect on students' engagement and self-directed learning. These findings support the findings of RQ2. As to motivation for learning, prior research demonstrates that digital educational resources could improve the effectiveness of the educational process and student learning motivation, which agrees with the findings of this study (Talysheva et al., 2021).

As to awareness development, 9 categorized responses reported that their mobile learning experiences positively influenced their self-directed learning and learner control through developing an awareness about the educational function of smartphones. Ramli et al. (2018) suggest that internal factors have direct significant influences on self-directed readiness, which is consistent with the results of qualitative analysis since awareness belongs to internal factors. Hughes et al. (2013) examine the significant positive influence of cognitive ability on the effectiveness of self-control learning, confirming the findings of RQ2 in this study. For getting acquainted with learning technologies, 7 responses mentioned the influence of mobile learning experiences on their computer self-efficacy and online communication self-efficacy by making them get acquainted with learning technologies. He and Freeman (2010) prove that computer knowledge and computing experiences influence the formation and development of CSE, which is consistent with the findings of qualitative analysis. Moreover, a prior study concludes that technology use affects several domains of self-efficacy (Shank & Cotten, 2014), which mostly confirms the findings of this study since CSE and OCS are two elements of self-efficacy.

As to app features, 4 responses stated that their mobile learning experiences had a positive effect on their motivation for learning by benefiting from the features of mobile learning applications. According to Pituch and Lee (2006), system characteristics, including functionality and interactivity, have a significant influence on the outcomes and beliefs of e-learning use, which is consistent with the findings of qualitative analysis. When it comes to motivation for searching information, 3 responses recognized the effects of mobile learning experiences on their internet self-efficacy via improving motivation for searching information. According to social cognitive theory, it is proved that physiological/emotional indexes are sources of self-efficacy (Schunk, 2012), which confirms the findings of RQ2 in this study. For learning environment, 3 categorized responses commented that their mobile learning experiences positively influenced their OLR, including online communication self-efficacy, through providing them with a learning environment for communicating online. By situating self-efficacy in social

cognitive theory, Usher and Pajares (2008) suggest that contextual factors can impact the process of forming self-efficacy beliefs, such as what learners observe peers doing and what the instructor tells them, which is consistent with the findings of this study. As to limit on access, 3 responses believed that mobile learning experiences improved their OLR, like learner control, by limiting their access to social media while learning on their smartphones. According to Sorgenfrei and Smolnik (2016), environmental factors including learning conditions may influence the effectiveness of learner-controlled instruction, similar to the findings of the qualitative analysis in this study since access to social media belongs to learning conditions.

On the other hand, some participants denied the influence of mobile learning experiences on some measurements of OLR. Five of 11 participants did not believe their mobile learning experiences affected their motivation for learning. So was learner control. Thus, the partial results of RQ1 could be controversial. Furthermore, only one of the participants did not agree that her mobile learning experiences had any effects on self-directed learning. So was online communication self-efficacy. Thus, among all six measurements of OLR, the influence of mobile learning experiences on self-directed learning and online communication self-efficacy was mostly confirmed by the qualitative analysis results.

In summary, Students with prior mobile learning experiences (MLE) reported significantly higher online learning readiness (OLR) across five dimensions—computer/Internet self-efficacy (CIS), self-directed learning (SDL), motivation for learning (MFL), online communication self-efficacy (OCS), and learner control (LC). Qualitative themes (e.g., access to resources, getting acquainted with learning technologies, awareness development, app features, motivation to search, learning environment, limits on access) explained how MLE may translate into OLR gains.

The CIS quantitative difference converges with findings that repeated technology use and blended/online exposure strengthen general computer self-efficacy (He & Freeman, 2010; Geng et al., 2019). It also aligns with work showing that learners capitalize on online flexibility (time/place), which likely normalizes digital study behaviors (Soffer et al., 2019; Muthuprasad et al., 2021). In contrast, device access alone has not reliably predicted self-direction or outcomes (Bartholomew et al., 2017), and personality factors (e.g., introversion/extraversion) may moderate comfort with online study (Harrington & Loffredo, 2010). Our qualitative "no influence" accounts are consistent with these moderating effects: when baseline confidence is already high—or when access is not paired with purposeful use—CIS gains are attenuated.

Quantitatively higher SDL and rich qualitative confirmations converge with SDL models that emphasize learner-initiated regulation (Song & Hill, 2007; Murad et al., 2010), as well as evidence that SDL is closely tied to intrinsic motivation in large-scale online contexts (Altinpulluk, 2023). However, literature also shows that structure matters: access alone does not guarantee self-direction unless activities are scaffolded (Boticki et al., 2015), whereas mobile designs that provide feedback and clear tasks enhance SDL (Li et al., 2018). Our interviews echo this nuance—participants pointed to app features (progress bars, reminders, micro-tasks) and motivation to search as mechanisms, suggesting that MLE promotes SDL to the extent that it embeds visible progress and actionable feedback.

The MLE group's higher motivation agrees with studies where mobile/AR vocabulary tools improved both motivation and performance relative to traditional methods (Lai & Chang, 2021) and with reports that perceived flexibility supports engagement (Turan et al., 2022). By contrast, several interviewees reported no motivational gain. This contrast is consistent with reviews linking motivation/satisfaction to interaction structures and instructional design choices (Martin & Bolliger, 2022): when courses lack clear pacing, timely feedback, or social presence, MLE may not translate into stronger MFL. Thus, our data extends prior work by highlighting design-quality and learner-preference contingencies.

Our OCS difference converges with studies linking interaction affordances and acceptance to participation in online learning (Arain et al., 2017; Rizun & Strzelecki, 2020). Students' perceptions of reduced evaluation apprehension align with social-cognitive sources of efficacy (social persuasion, vicarious experience) (Usher & Pajares, 2008; Schunk, 2012).

Although LC differences favored the MLE group, interview evidence was mixed. It is demonstrated that learner control improves outcomes when scaffolded (guidance on pace/

sequence, progress visibility) but is not uniformly beneficial across contexts and learners (Fisher et al., 2010; Sorgenfrei & Smolnik, 2016). Participants who did not connect MLE to LC often framed distraction as content-driven rather than device-driven, indicating that without micro-deadlines, chunked activities, and progress dashboards, device familiarity alone may not yield sustained control.

Several interviewees reported no perceived influence of MLE on motivation and/or learner control. Rather than contradictions, these accounts likely mark boundary conditions for the observed effects. First, design quality and interaction structures (e.g., pacing, progress visibility, timely feedback) appear decisive. When absent, MLE may not translate into higher motivation or sustained control (Fisher et al., 2010; Martin & Bolliger, 2022). Second, task–interest fit matters. Participants often framed distraction as content-driven, not device-driven, implying that engaging, chunked tasks are necessary for control to materialize. Third, prior digital fluency may cap perceived gains (e.g., already high confidence; Harrington & Loffredo, 2010). Fourth, contextual constraints (multitasking demands, connectivity, competing obligations) can mute benefits even when access is available (Sorgenfrei & Smolnik, 2016). These boundary conditions help reconcile the divergent cases with the overall pattern. MLE tends to support OLR when paired with structured design, relevant tasks, and supportive study contexts.

IMPLICATIONS

To leverage MLE as a OLR catalyst, institutions should (a) design for SDL and LC via clear pacing, micro-deadlines, and visible progress; (b) structure interaction to build OCS through frequent, low-anxiety exchanges; (c) broaden access to devices/broadband and adopt accessible materials; and (d) prepare instructors through standards-aligned training and practicum experiences. These actions are consistent with the mechanisms students identified (app features, learning environment, and access to resource).

LIMITATIONS

This study has some limitations which should be paid attention to. According to the demographic information of interview participants, there is only one male of total 11 participants. The qualitative data could be controversial because of the gender ratio of interview participants. Also, the sample size of quantitative data could be larger since it has a 60% power. Cohen (1992) categorizes effect sizes as small (0.2), medium (0.5), and large (0.8), and the medium effect is visible to a careful observer. To mitigate typical concerns about 60% power, we (a) report CR alongside p-values, (b) triangulate with qualitative evidence explaining mechanisms, and (c) recommend larger, multi-site samples in future work to improve precision and detect smaller effects. In this study, some participants in the interview were confused about some questions at the beginning, and the interviewer had to explain further to clarify the questions. With the support of enough funding and longer timescale, it will be ideal to replicate the same study with experiments on mobile learning instead of utilizing survey and interviews.

DATA ACCESSIBILITY STATEMENT

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

SUSTAINABLE DEVELOPMENT GOALS (SDGs)

This study is linked to the following SDG(s): Quality education (SDG 4).

ETHICS AND CONSENT

All necessary ethical approvals were obtained from the appropriate Institutional Review Board (IRB) to ensure that the research adhered to ethical standards and regulatory guidelines. All participants provided written or verbal informed consent to conduct the survey and interviews.

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS (CRediT)

Shang Li: Conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing—original draft preparation, writing—review and editing; Wenhao Huang: supervision, project administration, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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TO CITE THIS ARTICLE:
Li, S., & Huang, W. (2025). Do Mobile Learning Experiences Affect College Students' Online Learning Readiness? *Open Praxis*, *17*(4), pp. 785–802. DOI: https://doi.org/10.55982/openpraxis.17.4.894

Submitted: 06 April 2025
Accepted: 09 October 2025
Published: 25 November 2025

Open Praxis is a peer-reviewed open access journal published by International Council for Open and Distance Education.