Miller, B., & Thomas, M., (2021). Accessing Learning Management Systems with Smartphones: What is the Effect on Learning Behavior and Student Engagement? In Crawford, C., & Simons, M.A. (Eds.), *eLearning Engagement in a Transformative Social Learning Environment* (pp. xx-xx). Hershey, New York: IGI Global.

INTRODUCTION

While there has been an increasing amount of research on mobile learning over the last five years (Azizi & Khatony, 2019; Buabeng-Andoh, 2021; Lai, 2019; Ramirez, Arias & Duque, 2019), few studies have specifically investigated university students' approach to learning and engagement patterns in terms of how they access Learning Management Systems (LMS) using smartphones. Where studies do exist of smartphone usage as gateway devices to LMS, the research has often involved students from one particular subject area, rather than quantitative research that explores learning-related variables across a diverse range subject areas (Su & Cheng, 2015). Moreover, the use of terms such as ‘approach to learning’, ‘student engagement’ and a plethora of terms commonly used in research on e-learning have often been used interchangeably and the field would benefit from more precise definitions (Basak, Wotto & Bélanger, 2018; Singh & Thurman, 2019).

In order to address these gaps, this chapter is significant in that it investigated the use of smartphones to access an LMS by undergraduate students in the online courses of a regionally accredited university in the United States involving 1,843 students spread across five diverse disciplinary areas (Education, Health Care Professions, Humanities and Social Sciences, Business and Theology). Arising from a review of relevant research, this quantitative study was guided by two main research questions:

RQ$_1$: Is there a difference in learning approach between students using a smartphone to access an LMS and that taken by students who use other access mediums?

RQ$_2$: Is there a difference in engagement between students using a smartphone to access an LMS and students who use other access mediums?

In the study ‘approach to learning’ was defined by the influential typology of approaches to learning developed by Marton and Säljö (1997) and Purdie, Hattie and Douglas (1996). Following Krause and Coates (2008), ‘engagement’ was defined as the time, commitment, resources, and intentional student-to-student and student-to-instructor proactive involvement that students contribute toward their learning. In what follows, the chapter first contextualises these key terms in a review of relevant research before outlining the methodology of the study and presenting its findings and implications. Given the swift transition to remote forms of online teaching and learning resulting from COVID-19 (Affouneh, Salha & Khlaif, 2020) and the likelihood that educators will need to respond in resilient ways to a rapidly changing and increasingly disaster prone world in future (Baytiyeh, 2018; Tull, Dabner & Ayebi-Arthur, 2017), the chapter’s findings will be of particular value to university teachers, curriculum developers, e-learning designers and program managers, as well as those with limited previous experience in the field, who aim to a) understand how students are using smartphones to access specific online LMS content remotely, and b) develop next generation collaborative learning environments in which mobile devices will be an integral component.

BACKGROUND

Issues, Controversies, Problems

The use of smartphones as a mobile computing device has increased substantially over the past decade, with many students preferring them to obtain course content and to interact with instructors and peers in online courses in place of desktop or laptop computers (Bernacki, Greene & Crompton, 2020; Mayer, 2019). While patterns of ownership and access have increased, the research suggests that a lack of support for applications which utilize smartphones in the learning environment may affect the way students use them in online courses (Shukla, & Shinde, 2016), since social, technological and individual-level constraints for online learning can exist (Song, & Kong, 2017). At the same time Learning Management Systems have emerged as the standard interface for online learning materials, and they typically integrate a variety of teaching tools to provide access to lectures and web-based systems for delivering education (Fearnley & Amora, 2020; Mozahem, 2020). In their study of university instructors using LMS for both distance learning and web-assisted courses in the United States, Wang et al. (2013) found that high levels of interface, interaction and content configurability were associated with higher rates of success for course developers in implementing effective teaching principles. Moreover, the research indicated that the configurability of an LMS is likely to be positively associated with the quality of course content and teaching practices in distance learning environments. Consequently, research suggests that while the decision to use a smartphone depends on the perception that it will be useful for performing meaningful learning tasks (Prahani, Jatmiko, Hariadi, Sunarto, Sagirani, Amelia & Lemantara, 2020), more research is needed on the strategies and approaches to learning students use to complete them.

A widely published conceptualization of the diverse ways in which students approach academic tasks is the three-way categorization of deep, surface and strategic learning arising from the earlier but still seminal work of Marton and Säljö (1997), Tait et al. (1998) and Trigwell and Prosser (1991) that is still highly influential today. When students engage in surface learning, they are often simply regurgitating information without engaging in any further thought or analysis of the information (You, 2019). In contrast, deep learning occurs when students question the information they receive and attempt to connect and synthesize it in relation to larger ideas and concepts (Leenkneckt, Hompus & van der Schaaf, 2019). Students who develop deep learning habits learn to interact with the information they are processing. The third type of learning, strategic learning, is generally defined in terms of moving between deep and surface learning (Häkkinen, Järvelä, Mäkitalo-Siegl, Ahonen, Näykki & Valtonen, 2017). According to Mackay and Burt (2015), students who use strategic learning tend to be organized workers, have a set time for studying, and learn to understand the instructor's marking schemes. While ‘approaches to learning’ is important for understanding particular strategies, we also need to understand the term ‘student ‘engagement’, which has become highly significant in higher education over the last decade, although it is sometimes used in interchangeable ways with it.

Student Engagement

Student engagement is a process of becoming actively involved in learning in which course content and information is considered, discussed and debated, as opposed to passive involvement in which students simply seek to memorize information for the sake of completing a test (Bond, 2020; Salter & Conneely, 2015). Recent research has shown that various technologies such as those that make up Web 2.0, social networks, cloud computing and Student Response Systems (SRS) can be successfully incorporated into education, while contributing to the creation of online learning communities (Chuang, 2016), while over the last year COVID-19 has rapidly expanded remote forms of teaching and learning and raised questions about the future of digitally-mediated instruction (Dhawan, 2020). Indeed, as Basilaia et al. (2020) suggest, it is now essential that students are able to access platforms offering video conferencing applications and recorded content, interaction is available to students via online fora, and that instant feedback can be received by and provided to students.

Earlier research studies exploring the role of mobile phones and student engagement (Keegan, 2005) identified a range of technical issues (e.g., battery life) which have now been solved by the increased levels of sophistication offered by contemporary smartphones. However, few studies examined the relationship between mobile learning, engagement and learning approach. The US National Survey of Student Engagement, for example, found that collaboration among instructor and peers through group work can positively affect student engagement and learning (Ma et al., 2015). Engagement as part of active learning supports group work, including peer instruction. Blackburn and Stroud (2015) asserted that active learning techniques in which students take action rather than merely sit and listen are more effective than merely lecturing. They developed a student response system where instructors could "call on" learners, who then respond by voting with their phones. Blackburn and Stroud (2015) found that this technological implementation increased student participation and engagement.

One of the most difficult facets of mobile instruction appears to be developing the questions to stimulate student engagement. At Stanford University, this problem was solved with an innovative format that provided eight to ten minutes of video lectures interspersed with a software platform that would allow students to network and discuss issues online (Waldrop, 2013). The issues of online learning, such as low completion rates, appear to be largely mitigated using interactive software platforms of this type such as the Socrative student response system developed for the purposes of collaborative learning, as Awedh et al. (2015) found in their study. These platforms allowed students to use smartphones for real-time feedback and networking, which can be integrated not only in classroom environments but also in online environments, and to enhance student engagement as a result. The research implies that m-learning could be effective for those students who do not attend classes physically and using their smartphones makes it easier to access online learning. SRS, which are systems allowing immediate in-class interactions and dialogue between students and instructors, represent a promising development in learning technology in this respect.

Student engagement, as has been discussed within the context of higher education, is a process of becoming actively involved in learning in which course content and information is considered, discussed and debated, as opposed to passive involvement in which students simply seek to memorize information for the sake of completing a test or some other examination (Wang et al., 2009; Osman et al., 2010; Salter & Conneely, 2015). Researchers have argued that the use of mobile devices can lead to greater student engagement because students tend to become more actively involved in the learning process through online networks, such as a possible positive impact of mobile learning on student involvement (Reychav & Wu, 2015). The high level of smartphone use, particularly among higher education students in the United States, makes the smartphone an ideal successor to earlier efforts at developing engagement that tended to use a combination of overhead projectors and 'clickers.'

The problem of engagement might be easier to overcome by exploiting students' natural proficiency with their personal devices. For this reason, Web 2.0, which can loosely be defined as a collection of tools that can be used to create, edit, share, and collaborate online, allows students to take classes through any equipment that can access the Internet. It effectively turns electronic devices into interactive learning devices (Wankel & Blessinger, 2013). The social-centric paradigm emphasizes applications that are participatory and tools that can be used to socially network, to access social media, and to interact in a number of other ways. These technologies are digital, ubiquitous, low cost, and easily applied in academic contexts (Wankel & Blessinger, 2013). While Web 2.0 and SRS do not specifically involve the use of smartphones interacting with an LMS, research on them suggests that incorporating smartphones into education has the potential to encourage higher student engagement.

Notably, Handelsman et al. (2005) developed a 27-item questionnaire for estimating student engagement in classroom environments: The Student Course Engagement Questionnaire (SCEQ), which uses a 5-point measurement scale. Based on their exploratory factor analysis of the primary survey data collected from 266 undergraduate students aged from 18 to 56 at the University of Colorado, Handelsman et al. (2005) defined engagement as a multi-faceted construct involving several aspects: skills engagement (what students "do"); emotional engagement (how connected they feel to the course/content, which is particularly essential in online courses; how pertinent they feel it is); participation/collaboration engagement (connecting with others, getting a charge out of the substance/course); and performance engagement (students' yearning/objective to prevail in the course). Whereas Handelsman et al.'s (2005) study has validated the SCEQ, given that it has found four relatively independent factors corresponding to the skills-related, participatory, emotional and performance-related aspects of engagement with high correlations between skills and emotional engagement and low correlations between other factors, this measurement scale is yet to be thoroughly validated for mobile learning environments.

The above review of the literature indicates that there are technical issues that must be addressed in order to continue to improve LMS accessibility. Additionally, the use of smartphones in online education may have the potential to substantially reduce transactional distance because students so that they implement learning transactions regardless of their location (Andrade, 2016; Dron &

Anderson, 2014). However, this statement demands empirical substantiation, since previous research does not shed sufficient light on this aspect of smartphone use.

Several further gaps have been identified. More specifically, the relations between mobile course structure, the degree to which dialogue between learners and their peers and instructors is present, and the extent of learner autonomy in m-learning settings demand additional empirical inquiry, due to the lack of theoretical and empirical consensus. Likewise, in previous studies divergent empirical findings and theoretical arguments concerning the effectiveness of m-learning exist, especially since mobile learning can be more suited for some student groups than for others (Friedel, Bos, & Lee, 2013; Ayebi-Arthur, 2017). Therefore, it is possible to indicate that a gap in scholarly literature exists, which refers to the degree to which mobile devices can be integrated into learning practices and bring pedagogical advantages to students and instructors alike.

METHODOLOGY

Based on the gaps identified above, this study investigated the ways in which online students use smartphones for learning purposes, the learning approaches they take when accessing LMS, the level of student engagement that mobile learning involves, the learning tasks that students accomplish when using mobile devices and the reasons for students' preferred access to LMS in mobile learning settings. The study focused on two main research questions:

RQ_1: Is there a difference in learning approach between students using a smartphone to access an LMS and that taken by students who use other access mediums? In this context, the study used the categories of deep, surface and strategic learning to describe the ways students approach academic tasks (Marton & Säljö, 1997).

RQ$_2$: Is there a difference in engagement between students using a smartphone to access an LMS and students who use other access mediums? Student engagement is defined as the contribution that students make toward their learning process, including time, personal commitment and resource contributions (Krause & Coates, 2008, as cited in Kahn, 2014).

Participants

Email invitations to participate in the study were sent to the entire online undergraduate population of a regionally accredited university in the United States totaling 24,550 students. The university was based in Arizona and had over 14,000 full-time students at its local campus, and over 60,000 students enrolled for online courses. It was a non-profit organization offering undergraduate, masters and doctoral programs. Of the 24,550 online undergraduate questionnaire invitations, 31.54% unique emails were opened with a click-through-rate of 9.3%, which yielded 1,843 total respondents. Of the 1,843 students, 80% were female with an average age of 39, and 20% were male with an average age of 40. Program category percentages for the respondents, from largest to smallest, were Education (31.78%), Health Care Professions (27.61%), Humanities and Social Sciences (16.73%), Business (16.23%) and Theology (7.65%).

Data Collection

A questionnaire was constructed based on several well-validated tools. First, to identify students' approach to learning, several questions from the Learning and Studying questionnaire developed by the Edinburgh University Centre for Teaching, Learning and Assessment were modified to fit the online context (Tait, Entwistle & McCune, 1998). Additionally, the Student Course Engagement Questionnaire (SCEQ) developed by Handelsman, Briggs, Sullivan and Towler (2005) was adapted because it was found to be reliable over the four engagement dimensions (skills, participation/interaction, emotional and performance). The engagement subscale consisted of 15 items, and the approaches to learning subscale consisted of 12 items. Cronbach's alphas for the 15 engagements and 12 approaches to learning items were .84 and .66 respectively. Nunnaly and Bernstein (2010) assert that .70 can be an acceptable minimum for newly developed scales. Although most questions within the approaches to learning subscale were adapted from the Learning and Studying questionnaire from the Edinburgh University Centre for Teaching, Learning and Assessment, the researcher felt it necessary to remain strict in determining internal reliability and validity as if the approaches to learning subscale were an entirely new scale. Thus, a Cronbach's alpha of at least .70 was needed to validate the reliability of this subscale. The item correlations for two items within the approaches-to-learning subscale were anomalously low; therefore, the decision was made to remove these two items (item 21 and 23), which resulted in a corresponding increase in Cronbach's alpha for the approaches-to-learning subscale to .73 and a total item count of 10. Although these items were omitted from future analyses within the approaches to learning subscale, they were not removed from the final survey instrument sent to the remaining online undergraduate student population. The results of a pilot study gave merit to the survey's construct validity and reliability, so the decision was made to proceed in emailing the survey to the remaining online undergraduate population.

Data Analysis

The data analyses of the questionnaire results consisted of a reliability analysis, factor analysis, ANOVA, post-hoc tests and logistic regression. Reliability and factor analyses were used to test and confirm the appropriateness of the approaches to learning and engagement subscales. ANOVA, post-hoc tests and logistic regression were used to measure differences, if any, in the approaches to learning and engagement subscales between varying levels of smartphone use to access the LMS.

SOLUTIONS AND RECOMMENDATIONS

Research Question 1

The first research question explored whether there was an approach-to-learning difference between online students using a smartphone to access their LMS and those who used other mediums. Table 1 shows the subscale variables that were used to answer this question (e.g., deep, surface and strategic learning).

Table 1. Survey Items Included in Learning Approaches Subscales

Learning Approaches and Subscale Items
Deep Learning Subscale
15. I seek to understand for myself the meaning of what is being taught.
16. I try to make sense of things by linking them to what I know already.
18. I look at evidence carefully to reach my own conclusion about what I'm studying.
19. When reading course material, I try to find out for myself exactly what the author means.
Surface Learning Subscale
20. Much of what I've learned seems no more than lots of unrelated bits and pieces in my mind.
22. I tend to take what is taught at face value without questioning it much.
Strategic Learning Subscale
24. I manage to find conditions for studying which allow me to get on with my studying easily.
25. I create a study schedule.
26. I pay attention to what my instructors seem to think is important and concentrate on that.
27. I look carefully at instructors' comments on my assignments to see how to get a higher score next time.

An ANOVA was performed with the variable of "How often do you use your smartphone to sign into your online classroom?" as the dependent variable, and the subscale variables for deep, surface and strategic as the independent variables. The results of the ANOVA are shown in Table 2 and indicate that for the deep learning approach, there was no statistically significant difference in learning approaches for the participants based on how often they used their devices. However, the results showed that there was a statistically significant difference with regard to the strategic learning approach based on how often participants used their smartphones to sign into the online classroom. The results in Table 2 also showed that there was a statistically significant difference with regard to the surface learning approach based on how often participants used their smartphones for this process.

Table 2. ANOVA for Learning Approaches Subscales

Subscale		Sum of Squares	df	Mean Square	F	Sig.
DEEP	Between Groups	20.255	4	5.064	0.85	0.494
	Within Groups	9767.022	1639	5.959		
	Total	9787.277	1643			
STRATEGIC	Between Groups	79.987	4	19.997	2.71	0.029
	Within Groups	12204.35	1654	7.379		
	Total	12284.338	1658			
SURFACE	Between Groups	78.1	4	19.525	7.158	0.000
	Within Groups	4506.273	1652	2.728		
	Total	4584.373	1656			

Based on the results of the ANOVA, there were also significant differences in the learning approaches of the participants in terms of how often they used their smartphones.

In relation to the second research question, data indicated that the frequency of LMS use via smartphones was not related to deep learning, but was significantly interrelated to both strategic and surface learning. Consequently, it was necessary to ask where differences existed in terms of how often students signed into their online classes using their phones. To answer this question, the post-hoc test of least significant difference (LSD) was performed. The results in Table 3 show that for the strategic subscale, the only response category that was significantly different from the others was the "always" response, which allowed us to reject the null hypothesis that no difference existed, whereas the low p value levels (0.002-0.007) indicated a low probability of Type I error. These results implied that students who always used their smartphones to sign into the online classroom had a higher strategic learning and surface learning approach than the students who "never", "very seldom", "occasionally", and "frequently" used their smartphones.

Table 3. ANOVA Results for Approaches to Learning Subscales

Subscale			Mean Difference	S.E.	Sig.
STRATEGIC	Never	Very seldom	-7.51E-02	0.2041	0.713
		Occasionally	5.32E-03	0.1852	0.977
		Frequently	3.11E-03	0.1841	0.987
		Always	-0.9529	0.3075	0.002
	Very seldom	Never	7.51E-02	0.2041	0.713
		Occasionally	8.04E-02	0.2095	0.701
		Frequently	7.82E-02	0.2085	0.708
		Always	-0.8778	0.3227	0.007
	Occasionally	Never	-5.32E-03	0.1852	0.977
		Very seldom	-8.04E-02	0.2095	0.701
		Frequently	-2.21E-03	0.1901	0.991
		Always	-0.9582	0.3111	0.002
	Frequently	Never	-3.11E-03	0.1841	0.987
		Very seldom	-7.82E-02	0.2085	0.708
		Occasionally	2.21E-03	0.1901	0.991
		Always	-0.956	0.3104	0.002
	Always	Never	0.9529	0.3075	0.002
		Very seldom	0.8778	0.3227	0.007
		Occasionally	0.9582	0.3111	0.002
		Frequently	0.956	0.3104	0.002
SURFACE	Never	Very seldom	-4.33E-02	0.124	0.727
		Occasionally	-0.1158	0.1125	0.304
		Frequently	-0.1921	0.1125	0.088
		Always	-0.959	0.1846	0.000
	Very seldom	Never	4.33E-02	0.124	0.727
		Occasionally	-7.25E-02	0.1271	0.569
		Frequently	-0.1488	0.1271	0.242
		Always	-0.9157	0.1938	0.000

Subscale			Mean Difference	S.E.	Sig.
	Occasionally	Never	0.1158	0.1125	0.304
		Very seldom	7.25E-02	0.1271	0.569
		Frequently	-7.64E-02	0.1159	0.510
		Always	-0.8432	0.1867	0.000
	Frequently	Never	0.1921	0.1125	0.088
		Very seldom	0.1488	0.1271	0.242
		Occasionally	7.64E-02	0.1159	0.510
		Always	-0.7668	0.1867	0.000
	Always	Never	0.959	0.1846	0.000
		Very seldom	0.9157	0.1938	0.000
		Occasionally	0.8432	0.1867	0.000
		Frequently	0.7668	0.1867	0.000

The results indicated that the difference in the learning approach of students in terms of how often they used their smartphones was based on strategic and surface learning. Another way to examine the research question of whether there was a difference in learning approaches among the students was to perform a logistic regression using the data from the question of "have you used your smartphone to sign into your online classroom" as the dependent variable. The independent variables for the logistic regression were those created for the learning subscales of deep, surface and strategic. The results showed if the independent variables were predictors of the dependent variables (i.e. if approaches to learning sub scores were predictors of smartphone use within the LMS).

Unlike the results with the ANOVA, the results of the logistic regression showed that none of the three learning approach variables were significant predictors of signing in with their smartphones (see Table 4). Given the relatively high p values for all of the examined learning approaches, the probability of Type II error was relatively low, as in each case the null hypothesis was accepted. This means that approach to learning categorical variables were not strong predictors of whether or not students used their smartphones.

Table 4. Logistic Regression to Predict Usage of Smartphone in the Online Classroom

Subscale	Beta	S.E.	Sig.
Deep	-0.029	0.0276	0.2936
Strategic	-0.0017	0.024	0.9451
Surface	-0.0581	0.0352	0.0984
Constant	-0.0176	0.4727	0.9702

The conclusion that can be drawn from these results is that there was a difference in learning approaches between the participants in their use of smartphones to access their LMS. However, the difference was not related to those students who had or had not used their smartphones to access the LMS. Instead, the difference in learning approaches was related to how often the students accessed the LMS. For those students who always accessed the LMS with their smartphones, there was a greater likelihood of utilizing both strategic and surface learning approaches compared to the other students. However, there was no difference between students in the use of the deep learning approach based on the frequency with which they used smartphones.

By contrast, the two questions that formed the surface subscale were: “Much of what I’ve learned seems no more than lots of unrelated bits and pieces in my mind” and “I tend to take what is taught at face value without questioning it much” (items 20 and 21). These questions gave credence to Tait et al.’s (1998) description of surface learning and suggested that the students’ behavioral study habits may have been the cause of the higher score on the surface learning subscale rather than the use of their smartphone. Additionally, the finding that the effect on surface learning only occurred with the “always” frequency group suggested that some confounding variable not accounted for in the design of the study may have mediated the frequency of smartphone use and the outcome of higher levels of surface learning.

To draw out this latent factor of the “always” group (those who selected “always” to describe the frequency of using a smartphone to log into their online classroom) and their correlation with higher levels of surface learning, an ANOVA of how often students indicated they used the smartphone to log into the LMS was used as the factor, and the students’ university grade point average (GPA) was the dependent variable.

This ANOVA tested the null hypothesis that GPA (e.g., a measurement of student performance) was related to the frequency of smartphone use to log into the LMS. The results of the ANOVA indicated that smartphone use frequency was not a significant factor to student GPA for either female or male respondents. These results indicated that low-performing students were not likely to be more susceptible to further smartphone use frequency, as one might assume.
However, a noteworthy finding of the post-hoc t-tests of the ANOVA revealed a statistically significant difference in GPA for male respondents between the “never” and “always” groups to the question of “how often do you use your smartphone to log into your online classroom?” Tables 5 and 6 provide the ANOVA analysis results for student GPA based on how often participants used a smartphone to sign into the online classroom.

Table 5. Student GPA and Smartphone Use Frequency

Subscale		Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Between Groups	1.154	4	0.289	0.857	0.489
	Within Groups	394.438	1172	0.337		
	Total	395.592	1176			
MALE	Between Groups	1.770	4	0.443	1.409	0.231
	Within Groups	91.727	292	0.314		
	Total	93.497	296			

More specifically, the above results indicate that a low probability of Type II error existed, when the null hypothesis that there was no difference for female and male respondents in the interrelation between student GPA and smartphone use frequency was accepted, since the p value (0.489; 0.231) levels were found to be significantly higher than 0.05. By contrast, only male students who always used their mobile phones to access LMS were found to have significant differences in their GPA levels as opposed to students who had never used their smartphones for LMS access, since the corresponding p value (0.026) was lower than 0.05.

Table 6. Post-Hoc ANOVA Results for Student GPA and Smartphone Use Frequency

Subscale			Mean Difference	S.E.	Sig.
MALE	Never	Very seldom	0.073	0.099	0.460
		Occasionally	0.035	0.097	0.718
		Frequently	0.109	0.087	0.211
		Always	.31231*	0.140	0.026
	Very seldom	Never	-0.073	0.099	0.460
		Occasionally	-0.038	0.107	0.720
		Frequently	0.036	0.098	0.716
		Always	0.239	0.147	0.105
	Occasionally	Never	-0.035	0.097	0.718
		Very seldom	0.038	0.107	0.720
		Frequently	0.074	0.096	0.441
		Always	0.277	0.146	0.058
	Frequently	Never	-0.109	0.087	0.211
		Very seldom	-0.036	0.098	0.716
		Occasionally	-0.074	0.096	0.441
		Always	0.203	0.139	0.145
	Always	Never	-.31231*	0.140	0.026
		Very seldom	-0.239	0.147	0.105
		Occasionally	-0.277	0.146	0.058
		Frequently	-0.203	0.139	0.145

The results of the study also showed that the participants who always used smartphones to access the LMS for online courses had higher strategic learning subscale scores. The four survey questions that formed the strategic subscale were: “I manage to find conditions for studying that allow me to get on with my studying easily”; “I create a study schedule”; “I pay attention to what my instructors seem to think is important and concentrate on that"; and "I look carefully at instructors' comments on my assignments to see how to get a higher score next time" (items 24, 25, 26 and 27).

An explanation for the findings can be drawn from items 24 and 25: students who always used their smartphones to access the online course may have been able to (or perceive that they could) adapt to their environment more easily and convert their current environment into a study situation through their use and aptitude of the smartphone. Another explanation of the findings from items 26 and 27 might be that students who always used their smartphone to access the online course perceived that they were strategic in their learning habits, whether effective or not. From this perspective, the data suggested the importance of the student characteristics for converting information into knowledge. As a result, the smartphone may have merely provided a tool for the students to engage in behaviors that led to strategic learning. Therefore, one must consider that this effect was only significant for the group of students who indicated they always used their smartphone.

Research Question 2

To answer research question 2 (Is there an engagement difference between students using a smartphone to access their LMS and students using other media?), four engagement subscale questions were used related to skills, emotional engagement, participation/interaction and performance (see Table 7).

Table 7. Survey Items Included in Learning Engagement Subscales

Learning Engagement and Subscale Items
<u>Skill Engagement</u>
1. Make sure to study on a regular basis.
2. Create study notes while reviewing course material.
3. Frequently check for instructor comments and updates.

Emotional Engagement
4. Find ways to make course material relevant to me.
5. Applying course material to my life.
6. Reflect on course content and topics even when I'm not actually logged into class.
7. Really desiring to learn the material.
Participation/Interaction
8. I frequently ask my instructor about specifics related to feedback of my assignments.
9. I frequently exceed the minimum online discussion participation requirement.
10. I enjoy interacting with other students in class.
17. I typically only meet the minimum online discussion participation requirement.
Performance Engagement
11. I desire to do well on tests and assignments.
12. Earning a good grade is important to me.
13. I regularly checked the progress of my course grade.
14. I'm confident I can learn the course material.

To answer the second research question, an ANOVA was performed with the variable of "How often do you use your smartphone to sign into your online classroom?" as the dependent, and the subscale variables for skill, emotional engagement, participation/interaction and performance as the independent variables. The null hypothesis for the ANOVA was that there was no statistically significant difference in engagement subscales of students based on how often they used their smartphones to sign into their online classes. The alternative hypothesis was that there was a statistically significant difference between the engagement subscales based on how often they used their smartphones to sign in.

Table 8 shows the results of the ANOVA and indicates that the only learning engagement subscale in which there was a significant difference based on how often the participants used their smartphones was emotional engagement, in relation to which a Type I error was unlikely to be made, as the p value (0.02) for the emotional subscale was below 0.05. None of the other subscales were significantly different with regard to how often the participants used their smartphones to access the online classroom. Thus, as regards skills, participation and performance subscale, it is unlikely that a Type II error was committed, as all respective p values (0.46; 0.23; 0.22) were found to be significantly higher than 0.05. The ANOVA for learning engagement was based on how often participants used smartphones to sign in.

Table 8. ANOVA Results for Learning Engagement Subscales

Subscale		Sum of Squares	df	Mean Square	F	Sig.
SKILLS	Between Groups	16.653	4	4.163	0.896	0.465
	Within Groups	7867.848	1694	4.645		
	Total	7884.5	1698			
EMOTIONAL	Between Groups	84.733	4	21.183	2.85	0.023
	Within Groups	12420.596	1671	7.433		
	Total	12505.329	1675			
PARTICIPATION	Between Groups	60.217	4	15.054	1.378	0.239
	Within Groups	18042.378	1652	10.922		
	Total	18102.595	1656			
PERFORMANCE	Between Groups	17.442	4	4.361	1.416	0.226
	Within Groups	5129.495	1666	3.079		
	Total	5146.937	1670			

The question that arose relates to where the differences existed in terms of how often students actually signed in. To answer this question, the post-hoc test of least significant difference (LSD) was performed. This is a t-test in which differences between the means of each response category of the factor are compared, which in this case was how often the students indicated that they signed in on their smartphones.

Table 9 shows the results of the LSD test for each of the response categories for the emotional engagement subscale. Any category with a significance of 0.05 or less indicates that the mean difference from the other response categories was statistically significant. The results show that for the emotional subscale, the only response category that was statistically different from the others was the “always” category, as compared to the “never” category, which also indicated a low probability of Type I error for the combination of these categories, given its low p value (0.02). This meant that a significant difference in emotional engagement existed between the students who indicated that they always used their smartphones to access the online classroom as compared to the students who indicated that they never used their smartphones to access the online classroom.

Table 9. Post-Hoc ANOVA Results for Engagement Subscales

Subscale			Mean Difference	S.E.	Sig.
EMOTIONAL	Never	Very seldom	-0.3205	0.2037	1.000
		Occasionally	-0.3245	0.1848	0.793
		Frequently	-0.117	0.1843	1.000
		Always	-0.945	0.3057	0.020
	Very seldom	Never	0.3205	0.2037	1.000
		Occasionally	-3.99E-03	0.2088	1.000
		Frequently	0.2035	0.2084	1.000
		Always	-0.6246	0.3208	0.517
	Occasionally	Never	0.3245	0.1848	0.793
		Very seldom	3.99E-03	0.2088	1.000
		Frequently	0.2075	0.19	1.000
		Always	-0.6206	0.3091	0.449
	Frequently	Never	0.117	0.1843	1.000
		Very seldom	-0.2035	0.2084	1.000
		Occasionally	-0.2075	0.19	1.000
		Always	-0.828	0.3088	0.074
	Always	Never	0.945	0.3057	0.020
		Very seldom	0.6246	0.3208	0.517
		Occasionally	0.6206	0.3091	0.449
		Frequently	0.828	0.3088	0.074

Another way in which to examine the research question of whether there was a difference in learning engagement among the students who used smartphones to access the online classroom was to perform a logistic regression using the data from the question "have you used your smartphone to sign into your online classroom?" as the dependent variable. This question allowed for the complete separation of students who used their smartphones in any way as compared to those students who did not. Table 10 shows the results of the logistic regression analysis. The null hypothesis for the regression was that the independent variables were not significant predictors of the dependent variable. The alternative hypothesis was that the independent variables were significant predictors of the dependent variable. Any independent variable with a p-value of less than 0.05 was determined to be a significant predictor of the dependent variable.

Table 10. Logistic Regression Results of Independent Variables Regressed

Subscale	Beta	S.E.	Sig.
Skills	0.073	0.035	0.040
Emotional	-0.109	0.028	0.000
Participation/Interaction	0.027	0.020	0.164
Performance	0.028	0.036	0.439
Constant	-0.603	0.592	0.308

Unlike the results with the ANOVA, the results of the logistic regression showed that both the skills and emotional engagement variables were significant predictors of whether the participants had ever used their smartphones to sign in. For this reason, for the variables skills and emotional, the null could be rejected with a low probability of Type I error, due to low levels of p values (0.040; 0.000) respectively. Conversely, for the variables participation/interaction and performance, the null hypothesis was accepted with a low probability of Type II error, given the significantly high p values (0.164; 0.439) respectively.

The positive beta coefficient from the logistic regression for the skill variable showed that the students had accessed the online classroom with their smartphones had higher scores on the skills engagement variable than the students who had not. However, the negative beta coefficient for the emotional variable indicated that the students who accessed the online classroom from their smartphones had lower emotional learning engagement scores.

Therefore, in relation to the second research question, the data indicated that a consistent, but situation-dependent difference, such as among those who always used their mobile phones to access LMS, between students using a smartphone and those making use of a computer in relation to the emotional subscale of engagement, existed. Nevertheless, the logistic regression results also suggested that the skills subscale of engagement was also positively interrelated with the tendency to use a smartphone to access the LMS, whereas the emotional subscale was found to have a negative loading on the latter dependent variable.

Discussion

The empirical findings indicate that the frequency of smartphone use did not significantly affect students' academic aptitude, as measured by their GPAs. However, it was also found that for male students, a significant difference in GPA score levels existed (a lower GPA), in particular, for those who always used their smartphones to access course materials as opposed to those that never used their mobile phones for that purpose. Moreover, smartphone use frequency was significantly associated with the strategic subscale of learning approach.

The results also indicated that the constant use of smartphones to access the LMS did not contribute to higher levels of deep learning among students in online courses when compared to the use of the smartphones for either frequent or occasional access to the LMS. Prior research has not investigated the relationship between mobile technology and deep learning. Deep learning involves the effort of students to connect the information learned in class to larger ideas. Consequently, deep learning involves some degree of critical thinking as delineated in Bloom's taxonomy (Forehand, 2010). The use of a smartphone as the primary means of accessing the

LMS had a positive correlation to surface and strategic learning. However, the existence of a positive correlation does not necessarily constitute causality. The use of the smartphone to access the LMS may be an associated behavior of learning rather than a casual factor of surface or strategic learning. These findings also relate to the suggestion of Kashi (2016) that, rather than being a passive activity, learning is mutually constituted by self-directed practices, such as the cognitive experiences that learners gain via their mobile devices and their social interactions with other learners and instructors.

Although there were no differences among the groups that had “never”, “very seldom”, “occasionally”, and “frequently” used smartphones to access online content, a significant interrelation between the group of respondents that always made use of smartphones and higher scores on surface and strategic learning was found. This partially supported the argument of Kashi (2016) that the social and cognitive dimensions of learning are interrelated. Nevertheless, the findings also suggest that the rate of smartphone use is not likely to affect the levels of deep learning and academic aptitude that students exhibited. By contrast, and particularly among students that used their smartphones very frequently, smartphone use for LMS access can be expected to lead to differences in the strategic and surface aspects of their learning approach. Those with higher levels of surface and strategic learning approaches may be more inclined to use the smartphone as an LMS access tool, which demands additional research into the interrelations between these variables. Remarkably, 30% (n=519) of the respondents indicated they “frequently” or “always” used their smartphone to access the LMS.

In relation to the second research question, the findings supported the conclusion that students in online courses who use smartphones to access the LMS have greater emotional engagement with the course and the online learning experience. Additionally, the skills and emotional scales in the questionnaire were found to be predictors of whether students used a smartphone to sign into the LMS.

The structure of the questionnaire fundamentally tested the proposition of Handelsman et al. (2005) that engagement consists of the four constructs of skills, emotional, participation and performance engagement. The analysis showed that there were no statistically significant differences among the groups in the subscales concerning skills, participation/interaction and performance engagement. The findings, however, determined the existence of a statistically significant difference among the groups in the subscale of emotional engagement.
The LSD assessment of the emotional engagement data indicated that a statistically significant difference existed in the dimension only between the group that never used the smartphone to access the LMS and the group that always used the smartphone to do so, which indicates that emotional engagement is significantly associated with smartphone use behavior. The logistic regression analysis of the data, however, found a negative correlation between use of the smartphone and emotional engagement as well as a positive correlation between use of the smartphone and skills engagement, which supports the previous findings.

The finding that frequent use of the smartphone was negatively associated with emotional engagement may reflect the personal characteristics of the individual student. The four survey questions that constituted the emotional engagement subscale were: “I find ways to make course material relevant to me”; “applying course material to my life”; “reflect on course content and topics even when I’m not actually logged in to class”; and “really desiring to learn the material” (items 4, 5, 6 and 7). Emotional engagement corresponds to the desire to truly learn the material and to apply the learning to their lives (Handelsman et al., 2005). The explanation, however, does not consider why a student would prefer to use a smartphone at times when access to the

LMS with a larger screen computer is possible. The assumption was made when the study began that the smartphone would merely provide access to the LMS when away from computers or other types of mobile devices. Instead, it is possible that smartphone use was simply a preferred mode of utilization for some portion of the students. If the students preferred to use the smartphone rather than the desktop, there may have been a few confounding variables not addressed in the study.

The positive correlation between skills engagement and smartphone use also suggests that those with lower smartphone use levels may have had difficulties, while accessing LMS online for the purposes of m-learning. This can also have implications for the overall engagement levels of mobile learners. The three survey questions that formed the skills engagement subscale were: “I make sure to study on a regular basis”; “create study notes while reviewing course material”; and “frequently check for instructor comments and updates” (items 1, 2 and 3). Skills engagement involves study habits and organizational practices (Handelsman et al., 2005). The finding concerning the skills subscale, thus, may be understandable based on the multi-dimensional definition of engagement offered by Krause and Coates (2008), such as in relation to online learning, self-managed study, peer relations and student-staff interactions. Without the use of the smartphone, the student may need to make a greater scheduling commitment and spend more time studying and organizing the personal learning process.

LIMITATIONS OF THE STUDY

The data were collected from students at a single, regionally accredited US university, which raises the possibility that specific practices exist at the institution that are not common in other institutions. Although the number of student responses to the questionnaire was significant (n=1,843), the response rate was relatively low, which may indicate that the findings were subject to self-selection bias and did not reflect the practices and perceptions of the entire university's online student-body. Likewise, the research variables may have been affected by factors external to the m-learning context in which smartphone use was investigated. Moreover, reliance on student perception in a questionnaire limited the generalizability of the study. Because the LMS was unable to track student interactions with the platform, the lack of student behavioral data limited the possible conclusions of the study.

FUTURE RESEARCH DIRECTIONS

Recommendations for future research include the requirement to measure approaches to learning and student engagement differences using actual LMS data. This approach would seek to obtain data to understand the profile of learners through as a result of the frequency of LMS access, the number of posts, the time signed in etc. LMS student behavioral data could provide a more acute overview of what students do when signed into the LMS via smartphone, and future research could apply student and institutional data such as program of study and student year of study, thus investigating any latent approaches to learning and student engagement differences between specific student populations when using a smartphone.

The current research examined the relationship between smartphone use and constructs such as learning approaches and student engagement. The research did not investigate the effect of smartphone use on learning outcomes and performance. Although course grades (a summative assessment) were considered, grades are not a pure indicator of learning (LaFave, 2016). As a result, future research could study the use of the smartphone and specific outcomes related to the online class such as academic performance and student perceptions of instructor immediacy as related to students using the smartphone to access their LMS. Additionally, future research could investigate student outcomes related to agendas such as smartphone use and the effect on retention. Methodologically speaking while the use of the quantitative approach described above can provide insights into what students do, there are clearly opportunities to supplement this approach with qualitative data from student perspectives. A mixed approach could thus provide an evidence base to justify additional expenditure necessary for institutions to develop smartphone apps and to make other technological changes necessary to maximize the ability of students to use smartphones in online courses in the ‘new normal’ of the post-COVID world.

CONCLUSION

The results tend to support some of the arguments of previous researchers concerning smartphone usage patterns. The quantitative analyses, such as the regression analysis of the empirical data, have identified a correlation between the frequency of use of the smartphone to access the online course and the learning approach dimensions of surface and strategic learning. More specifically, the study indicated that a significant difference in strategic and surface learning approaches between students that always used their smartphones to access LMS exists, whereas no significant differences were found in relation to deep learning. This suggests that smartphone use among students is not likely to detract from their levels of deep learning and their consequent aptitude levels.

Moreover, there were no significant differences among the groups based on the frequency of use of the smartphone to access the LMS and the performance and participation dimensions of student engagement. In other words, students who make use of their smartphones very frequently to access online courses and LMS interface are likely to be associated with strategic and surface learning practices. By contrast, accessing the LMS via mobile phone may be promoted by student skill levels, as a factor influencing student engagement, even though m-learning may be affecting negatively the emotional engagement of m-learners, especially among those who use their smartphones infrequently.

In terms of recommendations for universities and course designers, a primary impact and practical application of the findings of the study are the recommendations for the design of the technology associated with online courses to ensure that the LMS can support the use of smartphones by students and instructors. A smartphone-friendly app allowing LMS students and instructors access to their online LMS may augment the student-to-instructor and peer-to-peer interaction frequency. The general trend in society toward increased use of smartphones suggests that students in online courses are very likely to use them as a preferred device for connecting with an LMS. As a result, institutions offering online courses should ensure that smartphones could be easily used with the LMS technology. Higher education institutions should also consider developing apps or entering an agreement to secure rights to use apps to facilitate the smartphone interactions with the LMS. Because of the need for institutions to ensure that LMS can support and interface with smartphones, the cost of developing online courses could increase. The changes, however, may be necessary for institutions to remain competitive as students shift toward increasing use of smartphones for online learning. Therefore, universities may want to consider the possibility of decreasing assignments that would not contribute to social learning environments, while increasing the share of those assignments that are based on and promote social and interactive online learning from mobile devices. Universities may also be advised to not only develop mobile-friendly LMS but also contribute to the development of m-learning skills among distance learning students. Especially given that students can use a range of mobile devices to access LMS over the Internet, the results of the study suggest that there is a significant relationship between the technology in smartphones and the ability of students to perform tasks required in online courses. The course design should also assume that many students will be learning and performing required tasks in relatively short segments of time because of accessing the LMS from remote locations when time is available. The course sections or segments should be relatively brief or condensed to reflect the actual behaviors and practices of students using smartphones. In addition, the course content could be designed with the smartphone in mind, such as increasing the amount of audiovisual material in the course that is suitable for downloading to a smartphone and which may help mitigate surface learning and promote deeper levels of learning. However, consideration should be given to avoid constraining curriculum and course design to fit the student and teacher relationship if it is not the best solution for student learning. Care must be taken to make choices that will lead to solutions for effective student learning (Affouneh, Salha & Khlaif, 2020).

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KEY TERMS AND DEFINITIONS

Approach to learning: what students do to learn, how they learn and what strategies they use.

Deep learning: an approach in which students aim to achieve understanding of what they are learning.

Learning Management System: or LMS is an online content-management system such as Moodle or Blackboard.

Mobile learning: or M-learning is the use of portable digital devices such as tablets or smartphones.

Online learning: learning using Internet-based platforms which can involve synchronous, asynchronous or a combination of both approaches.

Student engagement: the time, commitment, resources, and intentional student-to-student and student-to-instructor proactive involvement that students contribute toward their learning.

Surface learning: an approach in which students are often merely engaged with memorizing information or rote learning.