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A MOBILE LEARNING COMMUNITY IN A LIVING LEARNING COMMUNITY: PERCEIVED IMPACT ON DIGITAL FLUENCY AND COMMUNICATION

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ABSTRACT
Though mobile devices like smartphones, tablets, and tablet computers have an immense potential for improving student learning, there is little empirical research which reports ways in which students actually use these technologies for learning, especially in fields like Engineering. Based on a social-constructivist approach to learning, the purpose of this mixed methods study was to investigate student perceptions regarding changes in mobile device based digital fluency and communication, after participation in a Living Learning Community (LLC) based Mobile Learning Community. This study contributes to existing literature in the field in that it reports student perceptions of how mobile devices can support learning, impact soft skill practice through peer communication, and enhance basic digital fluency among students living in an Engineering LLC. Based on the findings of this study, recommendations are made which might be useful for LLC Faculty in Residence (FIRs), housing staff, and those working with LLCs.
Keywords: Living Learning Community, Mobile Learning, Mobile Devices, Digital Fluency, Soft Skills, Communication, Housing

Introduction

Mobile devices facilitate learning that can happen anytime, anywhere (Foti & Mendez, 2014) blurring the boundaries between formal and informal learning (Falloon, 2015). The use of mobile devices like tablets and smartphones are a rapidly emerging trend in learning, both within and outside the formal educational setting (Carroll et al., 2017; Kumari, Matthew, & Syal, 2017; Moreira, Ferreira, Santos, & Durao, 2017; Nweke, Teh, Al-garadi, & Alo, 2018). Mobile devices enable users to easily connect with each other, communicate, create content, conduct online research, store, and share information. Often, learners using mobile devices to support learning, perform better than learners using traditional forms of instruction (Volk, Cotič, Zajc, & Istenic Starcic, 2017; Wang, 2017) unsupported by such devices. Therefore, it can be a worthwhile goal to harness the multiple educational, creative, and communicative potentials of mobile devices using appropriate mobile device based learning strategies.

Background

Mobile devices like smartphones, tablets, and tablet computers have an immense potential for improving student learning (Riley, 2013; Welsh et al., 2015; Zhen, 2017). Learning can happen in collaborative (Brandon van der, Richard, Lise, & FAlan, 2016; Falloon, 2015), authentic settings, i.e. real life contexts (Naylor & Gibbs, 2015), and use active learning approaches (Gibeault, 2015). Mobile devices have been found to facilitate learning when students created digital learning content individually (Bose & Pakala, 2015; Liao & Humphreys, 2014) and in specific teams (Bose & Pakala, 2014; Ke & Hsu, 2015), as well as learned collaboratively with others (Kukulska-Hulme & Viberg, 2018).

The impact of using mobile devices largely depends on how it is used for teaching and learning in any particular setting (Montrieux, Vanderlinde, Schellens, & De Marez, 2015). Sometimes, the best educational outcomes are achieved when digital learning tools like tablets are used to complement traditional learning tools like paper and pencil (Souleles, 2017). While the use of tablets to facilitate learning and communication has been studied in disparate fields like medicine (Ji-Hyun et al., 2013; Langius-Eklöf et al., 2017; Mallet et al., 2016), intergenerational social development (Amaro, Oliveira, & Veloso, 2017), and early childhood education (Jauck, & Peralta, 2016),

there has been limited evidence on how it affects student learning in higher education (Wakefield, Frawley, Tyler, & Dyson, 2018).

With the connectivity, convenience, and learning opportunities enabled by mobile devices, comes the notion of the "problematic use" of such devices (Kim, 2018, p. 390) such that some have questioned whether mobile learning supports or endangers learning in classrooms (Pedro, Barbosa, & Santos, 2018; Tossell, Kortum, Shepard, Rahmati, & Zhong, 2015). Moreover, though smartphones and internet access are commonly found infrastructures in many academic campuses, there is little empirical research which reports in detail, the ways in which students actually use these technologies for learning (Barden & Bygroves, 2017).

Often, studies indicating the benefits of using mobile devices for educational purposes have shown mixed results (Garcia-Sanjuan, Jurdi, Jaen, & Nacher, 2018), statistically insignificant effect size (Kukulska-Hulme & Viberg, 2018), and have not yet been conducted in many disciplines (Hlodan, 2010) of higher education, especially with first-year Engineering students.

Theory of mobile learning. While hypothesizing on what can constitute a theory of mobile learning, some early theorists have stated that what differentiates mobile learning from other forms of learning is the assumption that learners are continually on the move (Sharples, Taylor, & Vavoula, 2005). Learning occurs across space, time, and topic, such that learning and skills can be transferred across contexts and life transitions. New technologies are increasingly being designed for a society of people on the move, trying to fit learning into the gaps of their usual life functions. Since a lot of learning occurs outside of physical and online classrooms, the challenge is to understand how learners may be engaging with their environments to create spontaneous sites of learning.

This study draws on El-Hussein and Cronje's (2010) interpretation of mobile learning as having three components – mobility of the technology, mobility of the learner, and mobility of the learning process. Though learning is inherently a process and mobile technology simply facilitates that process (Walsh, 2015), for the purposes of this study, learning specifically refers to the acquisition of basic skills and knowledge required to fluently or effortlessly use mobile devices to communicate with others and to support the gain of discipline based subject matter content expertise. This form of learning is related to mobile learning in that the former is assumed to be an inherent part of the latter.

Social-constructivist theory of learning. Mobile devices provide the learner with certain affordances like flexibility, continuity of use, quick feedback, personalized content, socialization, self-evaluation, active participation, peer coaching, outdoor and cultural authenticity (Kukulska-Hulme & Viberg, 2018, p. 207; Sharples, Taylor, & Vavoula, 2005). These affordances suggest that a social-constructivist approach may be an appropriate theory of learning which can support mobile learning. Based on the writings of Vygotsky (1978), the social-constructivist approach to education views learning as a process situated within a social context, which involves complex social interaction, and requires an understanding of the relationship between how people think and the activities they engage in (Hashim & Hoover, 2017).

Soft skill learning in Engineering. In order to succeed at their jobs, 21st century engineers are expected by their employers to possess certain soft skills including communication, teamwork, management, and entrepreneurial skills (Itani & Srour, 2016; Miller, 2017; Nair & Mukerjee, 2015). For the purposes of this paper, soft skills are being defined as human "inter-personal and intra-personal skills" (Knobbs & Grayson, 2012, p.307). Soft skills are often referred to as soft because they are intangible and difficult to quantify when compared to the relatively easier to measure, hard technical skills (Colman & Willmot, 2016).

Traditionally, Engineering has been a discipline where students and practitioners have been known to struggle with soft skills. Some claim that in certain disciplines like software engineering and computer science, the missing skill set is often soft skills like collaboration, communication, problem-solving, interpersonal, and critical thinking (Captrez & Ahmed, 2018).

Accordingly, the Accreditation Board for Engineering and Technology (ABET)'s engineering programs' accreditation criteria includes a set of soft skills, in addition to the set of traditional technical skills (Itani & Srour, 2016). This calls for a need to place emphasis on the development of both hard technical skills as well as soft skills

among engineers. As a result, many engineering programs have acknowledged the need to provide their students training on soft skills, as part of their regular engineering education curriculum.

The university is potentially a suitable place where soft skills can be nurtured through contextual (Arat, 2014) or situated learning, if soft skill building opportunities are seamlessly inbuilt into curricula (Beard, Schwieger, & Surendran, 2008). However, even with identified need and acknowledgement of its importance for future career success (Shuman, Besterfield-Sacre, & McGourty, 2005), often engineering curricula at universities do not put enough emphasis and resources on the teaching and learning of soft skills (Burnik, & Košir, 2017; Colman & Willmot, 2016; Deveci & Nunn, 2017). Earlier studies involving undergraduate Mechanical and Biomedical engineering students have indicated that, though students are aware of the professional importance of soft skills like collaboration (Wallen & Pandit, 2009), it may be difficult to teach and assess such soft skills.

Drawing from a social constructivist approach to learning and recognizing the immense educational potential of mobile devices in facilitating communication and anytime anywhere learning, a goal of this study was to investigate how mobile devices can support learning in an undergraduate engineering Living Learning Community (LLC), through the development of soft skills like communication (Börner, et al., 2018).

Living Learning Community. For the purposes of this study, LLCs are being defined as "residential housing programs that incorporate academically based themes and build community through common learning" (Brower & Inkelas, 2010, para. 4). LLCs have historically been shown to have a positive impact on student learning, interaction, and college experience (Stassen, 2003). It has increased students' mutual support, self-determination (Bauer & Kiger, 2017) as well as faculty-student interaction (Garrett & Zabriskie, 2003). A MLC within a LLC is an environment where learners have the opportunity to engage in social-constructivist learning. Learners living in the LLC can engage with peers, instructors, and housing staff to co-construct meaning and learning. Often their interpretation of the impact of this environment can be subjective, complex, and formed after discussion and interaction with others in the same community (Creswell, 2003).

Ideally, a successful LLC should have a strong student affairs-academic affairs presence and partnership, clear learning objectives and a strong academic focus throughout the program (Brower & Inkelas, 2010). Also, it should capitalize on community settings to create opportunities for learning whenever possible. However, it is also possible that when living in LLCs, certain groups of students like international students may face challenges of communication, language differences, and lack of cultural understanding (Antonio & Ofori-Dwumfuo, 2015). Hence, communication among participants of an LLC is an important area of investigation, given that communication, especially through an online medium, has been shown to have a positive bearing on achievement of student learning outcomes (Nkhoma et al., 2015; Nkhoma et al., 2018). Communication is also a much needed engineering soft skill (Ahmed, Capretz, & Campbell, 2012).

Surveying the existing literature related to the use of mobile devices to facilitate digital fluency and communication in LLCs, the researchers could not locate studies which investigated this specific area. To address this gap, this study aimed to document student perceptions of whether participating in a MLC while living in a LLC had any impact on their digital fluency and communication using a mobile device. As such, it reports students' perceptions which have the possibility of being heavily impacted by their social interactions with others as well as environmental factors beyond the purview of this study.

Purpose of Study

The purpose of this study was to investigate and report student perceptions regarding changes in mobile device based digital fluency and communication, after participation in a LLC based MLC. Unlike some other studies in this area (Wilson, Bjerke, & Martin, 2015) which measured changes in academic achievement, this study did not mean to empirically measure changes or increase in learner achievement of disciplinary content as a result of using mobile devices. The broad goal was to qualitatively document learner perceptions of changes in digital fluency and communication using mobile devices after participating in a MLC, while residing in a LLC.

It was assumed that some participants were already quite digitally fluent and used mobile devices for communication before participating in the MLC and LLC. These learners were not identified or excluded from the study since the broad goal of the study was to view the participants' learning community experience as a whole.

The researchers were open to documenting the experiences of learners who were already digitally fluent and communicated using mobile devices, and resided in community with other learners who were not so experienced. This was done with the assumption that it may capture rich data on the varying levels of preparedness of a typical unit (group, course, learning community etc.) of students. However, there was no direct research question targeted to measure this diversity of digital fluency and communication ability using mobile devices, since that level of granularity was not the goal of this study. Also, advanced quantitative methods of statistical analysis were not used in this study since the goal of this study was to capture and report preliminary data on the topic.

The data collected in this study can form the basis of more detailed and complex future studies, designed to compare statistical differences within groups or repeated measures analysis to test differences. Accordingly, the following research question was investigated:

Research Question. What are student perceptions regarding changes in digital fluency and communication after participation in a Living Learning Community based Mobile Learning Community?

Method

Supported by a social constructivist (Amineh & Asl, 2015; Karahan & Roehrig, 2014; Reynolds, 2016) approach to learning, this study investigated the above-mentioned research question, through a mixed method research design. A Likert type online survey was used in combination with a face-to-face focus group to collect data.

Case description

Engineering Living Learning Community. This study focused on a yearlong, including Fall and Spring semesters, Engineering LLC at a mid-sized regional public university in NW United States. Established in 2006,it remains open to qualifying first-year Engineering students who meet the academic as well as general requirements and expectations for inclusion in the community. Though the LLC forms in Fall, students may enter the community in Spring, if they meet all admission requirements and space permits.

The LLC was mentored by a Faculty in Residence (FIR) whose role in the community, apart from general supervision and mentoring included, regular student advising sessions and faculty office hours. The academic requirements included completion of ENGR 150 which was a credit bearing course. While the focus of the engineering LLC was on academic success with the primary activities centering on academic support, one of the major goals of the LLC was to allow students the opportunity to explore the benefits of social/community living. This goal was geared to support the development of crucial soft skills like communication, public speaking, leadership, team-building, and group work abilities, through various social and community-building activities like weekly community meals, group study sessions, picnics, hiking trips, movie nights, and other social events.

Mobile learning community. One of the unique features of the engineering LLC during the time of this study was the inclusion of a Mobile Learning Community (MLC), which aimed to provide an informal learning community for students where they could enhance their existing digital fluency and communication, using mobile devices provided by the university.

While digital competence consists of a variety of skills and proficiencies, and is an evolving concept whose definition in educational research is not yet standardized (Ilomaki, Paavola, Lakkala, & Kantosalo, 2016), this research focuses on learner digital fluency. In many cases, the term digital fluency is used to describe “user interaction with technology in general”(Wang, Wiesemes, & Gibbons, 2012, p. 570). For the purposes of this study, digital fluency is being defined as a type of literacy or learning wherein people are comfortable using digital technology as they would be, when using any other language (Huffaker, 2004). As such, this form of digital fluency may be a prerequisite to sociability, lifelong learning, and employment opportunities (Adams Becker, Pasquini, & Zentner, 2017; Colbert, Yee, & George, 2016; Li, Ye, Liu, Yang, & Wang, 2018). Often digital fluency needs to be intentionally taught in order to prepare students to deal with the challenges of a digital age (da Cruz Alves, Rodrigues, Borgatto, Gresse von Wangenheim, & Hauck, 2016). Also, in this study, perceived changes in learning or knowledge of using mobile devices is deemed to be similar to perceived changes in digital fluency, though the latter may include other skills not directly measured in this study.

The main purpose of the MLC was to help students develop a sub-community within the LLC, where they can engage with peers and instructor(s) to enhance their existing digital fluency and communication skills using mobile

devices. The broader goal was to facilitate students' use of mobile devices as a tool which can support disciplinary learning. In order to support this goal, the university loaned each student a mobile device (iPad) which they could use for the duration of their participation in the LLC.

Participants

Participants in this study were a cohort of first-year Engineering students belonging to a year long, including Fall 2016 and Spring 2017 semesters, LLC at Western State. The LLC cohort started in Fall 2016 with 72 students. In Spring 2017, after the attrition of some students, due to factors beyond the scope of this study, 68 students completed the requirements of participating in the LLC.

Procedure

The Institutional Review Board (IRB) permission to conduct this study was obtained in the summer of 2016. At the beginning of Fall 2016, first-year students joined the Western State Engineering LLC and were loaned a personal mobile device, which in this case was an *Apple iPad*, for use, while they were a part of the LLC. Students also enrolled in ENGR 150 in Fall 2016. In this course, students were encouraged to use their tablets to support learning tasks as well as to communicate with the instructor and other students.

The students included in the LLC were identified to participate in this study so that their perceptions and experiences could be documented, and used to provide recommendations to better facilitate future iterations of similar LLCs. However, all students living in the LLC did not choose to participate in the study. In Fall 2016, 53 or 74% of the students completed the pre-semester survey, and 57 (79%) students completed the post-semester survey. In Spring 2017, 27 or 40% of the students participated in the focus group meeting.

Students in the LLC also registered for ENGR 150 in Fall 2016. Students completed this course as part of the requirements for obtaining their undergraduate degree. At the beginning of Fall 2016, all LLC students were informed via email about this study and invited to participate. Participation in this study, the focus group meeting, and anonymous online surveys were voluntary activities. It did not have any bearing on course grades that the students may otherwise have received for ENGR 150. No extra credit was provided for participation in the study. Occasional promotional videos and images of students working with mobile devices were taken for campus updates. Participation in this study did not in any way affect their inclusion in the LLC. As students in ENGR 150, learners were already expected to use mobile devices to support learning as a matter of course, to complete the requirements of the course, irrespective of whether this study was conducted or not.

The FIR in collaboration with instructional designers from the Western State IDEA (Instructional Design and Education Assessment) Shop, provided training on how mobile devices can be used to support learning, at three designated training sessions. Each of these 90-minute sessions were called "Technology Night." Students were also encouraged to use mobile devices in courses other than ENGR 150. During Technology Night, students learned basic tablet functionalities, used educationally useful apps, created content using mobile devices, and worked in groups to complete learning related tasks. It was assumed that these mobile device use skills would support students in their subject matter learning tasks in ENGR 150 and other courses.

At the beginning of Fall 2016, students invited to participate in a voluntary and anonymous online survey employing a 23 item Likert scale instrument. This survey aimed to collect data regarding student perceptions of their current digital fluency with mobile device use. They were also asked how they expected the use of mobile devices would support their learning and communication with peers and instructors. The same survey instrument with slight modifications representing end of semester perceptions, was used at the end of Fall 2016, as a post-semester survey to increase reliability of the results. A face-to-face focus group meeting was conducted at the end of Spring 2017. Both quantitative and qualitative data was collected in order to triangulate student perception data.

Instruments for data collection

In keeping with the mixed method research design, the data collection instruments for this study included pre and post-semester online anonymous surveys administered during Fall 2016, and a post-semester face-to-face focus group at the end of Spring 2017. The face validity of the survey and focus group instruments were determined by

two educational technology subject matter experts, in order to ascertain whether the questions were pertinent towards identifying changes in basic mobile device based communication and digital fluency competencies.

The 23 item, four-point Likert scale online survey which was delivered using Qualtrics, an online survey management and delivery system. There was a six item focus group meeting discussion guideline. This guideline was used to structure discussions during the face-to-face focus group meeting. In the survey, 10 questions were about perceived knowledge of mobile device use to complete certain tasks which can support learning, 6 questions related to perceived knowledge of mobile device use for improved communication, 5 questions were on perceptions of how participating in the MLC contributed to support learning using mobile devices. Also, there were a question each regarding students' plans for continued use of mobile devices in courses other than ENGR 150, and increased access to course content using mobile devices. The focus group guideline contained questions regarding the impact of community living on mobile device-supported skill development and transfer of such skills to other aspects of learning. Responses at the focus group were audio-recorded using a mobile device (iPad). Data from the online surveys and focus group were anonymously summarized and analyzed to identify themes which emerged out of the content of student responses to the questions used for data gathering.

Data analysis

In order to implement the mixed methods design of this study, a concurrent triangulation strategy (Creswell, 2003, p. 217) was used to confirm, cross-validate, or corroborate data within the study. Quantitative data obtained from pre and post semester surveys was triangulated with qualitative data from a post semester focus group meeting.

Survey result analysis. The pre and post semester survey data was quantitatively summarized by one of the researchers and represented under five categories (See Tables 1 through 6). These categories broadly corresponded with the topics of the survey questions, namely, perceptions of knowledge of mobile device use for tasks which supported learning, improved communication, whether living in the MLC contributed to mobile device supported learning, plans for continued use of mobile devices in courses other than ENGR 150, and perceptions of increased access to course content using mobile devices.

Focus group result analysis. The focus group audio recordings were transcribed and summarized by one of the researchers. The focus group was conducted using a guideline of pre-determined questions. A simple coding method was used where the summarized data was indexed by themes, which emerged out of the content of student responses to each of the focus group guiding questions. The transcription was read and the summary and coding were peer examined and agreed upon by a second researcher who is also a co-author of this study.

Results

The results of our inquiry are addressed below. Since this study used a concurrent triangulation strategy, qualitative and quantitative data are presented in separate sections (Creswell, 2003). The online survey results are reported first and then the responses from the focus group meeting are summarized. In the Discussion section, the analysis and interpretation combines the quantitative and qualitative data to seek convergence (Creswell, 2003, p. 222).

Online surveys

The researchers wanted to know whether students perceived experiencing changes in digital fluency and communication after participation in a LLC based MLC. Data from pre and post- semester surveys are presented so as to note the perceived changes, from before to after the semester. It has to be noted that this survey was anonymous and no respondent alignment between pre and post-semester survey data was conducted.

As seen in Table 1, the Fall 2016 pre-semester survey showed that a majority of the students "Strongly Agreed" that they were knowledgeable about using mobile devices to complete tasks which support learning like connect to the wi-fi (92.45%; *M*= 3.92), download an app (96.23%; *M*=3.96), turn device to silent mode (90.57%; *M*= 3.90), download (69.81%, *M*=3.62) and upload (66.04%; *M*=3.58) files to the cloud, adjust document privacy settings (58.49%; *M*=3.50), download/save media in the cloud (69.81%; M= 3.64), search for information in the internet (96.23%; *M*=3.96), and take notes using an app (67.92%; *M*= 3.56).

Table 1 *Pre-semester student perceptions of knowledge of mobile device use for tasks which support learning*

Degree of agreement with statement	[Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
Knowledgeable on how to connect to wi-fi network	0	0	4	49	3.92	0.26
Knowledgeable on how to download an app	0	0	2	51	3.96	0.19
Knowledgeable on how to turn device to silent mode	0	0	5	48	3.90	0.29
Knowledgeable on how to download a file from the cloud	0	4	12	37	3.62	0.62
Knowledgeable on how to upload a file to the cloud	0	4	14	35	3.58	0.63
Knowledgeable on how to adjust document sharing privacy settings	0	4	18	31	3.50	0.63
Knowledgeable on how to download/save media in the cloud	0	3	13	37	3.64	0.59
Knowledgeable on how to open browser/search for internet address	0	0	0	53	4.0	0
Knowledgeable on how to search for information in the internet	0	0	2	51	3.96	0.19
Knowledgeable on how to take notes using a mobile app	1	4	12	36	3.56	0.72

At the end of Fall 2016, as seen in the table (Table 2) below, there was an increase in the percentage of students from pre to post-semester, who strongly agreed that they were more knowledgeable on how to use a mobile device to complete certain tasks which aided their learning. Self-reported knowledge of basic tasks like connecting to the wi-fi (96.49%, *M*=3.93), downloading an app (98.25%; *M*=3.98), turning the device to silent mode (94.74%, *M*=3.94), downloading (87.72%, *M*=3.87), uploading (85.96%, *M*=3.86) files to the cloud, adjusting document privacy settings (78.95%, *M*=3.75), downloading/saving media in the cloud (82.46%, *M*=3.82), and taking notes using an app (84.21%, *M*=3.78), increased from the beginning to the end of the semester. Knowledge of how to search the internet for information remained approximately the same from pre (96.23%; *M*=3.96) to post (96.49%, *M*=3.96) semester. However, the closely related skill of opening a browser to search for an internet address using a mobile device, had reportedly decreased from pre (100%, *M*=4.0) to post (94.74%, *M*=3.94) semester.

Table 2 *Post-semester student perceptions of knowledge of mobile device use for tasks which support learning*

Degree of agreement with statement	[Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
More knowledgeable on how to connect to wi-fi network	1	0	1	55	3.93	0.41
More knowledgeable on how to download an app	0	0	1	56	3.98	0.13
More knowledgeable on how to turn device to silent mode	0	0	3	54	3.94	0.05
More knowledgeable on how to download a file from the cloud	0	0	7	50	3.87	0.33
More knowledgeable on how to upload a file to the cloud	0	0	8	49	3.86	0.12
More knowledgeable on how to adjust document sharing privacy settings	0	2	10	45	3.75	0.51
More knowledgeable on how to download/save media in the cloud	0	0	10	47	3.82	0.14
More knowledgeable on how to open browser/search for internet address	0	0	3	54	3.94	0.22
More knowledgeable on how to search for information in the internet	0	0	2	55	3.96	0.18
More knowledgeable on how to take notes using a mobile app	1	1	7	48	3.78	0.55

In the Fall 2016 pre and post-semester survey, students were asked what they felt regarding the use of mobile devices to support improved communication with their peers and instructors. Data from both the pre and post-semester surveys are presented so as to note the changes in perceived knowledge, from before to after the semester.
As seen in Table 3, at the beginning of their first semester at the LLC, many of the respondents strongly agreed that they were knowledgeable of how to change the privacy settings of shared content in social media (73.58%, *M*=3.67), how to use emoticons (88.68%, *M*=3.81), capture video (96.23%, *M*=3.92), create new content using already existing online media (47.17%, *M*=3.22), create presentations using mobile apps (32.08%, *M*=2.90), and use social networking apps to communicate with others in the LLC (58.49%, *M*=3.47).

Table 3 *Pre-semester student perceptions of knowledge of mobile device (tablet) use to support improved communication*

Degree of agreement with statement	[Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
More knowledgeable on how to change privacy settings of shared content in social media	0	3	11	39	3.67	0.58
More knowledgeable on how to use emoticons in social media	1	2	3	47	3.81	0.59
More knowledgeable on how to capture video	1	0	1	51	3.92	0.43
More knowledgeable on how to create something new using existing media available online	2	9	17	25	3.22	0.86
More knowledgeable on how to create presentations using mobile apps	2	18	16	17	2.90	0.90
More knowledgeable on how to communicate with MLC using social networking apps	0	6	16	31	3.47	0.69

At the end of Fall 2016 (see Table 4), there was an increase in the percentage of students from pre to post-semester, who strongly agreed that they were knowledgeable on how to use a mobile device to complete certain tasks which aided communication. These tasks were --changing the privacy settings of shared content in social media (77.19%, *M*=3.44), using emoticons (91.23%, *M*=3.87), and creating new content using already existing online media (70.18%, *M*=3.59). However, certain skills like capturing videos remained approximately the same from pre (96.23%, *M*=3.92), to post (96.49%, M=3.96) semester. Other skills like creating presentations using mobile apps (54.39%, *M*=3.28) and using social networking apps to communicate with others in the LLC (49.12%, *M*=3.29) reportedly dropped from pre to post semester.

Table 4 *Post-semester student perceptions of knowledge of mobile device (tablet) use to support improved communication*

Degree of agreement with statement	[Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
More knowledgeable on how to change privacy settings of shared content in social media	0	2	11	44	3.44	0.64
More knowledgeable on how to use emoticons in social media	1	0	4	52	3.87	0.46
More knowledgeable on how to capture video	0	0	2	55	3.96	0.18
More knowledgeable on how to create something new using existing media available online	1	4	12	40	3.59	0.70
More knowledgeable on how to create presentations using mobile apps	4	7	15	31	3.28	0.94
More knowledgeable on how to communicate with MLC using social networking apps	2	7	20	28	3.29	0.82

A goal of this study was to document how living in the LLC and participating in the MLC, impacted students' perceptions of mobile devices supporting their learning. At the beginning of their first semester at the LLC, pre-semester survey (see Table 5) respondents strongly agreed that they were comfortable seeking help on technical questions regarding mobile device use (49.06%, *M*=3.37) from their MLC peers, to try new ways of learning using mobile devices (33.96%, *M*=3.09), to build community with peers (26.42%, *M*=2.98), to learn collaboratively with peers (28.30%, *M*=3.03), and that being a member of the MLC accelerated their digital skills/comfort level with mobile device use (30.77%, *M*=3.03).

Table 5 *Pre-semester student perceptions of how living in the MLC contributed to mobile device supported learning*

Degree of agreement with statement	Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
Comfortable seeking technical help from MLC	0	6	21	26	3.37	0.68
Try new things while learning	2	9	24	18	3.09	0.81
Build community with peers	1	13	25	14	2.98	0.77
Learn collaboratively	2	9	27	15	3.03	0.78
Accelerated mobile device digital skills	2	10	24	16	3.03	0.81

At the end of their first semester in the LLC, the post-semester survey (see Table 6) respondents strongly agreed that they were comfortable seeking help on technical questions regarding mobile device use (55.36%, *M*=3.35), from their MLC peers, to try new ways of learning supported by mobile devices (45.61%, *M*=3.14), to build community with peers (29.82%, *M*=2.80), to learn collaboratively with peers (31.58%, *M*=3.0), and that being a member of the MLC accelerated their digital skills/comfort level with mobile devices (33.33%, *M*=2.80).

Table 6 *Post-semester student perceptions of how living in the MLC contributed to mobile device supported learning*

Degree of agreement with statement	Strongly Disagree----- Strongly Agree]				M	SD
	1	2	3	4		
Comfortable seeking technical help from MLC	3	5	17	31	3.35	0.86
Try new things while learning	3	12	16	26	3.14	0.93
Build community with peers	5	18	17	17	2.80	0.97
Learn collaboratively	3	12	24	18	3.0	0.86
Accelerated mobile device digital skills	10	10	18	19	2.80	1.09

In both the pre and post-semester survey, a question each regarding plans for continued use of mobile devices in courses other than ENGR 150, and perceptions of increased access to course content using mobile devices were asked. Responses indicated that in the beginning of their first semester at the LLC, students (49.06%, *M*= 3.39) strongly agreed that using a mobile device would provide better access to course content and that they planned to use the device in at least one or two course other than ENGR 150 (35.85%). At the end of their first semester, the post-semester survey respondents indicated that fewer students (47.37%, *M*=3.33) strongly believed that mobile devices provided better access to content. However, post-semester, more students (47.37%) believed that they would use a mobile device for at least one or two courses other than ENGR 150.

Focus group meeting

The results of the focus group meeting are being reported according to themes which emerged from the content of student responses to the guiding questions asked during the meeting.

Theme One: Multiple affordances of mobile devices. When asked how living in the Engineering LLC impacted their digital/mobile device use, participant reports varied but most students talked about the multiple affordances of the mobile device/tablet, which the LLC loaned to them. One student who was also a teaching assistant (TA), said that this was her first introduction to a tablet and it was useful in terms of the mobility it provided both to take the device to classes, as well as to provide anytime, anywhere access to emails. Another student who was also a TA said:

I use it to create assignments and also in my Heat Transfer class with Dr. P where he uses Notability to grade papers. We can store our papers in a Google Drive folder and it is really easy to find. Since I was already using Notability to take notes, I can use it to grade also.

Another student reported:
I was never considering using a tablet in school. I bought my laptop before school and that was what was going to be my device. Then I came in the LLC, got an iPad [sic] and I ended up using it a lot more than I expected.

A student said that after using the tablet at the LLC, she planned to buy her own device to continue using a mobile device even after completing her time at the LLC. Other students mentioned that it was worthwhile to buy apps like Notability since they were useful for multiple classes. The tablet from the LLC was useful in other Engineering classes which needed digital homework submissions and classroom responses. The use of tablets replaced the need to carry heavy textbooks to class and enabled students to be more organized through digital note-taking. A student mentioned that it was useful to be part of a group of students using tablets for class, since it allowed the group to troubleshoot for each other and to share learning resources and expertise.

Theme Two: Transfer of mobile device use skills to other learning areas. Students were asked whether they were able to transfer their digital/mobile device skills, learned as a result of having access to a mobile device, to other learning areas. A student reported that one of the unexpected benefits of having a tablet, was the ability to use it for her job as a learning assistant, she said:

I used it a lot for my job. I have an on-campus job helping other students. So I was able to take my own notes and upload the assignment they needed to help them with. I noticed that I used the iPad [sic] the most at my job other than for my classes. This, I did not expect.

Some students used it in courses other than ENGR 150 to complete homework and research assignments. A student majoring in computer science reported that the tablet was almost a replacement for a laptop computer. Certain applications helped to make required updates to programs quick and easy.

Certain features of the tablet like the dual window view was noted to be helpful in providing visual clarity, which was useful in learning:

With the new model of the iPad [sic] you can do the dual window, I used it for Notability and documents reader. One of the classes I had [sic], the teacher would post homework documents which would reference the text books. It was nice to have both open [sic] at the same time.

Theme Three: Use of mobile devices for non-academic purposes. When asked whether they used mobile device based skills learned at the LLC for non-academic purposes, students reported using the GroupMe application extensively to socially connect with other students for LLC and non-LLC related communication, However, as mentioned by a student "most of the social media was through the phone not the tablet" provided by the LLC. No other non-academic transfer of skills was reported.

Theme Four: Peer learning of mobile device use skills. When asked what digital/mobile device skills they learned from their peers at the LLC, a student mentioned "at the beginning of the school year I did not really know how to

use Notability. I learned it from peers who already knew how to." Students also said that they would benefit if they received more hands-on training on apps like Notability, Autodesk, and Google applications.

Theme Five: Stronger sense of community through the use of mobile devices. Students were asked if the availability of a mobile device and participation in the MLC helped to build a stronger sense of community. Students responded that access to the mobile device and social networking apps like GroupMe enabled them to connect with each other easily. A student said: "if we need to get a hold of someone in the suite, we can do that. I can make my own group chats [sic] it is easy to reach out."

Students living in the LLC received devices of the same configuration. This was helpful, as one student noted "just knowing that everyone else has the same tablet as you and if you did have a question, you just ask the people you live with." Availability of the device also enabled students to connect with each other for social interaction as mentioned by a student:

It connects us a lot more, it involves us a lot more. At the beginning of the year, I sent out a group message looking for people to go paintballing with. We could get many people to sign up as a community.

It also enabled students to seek assistance from their peers, as one student noted:
Having the iPad [sic] with a group of people and using it in class made a difference. Say if I had trouble doing an assignment and someone had an app which can make it easy. Then I would be like hey, pull out your tablet and let's see the periodic table. Then that would help my learning because that is there right on my fingertips.

Having individual access to a mobile device helped students to have a sense of pride in themselves for being a part of a community. One student said:
We have one class we take together. You can tell that we live in a community since we sit in front of the class, and all have our iPads [sic] out. Even though we might not see us as a community, people see us. We all have iPads [sic], we all sit together. So it makes us look like a community.

Having a mobile device enabled all students to have access to at least one digital device since not all students owned personal laptops or smartphones. A student said:
Most students have their own laptops, some don't and some don't have Smartphones. So if we are planning on doing something in class, the instructor will say, hey everyone bring your iPad [sic], that way everyone can participate in class, if you did not have the device, some people would not be able to participate.

Theme Six: Access to mobile devices as an incentive to retention. A couple of students responded to the question prompt asking whether the availability of the tablet impacted their decision to continue in the LLC. One student mentioned that having the tablet was not necessarily a deciding factor on the decision to continue in the LLC. Another student mentioned that having the tablet made her proud to be a part of the engineering LLC, since students living in other LLCs offered by the same university at that time, did not receive a tablet for use.

When prompted to voice other thoughts regarding their experience of using a mobile device in the LLC, all students participating in the focus group mentioned that would prefer to have a tablet beyond the year in which they lived in the LLC. A student expressed the need for tablets in operating systems other than Apple ios, for non Apple users.

Discussion and Implications

Similar to findings in some prior studies in the field, student perceptions in this study indicated that mobile devices supported learning and were fairly efficient means of enabling social communication (Cheng, Liang, &, Leung, 2015; Han, Min, & Lee, 2015) and digital fluency. However, this study was not without its limitations. The study had a relatively simple design and did not compare statistical differences within groups or use repeated measures analysis to test differences.

Part of the data for this study was collected using an anonymous online survey, where in order to maintain the anonymity of respondents, the pre-semester survey data was not matched with the post-semester data. Since there was no one-to-one matching of the responses, tracking progress for individual students over time was not possible. Also, there was no way to match the anonymous survey responses with the focus group meeting responses. Hence it

was not possible to measure which participants experienced a change in their perceptions from Fall 2016 to Spring 2017.

Barring certain limitations, this study contributes to existing literature in the field in that it reports student perceptions of whether mobile devices can support learning, impact soft skill practice through peer communication, and enhance basic digital fluency among students living in a discipline specific LLC.

Data was collected concurrently in this study using a concurrent triangulation strategy, but the analysis and interpretation combined the quantitative and qualitative data to seek convergence (Creswell, 2003, p. 222). Student responses collected via the online surveys and focus group meeting indicated the emergence of some broad themes. The following is a discussion of each of these themes:

Digital fluency in using mobile devices to support learning. While earlier studies on the impact of LLCs on student experiences have been done in various aspects of student experiences like critical consciousness development (Sears & Dawn, 2017) and communication barriers faced by international students (Antonio & Ofori-Dwumfuo, 2015), the findings of this study helps to lesson the existing gap in the knowledge of whether living in an LLC has any impact on the digital fluency of students. The survey results indicated that participating in the LLC based MLC, improved students' perceived mobile device digital fluency over the course of the semester. Students used mobile devices to support disciplinary learning and to communicate with instructors and peers. Self-reported knowledge of basic tasks which support learning like downloading an app, and turning the device to a silent mode were perceived to have increased from pre to post-semester, while that of searching for information in the internet remained the same from beginning to end of semester. Students might have gained from having access to a mobile device for individual use at all times. Also, the mobile device use and learning strategies taught to students during the Technology Nights, may have contributed to increase their digital fluency of completing basic device based tasks over the course of the semester, though there were no direct questions in the survey seeking confirmation regarding the impact of the Technology Nights.

In the focus group, some students mentioned that since they were already familiar with the basics of mobile device use, it would have been beneficial if the Technology Nights were dedicated to higher level training on apps like Adobe Spark and Notability. What is clear is that some students coming into the LLC were already knowledgeable or digitally fluent, in terms of being able to complete basic mobile device use tasks. During the course of the semester their skills improved slightly on certain tasks like creating new content and media using mobile devices. What they reported as still needed, was advanced training on specific apps.

Enhanced communication using mobile devices. In their first semester of living in the LLC, students reported having increased knowledge of how to use mobile devices for communication, from pre to post-semester, for all tasks under consideration except for communicating with MLC peers using social networking apps. It appears that though students had access to a device, they chose not to use the device to communicate with other students in the MLC using social networking apps. This finding is similar to earlier studies in LLCs where when domestic and international students were paired as roommates, most students preferred to communicate in person, even though they were otherwise heavy users of digital social media (Antonio & Ofori-Dwumfuo, 2015).

Since the online survey did not have an open-ended response area, no further information on why students chose not to communicate with their peers using mobile devices was available. They may have chosen to communicate using other means like verbal and face-to-face communication at the time when data was collected via the online surveys. However, when asked the same question during the focus group meeting, at the end of their second semester at the LLC, students responded in a completely different manner, saying that they used their tablets to connect with each other, mostly for social communication. They used a social media app called GroupMe and also used the mobile device to email each other and the FIR. This may have happened due to increased knowledge of social media apps and familiarity with mobile device use by the end of Spring 2017. Also, increased camaraderie among students after living in the LLC for a while, may have contributed to perceptions of increased communication at the end of the second semester.

Creating and accessing learning content using mobile devices. As observed in earlier studies, students in this study reported that mobile devices were used to create (Hopkins, Hare, Donaghey, & Abbott, 2015; Mouza & Barrett-Greenly, 2015) and access learning content (Reichert, & Mouza, 2018; Salisbury, Laincz, & Smith, 2015).

More respondents at the end of their first semester at the LLC, compared to the beginning, reported that they used a mobile device to download and upload cloud-based files, search for information, create media content, and create presentations. The same information was reported during the focus group meeting. Based on this information, it appears that personal access to the tablet for an extended period of time allowed students to learn better how to use it to support education and communication.

Mobile device supported learning gains. Compared to the pre-semester survey, the post-semester survey showed that more students were using mobile apps like Notability and Paperport Notes to take notes in class. As observed in previous studies, this study showed that using mobile apps as compared to paper-based content/notes, allowed students to have access to study materials anytime and anywhere (Barden & Bygroves, 2018; Diaz-del-Pino, Trelles, & Falgueras, , 2018). The focus group meeting responses confirmed this information, where students reported using the devices and apps for not only in-class learning but also for research, on-campus jobs, and to help other students in their role as learning assistants.

Mobile device supported learning at the MLC in the LLC. Similar to observations made in earlier studies, this study showed that as a result of their involvement in the LLC, students reported having tried new ways of using mobile devices to support learning, build community, seek technical help from peers, and learn collaboratively (Cerratto Pargman, Nouri, & Milrad, 2018; Manathunga & Hernandez, 2018; Reychav & Mchaney, 2017). In their first semester at the LLC, though students perceived having made learning gains supported by a mobile device, they did not necessarily make those gains through peer communication using mobile devices. There were no open-ended questions in the post-semester survey, asking students to elaborate on the reasons as to why they did not use the devices to communicate with their community peers. Further data collected in the focus group at the end of the second semester indicated a difference in perception. Students now felt that they benefited by living in the LLC, since it gave them the opportunity to seek help from their peers in-person as well as by using mobile device based social media applications. Also, having personal access to a tablet and living in the LLC gave them a sense of camaraderie which transferred to the students' life outside the LLC.

Continued learning using mobile devices. As seen in some earlier studies on mobile devices, users of such devices often believe that they will be or are useful for various functions like security monitoring (Potnis, Demisse, & Deosthali, 2017), cloud storage services (Arpaci, 2016; Yang & Lin, 2015), and for learning enhancement (Hur, Shen, Kale, & Cullen, 2015;Wardley & Mang, 2016). At the end of their first semester at the LLC, students continued to believe that having a mobile device would support their learning. As compared to the pre-semester survey, a larger percentage of respondents in the post-semester survey indicated that they would be using mobile devices for courses other than ENGR 150. However, the continued use of mobile devices for other courses is largely dependent on course instructor initiative, course design, subject matter, and device availability and are beyond the scope of this study.

At the end of Spring 2017, when further data was collected via the focus group, participants confirmed their optimism about using mobile devices for future courses. Though earlier studies have shown that students often don't actually use mobile devices as much as they plan to (Bartholomew & Reeve, 2018), all students participating in the focus group of this study, indicated that they would prefer to have a tablet for future use . Some students talked about how they were using the tablet for multiple purposes like social communication, campus jobs, as well as for other classes.

Mobile devices may not support all forms of learning for all learners. At the end of their first semester, the post-semester survey responses indicated that fewer students (47.37%, *M*=3.33) believed that mobile devices provided better access to content. This finding is similar to earlier studies which showed that learners often prefer to use mobile devices like smartphones for social communication and less to access academic content, especially when they are not trained to use it for the latter purpose (Adedoja & Abimbade, 2016; Lau, Chiu, Ho, Lo, & See-To, 2017). Mobile devices are not the only means through which students can get access to learning content. Some students may prefer to access content through their desktops or other paper-based sources. This result may not be an indication of learners' lack of digital fluency and communication with mobile devices, as much as a preference to use mobile devices to support some and not all ways of learning.

Recommendations

Based on the results of this study, some recommendations can be made which might be useful for FIRs, faculty who work with students living in LLCs, housing, and student affairs personnel.

Varying levels of digital preparedness. Digital tools and content in digital formats often facilitate learners' mastery of content (Chen, Tan, & Lo, 2016; Tan, Chen, & Lee, 2013; Thoermer & Williams, 2012). With the advancement and global expansion of digital connectivity (Georgiou, Motta, & Livingstone, 2016), most students may come to the classroom already prepared, in terms of having basic digital fluency for the use of mobile devices, especially for its use for social media communication (Kim, Wang, & Oh, 2016) and for non-academic purposes (Bluestein & Kim, 2016; Dashtestani, 2016; McCoy, 2016). However, all students still may not actually know how to use digital and or mobile devices for academic purposes (Chen & deNoyelles, 2013). Moreover, digital fluency and the ability to communicate using digital devices may vary across students in the same learning or group setting (Teo, 2015). The challenge then is for instructors and student support staff to design courses and social activities, based on this already existing skill set and variety of proficiency.

Learning by purposeful design. Earlier research has shown that certain desired psycho-social learning factors related to academic development like STEM identity, self-efficacy, and metacognition, can improve when students participate in learning communities (Carrino & Gerace, 2016). However, simply providing learners with resources like mobile devices and having them live in a discipline specific residential learning community, may not necessarily provide them with sufficient reason, immediacy, or motivation to build community with their peers, learn collaboratively using mobile devices, or advance on digital fluency. More purposeful instructional and activity design, which integrates the use of mobile devices for both learning and completion of community/social activities may be required. The goal should be to utilize existing and developing digital fluency in students, to master learning and community living goals more efficiently. While designing academic and social activity curriculum for such students, examples of important questions that might guide the design may be "how can students achieve higher levels of learning facilitated by mobile devices?" Or "how can mobile devices enable students to achieve greater levels of peer interaction that would not be possible without the use of the device?"

Peer instruction and mentoring. Peer instruction which has been shown to be an effective pedagogical strategy for enhanced learning in several disciplines like Physics (Gok, 2015; Zhang, Dang, & Mazur, 2017) and Computer Science (Zingaro & Porter, 2014), may be used among LLC participants. Peer mentoring has been found to have a positive impact on the learning of a wide gamut of people like students with Autistic Spectrum Disorder (Siew, Mazzucchelli, Rooney, & Girdler, 2017), pre-service teachers (Faucette & Nugent, 2017), and undergraduate medical students (Abdolalizadeh, Pourhassan, Gandomkar, Heidari, & Sohrabpour, 2017).

Students living in a LLC already live in a community setting where a FIR or disciplinary instructor led learning and or review sessions may be arranged. This may be an ideal environment where students can communicate with peers and instructor(s) using mobile devices and teach each other digital fluency skills that support disciplinary learning. Students might be able to make more gains from a LLC in general and from specialized components of an LLC in particular, if they are provided support through peer mentors who could establish peer support networks and provide an additional layer of staff support (Rieske & Benjamin, 2015).

Soft skills. Soft skills are of increasing importance for graduates seeking employment in a competitive job market (Jones, Baldi, Phillips, & Waikar, 2016; Sethi, 2016). Students may be able to make gains in their ability to master soft skills like communication, facilitated by mobile devices. This is especially significant in certain disciplines like Engineering, where learning soft skills like interpersonal communication, leadership, and teamwork are desired learning goals (Kumar & Hsiao, 2007). By viewing learning through a social constructivist lens and leveraging mobile devices, a LLC appears to be a learning environment where such soft skills can be organically nurtured and practiced. Having long term personal access to a mobile device over an extended period of time, often allows students the time to learn how to use it more organically and productively, for academic as well as for social communication and job-related purposes.

Housing and student affairs. As seen in this study, students perceive that mobile devices can support learning, impact soft skill practice through peer communication, and enhance basic digital fluency among students living in an Engineering LLC. These findings may be helpful for housing staff and those working with LLCs, to identify and

design ways in which cross campus partnerships can be forged between university units like Student Affairs and Academic Affairs, which may otherwise work in silos.

Further studies. This study was meant to provide preliminary data on what students felt about changes in their mobile device based digital fluency and communication, after participating in a MLC within a LLC. As such it was not designed to be granular enough to measure individual participant growth over time or to compare differences within groups. However, based on the observations made in this study, more nuanced studies can be designed in the future that can provide more elaborate data. Studies which can answer questions like "how did the students' prior knowledge or existing level of digital fluency determine changes in learning that occurred after participating in the LLC?" or "what demographic of students made maximum gains from participating in a MLC based LLC?"Answers to these questions may help design better learning and college experience opportunities for students.

Conclusions

The purpose of this study was to document and report student perceptions regarding changes in digital fluency and communication after participation in a LLC based MLC. Results indicated that over time, students perceived that their mobile device digital fluency and communication skills changed as a result of having personal access to a mobile device. Also, students thought that mobile devices supported their learning and they intended to use mobile devices for future courses and tasks. Based on the findings of this study, some recommendations were made which might be useful for faculty, especially FIRs, aiming to use mobile devices to support teaching and learning, housing staff, and others working with LLCs. The data collected from this study can form the basis of more detailed and complex future studies, designed to compare statistical differences within groups or repeated measures analysis to test differences.

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