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Academics adopting mobile devices: The zone of free movement

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This exploratory research characterised the degree of adoption of mobile learning (ML) devices among academic staff at an Australian university. It also sought to evaluate the impact of academics' perceptions about possibilities and constraints in the adoption of these technologies. A zone of free movement (ZFM) scale was developed and validated to quantify the magnitude and direction of those perceptions. Results showed that academic staff are characteristically at the third of the Russell's (1995) six developmental stages of technological adoption. Lack of time to integrate ML into courses, limited availability of mobile devices, little familiarity with the tools, as well as the perception that students cannot use them as a word-processor, act as inhibitors to the adoption of the technology. In turn, the perception that mobile tools enhance student-lecturer communication outside class was found to be a positive predictor of adoption.

Keywords: Mobile learning, academics, perception, adoption, implementation

Introduction

Appraising academics' perceptions of the value of educational technologies is paramount to the success of any technological innovation in education. Several studies have found that among academics there are a number of counterproductive beliefs about electronic learning technologies that might hamper implementation (Handal, Groenlund & Gerzina, 2011; Moron-Garcıa, 2002; Newhouse, 1998; Niederhauser & Stoddart, 1994). It is crucial, then, to explore those perceptions and target them through professional development and other institutional implementation programs.

The implementation of mobile technologies for teaching and learning in higher education can be a complex institutional endeavour. Universities and academic staff are under constant pressure to embrace change as these new technologies increase their presence in course delivery. Rather than being a matter of choice, both experienced and novice academic educators are required to adopt these tools in their programmes (Mostakhdemin-Hosseini & Tuimala, 2005). This study articulates the relationship between related variables in tertiary environments and academics' opinions about the stages of ML adoption. It also proposes recommendations to make this adoption process smoother, and more thoughtful and systematic.

Literature Review

Stages of Adoption

Originally identified by Russell (1995) through qualitative research, the stages of adoption scale describes the phases that teachers pass through in order to embrace a learning technology. According to Russell, teachers go through these stages at their own rate of progress and might start at any phase according to their background and life experiences. The stages of adoption scale was adopted to represent the take-up of a learning technology in six developmental phases, namely, (a) awareness, (b) learning the process, (c) understanding and application of the process, (d) familiarity and confidence, (e) adaptation to other contexts, and (f) creative applications to new contexts. These six stages have been outlined in various formats according to the specific learning technology to be used (Christensen, 1997; Handal, Chinnappan & Herrington, 2004; Handal, Cavanagh, Wood & Petocz, 2011). In general, the scale can be represented as follows:

> *Awareness: I am aware that the technology exists but have not used it - perhaps I'm even avoiding it. I am anxious about the prospect of using mobile devices.*
>
> *Learning the process: I am currently trying to learn the basics. I sometimes lack confidence when using the technology.*
>
> *Understanding and application of the process: I am beginning to understand the process of using this technology and can think of specific tasks in which it might be useful.*
>
> *Familiarity and confidence: I am gaining a sense of confidence in using the technology for specific tasks. I am starting to feel comfortable using the technology.*
>
> *Adaptation to other contexts: I think about this technology as a tool to help me and am no longer concerned about this technology. I can use it in many applications and as instructional aids.*
>
> *Creative application to new contexts: I can apply what I know about this technology in teaching and learning. I am able to use it as an instructional tool and integrate it into the curriculum.*

Zone Theory

The adoption of a learning technology can be better understood in the context of the interface between the academic and his/her environment. In other words, research on embracing information and communication technologies (ICT) in education should focus on the interaction between an academic's knowledge and beliefs and the possibilities and constraints surrounding his/her professional environment. For Valsiner (1987, 1997) this learning working space is created by the synergies generated among three main zones, which he outlined as the zone of proximal development (ZPD), the zone of free movement (ZFM) and the zone of promoted action (ZPA).

ZPD was earlier conceptualised by Lev *Vygotsky (1978)* as the gap between a learner's present capabilities and the higher level of performance that could be achieved with appropriate assistance. *ZPD itself can be associated with a set of capabilities in the form of skills and knowledge embedded within the learner, allowing him/her to potentially perform at higher and increasing levels of achievement.* According to *Vygotsky:*

> The zone of proximal development defines functions that have not matured yet, but are in a process of maturing, that will mature tomorrow, that are currently in an embryonic state; these functions could be called the buds of development, the flowers of development, rather than the fruits of development, that is, what is only just maturing (*Vygotsky, 1935, pp. 33-52).*

Applied to the field of learning technologies deployed by academics in higher education, ZPD refers to those capabilities endowing the academic to effectively deploy ICT to advance teaching and learning. It explains academics' ability to efficiently integrate pedagogy, technology and discipline content at various developmental stages of adoption to progressively enhance students' learning experiences.

Valsiner (1987, 1997) added that such dynamics are also influenced by facilitating and hindering factors operating within the same learning environment. In that vein, ZFM was outlined as the enclosed environment in which the individual interacts for teaching and learning purposes. ZFM represents both processes and structures that condition the circumstances in which teaching and learning are enacted. It also represents availability and access to hardware/software, technical support and infrastructure. ZFM includes students' characteristics, perceptions about the role of technology in education, and curriculum and assessment requirements. Furthermore, ZFM elements can be further characterised as a possibility or a constraint factor delineating what can or cannot be done or achieved. For the purpose of this study, these elements have been additionally grouped into operational and pedagogical factors to distinguish their underlying role in the implementation of mobile learning.

In turn, ZPA represented the opportunities for professional growth that the individual can access to advance his/her professional learning in order to achieve students' academic progress (Goos & Bennison, 2007). ZPA stands for those empowering factors aiming at skill development in ICT in education. It also includes participation opportunities in professional development, either external or internal to the university, and chances for collaboration and peer professional learning, including informal individual learning or assistance from colleagues. In general, ZPA corresponds to openings for becoming familiar with ICT and their pedagogies.

More importantly, zone theory permitted a theoretical framework where ZPD incorporates the social setting as another determinant of the learning experience. When associated with ZFM, ZPD works along two other dimensions: possibilities and constraints. *Such continuous advances can be affected by mediating variables either empowering or disempowering the personal espousal and institutional implementation process (Goos & Bennison, 2008).*

If effective teaching and learning is to happen then the ZPD must synchronise with the academic's opportunities for continuous progress (ZPA), as well as operating within a doable working space delineated by the ZFM. This study focused on the ZFM as perceived by academics in regard to possibilities and constraints related to using mobile devices in teaching and learning. It also looked at the interaction of those perceptions with their ML stages of adoption.

Mobile Learning

Mobile technologies have opened the way to a more seamless approach to teaching and learning. This is so not only for the ubiquity and portability of mobile devices such as tablets and smartphones (Sharples, Taylor & Vavoula, 2007) but also because of their capacity to act as teaching hubs both for the individual and a group. Mobile technologies allow users to use these appliances as multiple devices where various teaching tools can be simultaneously accessed (Wong, 2012). In fact, smartphones and tablets permit learners to integrate computational, productivity, simulation, exploration and information retrieval tools in a central hub (Handal, El-Khoury, Cavanagh & Campbell, 2013). Furthermore, learners and instructors are able to immerse themselves dynamically in their learning and teaching tasks and in the virtual world 'anywhere, anytime'. Opportunities for broader online interaction through conversations and quasi real-life scenarios make situatedness a singular characteristic of mobile technologies in the university educational environment (Hwang, Tsai & Yang, 2008). Teaching and learning have been thus extended beyond the university bricks-and-mortar surroundings, opening new academic vistas to tertiary education in the early 21st century. From the learners' perspective, students are bringing their own devices (BYOD) moving away from university proprietary software and hardware and becoming more independent in their digital choices (Wong, 2012).

For the purpose of this study, mobile devices are portable handheld devices providing computing, information storage and retrieval functionalities as well as multimedia and communication capabilities. Mobile devices are available in the market as smart phones (also known as "mobiles") or tablets.

Research Questions

There is evidence of a number of differential effects, traditionally examined in research on the adoption of educational technology among educators, such as gender, employment status, regular access to mobile devices and technology ownership (Handal, Cavanagh, Wood, & Petocz, 2011).These factors, and others such as academics' perceptions of their zone of free movement (ZFM) when adopting mobile technology in teaching and learning, have not yet been explored in-depth in the context of mobile technology in tertiary environments.

The following research questions were adopted in the present study:

i. At which stage of adoption of mobile learning technology do academic staff perceive themselves?
ii. What are the ZFM features when adopting mobile learning, as perceived by academics?
iii. How does
    a. gender
    b. employment
    c. regular access to a smart phone or a tablet
    d. mobile tablets owned by a school/faculty

impact on ML stages of adoption?

iv. Which ZFM aspects influence stages of adoption of mobile technology?

Methodology

Subjects

Subjects for this study were academic staff from an Australian university comprising nine schools. Staff were invited to participate in an online survey through an email providing a dedicated link, followed later by a reminder email. The survey remained online for three weeks.

Instrument

A ZFM scale was designed to measure educators' stages of adoption and attitudes towards mobile learning technologies (Tables 1, 2, 3 and 4). Stage of adoption of mobile learning was determined through an adaptation of Russell's scale (1995) outlined in the Teachers' Attitudes toward Information Technology Questionnaire (TAT) version 2.0. The TAT modified version includes a number of explanatory and response variables for further statistical analysis (Handal et al., 2011).

The explanatory variables for this study were associated with the ZFM in mobile learning in higher education. A scale of thirty-two ZFM items was designed which included 16 ML possibilities and 16 ML constraints. In turn, each of these two groups was subdivided into 7 pedagogical (teaching and learning) and 9 operational (technical) categories. The items were created by the researchers or adapted from previous questionnaires appraising students' and academics' perceptions on ML (Al-Fahad, 2009; Bradley & Holley, 2010; Handal, Groenlund & Gerzina, 2011; Goos & Bennison, 2007, 2008; Hamza Hussein & Bassam Nassuora, 2011; Khwaileh & Al-Jarrah, 2010; MacCallum & Jeffrey, 2009; Oliver, 2005; Yang, 2012). The items, displayed with their arithmetic means in tables 1-4, are indicative of the major ML possibilities and constraints identified in the literature.

The dependent variable was teachers' stage of adoption. To further explore the impact of those thirty-two items on stage of adoption, other demographic and environmental variables were included such as gender, UNDA school/campus, employment status, regular access to mobile devices and mobile technology available. Responses to the open-ended items of the questionnaire explain the instructional, curricular and organisational contexts of the mobile learning implementation process and are discussed elsewhere (Handal, MacNish & Petocz, in press).

Data Analysis

Response Rate

The final response rate was 17% (N =177). While there is no definite answer as to an appropriate response rate for online surveys (Nulty, 2008) it is noteworthy that despite its apparent low rate the internal reliability coefficient resulted in an acceptable and moderately high alpha of 0.707. Similarly, the subsequent principal component analysis proved the structural worth of the ZFM scale by identifying two distinctive factors. Likewise, the gender participation ratio was almost balanced, 43% and 57% for females and males respectively. A similar balance was achieved for employment status where 48% and 52% of the respondents were part and full time, respectively. The above figures add consistency to the sample and strengthen the results. The percentage of female academics and full-time academic staff was about 51% and 26%, respectively.

Descriptive Statistics

Scores were used to compare responses to individual ZFM scale items. All responses were coded in a 3-point Likert scale: *agree*, *undecided* and *disagree*. In general, scores less than 2.0 were examined on a continuum ranging through *low* to *slightly below average* while scores greater than 2.0 represented a continuum ranging from *slightly above average* to *high*. A score of 2.0 would indicate an orientation that lies midway in a particular opinion. The item stem was: *In my opinion, mobile devices present the following capabilities and constraints in teaching and learning ...*

Respondents tended to agree with all nine statements related to operational constraints, as shown in Table 1. The statement with the highest mean score of 2.87 was "Sometimes the connectivity is poor in some areas" (OC7) with a standard deviation (SD) of 0.37, indicating a fairly strong and coherent agreement. The OC7 variable was followed by "Not all students or lecturers have mobile devices or are not in the habit of using them" with a mean score of 2.68 and an SD of 0.63. This indicates that devices are not generally being used for teaching and learning, and are not yet embedded into the fabric of the university. A critical mass might be needed to get pedagogical value for mobile technologies. The primary operational constraints therefore are perceived lack of connectivity and perhaps related to this the tendency of staff and students not to use their mobile devices.

Table 1: Operational constraints (OC)

Variable	Operational constraints	Mean	*SD*
OC7	Sometimes the connectivity is poor in some areas	2.87	0.373
OC8	Not all students or lecturers have mobile devices or are not in the habit of using them	2.68	0.627
OC9	Have restrictions on screen size and resolution	2.52	0.674
OC5	Internet connection outside the University and home network can be expensive –lack of wifi in many locations	2.46	0.767
OC4	In a fast moving market mobile products can be out of date very quickly	2.32	0.747
OC3	Do not offer the same interface richness/immersiveness compared to a laptop/desktop	2.18	0.768
OC1	Apps do not work across main mobile platforms	2.11	0.655
OC2	Data storage capacity is limited	2.07	0.786
OC6	Lack of a mouse and a keyboard makes usability difficult	1.83	0.842

There was general agreement with the statements in relation to pedagogical constraints (see Table 2 below). The variable with the highest mean score of 2.58 highlighted the need for teachers to have more pedagogical support on how to integrate mobile learning. Further, there was high agreement with the statements about special curriculum tasks being required to support the use of mobile devices (PC3) and the lack of time to integrate mobile learning (PC7), both with mean scores of 2.46. Variable PC1, concern that the students will cheat using mobile devices, with a mean score of 2.06, had the highest standard deviation of the survey at 0.87 suggesting a wider range of opinions. It is noteworthy that while the mean scores for operational constraints varied from 1.83 to 2.87 the mean scores for pedagogical constraints ranged from 1.92 to 2.58, on the three-point scale. These results suggest that respondents were overall more concerned with operational constraints than pedagogical constraints.

Table 2: Pedagogical constraints (PC)

Variable	Pedagogical constraints	Mean	*SD*
PC6	There are not many formal opportunities to learn about mobile learning	2.58	0.659
PC3	Special curriculum tasks to support the use of mobile devices are required	2.46	0.713
PC7	Lack of time to integrate mobile learning into my course	2.46	0.744
PC4	Students do not adequately know how to use them for their learning	2.32	0.727
PC5	Students will be distracted in class	2.31	0.781
PC1	Concerned that students will cheat using mobile devices	2.06	0.867
PC2	Reduce lecturer student personal contact	1.92	0.835

There was high agreement with the statements in relation to operational possibilities (see Table 3 below). Many staff members felt that mobile devices would make the operational life of both lecturers and students easier; for example, carrying of digital curriculum related files (mean 2.82), studying in times and locations that suited individuals (mean 2.81), accessing online resources (mean 2.79), personal study notes (mean 2.68) and organising tasks (mean 2.67). Overall, the respondents perceived operational possibilities in mobile technologies for users, both lecturers and students.

Table 3: Operational possibilities (OP)

Variable	Operational possibilities	Mean	*SD*
OP1	Allow easy physical carrying of digital curriculum-related files (e.g., PDF, Word, PowerPoint, course notes)	2.82	0.480
OP2	Allow students and staff working at own time and location that suit them	2.81	0.484
OP7	Improve access to online teaching resources (e.g., internet browsing, podcasting, online Library catalogue, Blackboard, virtual galleries)	2.79	0.527
OP9	Let students write and save their own personal study notes	2.68	0.619
OP3	Assist lecturers and students in organising their course tasks (e.g., calendars, diaries, timetables, reminders)	2.67	0.576
OP4	Empower lecturers and students in producing multimedia presentations through taking their own pictures or recording audio and video footage	2.62	0.611
OP8	Keep students constantly connected to the course content and developments	2.56	0.672
OP5	Enable students to record lecture presentations or any other course learning experience	2.50	0.704
OP6	Facilitate educational management of marks, attendance and students records	2.37	0.714

Again, there was high agreement with the statements in relation to pedagogical possibilities (see Table 4). There was strong agreement in the potentiality of mobile technology facilitating learning anywhere and anytime (mean 2.72), individualised instruction (mean 2.68) and collaboration and interaction among students (mean 2.61). Changing technologies and pedagogical strategies may require teachers to join communities of practice where they can share ideas. Operational possibilities had mean scores ranging from 2.37 to 2.82, while those for pedagogical possibilities varied from 2.31 to 2.70. Differences in the maximum values from both sets suggest that respondents put a greater value on ML electronic affordances for tasks that might not be directly instructional related.

Table 4: Pedagogical possibilities (PP)

Variable	Pedagogical possibilities	Mean	*SD*
PP7	Facilitates independence in learning anywhere and at anytime	2.72	0.570
PP4	Offer greater possibilities for distance remote learning and individualised instruction	2.68	0.549
PP2	Facilitate collaboration and interaction among students	2.61	0.646
PP6	Educational apps empower students to explore new concepts, simulate real-life situations, collect data or practice content	2.58	0.631
PP5	Permit real-time learning interactions in class (e.g., resource sharing, surveys, questions)	2.56	0.671
PP1	Enhance student-lecturer communication beyond class time (e.g., email, SMS, file sharing, quizzes, feedback, updates, discussion forums, social networking)	2.46	0.767
PP3	Increase communication with colleagues	2.31	0.779

Principal Component Analysis

The principal component analysis (PCA) aimed to show how the ZFM scale items fit with each of the two scales by the way respondents discriminated items across the two scales. It was anticipated that there are might be subtle differences between the two constructs, namely, possibilities and constraints.

The procedure for selecting semantic items for the ZFM scale was based on item scale reduction. Items with loadings between -0.4 and 0.4 were considered for inclusion in the final scale. A Cronbach's alpha coefficient of 0.703 for the ZFM scales was obtained. This is a measure of inter-item correlation expressing the internal consistency of the instrument. The literature suggests that internal reliability coefficients higher than 0.60 are acceptable (Litzelman, Stratos, Marriott, & Skeff, 1998). The two-factor solution extracted 34.5% of the variance using Varimax rotation for the ZFM scale. The eigenvalues of the two factors from the principal component were all larger than one. The factor analysis of the ZFM scale clearly identified the possibilities as one dimension and the constraints as another dimension. Table 5 shows the PCA results:

Table 5: Rotated component matrix of ZFM scale

Components					
Item	1 (Possibilities)	2 (Constraints)	Item	1 (Possibilities)	2 (Constraints)
OC1		0.459	OP8	0.735	
OC2		0.556	OP9	0.523	
OC3	-0.360	0.547	PC1		0.443
OC4		0.540	PC2		0.449
OC5		0.511	PC3		0.492
OC6	0.388	0.466	PC4		0.484
OC7		0.464	PC5	-0.341	0.412
OC8		0.587	PC6		0.445
OC9		0.528	PC7		0.545
OP1	0.341		PP1	0.620	
OP2	0.597		PP2	0.686	
OP3	0.606		PP3	0.536	
OP4	0.641		PP4	0.712	
OP5	0.494		PP5	0.727	
OP6	0.522		PP6	0.585	
OP7	0.716		PP7	0.784	

The only cross-factored item identified was OC6 ("Lack of a mouse and a keyboard makes usability difficult"). A subsequent analysis of the ZFM scale when the OC6 item was deleted yielded an increase of Cronbach's alpha from 0.703 to 0.714 and an increase in the scale variance from 34.5 to 44.7. Hence, it can be safely removed from the scale, although a recommendation could be made to leave the item on the scale as it correctly loads more on the constraints rather than on the possibilities construct. Such loadings might also imply that lack of a mouse and keyboard might be perceived both as an advantage and disadvantage or, in other words, a matter of personal preference difficult to establish statistically. Finally, when each subgroup of the ZFM scale (e.g., OP, OC, PC, PP) was analysed then one dimension was identified, confirming the scale division into possibilities and constraints.

Regression Analysis for Sub-Group Averages

An early analysis using stages of adoption as the dependent variable and the remainder of the questionnaire questions as explanatory variables revealed that only significant predictor was the variable 'Access', represented by the questionnaire item *"I have regular access to a smart phone or a tablet"* ($p = 0.006$). In a subsequent regression analysis, average responses were calculated for each of the groups (OC, OP, PC, PP) to be used as potential predictors, along with Access, which is significant. In that model, average OC is significant ($p=0.001$), average PC could be considered marginal ($p=0.09$) and average OP and average PP are not significant, while Access has $p<0.001$. Average OC has a Beta = -1 meaning that for one unit increase on the subgroup there is a corresponding one unit decrease on the stages scale. Results are shown in Table 6.

Table 6: Multiple regression using sub-group averages

Variable	Beta	Std. Error	*T*	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	6.152	1.274	4.830	.000	3.634	8.670
Access	1.009	.268	3.769	.000	.480	1.538
Average OC	-1.096	.338	-3.247	.001	-1.764	-.429
Average OP	-.438	.479	-.916	.361	-1.384	.508
Average PC	-.557	.327	-1.704	.091	-1.203	.089
Average PP	.574	.403	1.427	.156	-.221	1.370

Dependent Variable: Stage of adoption

Stepwise Regression Analysis for ZFM Scale items

At the item level, all questionnaire items were entered into the multiple regression analysis allowing for the selection of significant predictors stepwise. This had the nice outcome that, as well as Access ($p<0.001$), exactly one item was selected as significant from each of the four groups: PC7 ("Lack of time to integrate into course') ($p<0.001$), OC8 ("Not all students/lecturers have devices") ($p=0.004$), PP1 ("Enhance student-lecturer communications outside class") ($p<0.001$) and OP9 ("Students can write and save own notes") ($p=0.026$). Results are shown on Table 7.

Table 7: Stepwise multiple regression by items

Variable	Beta	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
(Constant)	4.888	0.810	6.037	0.000	3.287	0.6489
Access to Device	1.031	0.256	4.025	0.000	0.524	1.538
PC7	-0.543	0.151	-3.591	0.000	-0.842	-0.244
OC8	-0.496	0.170	-2.913	0.004	-0.833	-0.159
PP1	0.576	0.143	4.023	0.000	0.293	0.859
OP9	-0.380	0.169	-2.258	0.026	-0.714	-0.047

In general, an increase of one unit on those four opinions would cause about half a unit variation on the stages scale. For three of them the effect will be negative: PC7 ("Lack of time to integrate into course"; Beta = -0.543), OC8 ("Not all students or lecturers have mobile devices or are not in the habit of using them"; Beta = -0.496) and OP9 ("Let students write and save their own personal study notes"; Beta = -0.380). The negative coefficient is unexpected, and will be discussed later. In turn, PP1 ("Enhance student-lecturer communication outside class") will yield a positive effect on the stages of adoption scale.

Stages of Adoption

As shown in Table 8, a quarter of respondents indicated that they were in the third stage of adoption of mobile devices: *Understanding and application of the process: I am beginning to understand the process of using mobile devices and can think of specific tasks in which it might be useful.* This was also the modal response; the full range of stages was reported, with lowest frequencies in the two extremes.

Table 8: Response to stages of adoption items

Stage	Percent
1. Awareness	12
2. Learning the process	19
3. Understanding and application of the process	24
4. Familiarity and confidence	16
5. Adaptation to other contexts	19
6. Creative application to other contexts	10

Discussion

Stage of Adoption of Mobile Learning Technology as Perceived by Academics

At this university, academic staff scored on average at the third of the six points of the ML adoption scale: *Understanding and application of the process: I am beginning to understand the process of using this technology and can think of specific tasks in which it might be useful.* Recommendations are incluced in this study to go beyond the midway point and attain the fourth stage, which is: *Familiarity and confidence: I am gaining a sense of confidence in using the technology for specific tasks. I am starting to feel comfortable using mobile devices.*

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The descriptive analysis of arithmetic means for the four sub-group ZFM scale provides valuable indications about what academics think as a cohort about each ML possibility and constraint factor. They believe that an efficient Wi-Fi connectivity is paramount to the success of any ML innovation (Melhuish & Falloon, 2010). They are also of the opinion that a major constraint is students' and academics' limited access to mobile devices as well as their limited familiarity with the complex functionalities of technology devices (Schuck, Aubusson, Kearney & Burden, 2012).

Lack of professional development as to how to incorporate technology into content and pedagogy, as reported by the participants in this study, can hinder effective integration, an observation supported by Yang (2012). As with operational and pedagogical possibilities, academics regarded ML devices as vehicles to enhance autonomous learning, to allow ubiquitous course engagement and to promote collaboration beyond university walls (Hamza Hussein & Bassam Nassoura, 2011). Similarly, staff were appreciative of the tools' portable ability to store and access teaching related files. What did not come through very strongly was their concern for using devices to articulate specific learning and teaching activities through touch screen experiences such as educational app or multimedia resource creation, as well as other interactive functionalities like real-time interactions in class, online forums or online quizzes (Kukulska-Hulme & Pettit, 2009).

Impact of Differential Variables on ML Stages of Adoption

Interestingly, gender, employment status and number of tablets owned by each School were not found to be significant explanatory variables in regard to stages of adoption. The statistical significance of responses to the item *"I have regular access to a smart phone or a tablet"* tell us how important it is for lecturers to have constant contact with an ML device to develop familiarity and confidence (MacCallum & Jeffrey, 2009). This finding suggests that universities should ideally provide those tools to lecturers for training, on loan or via bulk purchases at competitive prices for staff acquisition.

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PC7 ("Lack of time to integrate into course") and OC8 ("Not all students or lecturers have mobile devices or are not in the habit of using them") emerged as significant explanatory variables of stages of adoption (Oliver, 2005). These logistics issues appear often in various studies on mobile learning implementation. ML requires lecturers to develop new approaches and resources, adding pressure to their workload and other demands such as research and administration (Ting, 2012). For example, investigating quality educational apps to demonstrate disciplinary concepts requires individual time, as well as time spent liaising with eLearning staff and engaging in a trial-and-error learning exercises (Johnson, Adams Becker, Cummins, Estrada, Freeman, & Ludgate, 2013). Similarly, some staff and students are still using first-generation mobile phones that do not have an Internet display and other more elaborated electronic affordances that can be used pedagogically. Mobile tablets are still out of the reach of students' budgets, limiting their familiarity with the tool.

For the surprising OP9 negative explanatory effect ("Let students write and save their own personal study notes") one would argue that lecturers might think that students writing and saving their own notes was a mixed blessing — such responses might represent lecturers' acknowledgement that the word-processing capabilities are underrated as compared to more complex desk/laptop software such as Office Word or Excel (Marmarelli & Ringle, 2011). Lecturers might even think that learning materials are not compatible with mobile formats. It might also be that lecturers feel that students are not paying attention when students look at their ML screens (Barnes, & Herring, 2011).

Operational constraints as a subgroup also had a negative explanatory effect on the stage scale. Interestingly, while 78% of the participants stated that they possessed a smart phone or a mobile tablet, 74% indicated that their schools owned only 0-5 mobile tablets, reflecting a lack of availability of this technology. Only 21% of the participants owned a mobile tablet, with brands varying within a broad range of commercial products, almost half of them being Apple iPad users.

Finally, PP1 – the only positive effect – represented a widely acclaimed feature of ML to improve student-lecturer communication beyond the lecture walls (Khwaileh & Al-Jarrah, 2010). Mobile devices through email, SMS, file sharing, quizzes, feedback, updates, discussion forums and social networking are powerful tools in broadening 24/7 communication channels at a distance between students and lecturers and among students themselves (Bradley & Holley, 2010).

Conclusion

In a time when academics and students are increasingly utilising their mobile devices and interfacing them more seamlessly with the University electronic equipment, it is apparent that technology is becoming more integrated with learning and teaching. This is so not only for procedural purposes such as up/downloading resources or emailing but also for curricular and instructional reasons. Such a merging has profound implications for course delivery and the student experience. Academics are gradually required to provide more resources that are in line with the multimedia features of digital resources. To their advantage, these resources incorporating image, audio and animation can be played on students' BYOD devices in their own time and place. Universities are also progressively adapting their mobile digital infrastructure to accommodate students' needs and to facilitate academics' work. The findings of this study are significant because they identify academics' perceptions of a seemingly fluid and complex landscape contextualised within their own zone of free movement. Such data are relevant to guide professional development and policy in order to enhance the student experience.

The conclusions of the present study are valuable to the process of implementing mobile learning in tertiary education from a ZFM perspective. As the university prepares to introduce a new version of Blackboard through mobile technology, this study characterises a broad range of issues contributing to ML implementation during such a transition context. It was thought that such a transition environment would present a unique context for appraising academics' beliefs. In general, respondents to the survey seemed to have seen the benefits and potential of mobile learning technologies but were cautious about implementing them due to a lack of confidence in the infrastructure.

As a result, this study has extended the existing body of literature on implementing mobile learning technology in higher education particularly on methodology and research design. The use of multiple regression analysis provided a statistical avenue to explain the influence of environmental variables on stage of ML adoption, complementing well with descriptive data. The ZFM scale developed in this study is structurally solid and can be used in other higher education institutions that, as part of ongoing implementation processes, would like to appraise their academic staffs' perceptions of possibilities and constraints of ML devices in teaching and learning. Although generalisation is an issue because of the limited response rate of 17% , due to the scale's appropriate internal reliability and the composition of the participant group, the instrument is able to provide meaningful data to other tertiary institutions. Valsiner (1987, 1997) explained that "ZFM is a means to an end, rather than an end in itself" (1987, p. 190). Hence, the evidence generated can be used to reconstruct the ZFM through professional development, challenging academics' misconceptions on ML, enhancing the IT infrastructure and support, providing access to technology and producing creative policies.

Professional development workshops should target both healthy beliefs problems as well as misconceptions about possibilities and constraints in using mobile learning (Li & Walsh, 2010). For example, in order to promote positive attitudinal beliefs to increase level of adoption, inservice could put more emphasis on the communication and associated issues provided by ML devices (Pollara & Broussard, 2011). Similarly, clarification will be needed on the type of functionalities allowing students to directly make and take notes both during lectures or tutorials and in their private study. More importantly, emphasis should be made on training staff in articulating teaching experiences at the discipline level that take into account the dynamic affordances of mobile devices. Also effective would be creation of professional development networks within the university, both formal and informal, to share ideas that will help to alleviate academic workloads and yet integrate mobile learning into course delivery (Schuck et al., 2012). Such activities will certainly enhance the zone of promoted action (ZPA) as described by Valtimer (1987, 1997) and Goos and Bennison (2007, 2008).

Further longitudinal research as to how these opinions evolve during implementation, through professional development, policy-making, technology access and enhanced IT infrastructure, can provide clearer clues on the impact of the explanatory variables. Such prospective research should evaluate the interaction of those variables with instructional, curricular and organisational contexts operating within each discipline.

In general, the study reflected a healthy set of beliefs that need to be harnessed to efficiently implement the use of mobile devices in teaching and learning using the ZFM framework. As an academic stated in the comments section of the questionnaire: "The horse has already bolted. We need to catch it or we'll be out in the paddock without a horse."

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