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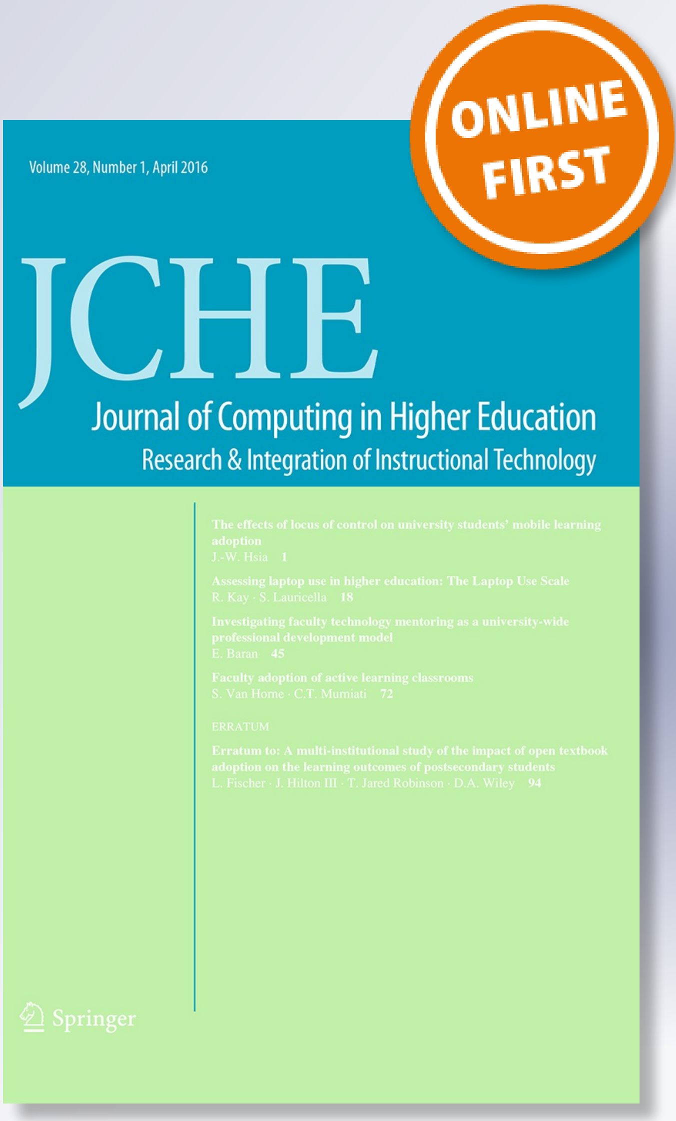

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An empirical analysis of the determinants of mobile instant messaging appropriation in university learning

Aaron Bere[1] · Patient Rambe[2]

Abstract Research on technology adoption often profiles device usability (such as perceived usefulness) and user dispositions (such as perceived ease of use) as the prime determinants of effective technology adoption. Since any process of technology adoption cannot be conceived out of its situated contexts, this paper argues that any pre-occupation with technology acceptance from the perspective of device usability and user dispositions potentially negates enabling contexts that make successful adoption a reality. Contributing to contemporary debates on technology adoption, this study presents flexible mobile learning contexts comprising cost (device cost and communication cost), device capabilities (portability, collaborative capabilities), and learner traits (learner control) as antecedents that enable the sustainable uptake of emerging technologies. To explore the acceptance and capacity of mobile instant messaging systems to improve student performance, the study draws on these antecedents, develops a factor model and empirically tests it on tertiary students at a South African University of Technology. The study involved 223 national diploma and bachelor's degree students and employed partial least squares for statistical analysis. Overall, the proposed model displayed a good fit with the data and rendered satisfactory explanatory power for students' acceptance of mobile learning. Findings suggest that device portability, communication cost, collaborative capabilities of device and learner control are the main drivers of flexible learning in mobile environments. Flexible learning context facilitated by

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learner control was found to have a positive influence on attitude towards mobile learning and exhibited the highest path coefficient of the overall model. The study implication is that educators need to create varied learning opportunities that leverage learner control of learning in mobile learning systems to enhance flexible mobile learning. The study also confirmed the statistical significance of the original Technology Acceptance Model constructs.

Keywords Adoption · Technology acceptance model · Mobile learning · Mobile instant messaging · WhatsApp

Introduction

Over the past decade, handheld devices have become one of the fastest growing communication technologies on the African continent. The global popularity of emerging technologies such as mobile phones has not yet reached saturation point (Park and Ohm 2014). The Techcrunch (2015) market report speculates a 9.2 billion mobile cellular subscriptions in 2020 and 6.1 billion of these subscriptions will be smartphones based. The meteoric growth in mobile-broadband penetration (from 2 % in 2010 to 20 % penetration in 2014) makes Africa the leading continent in the mobile revolution (International Telecommunication Union 2014). Arguably, mobile-broadband growth positions Africa as a key player in the mobile communication industry for years to come.

In South Africa, mobile instant messaging (MIM) services such WhatsApp, Black Berry messenger, and WeChat have taken the nation by storm. As of February 2016, WhatsApp had over one billion users, up from approximately 700 million in January 2015 (Statista 2016). The increasing popularity of MIM services in South Africa has been attributed to the following: their ability to promote peer-to-peer collaboration (Nikou and Bouwman 2014); capacity to enhance low-cost social networking (Dlodlo 2015; Nikou and Bouwman 2014); and messaging to multiple audiences (Dlodlo 2015; Statista 2014) at costs significantly lower than short message servicing (SMS). Amid the surging popularity of MIM are corresponding discourses on determinants of mobile adoptions that have often targeted MIM characteristics (Levine et al. 2013; Lin and Li 2014) and user preferences (Levine et al. 2013; Lin and Li 2014; Shih and Fan 2013).

These studies, however, have often foregrounded technical considerations and personal traits at the expense of contextual variables that invariably influence technology adoption in developing world contexts (Buchanan et al. 2013; Venkatesh et al. 2003). In the Technology Acceptance Model (TAM), the focus is on perceived ease of use and perceived usefulness; socio-technical concepts that, although they resonate with behavioural control and human agency, seem to negate situated contextual factors (such as communication cost, device capabilities and user traits) that make effective adoption of mobiles a reality. This paper argues that mobile adoption cannot be conceived out of its situated contexts given that user' agency shapes and informs mobile technology adoption. In technology adoption, the arguments should transcend mobile users' *perceptions* about the influence of the social world on the individual's behavior to include the actual pressure that the context exerts on the individual.

Drawing on social cognitive theory, (Compeau and Higgins 1995) posited that environmental influences such as social pressures or unique situational characteristics, cognitive and personality, as well as demographic characteristics and behaviour are reciprocally determined. Therefore, contextual variables impart behavioural intentions and actual adoption of technology in ways comparable to that of personal traits and technical considerations.

Consistent with the view of the preponderance of contextual variables, this study proposes personal traits (learner control, collaboration), technical variables (device portability) and contextual variables (cost of communication) as critical antecedents to students' behavioural intentions to adopt and the actual adoption of mobile technologies such as mobile instant messaging systems. A more holistic approach that considers personal, technical and contextual variables to mobile adoption is critical because the successful adoption of MIM in Africa has focused insufficient attention on contextual variables that shape successful adoption of technology (Bere 2012; Isaacs 2012; Rambe and Bere 2013; Roberts and Vänskä 2011). The few studies that have attempted to capture contextual variables have emphasised relevance of the technology for major courses (Park et al. 2012) and the general sociotechnical context of technology implementation (Leung 2007). These studies, however, were not focused on WhatsApp per se, but rather on the short message service (SMS) alert system and mobile learning adoption in general (Leung 2007; Park et al. 2012).

In view of paucity of research into the utilization of WhatsApp for teaching and learning in South Africa (Park and Ohm 2014), this study examines how antecedent variables influence WhatsApp mobile adoption and MIM academic performance among the South Africa tertiary students. Mindful of the confirmatory nature of mobile learning studies that deployed the TAM as a theoretical lens (Park et al. 2012), this study extends TAM through the incorporation of antecedent variables to student adoption of mobile instant messaging. The perceived flexible learning (portability, collaboration, cost, and learner control) and performance enhancement were integrated into TAM in an effort to establish factors that influence MIM adoption for academic purposes.

Theoretical foundation

Technology acceptance model (TAM)

In this study, learner acceptance of technology is defined as the demonstrable willingness of a student to use WhatsApp MIM for learning to enhance his/her academic performance. The conceptual foundation of learner acceptance is derived from the TAM, which was proposed by (Davis 1989, 1993) as a means of predicting technology usage (Chang et al. 2012; Venkatesh et al. 2012). The model postulates that *perceived ease of use* (PEU; that is, the extent of relative ease that people conceive using a technology system can be) and *perceived usefulness* (PU; that is, the extent to which people believe using a technology could enhance their work) of technology are predictors of user attitude toward, subsequent behavioural intentions, and actual usage of technology (Davis 1989, 1993). As such, TAM addresses two cognitive beliefs concerning technology usage, namely PU and PEU (Davis 1989, 1993; Venkatesh et al. 2012). PU is the degree to which the user believes that using the technology will improve their work performance, while PEU refers to how effortless users perceive using the technology will be (Chang et al. 2012; Davis 1989, 1993).

Research model and hypothesis

As shown below in Fig. 1, the learner's attitude towards adoption of MIM for learning is influenced by perceived usefulness, perceived ease of use, and the broader context of flexible learning. This situated context comprises device capabilities (portability), learner competencies (learner control of learning, collaborative engagements), and immediate milieu (cost of device, cost of communication). The following section presents the proposed research model based on these aforementioned constructs.

Flexible learning

According to Shurville et al. (2008) flexible learning is a product of educational systems that provides students with increased choice, convenience, and personalization to suit their learning needs. Collins et al. (1997) define flexible learning in terms of space, instructional delivery, entry requirements, content, and learner control. In this study, flexible learning context is defined by device portability, mobile-based collaborative learning, cost of bandwith and control of learning by the learner. Students' perceptions of flexibility of the MIM learning system (such as WhatsApp) are postulated to stimulate their behavioural intentions to adopt this system for learning (Mandeep 2010; Porter and Donthu 2006). Prior studies documented the academic dividends of adopting MIM as: fostering anywhere and everywhere learning due to device portability; enhancing collaborative discussions

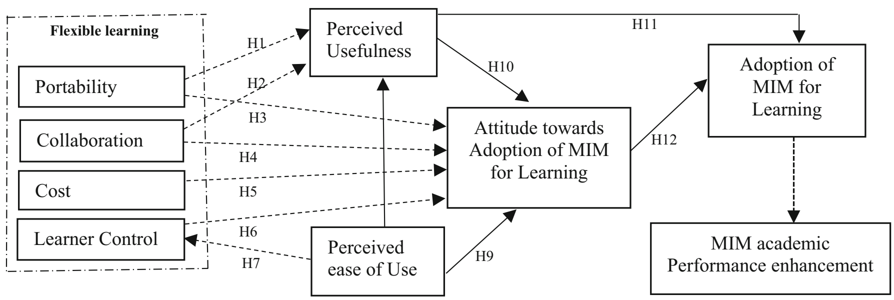

Fig. 1 Proposed study model

and providing academic support among students; encouraging active learning; providing instant feedback; cost-effective means of learning; integrating a variety of capacities; and affording authorised educational access to users (Bere 2012; Desai and Graves 2006).

Relationship between portability, perceived usefulness, and attitude towards MIM adoption for learning

In previous research investigations into MIM learning initiatives, WhatsApp and MXit (another popular mobile instant messaging service in South Africa) were accessed on portable devices such as smartphones, tablets and iPads creating possibilities for anywhere and everywhere learning (Roberts and Vänskä 2011). The adoption of mobile learning shifts the focus from the traditional perception of learning—that learning is influenced by place, time and space (Chu et al. 2010), towards acknowledging the intersection between device, content, connectivity and human learning capabilities. The availability of and effective access to learning resources via mobile devices create opportunities for mobile learners to learn across different contexts—in classroom or out of classroom, on campus or off campus. In a mobile learning context, both lecturers and students can trigger learning events (Looi et al. 2010) allowing them to deploy their communicative devices in ways that allow them to appropriate production and consumption simultaneously (thus becoming *producers*). In view of these convenience and ubiquitous learning opportunities afforded by MIM platforms, students are inclined to have positive dispositions to and authentic reception of this technology. The study, therefore, postulates a direct correlation between device portability and its perceived usefulness, and between device portability and attitude to adopt MIM.

H1: There is a positive relationship between portability and perceived usefulness.

H2: There is a positive relationship between portability and attitude towards adoption of MIM for learning.

Relationship between collaboration, perceived usefulness, and attitude towards MIM adoption for learning

Flexible learning requires the active engagements of peers and the facilitator. The various forms of collaborative activities fostered through WhatsApp and MXit adoption in South Africa enhance flexible learning for users (Roberts and Vänskä 2011). Collaborative learning fosters the development of new ideas, sharing of these ideas and improving them (Iqbal et al. 2011; Tan et al. 2006), making these processes beneficial to student learning. The study proposes a positive relationship between WhatsApp mediated-collaborative activities and perceived usefulness of this MIM. It also hypothesizes a positive relationship between collaboration via WhatsApp and its adoption for educational purposes:

H3: There is a positive relationship between collaboration and perceived usefulness.

H4: There is a positive relationship between collaboration and attitude towards adoption of MIM for learning.

Relationship between cost and attitude towards adoption of MIM for learning

Contemporary studies indicate that MIM is becoming more popular than SMS and phone calls—especially in developing countries where airtime is expensive (Dlodlo 2015; Yoon et al. 2014). WhatsApp (2016) indicates that there are no costs incurred for sending and receiving text messages. Unlike texting using the traditional short message servicing (SMSing) system where users pay a small fee for using the service. More so, international communications via WhatsApp is considerably cheaper than normal voice calls. It can be inferred that the low cost (such as affordability) of mobile instant messaging mediates flexible learning, which positively affects attitudes to adopt MIM.

H5: There is a positive relationship between cost and attitude towards adoption of MIM for learning.

Relationship between learner control, perceived ease of use and attitude towards MIM adoption for learning

Learner control is a concept based on Social Constructivism, which values students' construction of their own learning, their active interaction with peers and knowledgeable other (an expert, mentor, or knowledgeable peer) in learning activities as well as the significance of the social context in knowledge construction (Vygotsky 1980). Ally (2009) and Sotillo (2006) argued that mobile learning technologies allow students to take control of their learning since they can study at their own pace, time, and location at their convenience. Interestingly, mobile digital inclusion subverts notions of traditional learning where the location, time and environment for learning are regarded as important factors for effective instructional delivery (Chu et al. 2010). In mobile learning contexts, the pace and quality of learning is no longer defined by attending classes, but rather by the intersection of technology, learner dispositions, and connectivity.

Mobile learning using WhatsApp promotes learning through peer collaboration; hence, distributing control and management of learning to students (Rambe and Bere 2013). Moreover, students can also post questions concerning any chapter within the syllabus and get instant feedback from peers and facilitators. This enables learners to focus on certain aspects of their choice unlike in a classroom situation where the educator's lesson plan shapes and determines instructional delivery (Weaver 2006). Moreover, MIM affordances for synchronous and asynchronous learning promote learner control (Roberts and Vänskä 2011) by allowing students to engage their thought processes and to structure their responses accordingly.

Learning responsibilities are at times student-initiated, hence allowing students to take control of their learning (Looi et al. 2010). This study hypothesizes a positive relationship between learner control and attitude towards adoption of MIM, as well as a positive correlation between perceived ease of use and learner control.

H6: There is a positive relationship between learner control and attitude towards adoption of MIM for learning.

H7: There is a positive relationship between perceived ease of use and learner control.

Perceived ease of use

Perceived ease of use is defined as '*the degree to which a person believes that using a particular system would be free of physical and mental effort*' (Davis 1989). In this study, perceived ease of use involves students' experience of a lack of complexity or difficulty in their academic use of an MIM system. It entails users' ability to control the MIM system's behaviour to attain desirable outcomes. Tselios et al. (2011) reported that perceived ease of use positively influences attitude to use an e-learning platform. Furthermore, perceived ease of use was found to be the key determinant of the acceptance of e-learning. In view of this discussion, the following hypotheses are made:

H8: There is a positive relationship between perceived ease of use and perceived usefulness.

H9: There is a positive relationship between perceived ease of use and attitude towards adoption of MIM for learning.

Perceived usefulness

Perceived usefulness refers to *the degree to which a person believes that using a particular system would enhance his/her job performance* (Davis 1989, 1993). For the purposes of this study, perceived usefulness denotes the perception of the student that using MIM for learning heightens their performance. This perception is reinforced by the fact that perceived usefulness exerts a positive influence on both attitude towards MIM adoption for learning and the students' intention to adopt MIM for learning. A study conducted by Tselios et al. (2011) concluded that perceived usefulness is a key factor in shaping attitude toward systems use. The merits of utilising MIM for learning may trigger perceived usefulness among students. MIM allows students and peers to chat in "real time" (Rambe and Bere 2013) allowing instantaneous communication and feedback. MIM is profoundly valued for its capacity to foster a unique social presence that is qualitatively and visually distinct from e-mail systems and SMS in the following ways: (1) a "pop-up" facility to show messages the moment they are received; (2) a visible list ("buddy list") of users currently online (Quan-Haase et al. 2005).

A study conducted in Chilean academic contexts by Echeverría et al. (2011) revealed a positive relationship between perceived usefulness and the adoption of an institutionally supplied instant messaging learning system. This instant messaging for learning promoted mobile-based collaborative learning, which fostered knowledge creation and improved student-thinking abilities through interactions and information sharing. The authors found that students' perception of usefulness of the technology had a significant, positive impact on their attitude and intention to use the system. In other words, if individuals perceive that MIM utilization will enhance the efficiency of the learning process, they are more likely to adopt MIM for learning (Tan et al. 2012). Hence, in light of these findings, the following hypotheses are proposed here:

H10: There is positive relationship between perceived usefulness and attitude towards adoption of MIM for learning.

H11: There is positive relationship between usefulness and intention to adopt MIM for Learning.

Attitude towards technology use

Attitude towards technology use refers to users' positive or negative feelings linked to attaining a goal (Fishbein and Ajzen 1975). Users that perceive technology to be useful normally display a more favourable attitude toward such systems. Davis (1989) concluded that attitude is determined by perceived usefulness and perceived ease of use. In this study, attitude towards the use of MIM for learning affects adoption of MIM for learning. Therefore, the following hypothesis was developed:

H12: There is positive relationship between users' attitude towards adoption of MIM for learning and actual adoption.

Adoption of MIM for academic purposes

Adoption refers to the actual use of technology in order to accomplish a certain task (Davis 1989). Sim et al. (2014) reported that the main determinants for mobile technology adoption are perceived usefulness and perceived ease of use and users' attitude towards mobile technology use. In this study, mobile technology adoption refers to utilisation of MIM for learning. The authors assume that utilisation of MIM for learning may lead to higher student performance. Hence, the following hypothesis is posited:

H13: There is a positive relationship between MIM adoption for learning and enhancement of academic performance.

Methodology

This study adopted a survey founded on trend analysis. The purpose of this survey is theory building and testing since a trend study involves a detailed description of a complex entity or process with a view to inform theory or policy development (De Vos 2011). Consequently, the study's intention is to draw on an existing model, TAM, to understand its external variables and apply them to real world contexts. Such understanding would build on the theory; extend it as well as address its current shortcomings. Such a contribution to theory and confirmation are critical to generating theoretical insights closely grounded in real experiences (De Vos 2011), in contrast to speculative armchair theorizing (Thomas 2004). To explore the motivations behind students' behavioural intentions and actual use of WhatsApp instant messaging, the researchers adopted this mobile application as a collaborative environment that enables lecturer-student and students-peer interaction outside the classroom.

Participants

The study was conducted at a University of Technology in South Africa. Convenience sampling method was used in selecting courses for observation. Selected courses were from the Information Technology (IT) department, namely Internet programming and information systems. Internet programing was a Bachelor of Technology (BTech) degree course while information systems were a third-year diploma course. Eligible participants comprised 35 Internet programming students and 263 information systems students. These participants possessed web-enabled mobile devices with WhatsApp downloading and installing capabilities. Participants' ages ranged from 20 to 33 years. Participants' demographics are presented in Table 1 below.

Research procedure

The researchers were interested in exploring individual factors that influence students' attitude towards utilization of WhatsApp for academic purposes. At the beginning of the first semester in 2014, the main author of this study inquired about which students had used WhatsApp for social and academic purposes including the frequency of such use. This in-class exercise demonstrated that students had varying experiences and prior exposure to the use of WhatsApp. In order to support students with limited prior experience of using this MIM, the researchers uploaded a manual on *Ethuto* (the University-sanctioned learner management system), which guided them on downloading and installing WhatsApp applications onto their phones. The

Table 1 Demographics

Variables	Variable category	Frequency	Percentage (%)
Course	Diploma in IT	263	88.26
	Bachelor's Degree in IT	35	11.74
Gender	Male	111	37.25
	Female	125	62.75
Age	<21	13	4.36
	21–25	192	64.43
	26–30	66	22.15
	>30	27	9.06

manual also described procedures for joining groups and how to use WhatsApp. Mobile devices used by participants ranged from smart phones, PDAs, iPhones, iPads and tablets.

The lecturer randomly placed students into virtual discussion forums comprising at most 10 participants per cluster inclusive of the lecturer. Randomly placing students in groups addressed perceived knowledge gaps between peers, and student anonymity in these intra-cluster interactions was achieved by requiring students to use their cell numbers as their log-on IDs. The lecturer, however, used his authentic identity for easy recognition by all students. Since participation was voluntary, 279 students participated in the study. Four consultative WhatsApp clusters were formed for the BTech class involving 35 students, while 26 clusters were created for the 244 Diploma students who participated in the study. The study involved two cohorts with different discussions (BTech discussions were different from Diploma discussions). Any participant and the lecturer were free to post their academic questions and contributions at any time from any section of the syllabus. Group members were encouraged to provide feedback as quickly as they could to keep the discussions vibrant. Those who were unavailable were also allowed to respond as soon as they were online. In an effort to provide effective, authentic and task-focused learning, participants were encouraged to research and think critically before responding. The lecturer played a facilitator role of scaffolding on questions that appeared to be difficult to the students.

The paper-based survey was conducted at the end of the first semester (a semester comprised 12 weeks). In week 11 of the first semester of 2014, a paper-based self-report questionnaire was distributed at the end of a classroom session. The questionnaire was distributed again in the second classroom session of the week in order to reach out to participants who were absent in the first classroom session of the week. Participants were encouraged to use pencil to complete the questionnaire even though pen completed questionnaires were also accepted. Completion of the questionnaire took approximately 20–25 min and completed questionnaires were returned to the researcher in class. Since participation was voluntary, no questions were asked to participants who did not to return the questionnaire.

Study data collection method

Previous user acceptance studies utilized self-completion questionnaire (Donkor 2011; Turner et al. 2010). This technique has been reported to be easy to manage, and quick-to-score, resulting in the respondents and researchers requiring reasonably less time to complete (Donkor 2011; Turner et al. 2010). Based on these insights, this study used a self-report questionnaire for data collection.

The questionnaire for this study was developed based on the objectives of the study and existing TAM literature. It employed a 7-point Likert scale format. The responses options ranged from 1 to 7 representing "strongly disagree," "disagree," "partially disagree," "Neutral," "partially agree," "agree," and "strongly agree" respectively. Twenty participants were randomly chosen from the research population for pilot-testing purposes. Through pilot testing, ambiguous statements in the questionnaire were identified and improvements made. A revised 36-item questionnaire was tested for internal reliability and convergent validity using the pilot-testing data. Table 2 below presents the measurement items that were used as the basis for the questionnaire development for this study.

Table 2 Measurement items

Constructs	Item	Measurement items	Sources
Flexible learning contexts (FLC)	FLCP 1	Accessing MIM for learning anywhere and anytime promotes flexible learning	Suki and Suki (2011)
	FLCP 2	Access to portable data in real time enhances flexible learning	
	FLCP 3	Mobile device portability enhances flexible learning	
	FLCC 1	Academic collaboration in various textual formats (text, audio, video) improves flexible learning	Newly created
	FLCC 2	Academic collaboration with facilitators and peers via MIM platforms promotes flexible learning	
	FLCC 3	Academic collaboration 24/7 using MIM improves flexibility in learning	
	FLCC 4	Academic collaboration via MIM platforms contributes significantly to flexible learning	
	FLC $1	Low-cost access to academic contributions on MIM platforms promotes flexible learning	Newly created
	FLC $2	Low-cost access to academic consultations anytime, anywhere using MIM improves flexible learning	
	FLC $3	Low bandwidth requirements improves my flexible learning by keeping me up to date in MIM academic discussions	
	FLC $4	Low bandwidth cost significantly improves mobile flexible learning	
	FLCLC 1	Using MIM platforms to contribute to academic discussions at my convenience improves flexible learning	Newly created
	FLCLC 2	Allowing academic consultations in formats (video, text, audio) that suit me improves flexible learning	
	FLC LC 3	Anytime consultations for syllabus sections I struggle with promotes flexible learning	
	FLCLC 4	Receiving learning material I need synchronously promotes flexible learning	
	FLCLC 5	Learner-centered approaches supported by MIM significantly improve mobile flexible learning	
	FLC 1	Using MIM for academic purposes improves mobile flexible learning	Newly created

Table 2 continued

Constructs	Item	Measurement items	Sources
Perceived usefulness	PU1	Using MIM for learning would enable me to achieve learning objectives effectively	Park and Ohm (2014), Suki and Suki (2011), Tan et al. (2012)
	PU2	Using MIM for learning would improve my academic performance	
	PU3	Using MIM for learning would save me much study time	
	PU4	Overall, MIM for learning would be useful for my success in learning	
Perceived ease of use	PEOU1	Learning to use MIM for academic purposes is easy	Suki and Suk (2011), Tan et al. (2012)
	PEOU2	Using MIM for academic purposes would not require much mental effort	
	PEOU3	Using MIM for academic purposes is clear and understandable	
	PEOU4	It would be easy for me to become skilful at using MIM for learning	
Attitude towards use	ATT1	In my opinion it would be very desirable to use MIM for learning	Suki and Suki (2011), Tan et al. (2012)
	ATT2	I think that using MIM for learning is better than using other mobile learning systems	
	ATT3	I would like to use MIM for academic purposes	
	ATT4	It is desirable to use MIM for learning compared to other mobile learning systems	
Adoption	A1	I use MIM for learning	Davis (1989)
	A2	I would not stop using MIM for learning	
	A3	Using MIM for learning is invaluable	
Performance enhancement	PE1	Academic usage of MIM reduces my study time	Yang et al. (2011)
	PE2	Academic usage of MIM makes it easier to execute learning tasks	
	PE3	Academic usage of MIM improves my capability in executing learning tasks	
	PE4	Overall, academic usage of MIM enhances my performance in learning	

Main survey

Literature suggests that a sample of at least 175 participants would be ideal for achieving 95 % confidence (El-Gayar et al. 2011). The self-report questionnaire was administered in class using pencil or pen approach to 279 participants in week 11 of semester one in 2014. Two hundred and thirty-one questionnaires were returned, but eight were discarded as they were deemed incomplete. The 223 usable returned questionnaires constituted a response rate of 80 % and thus surpassed the minimum recommended sample size.

This study adopted partial least squares (PLS) for the statistical analysis of data. Previous studies on TAM (Chang et al. 2012; El-Gayar et al. 2011; Park and Ohm 2014; Suki and Suki 2011) applied PLS for conducting structural equation modelling (SEM). Application of PLS to several previous studies reveals its effectiveness in statistical analysis of TAM-related studies, and therefore PLS was chosen for this study as well. Additionally, PLS was adopted for this study due to its limited demand on data distribution compared to other statistical software package used for structural equation modelling, such as Linear Structural Relations (LISREL; Suki and Suki 2011).

The purpose of PLS is assessing the psychometric properties of the scales that measure the construct or measurement model. In addition, the direction and strength of the relationships among model constructs or structural models may be projected through its use. The PLS statistical analysis method also computes the weights and loading factors for each item in relation to the construct it was proposed to measure (El-Gayar et al. 2011).

Assessing the measurement model involves calculating the internal consistency for every batch of constructs and evaluating construct validity. The factor loadings are used to measure composite reliability (CR) and average variance extracted (AVE). CR and AVE are used for measuring internal consistency. CR and Cronbach's alpha measure reliability of the constructs, but CR provides a closer approximation (El-Gayar et al. 2011).

Results

The two snapshots in Fig. 2 below illustrate some of the academic conversations that took place on the WhatsApp platform after the database design lectures. For the purposes of maintaining participant privacy, WhatsApp contact details have been deleted in the interactions. An average of 40 messages was posted per day per cluster. Most of these interactions took place in the evenings between 18:00 and 23:00, representing on average twice the number of message exchanges that took place during the day. Weekends had higher WhatsApp academic exchanges than weekdays. A typical day during assessment week had an average of 90 instant message exchanges per cluster. The most commonly discussed topics were database modelling techniques, database relationships, and normalization.

Mean

The mean values for this study range from 5.14 to 5.78 as shown in Table 3. The mean values greater than 5 obtained in this study reveal that participants had a positive evaluation of the mobile learning initiative using MIM.

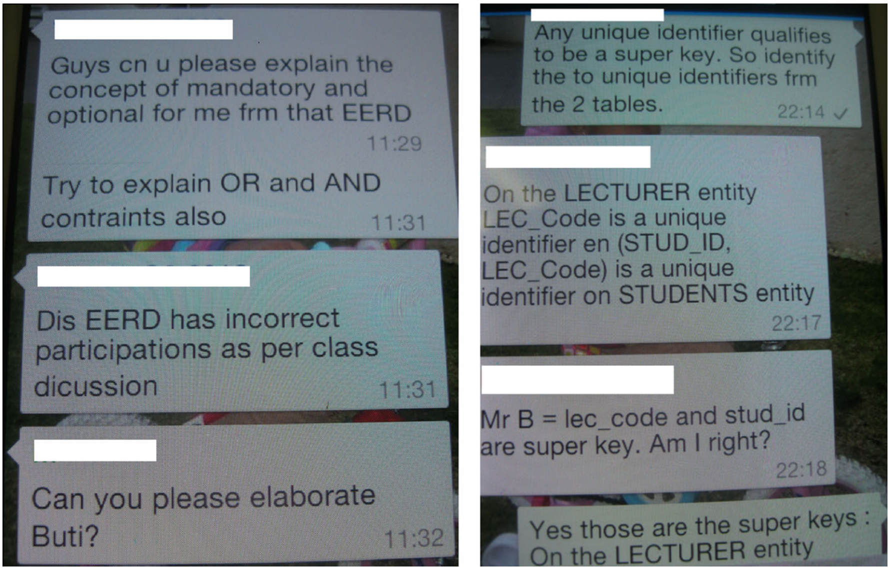

Fig. 2 Snapshots of data exchanged through MIM interactions: An overview

Factor loadings

Factor loadings of measured constructs on latent variables are estimates of individual item reliability. A factor loading of at least 0.7 is recommended for measured variables (El-Gayar et al. 2011; Hair et al. 2010). Factor loadings for this study shown in Table 3 are all greater than 0.7; an indication of a good reliability for measured variables. Factor loading is directly proportional to the explanatory power of the model; hence, higher factor loadings signify higher explanatory power of the model (Chang et al. 2012).

Composite reliability (CR)

According to Chang et al. (2012), the major pointers for assessing convergent validity are CR and AVE. CR of a construct emerges from reliabilities of all the measured constructs. These reliabilities include internal consistency of a construct. A desired CR should be > 0.7 (Hair et al. 2010). The composite reliabilities for this study all range from 0.854 to 0.943 signifying a good internal consistency for each construct (see Table 3 below). CR is directly proportional to internal consistency of a latent variable.

Average variance extracted (AVE)

AVE refers to the measure of the error-free variance of a set of items or measure of convergent validity. The AVE concept was proposed by Fornell and Larcker (1981)

Table 3 Constructs descriptive statistics and instrument reliability and validity

Constructs	Items	Mean	SD	Factor loading	Cronbach's alpha	Composite reliability	AVE
Flexible learning contexts	FLC P1	5.46	1.16	0.899	0.892	0.924	0.779
	FLC P2			0.878			
	FLC P3			0.921			
	FLC C1			0.901			
	FLC C2			0.899			
	FLC C3			0.912			
	FLC C4			0.879			
	FLC $1			0.842			
	FLC $2			0.674			
	FLC $3			0.811			
	FLC $4			0.812			
	FLC LC1			0.942			
	FLC LC2			0.909			
	FLC LC3			0.935			
	FLC LC4			0.933			
	FLC LC5			0.962			
	FLC 1			0.913			
Perceived usefulness	PU1	5.21	1.27	0.826	0.861	0.858	0.721
	PU2			0.842			
	PU3			0.855			
	PU4			0.874			
Perceived ease of use	PEOU1	5.69	1.19	0.871	0.872	0.859	0.760
	PEOU2			0.862			
	PEOU3			0.844			
	PEOU4			0.912			

Table 3 continued

Constructs	Items	Mean	SD	Factor loading	Cronbach's alpha	Composite reliability	AVE
Attitude towards use	ATT1	5.78	1.14	0.966	0.921	0.943	0.937
	ATT2			0.951			
	ATT3			0.977			
	ATT4			0.976			
Adoption	A1	5.74	1.21	0.894	0.796	0.854	0.570
	A2			0.721			
	A3			0.649			
Performance enhancement	PE1	5.14	1.26	0.789	0.763	0.895	0.707
	PE2			0.941			
	PE3			0.841			
	PE4			0.742			

AVE average variance extracted

Table 4 Discriminant validity calculation

	1	2	3	4	5	6
1. Perceived flexible learning	**0.883**					
2. Perceived usefulness	0.598	**0.849**				
3. Perceived ease of use	0.632	0.682	**0.872**			
4. Attitude towards use	0.657	0.688	0.725	**0.968**		
5. Adoption	0.573	0.596	0.531	0.798	**0.755**	
6. Performance enhancement	0.594	0.562	0.612	0.723	0.731	**0.841**

Bold values show all the square roots of AVE, which are greater than the correlation coefficients between the construct and the other constructs

as a measure of the shared or common variance in a construct (Dillon and Goldstein 1984). The higher the AVE value, the higher the convergent validity. An acceptable AVE value should be greater than 0.5 (Chang et al. 2012; Fornell and Larcker 1981). The AVE for each construct ranged from 0.570 to 0.937 (see Table 3). Based on these figures, constructs in the present study had good convergent validity as AVE exceeds 0.5 in all cases.

Discriminant validity assesses if the measured constructs that should be unrelated are in reality unrelated. The concept of discriminant validity introduced by Campbell and Fiske (1959) is supported when the square root of AVE for each construct is greater than the correlation coefficients between the construct and the other constructs (El-Gayar et al. 2011). In this study, discriminant validity exists among the constructs since the square roots of AVE are greater than the correlation coefficients between the construct and the other constructs. Table 4 presents the square roots of AVE and the correlation coefficients between the construct and other constructs.

Model testing

Structural model analysis is used to evaluate path coefficients (β) and R^2 among constructs of the research model. The path coefficient examines the relative strength and sign of causal relationships among constructs. The R^2 values indicate the percentage of total variance explained by an exogenous variable on endogenous variables. Furthermore, the R^2 values signify the predictability of the research model. Path coefficients and R^2 signify the common ground between the structural model and experimental data (Chang et al. 2012). Suki and Suki (2011) point out that "a path coefficient of at least 0.05 is recommended for a path to be statically significant".

The summary of the structural model analysis is depicted below in Fig. 2. The path coefficient for each path is shown and they range from 0.043 to 0.562. The R^2 values for each construct that has an R^2 value greater than zero are indicated within the textbox. The R^2 value for perceived ease of use, perceived usefulness, attitude towards use, adoption and performance enhancement explained 40.9, 48.6, 56.7,

Table 5 Hypothesis-testing results

Regression tests	β	*t* value	*p* value	Remarks
Flexible learning contexts → perceived usefulness				
H1: Portability → perceived usefulness	0.162	1.214*	0.009*	Accepted
H2: Collaboration → perceived usefulness	0.562	4.612***	0.000**	Accepted
Flexible learning contexts → attitude				
H3: Portability → attitude	0.232	3.063**	0.000**	Accepted
H4: Collaboration → attitude	0.541	4.267***	0.000**	Accepted
H5: Cost → attitude	0.113	1.194*	0.056*	Accepted
H6: Learner control → attitude	0.536	4.014***	0.000**	Accepted
Perceived ease of use → flexible learning, perceived usefulness, attitude				
H7: Perceived ease of use → learner control	0.043	0.562	0.198	Rejected
H8:Perceived ease of use → perceived usefulness	0.321	2.931***	0.210	Accepted
H9: Perceived ease of use → attitude	0.296	3.007**	0.021*	Accepted
Perceived usefulness → attitude, adoption				
H10: Perceived usefulness → attitude	0.285	3.297**	0.000**	Accepted
H11: Perceived usefulness → adoption	0.391	4.004***	0.031*	Accepted
Attitude → adoption				
H12: Attitude → adoption	0.264	3.143**	0.000**	Accepted
Adoption → performance enhancement				
H13:Adoption → performance enhancement	0.246	3.115**	0.0000**	Accepted

* p value < 0.05; ** p value < 0.01

36.9 and 44.7 % respectively. The R^2 obtained in this study indicate that the constructs are significant.

Table 5 indicates path coefficient values (β) similar to those shown in Fig. 3. The β values of at least 0.05 are acceptable for a path to be statically significant (Chang et al. 2012; Park and Ohm 2014). With reference to Table 5 β values, all hypotheses were found to be statistically significant except for H7 that was not supported having a β of 0.043. Hypothesis 2 (H2) had the strongest significant relationship (with a β of 0.562) while H5 had the least strong significant relationship among the supported hypotheses (with a β of 0.113). Other statistical values indicated below in Table 5 are *t* values and *p* values for the study (similar to those in Fig. 3).

Discussion

Path co-efficients (β) of 0.162 and 0.562 obtained in this study for H1 and H2 respectively reveal that flexible learning contexts enabled by device portability and student collaboration using MIM, correspondingly, had a positive influence on students' reports of mobile learning perceived usefulness. Furthermore, the findings of the study show that flexible learning contexts, which are enabled by device

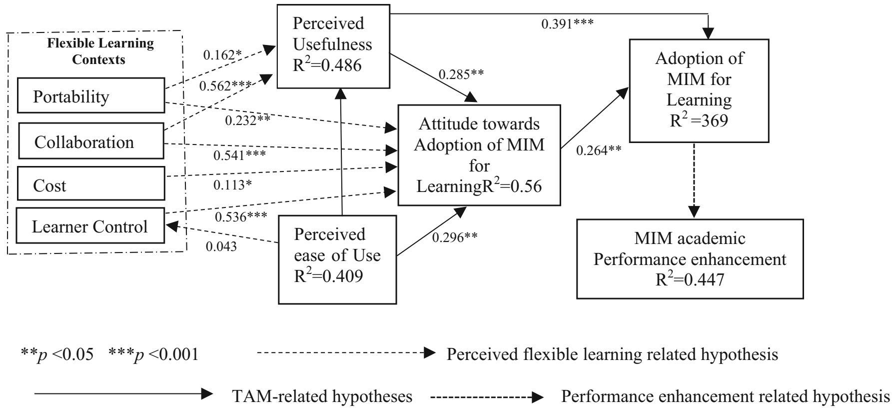

Fig. 3 Structural model analysis

portability, low cost communication, collaboration across different spaces, and learner control [β = 0.232 (H3), 0.541 (H4), 0.113 (H5), 0.536 (H6) respectively] positively influenced students' reported attitudes towards adoption of MIM for learning. These results reveal significant student appreciation of academic use of MIM, thus showing promise for mobile-enhanced engagement to be an effective way of transforming pedagogy in higher education. Mobile instant messaging appears to have the potential to create flexible learning contexts that support the transformation of higher education from instructive teacher-centred to active student-centred learning (Looi et al. 2010). While instructor-led teaching has its place, technically-oriented subjects (such as Internet programming; and Information systems) demand more student engagement in task execution and participation in collaborative learning processes that deepen their knowledge of the course. More so, flexible learning environments provide students with considerable latitude to choose what, when, and where they study (Ally 2009; Gan and Balakrishnan 2014).

Kalloo and Mohan (2012) aptly claimed that device mobility has proven to be critical to students in Trinidad and Tobago who had enrolled for multiple subjects and hence struggled to juggle academic study and other extra-curricular activities. Under such stressful circumstances, mobile learning augments learning opportunities by rendering opportunities for ubiquitous access to learning resources. In this study, learners reported that device portability influenced perceived usefulness and attitude towards MIM usage judging from their respective β values of 0.162 (H1) and 0.232 (H3).

The collaborative engagement capabilities of mobile devices were instrumental in creating flexible learning environments. In this study, student collaboration using MIM appears to have influenced perceived usefulness and attitude towards academic adoption of MIM [β = 0.562 (H2) and 0.541 (H4) respectively]. This confirms previous research that explored the capacity of MIM to support collaborative questioning through messages that trigger multiple questions (Ng'ambi 2006) as well as leverage the complexity of interaction by supporting more challenging questions (Bere 2012). Consistent with these views, (Rambe and Bere 2013) explained that mobile technology shifts the learning boundaries for both the educator and students by extending the information sources from books to mobile platforms. Essentially, learners also learned to explore, adapt and share knowledge amongst their peers without the facilitation of the educator.

Low cost of communication via WhatsApp allowed students to connect with their academic community persistently. The study shows that low cost of communication influenced students' reported attitude towards adoption of MIM for learning [$\beta = 0.562$ (H2) and 0.541 (H4) respectively]. These findings are consistent with Yoon et al.'s (2014) claim that MIM usage has spread rapidly mainly because of its advantage of free access. A study conducted by Lee (2008) on learners' use of portable multimedia players (PMP) revealed the devices' capacity to diminish costs and improve students' study time management as well as their attitudes towards learning. As the literature suggests, low-cost communication can also be derived from the multiplicity of devices from which SMS services can be sent. As (Traxler and Leach 2006) pointed out, apart from mobile phones, bulk SMSing can be done from networked desktop computers or wireless-enabled laptops, via an interface such as a standard office email client like Eudora or Outlook. The diversity of networked devices from which mobile messages can be transmitted implies that students have different options from which educational messages can be relayed to other learners. Although students did not report diverse points from which MIM were transmitted in this study, they stood to benefit academically from the affordances that these networked technologies provided.

Isaacs (2012) highlights bandwidth problems and limited financial resources as the major impediments to effective adoption of ICT enhanced learning. In view of such revelations, the popularity of low bandwidth intensive technologies such as MIM among students is unsurprising to educators in African contexts where alternative modes of communication such as voice calls and SMS are deemed to be expensive.

The findings of this study are consistent with contemporary literature on TAM-related hypotheses (Davis 1989; Tan et al. 2012; Teo and Zhou 2014). TAM-related hypotheses suggest that that (a) student's perceived ease of use of mobile learning has a positive influence on perceived usefulness of mobile learning [$\beta = 0.321$ (H8)]; (b) Students' perceived ease of use of mobile learning technologies and students' perceived usefulness of mobile learning have a positive influence on their attitude towards mobile learning adoption [$\beta = 0.285$ (H10) and 0.296 (H9) respectively]; (c) students' perceived usefulness of mobile learning and student's attitude towards use of mobile learning have positive influence on mobile learning adoption [$\beta = 0.391$(H11) and 0.264 (H12) respectively]. Furthermore and consistent with prior research, perceived ease of use was considered to be a significant determinant of students' motivations to use cell phones (Teo and Zhou 2014). With regard to perceived usefulness, the study resonates with Bouhnik and Deshen‘s (2014) findings that timeliness of messages, accessibility of messages, amount and relevance of information transmitted were key components of the perceived usefulness of the academic use of instant messaging. These factors are consistent with flexibility of learning, which demands real-time communication;

swift transmission and retrieval of information in transactional exchanges; as well as the transmission of relevant information.

Mindful of Venkatesh et al.'s (2003) claim that little research has addressed the link between user acceptance and individual or organizational usage outcomes, we sought to examine the relationship between usage and educational outcomes—especially performance enhancement. Adoption of MIM for learning was found to have a positive influence on learner performance. The findings are consistent with Rambe and Bere (2013), who reported that utilization of MIM for learning improved students' cognitive thinking and reasoning capacity. Kim (2006) attributed improved learning efficiency in mobile learning environments not only to exchange of textual resources (text messages, images and videos), but rather to cogitative communicative processes among learners and teachers via mobile devices. Similarly, a study conducted by (Kalloo and Mohan 2012) on the capacity of a mobile learning application, MobileMath—to enhance algebra skills—reported the potential of the application to improve learning performance (H13 has β of 0.246), heighten student motivation to learn and enhance their adaptability to learning.

Implications for practice

The findings of this study reveal that the flexibility of the mobile learning context contributes significantly to positive student attitudes towards utilising MIM. Since student collaborations via MIM positively influenced their attitudes towards adoption of MIM, university lecturers may need to design and assess tasks that require student collaborations using MIM to enhance the flexibility of the mobile learning environment further. Furthermore, university educators may also need to continually foreground educational uses of WhatsApp as this study's findings indicate that adoption of mobile learning systems positively enhances the academic performance of students.

Since university lecturers are not the only participants implicated in students' effective use of mobile devices and mobile learning contexts, the broader educational community may need to be considered in the design of flexible mobile learning environments. For instance, developers of mobile learning systems/applications need to be sensitized to the positive correlation among low-cost technology (especially MIM), perceived usefulness, and student attitudes towards using MIM. In view of the increasing popularity of low bandwidth technologies such as MIM platforms among students, therefore, more synergy between educators and application developers is required to synchronize technology application developments with student learning needs. For instance, educators may need to liaise with content developers to ensure more relevant educational materials are uploaded on mobile applications for students' benefit.

Furthermore, the study findings indicate that learner control significantly influences student attitude to use a mobile learning system and perceived usefulness of the learning platform. We inferred that learner control of learning improves when the learning system provides relevant, current content that reduces student dependence on the educators for educational materials. The application developers, therefore, need to continually update the educational content they provide on the system as well as provide easy-to-use, customized tools that engender learner-initiated content development. Since the study demonstrates that ease of use positively influences attitude to use technology and influences usefulness of mobile learning systems, application developers may need to continue experimenting with WhatsApp to ensure provision of more accessible content.

Yet the educational community itself cannot sustainably deliver relevant, current content without a consideration of the technological affordances of the MIM learning platform and interactive tools themselves. To the extent that opportunities for collaboration were reportedly critical to the usage of the MIM system and its perceived usefulness, the MIM platforms should provide more collaborative engagement-oriented functionalities and applications to increase student academic engagement with the system. Tools that emphasise collaborative knowledge sharing, peer-based, in-depth conversations, discussions and argumentation should be developed and supported.

Limitations

The study relied mainly on self-report data of students, the main data source used in this research. The data extracted from the study, therefore, may be a temporal expression of student perceptions of the WhatsApp tool and learning environment at the time when the investigation was conducted. Such perceptions were bound to change with students' increased exposure to this learning environment and learning tool in this course, and as they applied the tool across different courses they enrolled in for the duration of their studies. While the current study involved a large pool of students, which increased the dependability of the results, perhaps replicating the study with other courses could improve the extent of generalizability of the current study findings.

More so, the quantitative nature of the self-report questionnaire, which in some instances required respondents to provide definitive "yes or no" options could have restricted the choices available to respondents, as they could not explain their options. Such closed questions could have skewed the responses either in the affirmative or the negative. While the researchers restricted the number of closed questions in the self-report questionnaire, and provided a range of Lickert scale-based questions to allow for variability of responses, it is common knowledge that both structured and unstructured questionnaires have their own limitations. Perhaps, the challenge of skewed responses from closed questions would be reduced through providing additional spaces in each section of the questionnaire for respondents to justify their responses with some elaborations and explanations of their choices.

The study was limited to one institution, one department and one case scenario—which might constrain its broader application. To overcome this limitation, the model should be rolled out and tested on a wider scale—within the context of different universities, faculties and departments. Such wider application of the model could enhance its acceptability and dependability in mainstream IT literature.

The results of this study could have been improved by considering participants from different age groups and wider geographical scopes. Although the admission policies of the institution considered did not naturally discriminate students on the basis of age, it was natural that students of comparable age tended to be enrolled in the same cohort(s). Overcoming this scenario means that various cohorts, courses or disciplines need to be considered. That said, such consideration may mean integrating students with different disciplinary backgrounds, experience with IT, and academic levels—thus complicating possibilities for comparing heterogeneous groups.

The scope of this study was limited to the quantitative analysis of antecedents of learning using MIM. While the conduct of such a technology-oriented study may invoke consideration of the levels of trust between mobile adopters (for example educators and students) given their age differences and cyber bullying in view of the young population examined, these issues were beyond the scope of this study. The researchers' assumption was that the high student-peer and educator-student interaction on WhatsApp bore testimony to the prevalence of trust among these intergenerational groups. By the same token, the absence of student complaints about breaches of privacy by peers or the educator affirmed the educators' insistence in the academic conversations in these mobile learning environments. That said, future studies may need to establish whether trust is really an issue in such MIM learning environments.

Since the university has a zero tolerance for cyber bulling and imposes sanctions on students who are found guilty of such practices, we also eliminated cyber bulling in our model, although we cannot rule out further studies that investigate whether cyber bulling happens in academically-oriented MIM environments as well as its implications for effective academic engagement. Given our pre-occupation with theory building and extending the existing constructs of TAM, we emphasised the dependability of our proposed constructs and assumed that while understanding qualitative experiences of students on academic utilization of MIM would be informative, it would over-stretch the foci and loci of this investigation. We encourage other researchers to extend our model by considering the qualitative slant if deemed necessary.

Conclusion

Previous studies have reported on mobile technologies' potential to transform teaching and learning in higher education (Gan and Balakrishnan 2014; Hung and Zhang 2012; Looi et al. 2010). This study's findings reveal that students' perspectives of academic use of MIM are that it enhances their learning performance. This study considered flexible learning contexts, an antecedent to mobile learning to be predicated upon mobile device portability, student academic collaboration using WhatsApp, low cost of communication and the ability for learners to take control of their learning processes.

Although not necessarily flagged as the main findings of this study, there were a few context-specific observations that the researchers made that could be related to

WhatsApp usage in the course. For instance, it is plausible that students who missed lectures due to competing work commitments may have found WhatsApp an inexpensive, student-driven, and hands-on platform presenting convenient ways of staying up to date and maintaining connectivity with their classes on academic matters. Consequently, they may have found that the flexible learning contexts that presented ubiquitous learning opportunities resonated with their hectic schedules that disrupt their education and passion for learning-on-the-move. More so, some participants attended evening classes—which were characterised by low attention spans, low knowledge retention and possible academic disengagement of exhausted students, and WhatsApp usage created a fast, convenient ways of "catching up" and "putting the academic puzzles together." It is unsurprising that such students tapped into the educational value of portable mobile devices and applications at their convenience.

Keller's (1987) ARCS model of motivation asserted that provision of learning material in different formats captures students' attention. In Keller's (1987) study, students collaborated academically using text, audio, images and video messages in ways that ignited perpetual academic arousal among students and hence the claims about improved student performance. In this study, flexible learning contexts afforded student academic collaboration by syncing MIM affordances with student communicative capabilities and desire for networked engagement. Since a majority of the participants here had come from previously disadvantaged backgrounds (such as students from low socioeconomic groups who attended poorly resourced high schools), inexpensive, ubiquitous social technologies were the desirable communication modes they afforded. Bere (2012) argued that provision of learning at lower costs promotes adoption of mobile learning in developing countries.

Lastly, there is a convergence of educational literature on the capacity of learner-centred approaches to enhance student control of their learning (Hwang et al. 2015; McLean and Gibbs 2010; Xiong et al. 2015). We extend this conception of learner centred learning by providing the situated technology-enabled learning environments and conditions that make learner control feasible. In particular, we argue that in resource constrained environments, learner control of learning is made possible when sound educator pedagogy; relevant, lively generated content; continuous, task-focused student interaction; and low-cost, ubiquitous technologies are well synched and aligned. While the study validated the TAM hypothesis on the academic use of MIM, it also extended the model by demonstrating how mobile learning contexts serve as invaluable antecedents to behavioural intentions and actual adoption of MIM in South African environments.

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