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Learners' Perceptions of Mobile Devices for Learning in Higher Education - Towards a Mobile Learning Pedagogical Framework

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***Abstract*—**The dramatic effect of information technology on society is undeniable. In education, it is evident in the use of terms like active learning, blended learning, electronic learning and mobile learning (ubiquitous learning). This study explores the perceptions of 54 learners in a higher education institution regarding the use of mobile devices in a third year module. Using semi-structured interviews, it was found that mobile devices had a positive impact on learner motivation, engagement and enjoyment. It also improved the consistency of learning material, and the convenience and flexibility (anywhere, anytime) of learning. User-interfacelimitation, bandwidth and cognitive overload, however, were of concern. The use of cloud based resources like Youtube and Google Docs, through mobile devices, positively influenced learner perceptions, making them prosumers (both consumers and producers) of education content.

***Keywords*—**Active learning, education, mobile learning, pedagogy.

I. Introduction

EDUCATION is entering a period of major change based on the use of information technology [1].Described in educational literature under many terms (e.g. Internet mediated teaching, web-based education, online education, computer assisted learning, virtual classrooms, web-based learning, virtual learning), a cacophony of vernacular, the use of information technology in education is best designated as electronic learning (e-learning). The use of e-learning[1]in education promises specific advantages, including the reduction in educational cost, higher cost-effectiveness and scalability [13]. Research, as a consequence, has focused on technical, administrative and financial characteristics of e-learning, while less attention has been given to didactic[2] approaches best suited to e-learning[2].

Clearly, traditional pedagogies like objectivism (lecturer-centered), based on the behaviorist theory, will not be appropriate for e-learning [22].It is, however, vital that the implementation of e-learning is not based on financial or scalability motivators, but rather on the improvement of instructional practices. Amhag and Jakobsson[2], in investigating advancement in instructional practices for e-learning, considered cooperative learning. Reporting positive results, cooperative can be defined as the engagement of learners with their peers through social interactions, working together in learning.

Other didactic approaches are also applicable in the area of e-learning, including blended learning and active learning. Blended learning (b-learning) combines normal classroom instruction with e-learning and mobile learning (m-learning[3]), while active learning is the instructional method used to engage learners actively in the learning process [27]. Granic *et al*. [15] extends this definition by stating that active learning incorporates the concepts of knowledge acquisition (e.g. constructivism), management of learning activities (e.g. b-learning) and importance of the social element (e.g. collaborative learning). Constructivism, based on the behaviorist and experimental theories, signifies an instructional method where learners create their own knowledge and meaning, based on their own prior knowledge and experience [36]. Socio-constructivism incorporates social interaction (cooperation, collaboration), taking into account social parameters.

Information technology directly provides the tools required by e-learning, thus enabling active learning. Ktoridou and Eteokleous[21], specifically considering mobile devices, identified two techniques of tool implementation which can be generalized to e-learning. The first is as a supportive tool, for example, to assist communication between lecturer and learner or between learners. The second is as an instructional tool, where the mobile device becomes actively part of the instructional method. Specific characteristics of mobile devices that make them suitable for these roles include portability, instant connectivity and context sensitivity [8]. These characteristics directly influence again the pedagogical approaches that can be followed. For example, mobile devices support individualized learning (learner can pass learning at own speed), situated learning (learn in an authentic context), informal learning (learn outside of classroom) and collaborative learning, generally utilized in the active learning

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[1]E-learning is learning with the use of information technology devices [20], [21], for example the Internet, web and personal computers.

[2]Didactic is the science of teaching, focussing on practical elements like curriculum, teaching, instructional and assessment methods [18], [35]. Pedagogy, meaning child education, guides the instructional processes according to the curriculum goals.

[3]M-learning is e-learning with the use of mobile devices [21], for example mobile phones, laptops, notebooks, tablet computers, electronic readers and personal digital assistants.

approach. Based on a bibliometric analysis of new technology research trends in education[24], social web is designated as the highest impact technology, followed by mobile devices, augmented reality and immersive environments (e.g. games and virtual worlds). Research on the use of mobile devices in education is thus relevant, not only because it is forecast to play a major role in education, but since it also forms such an essential part of modern daily life.

In this study, factors impacting on learners' perceptions regarding the use of mobile devices as a supportive and instructional tool in active learning, incorporating social-constructivism, b-learning and collaborative learning, are considered. Specific factors explored include motivation, enjoyment, consistency, convenience and flexibility [5], [10], [17], [20], [28], [29], [30], [31]. Although research on the effectiveness of mobile learning are numerous, 58% of 164 studies reviewed by Wu *et al.*[38], only a limited number of studies considered perceptions of learners regarding the use of mobile devices for educational purposes [1], [3]. The aim of this study is to add to the discourse by elucidating the perceptions of learners regarding the use of mobile devices. This is performed by means of semi-structured interviews including open- and closed-ended questions. It is postulated that by exploring the perceptions of learners regarding the use of mobile devices, a better insight into pedagogical concerns regarding the use of e-learning can be obtained. Forming part of a project to develop a mobile learning pedagogical framework for education in South Africa, it constitutes the first phase.

In the next section, a background on current research related to the use of mobile devices in education will be provided, followed in section III by a review of the research method followed. Section IV will highlight the results and in the final section, a discussion and closing remarks are provided.

II. Theoretical Framework

The use of e-learning has the potential of transforming education by making it truly interactive [11]. This implies that information technology serves as an agent of change, allowing the introduction of new pedagogical approaches, more input from learners and more collaboration between learners than ever before. This is enabled by a societal change based on information technology, one in which the world is transforming from an industrial society to a knowledge-based society [33]. This change is causing a shift from lecturer-centered education(traditional education) to learner-centered education, focusing on learner innovation and growth. However, teaching and guidance of lecturers are still crucial regarding relevant learning content and assessment standards. This theme of e-learning not replacing the lecturer, but in effect supporting both lecturer and learner, can be identified in numerous m-learning studies [6]. An integrative (additive) approach is thus recommended, integrating traditional education and e-learning, in effect b-learning.

It is crucial to note that education is introduced to countless new information technologies, which leads to research in how they can provide solutions to educational challenges [14]. It is, however, preferable to focus on how best to incorporate these new information technologies with what already exists. Thus, the focus should be on the exploration of current and novel pedagogies to incorporate these new information technologies in the educational context. Lecturers are currently faced with insufficient pedagogical understanding of how best to include information technology in their classrooms [25], [26], [32], [35]. This is evident based on the fact that e-learning leads to a change in the teaching approach followed, since it encourages new instructional methods[18]. Two approaches to manage pedagogical change can be identified. The first is the disruptive pedagogy, which implies replacing the established pedagogy with a novel pedagogy, which incorporates new information technologies. The second is the additive pedagogy, in which information technology is integrated to support the established teaching pedagogy.

If literature regarding mobile devices in education is reviewed, two broad categories can be identified. The first relates to the development of mobile educational systems [7], while the second relates to the effectiveness of mobile learning [1], [3], [12], which is closely link to learner perceptions. Al-Fahad[1] surveyed the attitudes of higher education learners towards mobile learning effectiveness, reporting that mobile learning improved retention. Similarly, Baya'a and Daher[3], utilizing an experiment, studied the effectiveness of using mobile phones in a middle school. Again, positive results were reported. Evans [12], employing observations, considered the effectiveness of mobile learning implemented by means of podcasting. Again, positive results were reported with learners preferring the podcasts above learning aids like textbooks. Even though positive results, based on current research, are reported in literature, the use of mobile devices is still limited in education [15]. The reasons for this lack of mobile device integration in curricula, and information technology in general, is a combination of low access to information technology, teacher motivation and the absence of a validated mobile learning pedagogy. This is highlighted by Granic *et al*. [15], emphasizing the need for a mobile learning pedagogy with clear pedagogical objectives. The development of a mobile learning pedagogy, whether disruptive or additive, must consider the perceptions of learners regarding the use of mobile devices in education. This is the aim of this study: by investigating the perceptions of learners, it is postulated that more informed decisions regarding pedagogical objectives and pedagogical approaches can be made. If the perceptions are negative towards the use of mobile devices, it is unlikely that any novel mobile pedagogy will be successful.

III. Research Method

A. Research Context

The data presented in this study is derived from learners completing a third year information technology module. This module is presented in the second semester, with face-to-face lessons being supported by mobile devices. Implemented by means of a web-based platform, available both from non-mobile devices (e.g. personal computers) and mobile devices,

it served two purposes. Firstly, it provided learners with a repository of module content. Secondly, it provided an additional communication channel between lecturer and learner, as well as learner to learner. It is important to note that since learners utilize micro-blogging, text messaging, video recording, document creation, they not only consume mobile education content, but also create and re-create (produce) mobile educational content, becoming prosumers.

B. Participants

In total, 54 learners participated in the study, part of a group which completed an information technology module. This necessitated the use of convenient sampling, a nonrandom sampling technique[9].

C. Data Collection

Implemented as a single case study, semi-structured interviews (n=54), based on a questionnaire with both open- and closed-ended questions were performed. This approach is suited for exploring complex phenomena. Respondents were briefed on the importance of answering the questionnaire and assured that their responses would be anonymous and confidential. However, since one of the researchers was a lecturer, this may have influenced their responses. In general, findings based on a small sample or only one case are not generalizable, since it is not representative. However, utilizing a five-point Likert scale for close ended questions, the questionnaire provided a framework to evaluate specific factors, namely motivation, enjoyment, flexibility, consistency, engagement, convenience, learner ICT competence, lecturer ICT competence and pedagogy employed, each described in Table I.

TABLE I
FACTORS MEASURED

Factor	Description	Referring study
Motivation	Does the use of mobile devices lead to higher motivated learners?	[31]
Enjoyment	Does the use of mobile devices lead to higher enjoyment of educational content for learners?	[17]
Flexibility	Do learners find the learning more flexible, allowing learning to occur at anytime and anyplace?	[10]
Consistency	Do learners find the learning material to be more consistent, thus more relevant and trustworthy?	[5]
Engagement	Do learners engage with learning material more readily?	[28]
Convenience	Do learners find the use of mobile devices more convenient for educational purposes than non-mobile devices?	[20]
Learner ICT competence	Do learners feel competent in using mobile devices for learning?	[37]
Lecturer ICT competence	In the learner's opinion, does the lecturer have the required competence to use mobile devices in education?	[16]
Pedagogy	Does the pedagogy used by lecturer support/promote the use of mobile devices in the module?	[15]

D. Data Analysis

Data analysis was performed by means of descriptive statistics (e.g. mean, standard deviation) for closed-ended questions and thematic analysis for open-ended questions. Validation and reliability of data for closed-ended questions were based on Cronbach's alpha and the comparison of standard deviation with average mean. Open-ended questions were analyzed by means of the strategy proposed by Braun and Clarke [4]. Initial codes were identified as features of the data by hand, using colour markers. After the initial reading and coding, the main themes and subthemes were identified. Data extracts that substantiated or best illustrated the main themes were incorporated.

TABLE II
STRATEGIES EMPLOYED TO ENSURE RIGOUR

Approaches to rigour	Strategies applied	Goal
Credibility	Triangulation, Member checking	Soundness of study (link to participants)
Transferability	Detail descriptions	Generalizable to other settings
Dependability	Audit trail, Reflexivity	Description of context methods and procedures applied
Confirmability	Audit trail, Reflexivity	Findings can be collaborated by others
Authenticity	Verbatim quotes	Representing voice of participants

To ensure rigour and thus trustworthiness, the strategies suggested by Lincoln and Guba [23] were adopted, listed in Table II.

IV. RESULTS

There were in total 30 (56%) female and 24 (44%) male participants, which mirror the general ratio of female to male learners in the higher education institution. Participants' ages ranged from 20 to 28, with the mean age being 23. All respondents (100%) had access to a mobile device, specifically a mobile phone, classified as feature mobile phones. These phones in general support a web-browser. The most popular mobile phone used by learners was Blackberry at 48% (n=26, followed by Nokia at 39% (n=21), Samsung at 13% (n=7), Sony at 4% (n=2) and LG at 2% (n=1), depicted in Fig. 1.

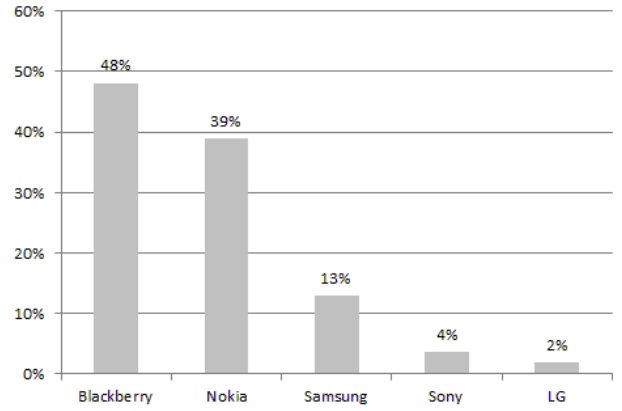

Fig. 1 Mobile phone by manufacturer

In Fig. 2, mobile phone application usage is depicted. Web-browser and mediaplayer are both at 100% (n=54), followed by social network application Facebook (93%), Whatsapp (83%) and Mixit (59%). Short Messaging Service (SMS) is at 57%, BlackBerry Messaging (BBM) at 54% and Twitter at 35%. Mobile phone games, LinkedIn and 2Go (messaging service) are at 31%, 18% and 11% respectively.

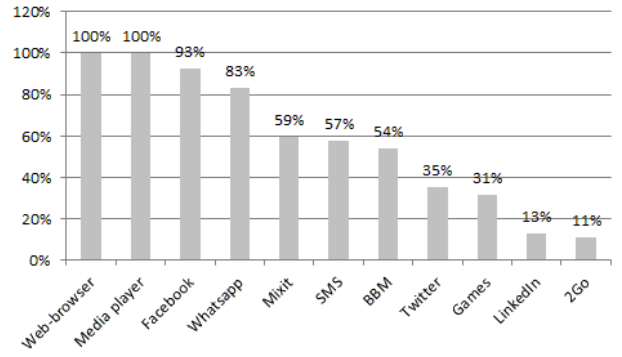

Fig. 2 Mobile phone application usage

In Table III, the factors measured by means of closed-ended questions are listed, with their mean and standard deviation (SD).

TABLE III
MEAN AND STANDARD DEVIATION

Factor	Mean (n=54)	SD
Motivation	3.72	.79
Enjoyment	3.80	.83
Flexibility	4.18	.76
Consistency	3.28	.90
Engagement	3.94	.84
Convenience	3.83	.72
Learner ICT competence	4.30	.62
Lecturer ICT competence	4.16	.81
Pedagogy	2.82	1.3
Average	**3.78**	-

The factors flexibility, learner ICT competence and lecturer ICT competence rated the highest, while consistency and pedagogy employed rated the lowest. Variability was low with the overall SD equal to 0.84, which denotes less than a ¼ of the average mean. This serves to affirm that the measures were homogeneous. Internal consistency was confirmed by the calculation of Cronbach's alpha for each factor, depicted in Table IV.

TABLE IV
CRONBACH'S ALPHA VALUES

Factor	Cronbach's alpha
Motivation	.82
Enjoyment	.73
Flexibility	.77
Consistency	.85
Engagement	.71
Convenience	.81
Learner ICT competence	.78
Lecturer ICT competence	.85
Pedagogy	.74

All values calculated were above 0.7, confirming internal consistency. Based on thematic analysis performed for open-ended question, three themes were identified. The first theme relates to user-interface limitation, which was specified in narratives as:

- "The input screen is very limiting (learner 8)."
- "Mobile phone screen is too small (learner 41)."
- "I struggle to understand some concepts using the mobile phone, I constantly need to scroll up and down (learner 36)."

All learners participating in the study only had access to mobile phones. None had access to tablet computers or notebooks. This directly affects the screen size available, which is a concern to learners. The second theme relates to network speed, which was specified in narratives as:

- "When I try to download audio or video clips, it takes forever (learner 34)."
- "Big files take too long to download (learner 12)."
- "Network speed is too slow, the browser is always giving me a timeout (learner 14)."

Network problems are related to mobile network capacity(bandwidth) and can be a problem if 3G is not available in a specific area. When Wi-Fi connections are utilized, the bandwidth barrier is of less concern:

- "The Wi-Fi connection works better than the cellphone network (learner 27)."
- "I prefer to use the Wi-Fi connection at the university, it's faster (learner 43)."

The third theme relates to cognitive overload. Mobile devices are mostly used for communication (e.g. voice, messaging) and entertainment (e.g. games, music) [12], not for accessing educational content. By adding educational content, it is an additional resource, over and above textbooks and lecture slides already available. This can result in cognitive overload, observed in the narratives:

- "I'm not sure which material I should study (learner 8)."
- "Is the mobile content as good as the textbook or slides (learner 34)."
- "I already have so many personal apps on my cell, I don't want class work on my cell (learner 17)."

It seems learners are concerned that they already have enough content on their mobile phones and do not wish to include educational content as well.

V. Discussion and Conclusion

Although the use of mobile devices is relevant to all forms of education, it is especially appropriate to consider it in higher education, based on the ubiquity of mobile devices on campuses. Used in this study specifically to provide a module content repository and an additional communication channel for collaborative learning, it implemented active learning in a real-world setting. Although reported in literature that the implementation of m-learning faces challenges based on social, cultural and organizational factors [32], these specific challenges were not identified in this study. All learners had access to mobile phones, considered as an essential element.

As a first step in the development of a mobile learning pedagogy framework, initial results are favorable. Factors that were found to be relevant included motivation (learners are more motivated when they have access to module content via mobile devices; mean=3.72), enjoyment (learners enjoy mobile access to module content; mean=3.80), flexibility (anywhere and anytime access is an important contributing factor; mean=4.18), consistency (related to reliability and trustworthiness; mean=3.28), engagement (based on flexibility, learners interacted with module content more often; mean=3.94), convenience (also based on flexibility, module content were easy to access; mean=3.83), both learner ICT competence (mean=4.30) and lecturer ICT competence (mean=4.16) were also rated high. Appropriate pedagogy to mobile learning was, however, low (mean=2.82). This indicated that learners feel that the way mobile learning is implemented in the classroom was not conducive. Future work in developing an appropriate mobile learning pedagogy is thus recommended.

Specific themes identified in the open-ended questions related to screen size, bandwidth and cognitive overload. The problem of limited screen size of mobile phones are being address by mobile phone manufacturers, based on the increased screen size of newer models, related to ergonomic influences. As data usage on mobile networks increase, mobile network providers are improving their network bandwidth capabilities. In relation to cognitive overload, the development of a mobile learning pedagogy must address this concern to ensure optimal educational value for mobile learners.

It is important to highlight some best practices outlined by Keeton [19]. These include the encouragement of cooperation between learners, encouragement of active learning, substantial feedback and the communication of high expectations. In addition, research on new pedagogies that can be applied in m-learning is also advisable. Connectivism, proposed by Siemens [34], is a new pedagogical approach that postulates that learning does not exist in individuals, but resides both in the individual and the networks to which the individual belong, including their connections. This is contrary to pedagogies like objectivism, which subscribes to individualism. Even the socio-constructivist approach, with interaction between members of a social grouping, remains an individualized vision of learning.

Limitations of this study include the relative small sample, only one case constituting 54 learners, focused on the micro-level (classroom environment). Results cannot be generalized to other learners or higher education institutions. Furthermore, since learners' perceptions change over time as they gain more experience with m-learning, it is proposed that a series of studies over time will deliver more informative results.

In conclusion, the implementation of mobile devices in higher education is a complex issue, with technical and possibly cultural challenges that may be faced. With advances in mobile computing power, many technical limitations will be solved, including small screen size and network bandwidth. However, if an ethos of m-learning is to be established in education, special attention must be given to learner perceptions (first phase of study), lecturer perceptions (second phase of study) and pedagogical approaches (third phase of study). Current results, which elucidate learner perceptions on mobile devices, will assist lecturers and higher education institutions to evaluate the future impact of m-learning.

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