

Mobile Learning in Developing Countries: A Synthesis of the Past to Define the Future

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Abstract—Mobile learning (m-learning) is a novel approach to knowledge acquisition and dissemination and is gaining global attention. Steady progress in wireless technologies and the portability of communication devices continue to broaden the scope and use of mobiles. With the convergence of Web functionality onto mobile platforms and the affordability and availability of mobile technology, m-learning has the potential of being the next prevalent channel of education in both formal and informal settings. There is substantive literature on developed countries but the state in developing countries (DCs) however appears vague. This paper is a synthesis of extant literature on mobile learning in DCs. The research interest is based on the fact that in DCs, mobile communication and internet connectivity are popular. However, its use in education is under explored. There are some reviews on the state, conceptualizations, trends and teacher education, but to the authors' knowledge, no study has focused on mobile learning adoption and integration issues. This study examines issues and gaps associated with its adoption and integration in DCs higher education institutions. A qualitative build-up of literature was conducted using articles pooled from electronic databases (Google Scholar and ERIC). To enable criteria for inclusion and incorporate diverse study perspectives, search terms used were m-learning, DCs, higher education institutions, challenges, benefits, impact, gaps and issues. The synthesis revealed that though mobile technology has diffused globally, its pedagogical pursuit in DCs remains quite low. The absence of a mobile Web and the difficulty of resource conversion into mobile format due to lack of funding and technical competence is a stumbling block. Again, the lack of established design and implementation rules to guide the development of m-learning platforms in DCs is a hindrance. The absence of access restrictions on devices poses security threats to institutional systems. Negative perceptions that devices are taking over faculty roles lead to resistance in some situations. Resistance to change can be a hindrance to the acceptance and success of new systems. Lack of interest for m-learning is also attributed to lower technological literacy levels of the underprivileged masses. Scholarly works on m-learning in DCs is yet to mature. Most technological innovations are handed down from developed countries, and this constantly creates a lag for DCs. Lack of theoretical grounding was also identified which reduces the objectivity of study reports. The socio-cultural terrain of DCs results in societies with different views and needs that have been identified as a hindrance to research. Institutional commitment decisions, adequate funding for the necessary infrastructural development as well as multiple stakeholder participation is important for project success. Evidence suggests that while adoption decisions are readily made, successful integration of the concept for its full benefits to be realized is often neglected. Recommendations to findings were made to provide possible remedies to identified issues.

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I. INTRODUCTION

TECHNOLOGY, though dynamic, brings about changes in age-old practices when adopted. The replacement of traditional learning by electronic means was first seen in the concept of electronic learning (e-learning). Improvement in wireless communication technologies received concern from academic researchers and practitioners [1]. It is believed that this signaled the origin of the concept of mobile learning (m-learning), which began as an alternate schooling procedure to reduce time and place restrictions in educational institutions. M-learning involves the use of mobile technology and devices to support teaching and learning [2]. It is a novel path to education. As an off-shoot of e-learning, m-learning is more convenient for knowledge acquisition [3] because it offers an opportunity for people who cannot afford regular forms of education, to tutor themselves at their convenience [4]. The planning and incorporation of the concept into learning environments requires both practical and academic considerations for its success.

Most parts of Africa, Latin America, Asia, South Pacific Islands and parts of South-Eastern Europe have countries categorized as DCs. DCs are nations with low ratings on the United Nations Development Program (UNDP) Human Development index, which is based on life expectancy, schooling and income [5]. Improper planning and cultural practices seem to thwart efforts at instituting effective educational systems in DCs. Inadequate infrastructure for formal learning environments often fail to support high population growth rates, especially among the rural poor in DCs. A report [6] identifies that the incorporation of technology into traditional learning will improve existing educational standards in DCs. This indicates that a solution is being sought to the numerous educational challenges faced by DCs through the m-learning pathway. Another report [7] bemoans that m-learning studies on DCs has not been well assessed and conveyed. The revelation sparked interest for this work.

This study is a qualitative build-up to uncover research perspectives, gaps and issues on m-learning research on DCs. The purpose is to contribute to knowledge. Previous reviews focused on Higher Education Institutions (HEI), teachers and students, frameworks for development and implementation challenges but no review has been conducted on how well its incorporation can be maintained. Thus, this study initiates an empirical discussion on m-learning in DCs and the emerging

route for sustainable integration. This paper is thus structured: the next section provides a brief introduction to m-learning which is followed by an evaluation of earlier reviews on DCs. A description of this study's methodology precedes a classification of m-learning research on DCs. Next, the conceptual, theoretical and methodological approaches and issues, research patterns and gaps identified are discussed. The conclusion involves a summary with recommendations.

II. M-LEARNING - AN INTRODUCTION

M-learning is an additional approach to the existing methods of learning brought about by the introduction of mobile technology. Apart from the benefits of ease and collaboration introduced by e-learning, m-learning has introduced location awareness, faster connectivity and handiness [8]. These benefits serve as a source of attraction to prospective learners hindered by time and place constraints.

Mobile telephony and devices are reported to be more popular in many DCs compared to land-line infrastructure [9]. Their popularity is based on their affordability, handiness and ease of use by both old and young generations. The pervasiveness of mobile communication has triggered researchers to consider its use for learning [10] which may account for an increase in m-learning awareness. Extant studies however reveal that there is no organized structure that defines m-learning adoption and integration to expedite knowledge acquisition. This study is an attempt to chart a course for sustainable m-learning integration and sustenance in DCs.

TABLE I
 SOME EARLIER REVIEWS ON M-LEARNING IN DCs

Author(s)	Study Focus	Country
[8]	Examination of theories, state, conceptualizations and implementation of m-learning in DCs.	Australia
[12]	Current trends and pedagogical implications of Mobile Assisted Language Learning (MALL).	Turkey
[13]	Categorization of models and frameworks for m-learning development and evaluation.	China
[14]	Identification of trends and gaps in m-learning integration for teacher education.	Turkey
[15]	An examination of mobile technological applications for learning in Africa.	Africa
[16]	A categorical meta-analysis of m-learning trends.	Taiwan
[17]	An investigation into applications and impacts of mobile technology enhanced learning.	Taiwan
[18]	A meta-analytic approach to uncover distribution of research purposes in m-learning studies.	Taiwan
[19]	Identification of status, sample groups and domains of mobile and ubiquitous learning.	Taiwan

III. AN EVALUATION OF M-LEARNING REVIEWS ON DCs

The representation of m-learning studies on developed countries appears higher than that of DCs. It is important to synthesize extant literature to identify the state, linkages and relationships to create a consciousness that guides future research and practice [11]. Though available reviews offer a valuable lead on the state of the concept, additional syntheses are needed to guide future research. A general direction of

some selected reviews on DCs examined is provided in Table I.

Reviews on DCs examine the concept from quite limited perspectives. These include frameworks for development [13], teacher development [14], applications [15], impact [17], trends [12], [16], [18] [19] and support for collaborative learning [20]. To elaborate on a few studies: [13] categorized five main design frameworks on m-learning which are instructional, platform, technology acceptance, evaluation and psychological construct, and recommended frequent and extensive reviews to complement their effort. In another study, [15] explored the concept in an African context by identifying implementation issues and extracting possible suggestions for remedy. The study by [8] examined the conceptualizations, theories and implementation methods of m-learning projects in DCs emphasizing that most projects were yet to mature because, inadequate funds impede implementation and recommended suitable theory development for DCs. Similarly, [14] identified gaps and trends in m-learning integration for faculty development only and regrets the lack of concrete and didactic grounding for sustainable integration, suggesting the need for further studies on integration sustenance in HEI. This review seeks to fill a gap in extant research on m-learning and embraces a holistic discussion on its adoption and sustainable integration in DCs.

IV. REVIEW METHODOLOGY

A qualitative review is an organized means of building up literature based on a transparent principle that supports responsibility, reliability and communication of findings [21]. Consideration given to all activities of inquiry ensures accuracy of results. Search and selection of articles was conducted over a four-week period. Literature selection was from electronic databases linked to Google Scholar. Due to the rapidly changing nature of mobile technologies, the study period was restricted to the past eight years. Initial search terms used were *mobile learning and* or *in DCs*. Less than 25 published articles were realized for the period. Another search using each specific developing region in the world increased the number of articles to 67. A setback encountered was the difficulty in retrieving articles on Latin America which had no English translation program. Searches were also conducted on randomly selected DCs, and again, using sub-themes like *challenges, benefits, impact, gaps and issues of m-learning in DCs*. A total of 183 articles were realized.

Based on the inclusion principle (peer-reviewed publications) one hundred and 25 articles published in 69 journals between January 2008 and November 2015 were selected. Articles were then analyzed to determine their frequency and geographic distribution. Due to the extensive size of Asia; the region was divided into two: the Middle East and Asia. In addition, islands in the South Pacific Ocean were placed in one group. A total of seven developing regions were categorized, including a region named Unstated Region (authors' construct), that represents studies with DCs as part of their key words but do not specify country or continent.

Articles were also categorized to identify themes, sub-themes, theoretical and methodological frameworks, contexts and general perspectives of the entire body of literature. Further analysis to reveal patterns and relationships amongst studies was done. Issues and Gaps identified were noted and discussed. In all, a total of one hundred and 25 articles published in 69 journals were selected. The highest number of articles was published in 2012. The years 2014 and 2015 follow in distribution ratings respectively. The lowest number was realized in 2009. Article distribution by year, geographic region and themes are represented in Figs. 1-3.

V. CLASSIFICATION OF M-LEARNING RESEARCH ON DCs

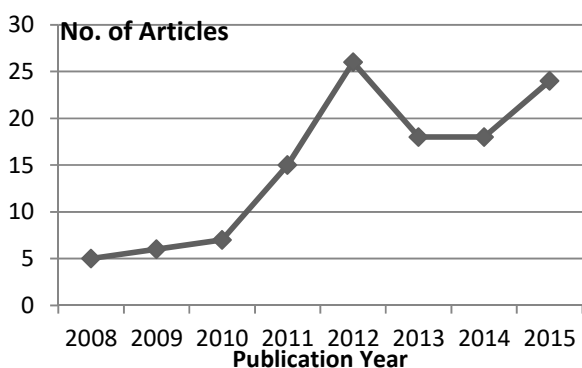


Fig. 1 Distribution of articles by year

Fig. 1 depicts a growth in m-learning studies on DCs during the eight-year study period. Between 2008 and 2010, a slight increase of about two percent occurs. A decline of about 6.5% is evident between 2013 and 2014, perhaps caused by changes in research interests. Another reason may be that studies and on-going projects had not been completed. 2015 marked an increase implying a sparked interest in the field. Extant research on m-learning in DCs shows that the highest number of articles was recorded in 2012.

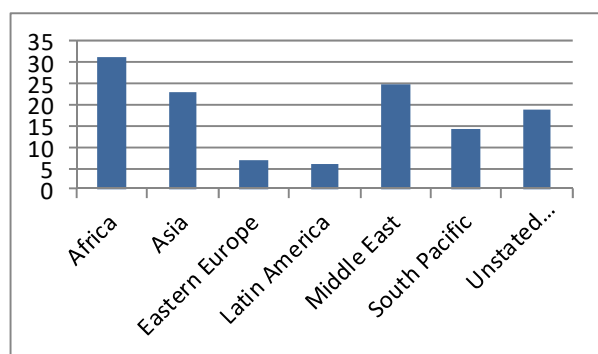


Fig. 2 Article distribution by geographic regions

Fig. 2 demonstrates that m-learning has been embraced by some DCs and is gradually evolving and maturing. This can be attributed to the widespread diffusion of mobile technology. Based on the categorization scheme of this study, Africa leads with a total of 31 articles because the continent was not

divided into its known developmental zones (North and Sub-Saharan Africa). The Middle East, where m-learning seems popular, follows with a total of 25 articles. The third highest representation is Asia with a total of 23 articles. A high number of extant DC studies are on this region. The Unstated region had 19. If specific countries or regions had been explicitly stated, the unstated category will not be included and the existing distribution pattern may differ. Fourteen articles on the South Pacific Islands were realized, while Eastern Europe is represented by seven articles. Though the states in Latin America are DCs, only six articles are included in this study because of language barriers which resulted in an inability to comprehend articles. This set-back has an influence on the stated figure.

No. of Articles

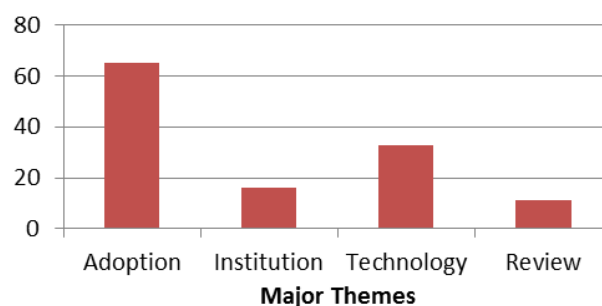


Fig. 3 Distribution of articles by major themes

Fig. 3 displays four major themes that emerged after examination of selected literature, the main theme being adoption with a total of 65 articles. The guiding technology of m-learning also attracts a lot of attention and is the second most researched area with 33 articles in all. Sixteen articles represent the Institution theme (educational and organizational settings). Literature reviews are the least represented with a total of eleven articles. Consequently, sub-themes identified followed the thematic pattern's prior distribution.

VI. EVALUATION OF CONCEPTUAL, THEORETICAL AND METHODOLOGICAL APPROACHES AND ISSUES

A. Conceptual Approaches and Issues

Efforts to conceptualize m-learning have been made but there is no specific concept that adequately accounts for the swift transformative character of the technology that guides m-learning environments [22]. Literature reveals that the perspective of researchers on the concept has been broad. While [23] adopts a techno-centric view of m-learning, others argue that this is limiting [24]. Some researchers focus on the pedagogical aspect of m-learning [25] because it involves a learning experience. The diverse attention of researchers poses difficulties in arriving at a precise definition [26]. Again, definition differences in studies signify its progressing state [27]. Immaturity compounds the difficulty in streamlining what constitutes m-learning.

Some latent factors may be hindering the incorporation of mobile technology into education. Change of traditional learning materials to suit mobile environments requires time and effort that some educators fail to allot [28]. Negative perceptions by faculty that devices are taking over their role may lead to disapproval. Resistance to change can hinder acceptance and use of new systems. Low interest for m-learning is also attributed to lower technological literacy levels [29]. Failure to understand a concept can reduce motivation and commitment to it.

The absence of established design and implementation rules to guide the development of m-learning platforms in DCs is also a hindrance. Technological improvements in business practices can be achieved only after complete detection of all necessary activities [30]. Failure to fully identify all requirements for a system can result in a project that fails to meet expectations and achievement of intended goals.

Systems security and data privacy issues have been reported in mobile technology use [31]. Threats posed by inadequate standards and unscrupulous persons are not peculiar to mobile learning but to electronic environments in general. The Buy-Your-Own-Device practice results in access to institutions networks via diverse devices which poses security threats [32]. The absence of access restrictions on devices permits incompatible operating systems and harmful software to easily become part of m-learning environments.

Standards for m-learning evaluation are non-existent and are reported as world-wide problems [33]. The inability to thoroughly measure the success of systems creates a knowledge gap which can affect motivation of potential adopters. In DCs, a guide to steer research on the concept and its effect on learning has not been established [34]. This makes it difficult for adopters to fully evaluate the success of implemented projects which may cast doubts on decisions to embark on m-learning.

TABLE II

SELECTED THEORY AND MODEL- BASED STUDIES ON M-LEARNING IN DCs

Study Perspective	Stated Theory/ Model	Theory Origin	Author(s)
Adoption effect on learning satisfaction	Technology Acceptance Model (TAM)	Information Systems (IS)	[35]
Teacher development in HEI	Zurita & Nussbaum's Constructivism	Cross Disciplinary (CD)	[36]
Behavioral intention to adopt	Unified Theory of Acceptance and Use of Technology (UTAUT)	IS	[37]
Critical Success Factors of concept	Capability Maturity Model	IS	[38]
Learner acceptance in distance learning contexts	TAM	IS	[39]
Instructional Design	Vygotsky Constructivism	CD	[40]
Adoption readiness in HEI	Theory of Planned Behavior (TPB)	IS	[41]
Leveraging mobile technology for seamless learning	Framework on Distributed Cognition Theory	CD	[42]
Reality of learning transfer	Item Response Theory	CD	[43]

B. Theoretical Approaches and Issues

The analysis uncovered that m-learning studies on DCs are not firmly grounded in theory. Of a total of 125 articles selected, 21 were guided by theories, while two articles applied a model and framework each. Table II illustrates the findings.

102 had no theoretical grounding. This confirms the lack of robustness in DC studies debated by [27], which may be attributed to the following reasons: Technology diffusion is generally from industrialized nations to DCs. Technological breakthroughs are sometimes received with initial mixed-feelings. Technology-followers adopt when convinced of the advantages leaders have gained, and this creates a lag between earlier adopters and followers. This is a reflection of the situation in DCs.

Secondly, existing Information Systems (IS) theories are from developed countries. Contexts may differ significantly between the two contrasting regions which may account for the inappropriateness of some theories in DCs. Theory development by DC scholars is needed to steer DC studies [8]. The essence is to nurture theory that can account for a wide array of issues surrounding study contexts. Though the rapidly changing nature of the technologically that backs m-learning environments may pose challenges, better meaning and understanding will be offered phenomena to strengthen research.

Thirdly, there may be instances where prevailing conditions in DCS are restrictive, and thereby, hindering the practicality of certain concepts and theories. This has been termed the heterogeneous nature of DCs [44]. Such occurrences can negatively influence m-learning acceptance and deter research endeavors. Consequently, strength and maturity in studies lingers.

Finally, [43] state that though mobile technology is popular, its quest for learning is low in DCs. Perhaps the concept has not been well understood and may account for its vague recognition and engagement in some DCs. Some studies are preliminary investigations [45]. Failure to understand a concept can thwart research efforts and objectivity in findings.

C. Methodological Approaches and Issues

The four methodological groups identified were qualitative, quantitative, mixed and unspecified methods with article representation as follows: Qualitative studies were 48, quantitative were 35, unspecified methods recorded 34 and mixed-methods were eight in number. A discussion following Table III highlights the links between applied theories and stated methodologies.

A contextual map of methodological approaches and guiding theories showed that quantitative studies employed the most theories in comparison with other stated methodologies. Out of a total of 125 articles selected, 15 quantitative articles stated theories, while 19 had no guiding theory. Similarly, three qualitative studies had theories, while 44 had none. One mixed method applied a theory, while seven did not. For unspecified approaches, one stated a theory, while 33 did not.

TABLE III
 MAPPING OF ARTICLES BY METHODOLOGICAL APPROACHES AND STATED
 THEORY OR MODEL

Methodological Approach	Stated Theory	Stated Model/ Framework	No Stated Theory	Total per Approach
Qualitative	3	1	44	48
Quantitative	15	1	19	35
Mixed	1	0	7	8
Unspecified Method	1	0	33	34
Total	20	2	103	125

Theories on IS adoption dominate quantitative studies. Five articles were realized on the UTAUT [37], [47]-[50]; five on TAM [35], [46], [51]-[53] and one on TPB [41]. Others applied CD theories such as Vygotsky's Constructivism [41], Item Response [43], Cognitive Load [54] and Uses and Gratification [55] theories. In qualitative studies, Zurita and Nussbaum's Constructivism was used to determine the effect of YouTube videos in enhancing faculty competence in HEI [37]. Siemens and Downes' Connectivism has been used to investigate English (foreign) language learning by university students [56], while the Transactional Distance theory was used to categorize m-learning applications in distance education situations [34].

An ethnographic study developed a framework to determine how mobile technology can be used to control formal and informal learning environments [42]. One statistical study applied the Capability Maturity Model to determine critical success factors influencing adoption [38] and found that m-learning success depends not only on technological competence, but on a combination of factors. An article with an unspecified methodology applied Mayer's Theory of Multimedia Learning in a content design study for m-learning platforms [57]. One mixed method approach to aid better triangulation of data also applied the TAM to uncover mobile phones acceptance for tutorials by students participating in a long-distance program [39].

D. Patterns and Relationships

Studies from various geographic regions revealed some peculiarities. Adoption is a major theme for most scholars in DCs, but its sub-themes differ significantly. Diversity exists in studies on different parts of Asia. Far East Asian scholars (China, Korea and Taiwan) had the highest number of reviews on m-learning in DCs [58] with application and technology development as dominant themes [59]. Indian and Pakistani scholars seem engrossed with m-learning as a means of providing informal learning opportunities for the marginalized [45]. Adoption determinants and user motivation appear to be of interest to Middle-East scholars [38]. The South Pacific Asian islands are also adoption centered [60].

For Latin American countries, two Brazilian studies on adoption perceptions were noted. One demonstrated the effectiveness of SMS for learning and the other the efficiency of knowledge construction, respectively [61] and [62]. Another study on Guyana examined the utility of the UTAUT in explaining adoption behavior amongst students in HEI based on a Web survey. The results indicate that culture and

country development level moderate adoption determinants which conceal other important factors [49].

Studies on Africa are also quite diverse. Kenya appears to be the leading African country in terms of m-learning research. East African researchers (Kenyan and Tanzanian) tend to promote the benefits of mobile learning as a means of empowering the rural masses through a Mobile for Development Plan instituted by various governments in their sub-region [53]. West African scholars seem engrossed with faculty development [63] and implementation challenges [64], while Southern African studies are learning-centered [65].

Another observation is the existence of comparative studies. For example, [66] conducted a study on the use of mobile phones to support literacy practices in Namibia and Tanzania, both southern African countries. In another study within a global context, solutions to mobile teaching development between developed and developing nations was compared, using the United States and Senegal as cases [67]. Similarly, in an evaluation report on mobile technology diffusion and its application in education (distance learning) Asia and Africa were compared with North America [68]. From a total of 125 articles on DCs reviewed, three comparative studies were realized. This revelation supports the concern of [69] on the scarcity of comparative studies in scholarly m-learning works.

VII. RESEARCH GAPS

M-learning research in DCs needs improvement. Much effort is required to better position m-learning studies on DCs. Though funding for research may sometimes be inadequate [70], scholars can tap into the limited resources to their best advantage. Kenya, for example, has inadequate Internet connectivity and cabled-phone infrastructure, but has capitalized on mobile technology for the benefit of the masses by instituting a mobile public health delivery (example 'WeiTei Kenya 1'), which is an SMS communication mode for anti-retroviral treatment of patients) and again, a mobile payment (M-Pesa) system which has positioned it as a leader in mobile use and studies on the African continent [71]. Other DCs can learn from Kenya's experience by extending this effort to m-learning to help nurture practice and improve studies.

The diverse socio-cultural terrain of DCs creates societies with different needs which can be a hurdle for conducting research [44]. Beliefs and practices may pose challenges to studies. In this regard, differences in views of what constitutes learning among different groups of people require studying for acceptance of m-learning in DCs [72]. Collaborative studies are needed to help streamline differences in norms and beliefs. This can help to foster agreement and improve research outcomes.

Initial studies focused on how m-learning can be used for development in DCs, but current studies appear to be adoption-centered with emphasis on acceptance and use factors that have skewed research findings in one direction to the neglect of other themes. This lowers the expression of diversity of thought and clouds findings on DCs. Other

perspectives require consideration to broaden the scope of m-learning literature.

To improve rigor in studies on the concept, suitable theories that account for implementation and integration challenges, learner experiences and impact on learning are needed. New theory development from DCs perspectives can help guide studies on DCs because prevailing conditions and practical experiences aid better understanding. Existing theories that do not account for some specific contexts can also be modified to incorporate such situations.

A. Studies on M-Learning Integration in DCs

Two studies on integration were identified. While one focused on student perceptions and project implication on an institution, the other looked at marginalized nomadic groups within a country. Both are qualitative studies that applied no theory. Adoption has been well researched to the neglect of evaluation and integration techniques [38]. Integration studies are deficient in existing literature on DCs, and hence, there is a need for further studies to enhance scope and help resolve m-learning integration-related issues.

TABLE IV
PERSPECTIVES OF INTEGRATION SUB- THEME STUDIES ON M-LEARNING IN DCs

Author(s)	Integration Perspective	Theory	Methodology	Data Source	Country
[73]	Challenges and resistance to integration in nomadic education	none	Qualitative	unstated	Nigeria
[74]	Personal devices integration; Students perceptions and implications on institution	none	Exploratory Case Study	Questionnaires Interviews Journal notes	United Arab Emirates

VIII. SUMMARY AND RECOMMENDATIONS

This paper provides a report on the state of m-learning in DCs between the years 2008 to 2015. The studies examined show the concept is rapidly being adopted in some DCs. The flexibility of m-learning appears to be a strong force of attraction to prospective learners. Learners have the chance to study anywhere and at any-time, which provides an opportunity for those who cannot afford regular forms of learning. A link between formal and informal education is created. In effect, m-learning can increase the number of educated people if engagement techniques are seriously adhered to.

This review has recognized pertinent problems facing m-learning establishment in DCs. The dominant use of mobile technology for communication and business transactions has not been extended to education. Initial funding for m-learning projects is also a deterrent to adoption. Training programs for various participants in HEI are often neglected resulting in ill-equipped users and m-learning rejection. Some institutions have implementation guidelines but no principles for

successful m-learning integration. With Information and Communication Technologies turning mobile, national policy enactment for use in schooling is necessary if an alternate means of education is to be well defined.

The identified concerns need to be resolved for the full advantages of m-learning to be experienced. Integration studies on DCs are limiting. To address this deficiency, a holistic perspective to resolve the issue is required. This will ensure an inclusive principle where the challenges of all stakeholders on an m-learning project can be assessed and addressed. Such a perspective is ideal for the heterogeneous nature of an m-learning environment which can be likened to that of DCs. The inclusion rule offers all participants the chance to contribute to the body of knowledge on m-learning. Subsequently, user engagement in m-learning activities can improve significantly.

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