

# A Proposed Theoretical Model for M-Learning Adoption in Developing Countries

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## ABSTRACT

This paper investigates the use of wireless technologies in education with particular reference to the potential for m-learning in developing countries. The reports of a number of current m-learning projects are explored, from which the perceived benefits of using wireless technologies in education, and potential barriers to their use are derived.

The use of wireless technologies in education impacts learner motivation, collaboration and mobility, which results in benefits for learners, parents and teachers. Benefits are perceived to outweigh the difficulties encountered when integrating wireless technologies in education. Considerations to be examined include limitations of the devices, pedagogical issues, safety and security concerns, training and support issues, as well as cost considerations. By examining the recommendations from developed countries, wireless technologies can be adopted by the educational sector in developing countries. These recommendations include the establishment of guidelines and principles to ensure the appropriate use of wireless technologies, designing the devices with the end user in mind, and involving all stakeholders concerned.

The proposed theoretical model for m-learning adoption in a developing country emphasises the importance of taking a systems view of all the elements that need to be in place in an m-learning environment, including the necessary stakeholders and key elements (communication infrastructure, mobile devices, learners and teachers), in order to ensure the effective adoption of wireless technologies in education. This model embraces the key issues with regard to m-learning as well as the critical success factors that are essential in ensuring successful adoption.

Keywords: *theoretical model, adoption, developing country, m-learning.*

## **1. INTRODUCTION**

There is an increasing and unprecedented adoption of wireless technologies in developed and developing countries alike (Keegan 2003). Wireless technologies are revolutionising education, transforming the traditional ways of learning and teaching into 'anytime' and particularly, 'anyplace' education. Empirical studies have reported the advantages of using wireless technologies in learning environments, including supporting group work on projects, engaging learners in learning-related activities in diverse physical locations, and enhancing communication and collaborative learning in the classroom (Liu, Wang, Liang, Chan, Ko, and Yang 2003). The focus of this research is to study wireless technologies in education. The paper investigates wireless technologies in the context of current uses, benefits and potential problems encountered with their use, and the subsequent relevance of m-learning in developing countries. Considerations to bear in mind when making use of wireless technologies in education will be explored, and recommendations for adoption will be made. The potential for mobile learning in developing countries is examined and the proposed theoretical model is presented.

While the more technical aspects of wireless access and a detailed technical analysis of the latest mobile technologies are not included here, it is acknowledged that the technical capabilities of mobile devices are a crucial factor in developing and sustaining feasible m-learning projects. A number of handheld computers offer telephone functionality as well as e-mail and Internet access, alongside conventional personal digital assistant (PDA) features. At the same time, a number of mobile telephones offer some computing or data functionality, making the distinction between phone- and data-centric handheld devices ever more difficult to draw (Becta 2004). Therefore, it is assumed that both handheld computing devices (for example, a PDA) and mobile phones are in fact handheld devices, and will be referred to as such in this paper.

Limited research has been conducted on the potential of wireless technology for educational use in developing countries. Wood (2003) states that using wireless technologies in education may contribute to combating the digital divide in developing countries, as this technology is generally cheaper than desktop computers, particularly mobile phones and PDAs. In order to develop a model that could be used for m-learning adoption, it is essential to gain a greater understanding of the considerations associated with the use of wireless technologies.

Results from current m-learning projects indicate that wireless technologies are emerging as a portable solution that enables learners to engage in collaborative and interactive learning activities. Considerations that need to be taken into account when exploring the adoption of wireless technologies in education range from limitations of the wireless technologies themselves, to broader issues such as safety and security, and training and support considerations. This paper concludes that using wireless technologies at educational institutions can be beneficial to all involved, provided that the necessary guidelines and policies are in place. The author identifies areas that are critical to the successful adoption of m-learning, and consequently need to be taken into consideration. These areas comprise the stakeholders (including parents, teachers and learners), critical success factors, communication infrastructure, and the mobile devices.

## **2. CURRENT USES OF WIRELESS TECHNOLOGIES IN EDUCATION**

Educational efforts to experiment with m-learning appear to be boundless, particularly within the academic community. Handheld devices are becoming more common, and their quality and capability is increasing due to technological breakthroughs in miniaturization and advancements in wireless bandwidth and data networks (Keegan 2003). According to the British Educational Communications and Technology Agency (Becta) (2004), handhelds are useful where learners need to record information during a lesson, but where moving to a desktop computer would be disruptive or impractical. For example, inputting data, extended writing (where the handheld has a good-sized keyboard and screen), shared writing (where text files can be moved easily between handhelds), and working on individual pieces of work around a table (where face-to-face interaction would be interrupted by sitting at a desktop computer). Juniu (2003) states that wireless technologies are easy to integrate into existing classrooms and school network environments. An important pedagogical aspect concerning handheld devices is that they extend the learning environment beyond the classroom, as they are portable, support the paperless classroom, and provide additional methods of communication (Juniu 2003). Roschelle (2003) postulates that handheld computers may become an increasingly compelling choice of technology for classrooms because they enable a transition from the occasional, supplemental use associated with computer labs, to frequent and integral use of computational technology.

Three European projects investigated wireless technologies in education, namely M-learning, DfES/Becta PDA Project, and MOBlearn. The M-learning project addressed the social and educational problems in young adults using handheld devices, and its aim was not to replace traditional education, but rather to re-engage those who have left educational institutions (M-learning 2004). The DfSE/Becta PDA project evaluated the use of small, handheld computing devices for both teachers and learners in schools (Becta, 2004). MOBlearn (2004) explored new ways to use mobile environments to meet the needs of learners working by themselves, and with others, using the latest wireless technologies. A further project conducted in Japan, investigated the extent to which mobile phones were utilised for educational purposes among university learners, and measured learners' reactions to educational materials developed specifically for mobile phones (Thornton and Houser 2004).

An m-learning initiative, primarily providing administrative support, at the University of Pretoria in South Africa is having significant success (Brown 2004). An m-learning initiative in Chile is introducing handheld personal computers into Chilean high schools in an attempt to improve the quality of education, by incorporating mobile technology in the classroom. Zurita and Nussbaum (2004) conducted an m-learning study in one low-income elementary school in Chile and state that this aspect of the larger Chilean m-learning project looked at the problems that occur in collaborative learning (widely used in elementary classrooms) when working without technology support. It also examined how a mobile computer supported learning environment, using handheld devices, can address these weaknesses.

### **3. IMPACT OF WIRELESS TECHNOLOGIES ON EDUCATION**

Mobile technology extends learning beyond the walls of classrooms, and this section explores the benefits for learners, parents and teachers with regard to the impact of wireless technologies on portability, collaboration and motivation.

#### **3.1 PORTABILITY**

Juniu (2003) states that many benefits accrue when using handheld computers, the most important of which to the learners and teachers is the opportunity to take the learning experience outside of the confines of the classroom. Due to their portability, these devices can be carried from class to class or wherever one goes and information can be acquired while interacting with one's peers. According to Perry (2003), too often Information Communication Technology (ICT) is taught in a specialist room and as the learning environment changes, teachers often find themselves in a foreign room with technology that they use infrequently. Teachers need ICT to support the subject being taught and available to "grab" those learning opportunities as and when they arise (Perry 2003). Portability can make a difference in a wide variety of settings, namely the classroom, a field trip, or outside of the school environment.

#### **3.2 COLLABORATION**

Handheld devices allow learner groups to distribute, aggregate, and share information with ease, resulting in more successful collaboration. According to Becta (2004), the use of wireless technologies results in parents' increased involvement in education and their increased knowledge of their children's learning and capabilities, owing to the increase in learning activity being situated in the home. Perry (2003) states that wireless technologies, notably PDAs, are proving to benefit 'family learning' as learners are able to use them for various literacy tasks, note-taking, reading e-books, and then take them home to continue working on them with their parents.

#### **3.3 MOTIVATION**

According to Vahey and Crawford (2003), teachers report that learners using handheld wireless technologies demonstrate an increased autonomy in learning, as learners show increased self-directedness in learning and take the initiative in finding ways to use the handheld devices for learning. According to Perry (2003), Becta project schools are unanimous that their learners were excited and highly motivated when they began using the handheld devices. Belt (2001) states that after implementing wireless technologies in the classroom, learner participation increases and they appear "more engaged in the process". According to Perry (2003), giving learners wireless technologies "lights up" their enthusiasm, although whether this will always be the case remains to be seen. Belt (2001) agrees with Perry (2003), suggesting that the increase in learner participation and enthusiasm can be partially explained by the novelty of using a handheld in the classroom. However, after the novelty of the new devices has worn off, learners come to view the devices as working tools (Belt 2001).

## **4. RESULTS OF CURRENT M-LEARNING PROJECTS**

This section focuses on the research findings of educational projects concentrating on mobile learning in developed countries and encompasses the successes and difficulties that the projects have experienced. To a lesser extent, this section explores considerations for the adoption of wireless technologies in education, examining potential barriers to use.

The M-learning project (M-learning 2004) findings show that mobile phones play an increasingly important role in the lives of young adults as a communication tool, and those new services, such as games designed to improve basic skills, are of interest to young adults. Stead (2004) states that it is easy to incorrectly assume that the learning process will be similar to that using a personal computer (only at a smaller size), but the M-learning project findings show that in fact both the limits of the technology and the lack of control over how and when the learning happens implies that a different learning model is needed. The M-learning project finds that with mobile learning learners are often surrounded by distractions; therefore learning has to be engaging. Developing materials that can be used in different forms across different technologies is imperative as it prevents the learning materials from being “out of date” when new mobile devices are released (Stead 2004).

### **4.1 AN OWNERSHIP PERSPECTIVE**

Becta's (2004) findings show that some of the most pronounced benefits are gained in schemes that give learners wireless technologies for their own use. According to Becta (2004), there is also evidence that 'ownership' of wireless technologies increases the learners' motivation and responsibility to extents that do not necessarily derive from the use of PCs and shared school-based hardware. Perry (2003) finds that allowing children personal ownership of equipment can bring benefits to disadvantaged learners who would otherwise have no access to ICT at home. However, personal ownership and home use of wireless equipment brings about concerns for the security and safety of children carrying such devices (Perry 2003). K12 Handhelds (2004) agrees, stating that many schools are reluctant to let learners take home handheld devices, fearing theft, loss, and damage of the wireless technologies. This seems reasonable when mobile phone crime – especially among children of secondary school age – is widespread (Perry 2003). Vahey *et al* (2003) emphasise the need to establish clear acceptable-use policies and parental agreements when assigning the wireless technologies as personal devices, in order to be effective in minimising the loss, theft, and inappropriate use of the devices.

### **4.2 A COLLABORATION PERSPECTIVE**

According to Becta (2004), there is evidence that the use of wireless technologies can help to increase collaborative learning and communication, as well as independent learning among learners, because of the mobility and capacity of the devices. Stead (2004) states that in every M-learning project trial, the learners engaged the most with the learning that they could do together, either by sharing the wireless technologies or by passing data between the devices, consequently learning should be built around this. The results of the Zurita *et al* (2004) research show that wireless technologies solve the weaknesses of coordination, communication, organisation, negotiation, interactivity and mobility encountered in collaborative learning (without technology) in education.

### **4.3 A TEACHER PERSPECTIVE**

Handheld technology has a beneficial impact on the learning environment in the classroom - teachers report greater learner engagement, more effective collaboration and increased learner independence when handheld devices are thoughtfully integrated into the classroom (Vahey *et al*. 2003). According to Becta (2004), information regarding the educational and technological capacities of the wireless technologies must be available, and both teachers and learners require sufficient time for familiarisation with the wireless technologies. Wood (2003) reiterates Becta's (2004) sentiments, stating that teachers and learners may require additional training in order to be able to use the wireless technologies effectively.

### **4.4 POTENTIAL BARRIERS TO USE**

Thornton *et al* (2004) report that some learners had difficulty hearing the audio on both PDAs and cellular phones, and learners suggest headphones would be required when studying in trains and other public places. Overall, Thornton *et al* (2004) find few serious technical limitations to widespread use of wireless

technologies in education. According to the Becta research, possible weaknesses include small screens, possibly not 'rugged' enough for school use, data input (especially free text) takes time, costs of software and accessories, and the necessity to charge the batteries regularly (Perry 2003). Thornton *et al* (2004) show that reading text on small screens does not concern Japanese university learners. Secondly, rich multimedia can capture their interest, and pushing study opportunities at learners via email (to their handheld devices) is effective in assisting them in learning. Perry (2003) notes that other concerns expressed include the need for more comprehensive training and access to technical support (in addition to the teachers), and the complexity of synchronisation with laptop or desktop machines (at home or networked at the school). Additionally, schools have to consider the size of the m-learning project, an estimated timeline for the plan, whether or not the school is eligible for any type of grants or funding, and the maintenance and ongoing support costs (Perry, 2003). Vahey *et al* (2003) note that simply having a set of handheld devices does not imply that they will be integrated into a teacher's curriculum with ease, and difficulties may be encountered. Keegan (2003) states that the main pedagogical issue to consider is the suitability of a course to the m-learning environment, as not all courses are suited to the m-learning environment. For example, short courses and mainly theory and information type courses are better suited to the m-learning environment.

## 5. THE POTENTIAL FOR M-LEARNING IN AFRICA

This section briefly describes the lack of telecommunications infrastructure in Africa, and investigates the prevalence of mobile phones on the continent and their growing adoption rate.

The African continent has many developing nations that are technologically far behind the developed world, and this lack of technological development has a detrimental effect on the education sector. As a result, young people in developing countries face immense challenges, which make it difficult for the next generation to catch up with the developed world (Beute 2004). According to Brown (2004), due to the lack of infrastructure for ICT (cabling for telecommunications and the Internet) in certain areas in Africa, the growth of wireless infrastructure is more rapid than in many first world countries. Jensen (2002) holds similar views to that of Brown (2004), and states that most of the existing telecommunications infrastructure in Africa cannot reach the bulk of the population, with 50 percent of the available lines concentrated in the capital cities, where only about 10 percent of the population lives. In more than 15 countries in Africa, over 70 percent of the lines are still located in the largest city. However, according to Jensen (2002), the situation is not quite as bad as it would appear because of the penetration of mobile networks, where these subscribers have now surpassed fixed line users in most countries, underlining the demand for basic voice services. Due to the low cost and long range of the cellular base stations, many rural areas have also been covered.

According to Jensen (2002), the use of the Internet has grown relatively rapidly in most urban areas in Africa, in much the same pattern as the adoption of the mobile phone that followed shortly after. As an indication, five years ago only a small number of countries had local Internet access, now it is available in every capital city. Jensen (2002) states that although these are encouraging trends, the differences between the development levels of Africa and the rest of the world are much wider in this area than they are when using more traditional measures of development. Generally the level of technology penetration in Africa is low compared to developed countries, primarily because the general population cannot afford it (Beute 2004). According to Jensen (2002), of the approximately 816 million people in Africa in 2001, it is estimated that only:

- 1 in 13 have a TV
- 1 in 35 have a mobile phone
- 1 in 40 have a fixed line
- 1 in 130 have a PC
- 1 in 160 use the Internet
- 1 in 400 have pay television

The fact that more people in Africa have mobile phones, in comparison to fixed lines, indicates the potential for m-learning in Africa.

<b>SOUTH AFRICA</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>
Mobile phones (per 1,000 people)	191	242	304
Telephone mainlines (per 1,000 people)	114	111	107

*Table 1: Growth of Phone Technology (World Development Indicators database, 2004)*

As indicated by the statistics and Table 1 above, mobile cellular telephony has experienced rapid growth in Africa, and more specifically, South Africa. The International Telecommunications Union (ITU) states that Africa has seen an increase of more than 1000% in cellular phone subscribers between 1998 and 2003 (Berger 2004). According to Jensen (2002), cellular providers have expanded from a presence in only six countries ten years ago to over one hundred networks in 48 countries serving over 14 million customers (excluding the ten million in South Africa), and provide access mainly in the capital cities but also in some secondary towns. Jensen (2002) states that although few studies have been made in Africa of the number of rural users in comparison to urban, it is safe to say that users in cities and towns vastly outnumber rural users. According to Berger (2004), what makes this growth seem to be particularly significant is its comparison with fixed-line subscribers on the continent whose numbers appear to be shrinking.

Brown (2004) suggests differentiating between two ideal target markets for m-learning, one consisting of first world learners who are the workforce on the move (with state-of-the-art mobile devices), and the other being third world rural or remote area learners who have mobile phones. Brown (2004) claims that the most appropriate mobile devices for learners in Africa are mobile phones. The research conducted by Thornton *et al* (2004) finds that when actually using educational materials designed for mobile phones, learners evaluate them positively and the test results show that the learners were able to learn via this medium.

With reference to the European based M-learning project, Keegan (2003) states that poor literacy, reluctance to participate in conventional education, and ICT “haves” and “have nots” resulting from a lack of access to computers, are the issues that need to be addressed using handheld devices. The poor literacy and creation of ICT “haves” and “have nots” can be likened to the situation in Africa, particularly in rural areas. The same problems exist in both developed and developing nations, and therefore m-learning with handheld devices can also be used in developing countries to address the aforementioned issues. The study of Japanese university learners conducted by Thornton *et al* (2004) show that wireless technologies such as mobile phones and PDAs can be effective tools for delivering foreign language (English) learning materials to learners. This could be particularly beneficial in developing countries like South Africa, where many learners are not educated in their home language. According to Brown (2004), mobile learning in Africa is a reality that will continue to grow in form, stature and importance, and it will become the learning environment of choice.

## **6. PROPOSED MODEL**

This section explores recommendations and proposes a model for the adoption of m-learning in developing countries. The proposed new model is not solely based on any particular existing model, but does draw on certain aspects mentioned within the current literature in order to provide a new model designed to provide a strategy for the effective adoption of wireless technologies in education. This proposed model takes an all encompassing view of the factors influencing the successful adoption of m-learning, and is applicable in developed and developing countries alike. Although the model requires necessary policies and standards to be in place, these will not be looked at in detail as that is beyond the scope of this paper.

### **6.1 RECOMMENDATIONS FOR THE ADOPTION OF M-LEARNING**

Becta (2004) recommend that when considering the adoption of wireless technologies in education, schools need to ensure that learners, teachers and parents are involved as much as possible in the planning of mobile learning initiatives. Becta (2004) suggest that schools need to contemplate whether they will be able to provide the training and technical support that may be necessary for the effective teacher and learner use of wireless technologies. Wood (2003) agrees with the Becta (2004) recommendations, stating that one has to make certain that the learners, their parents and the teachers, contribute to the wireless technologies adoption planning, and that the school concerned is able to provide support and training, in order to make a success of m-learning. Other recommendations include establishing guidelines and principles to follow ensuring appropriate use of wireless technologies (to exploit the potential of wireless technologies in education) and designing the devices with the end user in mind. The aforementioned recommendations for the adoption of m-learning are primarily based on reported experiences gained from using wireless technologies in education in developed countries. These suggestions can be as appropriate and effective to use in developing countries, provided that the countries have the necessary infrastructure in place.



## 6.2 PROPOSED MODEL AND DISCUSSION

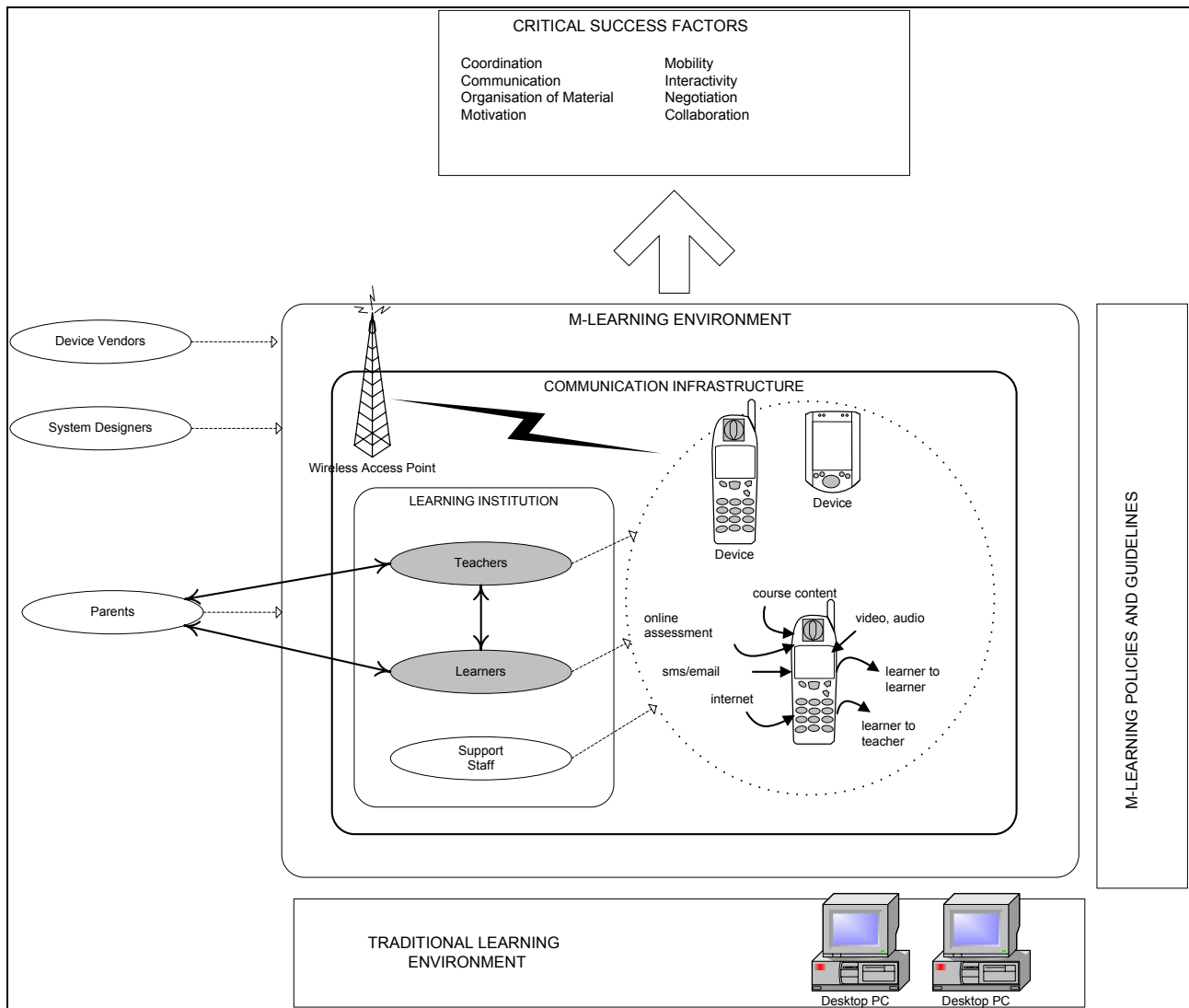


Figure 1: Model for M-learning Adoption

This proposed model for m-learning adoption contains an m-learning environment, which is underpinned by the traditional learning environment and also supported by effective m-learning policies and guidelines. Within the traditional learning environment, as indicated in the model, learning can still take place through desktop PCs. Within the m-learning environment, there is a communication infrastructure (represented on the diagram as a dashed line) containing wireless access points which enables communication between the mobile devices. The mobile devices depicted in the model can be mobile phones, PDAs or any other wireless handheld device. The proposed model demonstrates that the mobile devices can be used as academic support for learners via online assessment, providing course content and access to the Internet. The mobile devices in the proposed model for m-learning adoption enable learner-to-learner communication, as well as learner-to-teacher communication. The model portrays some of the essential elements of a mobile learning environment, as proposed by Chang, Sheu and Chan (2003), including at least one teacher, learners, learning and instructional mobile devices, and a communication infrastructure.

### 6.2.1 STAKEHOLDERS

The stakeholders identified in the proposed model (represented as ellipses) include learners, their parents, teachers, system designers, device vendors, and support staff. The designers of the systems that execute on the devices, the vendors that sell the devices, and the parents of the learners involved all occur outside the m-learning environment. However, they still have an impact on the m-learning environment. The system designers depicted in the proposed model include both software developers and hardware manufacturers. Teachers, learners and support staff are found in a learning institution within the m-learning environment.

The learning institution can be any type of educational institution (for example, a school) or it could simply be a community centre that functions as a place of learning. The proposed model indicates that the support staff are a part of the learning institution as opposed to outsourcing this function. The support staff would be involved in the day-to-day support and maintenance of the mobile learning infrastructure within their particular learning institution. As depicted in the proposed model, a unique relationship exists between three of the stakeholders. Although relationships do exist between the other stakeholders, the one depicted on the diagram is the most important as it is between the three primary stakeholders in m-learning adoption. Teachers and learners are the immediate beneficiaries of m-learning as they are actual users of the devices (represented as shaded ellipses in the diagram), and parents benefit from m-learning to a lesser extent. Teachers communicate with learners via traditional learning activities and using the mobile devices and vice versa. Learners and parents communicate after hours, and teachers communicate with the parents about the learner's progress. The mobile devices also enable communication with other learners, as well as enabling communication with peers and teachers about homework. Learners, teachers and parents should be included in the planning of an m-learning initiative in the learning institution (Becta 2004).

## **6.2.2 CRITICAL SUCCESS FACTORS**

Critical success factors in the proposed model are simply the collaborative learning components that determine the successful adoption of mobile learning. These include those factors emphasised by Zurita *et al* (2003) such as interactivity, coordination, negotiation and communication, organisation of material and mobility. Interactivity refers to the amount of interaction between learners using the mobile devices, and the extent to which using handhelds force learners to share information in a learning activity. Coordination refers to the use of mobile devices encouraging active participation by all learners and a need to coordinate activities. Using handhelds allows for negotiation between learners within group activities, as a consensus needs to be reached before moving on to another activity. Communication implies that a mobile learning environment needs to open the channels of communication between learners, and with their teacher. Mobility refers to the portability of the devices and the extent to which they enable the mobility of the learners. Additionally, the proposed model includes motivation and collaboration. Motivation implies the extent to which the m-learning environment motivates learners to engage with their learning and encourages teachers to develop innovative ways of using the devices to complement traditional teaching methods. Collaboration refers to the m-learning environment promoting collaboration between learners and teachers.

The proposed model emphasises the key issues with regard to m-learning, as well as the critical success factors that are essential in ensuring successful adoption. This model gives a broad, slightly user-centric, overview of all the elements that need to be in place in an m-learning environment, including the necessary stakeholders and key elements (communication infrastructure, mobile devices, learners and teachers), to ensure a seamless adoption of m-learning by the educational institution.

## **7. CONCLUDING REMARKS AND FUTURE WORK**

The prevalence of wireless technologies in education is growing, leading to an increase of literature on the subject of m-learning. This paper explores current available literature and expands on the existing m-learning models, in order to propose a new model for m-learning adoption that includes key stakeholders and critical success factors.

The current uses and the impact of wireless technologies in education were discussed. The proposed model was formulated based on the findings of the literature. Future research may lie in investigating the guidelines and policies that need to be in place to ensure the successful adoption of m-learning. Once determined, these policies (whether global m-learning guidelines or unique to each educational institution) must allow for an m-learning environment to be established. Other future research may lie in analysing the technical capabilities of different wireless technologies, and determining their suitability to an m-learning environment. This could then result in an "ideal" device being developed, adaptable to any m-learning environment, including educational institutions and the business environment.

Using wireless technologies in education impacts motivation, collaboration and portability, as well as resulting in benefits for students, parents and teachers. A few problems may be encountered when integrating wireless technologies in education. However these can be overcome and are therefore not critical in ensuring the success of wireless technologies, with the benefits clearly outnumbering the perceived difficulties. The proposed model highlights the importance of taking into account all the stakeholders of m-learning. The use of the proposed model will depend on the policies and guidelines with regard to use of m-learning. These need to be carefully considered in m-learning adoption.

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