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Using wireless-enabled Personal Digital Assistants (PDA) to access information and create communication patterns which enable the construction and transformation of knowledge in a Year Seven Classroom

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Personal Digital Assistants (PDAs) are mobile wireless communication and organisational devices. PDAs are increasingly being used broadly in Medicine, Nursing, Business and, in a limited fashion, Education (Chan, Chu, Cheng, & Chen, 2004, p. 3). This chapter presents an overview of the intended Doctoral research to be conducted in a Year 7 classroom where each student and teacher will use a wireless, network enabled, PDA. From a review of the literature related to international research and initiatives exploring learning and mobile technological devices, now commonly referred to as mLearning, a theoretical model will be proposed to guide the study. That model conceptualises the investigation of the transformational potential which the PDAs might have on the communication patterns of students. The model also provides a framework for investigating the ways in which students and teachers in the middle years of schooling access information and use communication patterns to construct and transform knowledge. Teacher pedagogy, peer relationships, group dynamics and the development of learning objects for PDAs will be analysed. The chapter will outline the methodology proposed to be used in the research. A qualitative, interpretive paradigm, mirroring the fluid and dynamic nature of education will be employed (Creswell, 1998). As the research will guide change at the school, the research project involves significant action research and critical theory. As an indication of the future direction for this study now in its early stages, the chapter concludes with a proposal for a pilot study of student use of mobile, wireless technologies in the middle years.

Earlier chapters of my research on the use of Personal Digital Assistants (PDAs) in a Year Seven classroom have focussed on sub topics such as early adolescents and their experience of schooling; eLearning; mLearning; and school restructuring. This chapter will focus specifically on the use of PDAs as a tool for learning. This is of significance for my thesis as mobile technologies (mobile phones, PDAs, laptops, MP3 players) are now commonplace in our society and are particularly prevalent amongst early adolescent learners, the target group of my research. For the purposes of this chapter, early adolescents are defined as aged 10 – 14 (Carrington, 2006). The availability of mobile technologies, at relatively low cost, has contributed to social change, particularly with early adolescents who use their mobile devices to maintain relationships unbounded by proximity (Peters, 2005). Early adolescents interact with the technology more than previous generations. While 20 years ago, most media was consumed passively, in the last 10 years a higher level of interactivity has evolved in electronic media use. The depth and richness of digital material readily available to the learner, via a PDA offers true flexibility of time, place and pace (Mellow, 2005) and allows for learning that is context specific, contextualised by mediation with peers and mentors, and “just in time, just enough and just for me” (Peters, 2005).

This chapter will explore a range of issues in relation to the use of PDAs. To better contextualise the discussion, various definitions and contexts of mLearning will be presented. The chapter will then examine the particular affordances of PDAs which make them a key mLearning tool. The impact of PDAs on communication, school structures and on cognitive function will also be explored. Following the literature review this chapter presents a new conceptual model which illustrates the development of various forms of communication within a Year Seven classroom, and also provides the preliminary conceptual framework for my doctoral thesis. Furthermore, this framework suggests a transformational model in terms of changes in the ways in which students and teachers access information and use communication to construct new knowledge and transform knowledge. Finally, this chapter will address key questions of my research project including:

1. Does the “learning mobility” provided by the technology shape the learning of the students?
2. What changes, if any, occurred to information/communication flow?
3. What was the effect of the use of PDAs in terms of peer to peer relationships and peer to teacher relationships?

Definitions of mLearning

Wireless enabled PDAs belong to a suite of mobile devices with potential educational applications and are the devices I have chosen as the mLearning tool in my research project as they offer the best combination of mobility and functionality (Keegan, 2005, p. 3), as indicated below in Figure One. The Literature reviewed focuses on the use of these devices in Primary and Secondary School Education.

[Insert Figure One Approx Here.]

Figure 1. Functionality and mobility in a definition of mobile learning (Keegan, 2005, p. 3).

Prior to exploring the educational potential of PDAs, it is necessary to define mLearning. There are many variants of the term Mobile or mLearning. Lehner and Nosekabel (2002), cited in Chen and Kinshuk (2005, p. 1), define mLearning as “any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge regardless of location and time”. Vavoula and Sharples (2002), cited in Chen and Kinshuk (2005, p. 1), indicated “three ways in which learning can be considered mobile - learning is mobile in terms of space; it is mobile in different areas of life; it is mobile with respect to time”. Traxler (2005), cited in Scanlon, Jones and Waycott (2005, p. 2), comments that “Mobile learning can be defined as any educational provision where the sole or dominant technologies are handheld or palmtop devices”. Rekkedal (2002, p. 4) defines mLearning as “distance learning with mobile technology”. Kay and Goldberg (1981), cited in Waycott, Jones, and Scanlon (2005), focus on the learner rather than on the technology as, in their view, the critical feature of mobile learning is that it is the learner who is mobile. Abernathy (2001, p. 1) defines mLearning as

The intersection of mobile computing and eLearning that includes anytime, anywhere resources; strong search capabilities; rich interaction; powerful support for effective learning; and performance based assessment.

Naismith, Lonsdale, Vavoula, and Sharples (2004, p. 7) classify the range of mobile technologies using two orthogonal dimensions of Personal vs. Shared and Portable vs. Static and believe that “mobile technologies comprise all devices from Quadrants One to Three, and those from Quadrant Four that are not at the extreme end of the ‘static’ dimension” (Refer to Figure Two).

[Insert Figure Two Approx Here.]

Figure 2. Dimensions of Mobile Technological Use (Naismith et al., 2004, p. 7).

Keegan (2005, p. 3) narrows the definition of mLearning to devices which can fit in a pocket and defines mobile learning as “the provision of education and training on PDAs / palmtops / handhelds, hybrid mobile devices (devices offering both voice and data features) smart-phones and mobile phones”.

Learning Contexts

mLearning can be understood as a subset of distance education. The educational domain is currently divided into two halves known as conventional education (set place; set time) and distance education (any place; any time). Most of the goals that today characterise just-in-time or life-long learning, were anticipated by distance learning (Keegan, 2005). Distance education took a step backwards, to some extent, when it converted from paper based to online learning, where students were largely required to study at a place (and at a time) where a computer with access to the Internet was available. Dye, Fagerberg and Rekkedall (2005) argue that the use of mobile technologies increases the flexibility of distance education and returns the any place; any time option to the distance learner. The domain of Distance education has been further refined to encompass the concept of Contextual Life-long Learning (CoLL) which postulates that

1. Learning is an activity not confined to pre-specified times and places and;
2. Traditional education cannot provide all the knowledge and skills that people need to prosper throughout their life-time (Sharples, 2000).

The general requirements for technologies to support contextual life-long learning require them to be highly portable, individual, unobtrusive, available anywhere, adaptable to the context of learning, and relevant to the learner's evolving skills and knowledge, persistent, useful, and easy to use (Chen & Kinshuk, 2005). PDAs appear to meet the requirements of (CoLL) as they can provide a “pervasive conversational learning space” (Sharples, 2003) by facilitating almost instantaneous information access “anytime, anywhere” (Trinder, Magill, & Roy, 2005). This is particularly true with the addition of wireless communication capabilities which enable users to access the Internet and communicate with other PDA users via Personal Area Networks (PANs), Local Area Networks (LANs), or Wide Area Networks (WANs) (Waycott, Jones, & Scanlon, 2005).

Technical Issues Involving PDA Use

As indicated previously, I have chosen wireless-enabled PDAs as the mLearning tool for my research project. Despite some technical limitations,

and considering that the current alternative is often limited or no access to computers, a PDA is, for school students, a potential quantum leap in computational availability (Soloway, Norris, Blumenfeld, Fishman, et al., 2001). The following sections of this chapter refer to the literature to further support my decision to use PDAs in my project. Klopfer, Squire, and Jenkins (2002), as cited in Naismith et al., (2004), identify five properties of PDAs that produce unique educational affordances facilitating collaborative mLearning environments:

- *Portability* – the small size and weight of mobile devices means they can be taken to different sites or moved around within a site.
- *Social interactivity* – digital data exchange and collaboration with other learners can happen face-to-face.
- *Context sensitivity* – mobile devices can both gather and respond to real or simulated data unique to the current location, environment and time.
- *Connectivity* – a shared network can be created by connecting mobile devices to data collection devices, other devices or to a common network.
- *Individuality* – scaffolding for difficult activities can be customised for individual learners. To these can be added a further affordance,
- *Price / Ease of Use* - PDAs are simple to use and start quickly “instant on”; and many are significantly cheaper than desktop or laptop computers. PDAs are an inexpensive way to engage students in developing technology skills and bridging the digital divide between the haves and have-nots. The size, portability, cost and versatility of a PDA makes it an effective tool for bridging the digital divide (Johnson, 2005).

As is the case with any technology, there are limitations to PDA use which may prove to be obstacles to their success as a mLearning tool. These limitations include

- *Ergonomic factors* – PDAs inherit human–computer interaction related issues, such as small screen size, slow and limited input techniques, low bandwidth, small storage capacity, poor audio interaction facilities, limited battery lifetime (particularly when accessing wireless networks), and slow computer processor unit speed (Serif & Ghinea, 2005).
- *Limited innovative, educational software* - the design of learner-centered applications that scaffold learners is more difficult when the target platform is a small screen Quintana, Norris, and Soloway (2003), as cited in Norris and Soloway (2004). The educational software community appears to be a few years away from developing techniques and even sharable code to help reduce the cost of

developing applications (Norris and Soloway, 2004). To test this claim, a web search was conducted on October 19, 2006 for “learning objects” at Edna Online. The search returned 443 sites. On the same day a search for “learning objects for handhelds” at Edna Online returned 0 sites and a search for “learning objects for PDA” at Edna Online returned one site. The small investigation appears to support the position of Quintana, et al., (2003) in terms of the current availability of educational software.

- *Compatibility / functionality issues* – because a clear PDA market leader (in terms of hardware, operating system and application software) has yet to emerge, the PDA sector continues to suffer from the lack of de-facto standard (Caughlin & Vincent 2004; as cited in Oliver & Barrett, 2004) causing compatibility issues between PDAs and standard PCs. Recent analysis of this issue continues to highlight problems with device integration as a limiting factor in widespread educational adoption of PDAs (Oliver & Barrett, 2004).

Communicating with Mobile Technologies

One of the primary purposes of my research is to determine the extent to which PDAs can facilitate social and “informatic” communication in a Year 7 classroom (Peters, 2005). Mobile technologies have enabled new ways of communicating for example, SMS, MMS, and MSN. These new communication modes have been rapidly adopted by young people for whom mobile communication is a way of life, are who are “always on” and connected to geographically-dispersed friendship groups in “tribal communities of interest” (Peters, 2005). Nyíri (2002), emphasising the need to facilitate face-to-face interactions, posits a new philosophy of mobile learning that points to mobile technologies as facilitators of the “innate anthropological need to communicate” (Nyíri, 2002) and identifies communication as the source from which mLearning emerges.

PDAs facilitate communication, not only through the functionalities mentioned above, but also through their ability to “beam” information via Infrared, Bluetooth or 802.11 technologies. Sharing information through beaming is a simple but very compelling activity. The ability to instantaneously share their work with others (and with the teacher) is motivating since children can receive relatively instant feedback on their work (Norris & Soloway, 2004). An important consideration, in understanding the value of beaming, is that there are no cumbersome steps between the physical parties and the act of collaborating. Beaming does not require that one look up an email address, remember an alias, or choose a name from a network list. Instead, beaming simply requires that the collaborators are physically near each other, and a beam is initiated through

a simple button click or menu selection. Because of this, beaming is often felt to be an “intimate” action, almost like shaking hands (Vahey & Crawford, 2002).

Apart from the intimate peer to peer communication between individuals sharing a physical space, PDAs provide opportunities for “swarm learning” where multiple members of a distributed group coalesce on a single point (Alexander, 2003). Learners can exchange information and collaborate with teachers, experts, experienced colleagues, workmates, friends, and co-learners nearby and around the world, gaining access to digital and physical content (Vahey & Crawford, 2002). By facilitating the rapid access to other users any time/any place, sharing content, knowledge, and experience, learners can develop “communities of practice” as well as informal discussion groups, as and when needed to optimise their learning processes (Taylor, 2005).

As well as facilitating communication, the increased use of PDAs has also prompted research in terms of text usage contexts (Swarts, 2005). PDAs allow users to be embedded in contexts that motivate them to look for, process, and arrange textual information to respond to particular information needs. Many of the traditional texts available via PDAs (e.g., reference books, articles, instructions) reflect genres of text that assume a particular social action and a situated motivation for using that information which do not translate to PDA use particularly well. Swarts (2005) believes that PDAs are an information management device incompatible with common conceptions of text and writing and they support very mobile, situated, and sometimes fragmented informational needs.

It appears clear that PDAs are devices that can facilitate various modes of communication and their use in a classroom allows them to become part of a complex network of communication. This communication occurs in the same physical space in which students and teachers participate socially and educationally in teaching and learning. Two distinct kinds of participation are occurring at the same time and in the same space: the normal social participation in classroom discussion and the new “informatic” participation among connected devices (Peters, 2005).

Human / PDA Interaction

It has been argued in this chapter that the use of PDAs, owing largely to the mobility and portability of the devices, can increase collaborative learning, independent learning and communication amongst students. They can help “normalise” the use of ICT in learning and facilitate the integration of technology into classrooms as another tool for learning (BECTA, 2004). PDAs are changing the educational experience of students and at the same time the tools are also changing the ways students perceive the values and

limitations of the technology (Swenson, Young, McGrail, Rozema, & Whiting, 2006). This tool/human interaction is a central aspect of socio-cultural theory (Vygotsky, 1978; Wertsch, 1998; both cited in Wishart, McFarlane, & Ramsden, 2005) which claims that all human action is

mediated by tools which may include technologies and artifacts such as the PDA or desktop computer; semiotic systems such as language including diagrams; social interactions such as those between student and class or student and class teacher and institutional structures such as school ICT policy (Wishart et al., 2005, p. 7).

A key component in the successful and innovative use of PDAs, therefore, is the user of the device as the success or otherwise of any technology is determined as much by the nature of the tool-user as by the nature of the tool. "Technology does not adhere in particular objects but, rather, objects acquire technological essence only when specific people envision, approach, or otherwise act toward those items as a means of accomplishing something" (Prus & Mitchell, 2000, cited in Schlosser, 2002, p. 408).

Further illustrating the implications of human/computer interaction, Norman (1999) as cited in Stead, Sharpe, Anderson, Cych, and Philpott, (2006) and Shneiderman (2000) as cited in Stead et al. (2006) believe that the Personal Computer (PC) presents several barriers to use since, as a device, it lacks flexibility and is overly complex and difficult to use. Consequently, PC users spend more time learning about the computer than using it. In contrast, handheld technologies do not feel overwhelming, intimidating, and overly functional to teachers; handhelds are an educationally appropriate technology (Norris & Soloway, 2004) and resemble more closely the flexible, mobile and to a certain extent "user friendly" technologies afforded by the digital lifestyle outside the school gates (Leadbeater, 2005 as cited in Stead et al., 2006). Riley (1997) believes that ubiquitous computing, or as he labels it "calm technology", is a paradigm shift where technology becomes virtually invisible in students' lives. Instead of having a desktop, or laptop, the technology they use will be embedded in their environment (Riley, 1997). As this research project progresses, a thorough analysis of the socio-cultural implications of the systematic use of PDAs will also be explored. Appendix One diagrammatically illustrates a range of socio-cultural implications to be considered (Sarker & Wells, 2003, p. 37).

Vahey and Crawford (2002) outline two alternate models of ubiquitous student PDA use; the Class Model and the Ownership Model. In the Class Model, students are allocated PDAs to use during lessons and then they are handed back to the teacher. In the Ownership Model, students are "given" a PDA for their sole use for an extended period of time. Research by Vahey and Crawford (2002) found that once students were allowed to use

the handhelds all day and take them home after school, the students discovered additional instructional uses for the handhelds. In addition, students who were assigned handhelds as personal devices were far more likely to spontaneously use them for learning activities without teacher direction. Various authors have indicated tangible and intangible benefits to students once they “own” the devices in terms of motivation; device optimisation; and real world simulation.

- *Motivation* – Stead, et al. (2006) found that the more students use PDAs, the harder it becomes to give them back and the more they become part of their life resources. These students then develop a strong sense of ownership and learning autonomy. Waycott et al. (2005) believe that because mobile technologies are personal and portable they incite in learners a feeling of personal ownership over learning tasks and the technologies used to support learning. This increased motivation is greater than is derived from the use of PCs or shared school-based hardware (National Literacy Association, 1996).
- *Device Optimisation* – As a consequence of deploying the Ownership Model of PDA use, students have greater opportunity to go beyond the necessary and play with the device to explore its potential (Naismith et al., 2004), enabling students to undertake various learning activities wherever they happen to be (Soloway et al., 2001). Waycott et al. (2005) found that in the “Ownership” model students were prepared to invest effort in learning how to best use them for their own purpose. They could benefit from this investment as they were using the PDAs over a long period of time and the devices came to be viewed as personal tools.
- *Real World Simulation* - As indicated earlier in this chapter, early adolescents are immersed in connected technology (e.g., SMS, MMS, MySpace, YouTube, Flickr, and MSN). This immersion is, to a large extent, switched off when they enter traditional classrooms (Selwyn, 2003). PDAs may prove to be a significant tool allowing schools to go beyond replication of pre-computing curriculum frameworks, and transform learning to catch up with the ways of doing things in the rest of society (Fluck & Robertson, 2006). The “personal ownership” of equipment can provide disadvantaged pupils with access to ICT at home and also be influential in heightening home–school links and increasing parental participation (BECTA, 2004).

Although there are some potential negatives to “ownership” for example, concerns for security and the safety of children carrying such devices (BECTA, 2004) and the challenge to the institutional control of the technology accompanying personal ownership (Naismith et al., 2004) the

personal ownership of a handheld computing device is emerging as a significant factor in allowing school education to truly integrate ICT into teaching practice (Becta, 2004). Soloway et al. (2001, p. 2) posit that

As long as computer labs are down the hallway and up the stairs, teachers will consider them irrelevant to learning and teaching. As long as the ratio of students to computers is 4-7 to 1, the effort needed to use them is simply too high, given all that has to be accomplished in a school day; as long as computers are not ready—at hand, they will not be used in a routine, day-in, day-out fashion; and the impact of computers on K-12 education will continue to be essentially zero.

The impact of PDA usage on School Structures

Various authors believe that the ubiquitous use of a handheld wireless device has the potential to fundamentally change teaching, learning and educational research (Sotillo, 2003 as cited in Cochrane, 2005). Cochrane (2005) writes of a “Copernican Revolution in teacher instruction” occurring in classrooms deploying these devices, with the teacher as guide and mentor rather than a fountain of knowledge or ultimate classroom authority. Alexander (2003) presents two educational views. One view is the “traditional classroom” which works largely on a two-step information access schedule (alternating between an isolated classroom and an out-of-class connection to the full world of information via libraries and the internet). The second view is a digital classroom with ubiquitous connectivity blurring those two modes, with always-on, connected learners accessing the internet on demand and, in mid-discussion, “beaming” classmates (and instructors) at any time. Naismith et al. (2004, p. 36) write that

The success of learning and teaching with mobile technologies will be measured by how seamlessly it weaves itself into our daily lives, with the greatest success paradoxically occurring at the point where we don’t recognise it as learning at all.

Individual student access to computers has enabled the educational opportunity for “disruptive learning” (Sharples, 2003). Disruptive learning is learning in a more personalised way and implies the handing over of control to the learners themselves. In this paradigm, instead of starting from the traditional perspective of how teaching ought to happen, teachers and learners start by reflecting on how mobile devices are being used in other domains, for example, business and medicine, and how those uses can be translated to teaching and learning. This is a far more personalised and challenging approach because control gets passed to the learners who stop being consumers of learning materials, and move on instead to become producers, collaborators, researchers, and publishers (Stead et al., 2006).

Other researchers encourage schools to show caution in the wholesale implementation of mobile technologies. Cuban (1996), as cited in

Purcell (2005, p. 86), writes “This persistent dream of technology driving school and classroom changes has continually foundered in transforming teaching practices”. In deciding on the educational use of any electronic tool, teachers should consider factors including the ease of student and teacher use, multiple applications of the technology, technical support, and relative advantage (Roblyer, 2005) in terms of energy expended vs. learning outcomes (Purcell, 2005). On the basis of this assessment teachers can ensure that the introduction of handheld devices is in response to a clear educational imperative. Although PDAs offer new and creative modes of learning, the primary educational goals remain the same; that is, to equip students with a set of skills and a body of knowledge that will help prepare them for later life (Finn & Vandenham, 2004).

A critical consideration for teachers, prior to the use of a new tool, is whether the new tool will enhance or compromise their authority to maintain order and cultivate learning (Selwyn, 2003). Whilst the potential exists for students to take increased ownership of their learning, classroom teachers may insist on taking responsibility for the ways in which students use these technologies. This changing locus of control is potentially problematic and requires consideration of the nature of control gained by students and relinquished by teachers (Facer, Faux, & McFarlane, 2005). Ito (2005), as cited in Facer et al. (2005), indicates that students automatically use mobile devices in a naturalistic and selective way, yet schools are still concerned to “teach” their use. In some sense, this teaching aims to inculcate the use of mobile technologies in a “school way”. Regardless of the potential of wireless PDAs in a classroom, if the hierarchical and social structuring of schools remains unchanged, the technology is likely to prove ineffective as a teaching and learning tool (Facer et al., 2005).

Initial Research Proposal.

Wireless Enabled Communication – A Transformational Model:

The focus of this chapter now shifts to an examination of a new conceptual model of wireless enabled classroom communication and knowledge formation. My conceptual model illustrates the development of various forms of communication within and beyond a primary school classroom and provides the preliminary conceptual framework for my doctoral research. This conceptual framework suggests a transformational model in terms of changes in the ways in which students and teachers access information and use communication to construct and transform knowledge.

A classroom can be conceptualised as a potentially rich communication environment where the nature of communication can be used to facilitate social relationships and also for the transmission of knowledge. The conceptual model of communication has been structured into four stages

(See Figures Three – Six). Stage One and Stage Two are adapted from Branson's (2006) Models of Instruction, whereas Stage Three and Stage Four, building on Branson's Model, are my contribution. In Stages One, Two and Three, all communication and information transmission occurs within the defined Physical and Intellectual Space of a classroom where the flow of information is primarily mediated by the teacher. Stage Four denotes a transformational change to the patterns of communication used in a classroom.

Stage One and Stage Two are essentially the same in that they both reflect the oral traditions of instruction where the transfer of information from teacher to student is the primary pattern of communication. The teacher, in Stage One, uses her/his knowledge and experience and selects the information to be conveyed to the class. In Stage One, successful teaching has occurred if the information distributed to the students is subsequently returned to the teacher via a variety of testing mechanisms. The individual learning needs of the students are only a secondary consideration at this stage. (See Figure Three)

[Insert Figure Three Approx Here]

Figure 3. Oral tradition - Adapted from Branson (2006)

Stage Two differs only slightly from Stage One with the teacher again using her/his knowledge and experience to select the information to be conveyed. Stage Two recognises that students are not homogenous and some attempt is made to tailor teaching methods to accommodate the individual learning needs of the students. Based on my educational experience, I contend that Stage Two is most widely used in education today. Although there is scope for the exchange of information between the teacher and student, these exchanges occur singularly and incidentally, with the driving force of the Stage Two model still remaining the transference of information from teacher to student. Both Stages One and Two are largely teacher centred/controlled and subject/discipline centred and employ an objectivist/directed instruction paradigm. (See Figure Four)

[Insert Figure Four Approx Here]

Figure 4. Current Predominant Teaching paradigm – Adapted from Branson (2006)

Stage Three occurs through the use of aggregation devices such as Classroom Performance System (CPS), Qwizdom, Turning Point, Hyper-

interactive Teaching Technology (H-ITT) or Personal Response System (PRS). (Refer to Figure Five)

[Insert Figure Five Approx Here]

Figure 5. Aggregation-Device Enabled Learning Space – Larkin (2006)

Although the teacher is still largely responsible for determining the flow of information, a significant feature of Stage Three is the bidirectional flow of information that allows the teacher to gather responses from all students instantaneously. In this stage the teacher delivers certain information, usually to the whole class, and then receives almost immediate feedback from the group. This information can then be used to modify the teaching sequence. The aggregation systems currently in use can only be used to provide limited feedback to multiple choice type scenarios. Although the devices can be set to display user information, that is, respondents name or designated student number, they do not facilitate peer to peer communication of data.

Stage Four is enabled via the ubiquitous deployment of Wireless Mobile Devices. In the case of my conceptual model, these devices are PDAs, capable of accessing Digital Information (e.g., files or the Internet) wirelessly via a school network. They are also capable of communicating this information wirelessly to any other PDA (or wireless device) in the classroom or nearby surrounds. As stated earlier, because of their relative advantage (Robyler, 2005) in terms of lower cost, greater sense of personal ownership, mobility, and security, PDAs, rather than laptops or tablets, are the wireless device most efficacious to use in this stage. (See Figure Six)

[Insert Figure Six Approx Here]

Figure 6. Wireless-Enabled PDA Learning Space – Larkin (2006)

The Stage Four model displayed in Figure Six demonstrates the potential to transform communication and information patterns in and beyond the classroom. The first transformation is that the walls of the classroom cease to be a barrier to knowledge and information and become merely a physical barrier. In Stages One – Three, the teacher is the sole determinant of what knowledge is allowed into the classroom and how it will be shared. Because the PDAs are wireless enabled, digital information is now accessible to the students at any time and in any space thus replacing the classroom teacher as the primary source of information in the classroom. This is a significant change from the previous three stages, where a key

component of the teacher's role was transmission of knowledge, and has enormous implications for the pedagogical role of the teacher in what has previously been a largely instructionist model of education.

The second transformation which occurs at Stage Four relates to the fundamental communication patterns occurring in the classroom. In the previous three stages, the teacher is the centre of all communication activities in the classroom. Communication is primarily teacher to whole class; individual student to the teacher; occasionally student to class; and only very rarely sanctioned student to student communication. When direct student to student communication occurs, it is likely to be largely non-educational in nature.

The wireless nature of the PDAs facilitates a myriad of communication patterns. These various patterns of communication have been diagrammatically expressed in the Stage Four model using a variety of bi or uni directional, coloured arrows. In the Stage Four model individual students are depicted as Student One (S1), Student Two (S2) etc. This coding is necessary to convey the myriad of communication patterns that can occur. By analysing the patterns available in the classroom it is evident that the teacher is able to communicate to all students at once or to a sub-group of students if she/he chooses (e.g., orange arrows to S16, S19, S17 and S10). The teacher can communicate in a two-way dialogue with one student (e.g., yellow arrow to S7); send but not receive information from a student (e.g., dotted white line to S11); or communicate with students in all areas of the school (e.g., S16).

The fundamental and crucial difference in Stage Four, as compared to its previous iterations, is the communication options open to the student. A student can choose to communicate to all other students at once; a sub group of students (e.g., black arrows between S2, S3, S12, S17 and S20); or a one to one dialogue with a specific student (e.g., red arrow S11 – S18). Students can also communicate from inside the classroom to other students outside of the classroom, from outside of the classroom to students in the room or outside of the classroom to other students outside of the classroom (e.g., S3 – S12). Inter-classroom communication is also possible (e.g., pink arrows from S16). Should the student choose to do so they can temporarily disable their communication facility and work on their own (e.g., S6). A primary aim of my research is to explore not only the myriad communication patterns but also the educational richness of these patterns.

Suitable Research Paradigm:

This research project adopts the interpretive, qualitative paradigm (Cohen, Manion, & Morrison, 2002). The features of this paradigm are outlined in Table One and they reflect my educational beliefs which

incorporate concepts of individual learning styles, life long learning and quality relationships. The current educational landscape appears to be dominated by quantitative measures; for example, Year 3, 5 and 7 tests, A-E rating scales, Core Skills test, and mandatory reporting frameworks. They appear to be based on the principle that if you “weigh a cow regularly it will gain weight”.

[Insert Table One Approx Here]

Table 1. Differing approaches to the study of behaviour (Cohen et al., 2002).

The qualitative paradigm, in contrast, focuses on the individual and better reflects the value of subjective rather than objective knowledge. This paradigm mirrors the fluid, dynamic nature of teaching and learning. It allows me, as a deputy in the school and the primary researcher in the project, to be involved in the project rather than just a dispassionate observer and recorder of events. Although I have some theories, gathered from a substantive literature review, regarding the potential educational benefits of PDA usage, the interpretive paradigm is also open ended affording the opportunity to engage with the students and to reflect upon what occurs Creswell (1998). As a deputy, I have a practical interest in this research as it will be used to guide future educational change at the school. In this sense, the project involves significant action research and touches on some elements of critical theory.

The qualitative paradigm recognises that people are not primarily subjects of the research but rather that the research examines the rich social interactions that occur between individuals and groups of individuals. This paradigm allows me to investigate what happens in a classroom without disrupting its integrity. It recognises that the education of the student is of paramount importance and that my research should enhance this educative process. I hold a position of significant power in the community. The interpretive paradigm recognises that this will influence the research without jeopardising the results as may be the case in a strictly quantitative model. This will require sensitive relationships and communications strategies.

The need for exhaustive qualitative data is replaced by “thick descriptions” of a particular situation. This allows the reader some measure of “generability” to their particular situation. Howe (2003) argues for the appropriateness of a bi-paradigm approach. Whilst the primary focus will be on interpreting the interactions between student and student and students and the teacher the opportunity exists for some qualitative measures. These will be used to situate my particular situation as relatively indicative of other similar situations. Surveys will be conducted with other Year 7

students/teachers across the Gold Coast and in Brisbane. Triangulative measures will then be employed to better “ensure” the validity of my situation.

Because of my choice of paradigm, and compounded by my position of authority in the research, I will need to be particularly mindful of a number of potential research pitfalls. The situation I define may not be, by deliberate or unconscious distortion, the real situation. Because of my position of authority the participants may react in a way which alters the research - the Hawthorne effect (Cohen, 2002). Because I am very familiar with the situation I may misread or misinterpret certain aspects of the situation. The presence of a “neutral” assistant researcher, continuous reporting back to the school participants to check my perceptions and the use of triangulative measures will minimise the potential impact of the above issues.

Research Approach:

The planned approach is influenced by the conceptual model and the research paradigm. Because the use of PDAs in education is a relatively new concept a significant component of the research project will be the location of current resources suitable for deployment to a PDA as well as the creation and design of suitable educational resources for a PDA. Another key aspect of the research will be the modification of the school’s current technical infrastructure to ensure the potential of the devices is realised.

Because of these factors, I will conduct a pilot study with a Year Seven class prior to the major study. This will allow me to test the learning objects I have created, and those already available, and also resolve the technological issues that will potentially arise. This pilot study will also assist in the fine tuning of other elements of the study including ethical clearances and research tools such as surveys, questionnaires, and interviews.

Preliminary Research Proposal:

In outlining my Research Proposal I will address issues raised by Cohen et al. (2002) in the successful planning of a research project. This proposal will address issues involving the initial planning of the research, research design and methodology, data analysis, presentation of results, and directions for further research.

Initial Planning:

The research project will investigate the impact of PDAs in a Middle School classroom in terms of information and communication flow, student

learning, school structures and student teacher relationships. The research will guide further decision making in terms of an expansion of the use of PDAs across other year levels within the school. The project will take place over a ten week school term and will initially involve a year seven class at Marymount Primary School. The project will then expand to involve students in Year 8 at Marymount College. I am a deputy principal at Marymount Primary School as well as the ICT coordinator.

As ICT Coordinator I am responsible for establishing the direction for ICT use in the school. This research project will assist me in determining the relative advantage (Robyler, 2006) of using PDAs as an educational tool. The research will also address issues relating to Middle Schooling, in particular the tension between school and students in terms of authorised mobile technologies. The data gathered will be owned by the school and will be used to direct further ICT innovation. Results of the research will be available to the School community, to Brisbane Catholic Education (BCE) and reported to the wider community in the form of a doctoral thesis.

Prior to the commencement of the research a number of procedural matters will be resolved. As the research will be taking place at a Catholic Primary School, I need to seek written permission from the Executive Director of BCE. Ethical issues then need to be addressed. Informed consent needs to be obtained from the participants in the study. As the study will include students I will also need permission from their parents/legal guardians.

Ethical approval will be sought from Griffith University. I do not anticipate that ethical approval will be difficult to obtain as I am deputy at the school and therefore well known to the community. I have worked for BCE for the past 23 years and the research project will not touch on highly sensitive issues such as gender, race or religion. Two ethical issues need to be considered. Firstly, a significant power differential arises due to my position in the school. Care will need to be taken throughout the research to minimise this power differential as it may “skew” the results. Secondly, as the students attend the school for a “quality education” it is imperative that the research does nothing to hinder the delivery of such an education.

Research Design and Methodology:

As stated previously, the project will investigate whether ubiquitous use of a PDA affects student learning, teacher pedagogy, communication patterns and school structures. Some specific questions will be addressed in the research. These include

1. Does the “learning mobility” provided by the technology shape the learning of the students?

2. What changes, if any, occurred to information/communication flow?
3. What was the effect of the use of PDAs in terms of peer to peer relationships and peer to teacher relationships?
4. Does ubiquitous access to a computing device translate into marked improvement in student outcomes?
5. Do any school structures (timetabling, ICT usage policies, access to Internet resources, and level of technical support) need to be modified to make best use of the technology?
6. Which model of PDA/Operating system will be most effective in my particular learning context?
7. Are peripheral devices (extendable keyboards, data projectors, wireless printers) needed to support the use of PDAs?
8. Will the “Class” or the “Ownership” model (Vahey & Crawford, 2002) be employed in terms of PDA distribution?
9. Were changes in teacher pedagogy required to facilitate the use of PDAs in a classroom?
10. Does the teacher need significant instruction on the use of PDAs prior to their classroom use?

The methodology I intend to use will be a mixed method approach as both qualitative and quantitative methodologies will be employed to enhance validity. To ensure a representative sample of the target class/teacher, I will survey all Marymount Year 7 students and all Year 7 teachers prior to the study. I will also survey a selection of other Year 7 Gold Coast students and teachers from both State and Non-State schools. Whilst not allowing generalisation on a macro scale, it will allow me to make some comparisons between the students in this study and students in general. Prior to the major research project I will complete a pilot study with a different Year 7 class. This will allow me to determine any technical infrastructure issues that I need to resolve and also provide an opportunity to test the learning objects I have discovered or created.

Data Analysis:

In terms of data gathering instruments, a variety of tools will be used. As mentioned previously I will survey all staff and students in Year 7 at Marymount. Students in the research project will also complete surveys at the beginning, during and at the completion of the project. Students and the classroom teacher will also be interviewed by me and a guest interviewer and the results will be coded for later analysis. Tools such as Leximancer, NVivo or NUDIST will be used to assist in this analysis. Observation by me, the teacher and a guest observer will also occur throughout the project. A

self-reflection anecdotal journal will also be kept by all participants in the study. Stimulated recall will also be used with the participants in the study.

Validity and reliability issues are often a concern in quantitative studies (Cohen et al., 2002). These issues will be minimised by a number of control measures.

- The presence of guest interviewers / observers to allow correlation of data.
- My knowledge and experience as an educator of Middle Years students.
- The purpose of the study is not to make broad generalisations. Rather the intent is to report what I have found using “thick descriptions” which provides readers with enough data to relate this to their own situation.

Reporting:

At the conclusion of the research project the results will be reported back to various recipients including-

- Griffith University, as partial requirements of a doctoral degree.
- The Marymount School Community
- Brisbane Catholic Education as they may wish to use information from this project to drive further change.
- Various educational publications.

[Insert Appendix One Approx here]

Appendix One. An integrated framework for the use and adoption of mobile handheld devices (Sarker et al., 2003, p. 37).

References

Abernathy, D. J. (2001). Get ready for M-learning. *Training & Development*, 55(2), 20-21.

Alexander, B. (2003). *Teaching in the Wireless Cloud*. Retrieved 15 May 2006 from the World Wide Web:
<http://www.thefeaturearchives.com/35265.html>

- Baumgart, D. C. (2005). Personal digital assistants in health care: experienced clinicians in the palm of your hand? *The Lancet* 366(9492), 1210 -1223.
- BECTA. (2004). *What the Research says about portable ICT devices in teaching and learning*. Retrieved 12 September 2006 from the World Wide Web:
http://www.becta.org.uk/page_documents/research/wtrs_portictcs.pdf
- Bent, P. D., Bolsin, S. N., Creati, B. J., Patrick, A. J., & Colson, M. E. (2002). *Professional monitoring and critical incident reporting using personal digital assistants*. Retrieved 12 September 2006 from the World Wide Web:
http://www.mja.com.au/public/issues/177_09_041102/ben10246_fm.html
- Branson, R. K. Alternative Models of Schooling: Technology Defeats Obsolescence. *Center for Performance Technology*. Retrieved 29 May 2006 from the World Wide Web:
<http://www.cpt.fsu.edu/pdf/alternativemodels.pdf>
- Burke, M., Colter, S., Little, J., & Riehl, J. (2005). *Utilizing Wireless Pocket-PCs to Promote Collaboration in Field-based Courses*. Paper presented at the mLearn 2005 4th World Conference on mLearning. Capetown, South Africa. Retrieved 12 October 2006 from the World Wide Web: <http://www.mlearn.org.za/papers-full.html>
- Carlson, S. (2006). *Are Personal Digital Assistants the Next Must-Have Tool? Colleges experiment with hand-held devices - with mixed results*. Retrieved 2 August 2006 from the World Wide Web:
<http://chronicle.com/free/v49/i07/07a03301.htm>
- Carney, S., Koufogiannakis, D., & Ryan, P. (2004). Library Services for Users of Personal Digital Assistants: A Needs Assessment and Program Evaluation. *Portal: Libraries and the Academy*, 4(3), 393 - 492.
- Carrington, V. (2006). *Rethinking middle years: early adolescents, schooling and digital culture*. Crows Nest: Allen & Unwin.
- Chan, S. S., Chu, C. P., Cheng, B. C., & Chen, P. P. (2004). Data management using the personal digital assistant in an acute pain service. *Anaesthetic Intensive Care*, 32(1), 81-86. Retrieved 17 August 2006 from the World Wide Web:

<http://search.informit.com.au/fullText;dn=87069267;res=MEDITEXT>

- Chen, J., & Kinshuk. (2005). Mobile Technology in Educational Services. *Journal of Educational Multimedia and Hypermedia*, 14(1), 89-107.
- Cimino, J. J., & Bakken, S. (2005). Personal Digital Educators. *The New England Journal of Medicine*, 352(9), 860 - 863.
- Cochrane, T. (2005). Mobilising learning: a primer for utilising wireless palm devices to facilitate a collaborative learning environment. *Balance, fidelity, mobility: maintaining the momentum. Proceedings of the 22nd ASCILITE conference, Brisbane. 4-7 December 2005.* edited by H Goss, volume 1, pages 147-157. Brisbane: Department of Teaching and Learning Support Services, Queensland University of Technology.
- Cohen, L., Manion, L., & Morrison, K. (2002). *Research Methods in Education. 5th Edition.* London: Routledge Falmer.
- Creswell, J. W. (1998). *Qualitative Inquiry and Research Design: Choosing Among Five Traditions.* London: Sage Publications.
- Dee, C. R., Teolis, M., & Todd, A. D. (2005). Physicians' use of the personal digital assistant (PDA) in clinical decision making. *Journal of the Medical Library Association*, 93(4), 480 - 487.
- Dunlop, M., & Brewster, S. (2002). The Challenge of Mobile Devices for Human Computer Interaction. *Personal and Ubiquitous Computing*, 6(4), 235 - 236.
- Dye, A., Fagerberg, T., & Rekkedall, T. (2005). *Designing an Always-Online Learning Environment for Mobile Learners and Teachers.* Retrieved 31 August 2006 from the World Wide Web:
<http://learning.ericsson.net/mlearning2/files/workpackage2/designing.doc>
- Enger, J. C., & Segal-Isaacson, A. E. (2001). 2002 guide to new technology-PDAs: The ABCs of PDAs. *Nursing Management*, 32(12), 60 - 62.
- Facer, K., Faux, F., & McFarlane, A. (2005). *Challenges and Opportunities: Making Mobile Learning a Reality in Schools.* Paper presented at the mLearn 2005 4th World Conference on mLearning. Capetown, South

Africa. Retrieved 12 October 2006 from the World Wide Web:
<http://www.mlearn.org.za/papers-full.html>

Finn, M., & Vandenharn, N. (2004). The Handheld Classroom: Educational Implications of Mobile Computing. *Australian Journal of Emerging Technologies and Society*, 2(1), 21-35.

Fluck, A. E., & Robertson, M. (2006). *User-owned computers: friend or foe in schools?* Paper presented at the Australian Council of Computer Educators Biennial Conference 2006. Cairns, Australia.

Fryer, W. A. (2003). *The Opportunities and Challenges of Wireless Computing*. Retrieved 31 August 2006 from the World Wide Web:
http://www.techlearning.com/db_area/archives/WCE/archives/weswire.html

Goggin, G. (2005). Mobile learning. *Professional Educator*, 4(1), 3 - 8.

Heath, A., Kruesi, L., Lasserre, K., Todd, H., & Thorning, S. (2004). *Opportunities in the palm of your hand: the challenge of handheld computing for libraries and information services*. In 'ALIA 2004 Biennial Conference: Challenging Ideas'. Gold Coast Qld: Australian Library and Information Association. Retrieved 26 August 2006 from the World Wide Web:
<http://conferences.alia.org.au/alia2004/pdfs/heath.a.paper.pdf>

Howe, K. R. (2003). Two Dogmas of Educational Research. In *Closing Methodological Divides: Toward Educational Research*. Norwell: Kluwer Academic Publishers.

Johnson, D. E., Pancoast, P., E., Mitchell, J., A., & Shyu, C.-R. (2004). Design and evaluation of a personal digital assistant-based alerting service for clinicians*(dagger). *Journal of the Medical Library Association*, 92(4), 438 - 445.

Johnson, D. G. (2005). Handheld Computers: No Child Left Behind (NCLB's) Digital Divide Equalizers? *Journal of the Research Center for Educational Technology*. Retrieved 31 August 2006 from the World Wide Web: <http://www.rcetj.org/?type=art&id=3385&>

Jonassen, David H., & Rorher-Murphy, L. (1999). Activity Theory as a Framework for Designing Constructivist Learning Environments. *ETR&D*, 47(1), 61-79.

Keegan, D. (2005). *The Incorporation of Mobile Learning into Mainstream Education and Training*. Paper presented at the mLearn 2005 4th World Conference on mLearning. Capetown, South Africa. Retrieved 12 October 2006 from the World Wide Web:
<http://www.mlearn.org.za/papers-full.html>

Kho, A., Henderson, L. E., Dressler, D. D., & Kripalani, S. (ND). Use of Handheld Computers in Medical Education. A Systematic Review. Retrieved 19 August 2006 from the World Wide Web:
<http://www.blackwell-synergy.com/toc/jgi/21/5>

Lehner, F., & Nosekabel, H. (2002). The role of mobile devices in e-learning-first experience with an e-learning environment. Paper presented at the *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. Los Alamitos, CA.

Martin, S. (2003). More than half of MDs under age 35 now using PDAs. *Canadian Medical Association Journal*, 169(9), 952 - 953.

McNett, M., & Voelker, G. M. (2004). *Access and Mobility of Wireless PDA Users*. Retrieved 31 August 2006 from the World Wide Web
http://www.cse.ucsd.edu/Dienst/UI/2.0/Describe/ncstrl.ucsd_cse/CS2004-0780

Mellow, P. (2005). The media generation: maximise learning by getting mobile. *Balance, fidelity, mobility: maintaining the momentum. Proceedings of the 22nd ASCILITE conference, Brisbane*. 4-7 December 2005. edited by H Goss, volume 1, pages 147-157. Brisbane: Department of Teaching and Learning Support Services, Queensland University of Technology.

Mercer, J. (2004). PDAS: automation without all the hardware. *Canadian Medical Association Journal*, 170(10), 63 - 73.

Murphy, E. A. (2005). Handheld Computer Software for School Nurses. *The Journal of School Nursing*, 21(6), 356 - 361.

Naismith, L., Lonsdale, P., Vavoula, G., & Sharples, M. (2004). Literature Review in Mobile Technologies and Learning. *FUTURELAB SERIES* University of Birmingham, Report 11. Retrieved 22 August 2006 from the World Wide Web:

http://www.futurelab.org.uk/download/pdfs/research/lit_reviews/futurelab_review_11.pdf

Newbold, S. K. (2003). New uses for wireless technology. *Nursing Management*, 22. Retrieved 22 August 2006 from the World Wide Web:
<http://proquest.umi.com/pqdweb?did=442886651&Fmt=7&clientId=13713&RQT=309&VName=PQD>

Newhouse, P. (2006). *Mobile Education Devices for Pre-Service Teachers*. Paper presented at the Australian Council of Computer Educators Biennial Conference 2006. Cairns, Australia.

Norris, C., & Soloway, E. (2004). Envisioning the Handheld-Centric Classroom. *Educational Computing Research*, 30(4), 281-294.

Nyíri, K. (2002). *Towards a Philosophy of M-Learning*. IEEE International Workshop on Wireless and Mobile Technologies in Education. Teleborg Campus, Växjö University, Växjö, Sweden: WMTE 2002.

Oliver, B., & Barrett, C. (2004). Comfort + ubiquity = adoption: enhancing first year students' communication skills with handheld computers. *Beyond the comfort zone: Proceedings of the 21st Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE)*. Perth: Australasian Society for Computers in Learning in Tertiary Education.

Oliver, B., & Wright, F. (2002). The next big thing? Exploiting channels and handheld computers for student learning, *Focusing on the student: Proceedings of the 11th Annual Teaching and Learning Forum*. Edith Cowan University: Professional Development @ Learning Development Services, Edith Cowan University.

Perry, D. (2003). Handheld Computers (PDAs) in Classrooms. *BECTA*. Retrieved on Retrieved 12 September 2006 from the World Wide Web:
http://www.becta.org.uk/page_documents/research/wtrs_porticts.pdf

Peters, K. (2005). *Learning on the move: Mobile technologies in business and education*. Retrieved 12 September 2006 from the World Wide Web:
http://pre2005.flexiblelearning.net.au/projects/resources/2005/Learning%20on%20the%20move_final.pdf

- Purcell, S. L. (2005). Educators' acceptance of and resistance to handheld technologies. *Curriculum and Teaching Dialogue*, 7(1/2), 79 -95.
- Rekkedal, T. (2002). *Trying Out a Learning Environment for Mobile Learners. Evaluation of the course "Online Teaching and Learning"*. Retrieved 12 September 2006 from the World Wide Web:
http://learning.ericsson.net/mlearning2/project_one/NKI2001mlearningevaluationFinal.doc
- Riley, M. (1997). *Ubiquitous computing: An interesting new paradigm*. Retrieved 25 October 2006 from the World Wide Web:
http://www.cc.gatech.edu/classes/cs6751_97_fall/projects/say-cheese/marcia/mfinal.html
- Roschelle, J. (2003). Unlocking the learning value of wireless mobile devices, *Journal of Computer Assisted Learning*, 19, 260-272.
- Rosenthal, K. (2004). Get "smart" with a PDA. *Nursing Management*, 35, 17 - 18.
- Sarker, S., & Wells, J. D. (2003). Understanding Mobile Handheld Device Use and Adoption. *Communications of the ACM*, 46(12), 35-40.
- Savill-Smith, C., & Kent, P. (2003). *The use of palmtop computers for learning. A review of the literature*. Retrieved 12 September 2006 from the World Wide Web:
<http://www.lstda.org.uk/files/PDF/1477.pdf#search=%22The%20use%20of%20palmtop%20computers%20for%20learning%3A%20A%20review%20of%20the%20literature%22>
- Scanlon, E., Jones, A., & Waycott, J. (2005). Mobile technologies: prospects for their use in learning in informal science settings. *Journal of Interactive Media in Education*, 25, 1-17.
- Schlosser, F. K. (2002). So, how do people really use their handheld devices? An interactive study of wireless technology use. *Journal of Organizational Behavior*, 23, 401 - 423.
- .Serif, T., & Ghinea, G. (2005). HMD versus PDA: a comparative study of the user out-of-box experience. *Personal and Ubiquitous Computing*, 9(4), 238 - 249.

- Selwyn, N. (2003). Schooling the Mobile Generation: the future for schools in the mobile-networked society, *British Journal of Sociology of Education*, 24, 131 - 145.
- Sharma, M. D., Khachan, J., Chan, B., & O'Byrne, J. (2005). An investigation of the effectiveness of electronic classroom communication systems in large lecture classes. *Australasian Journal of Educational Technology*, 21(2), 137-154.
- Sharples, M. (2000). The design of personal mobile technologies for lifelong learning, *Computers & Education*, 34(3/4), 177-193.
- Sharples, M., Corlett, D., & Westmancott, O. (2002). The Design and Implementation of a Mobile Learning Resource. *Personal and Ubiquitous Computing*, 6, 220-234.
- Sharples, M. (2003) Disruptive Devices: Mobile Technology for Conversational Learning. *International Journal of Continuing Engineering Education and Lifelong Learning*, 12, 5/6, 504-520.
- Solomons, T. (2004). *Beam me up! Supporting PDAs (Personal Digital Assistants) in medical libraries: new technology, or just another format?* Breaking boundaries: integration and interoperability: 12th biennial VALA conference and exhibition. Melbourne Convention Centre: Victorian Association for Library Automation.
- Soloway, E., Norris, C., Blumenfeld, P., Fishman, B. (2001). Handheld devices are ready-at-hand. *Association for Computing Machinery. Communications of the ACM*, 44(6), 15 - 21.
- Stead, G., Sharpe, B., Anderson, P., Cych, L., & Philpott, M. (2006). *Emerging Technologies for Learning*. Retrieved 31 August 2006 from the World Wide Web:
[http://www.becta.org.uk/corporate/publications/documents/Emerging Technologies_Accessibility.pdf#search=%22Emerging%20Technologies%20for%20Learning%22](http://www.becta.org.uk/corporate/publications/documents/Emerging_Technologies_Accessibility.pdf#search=%22Emerging%20Technologies%20for%20Learning%22)
- Strom, G. (2002). Mobile Devices as Props in Daily Role Playing. *Personal and Ubiquitous Computing*, 6(4), 307 - 310.

- Sung, M., Gips, J., Eagle, N., Madan, A., Caneel, R., DeVaul, R., et al. (2005). m-learning applications for classroom settings, *Journal of Computer Assisted Learning* 21, 229-237.
- Swarts, J. (2005). PDAs in Medical Settings: The Importance of Organization in PDA Text Design. *IEEE Transactions on Professional Communication*, 48(2), 161 - 162.
- Swenson, J., Young, C. A., McGrail, E., Rozema, R., & Whitin, P. (2006). Extending the Conversation: New Technologies, New Literacies, and English Education. *English Education*, 38(4), 351.
- Taylor, J. (2005). *Pedagogy in the mobile learning environment*. Retrieved 22 August 2006 from the World Wide Web: <http://kn.open.ac.uk/public/getfile.cfm?documentfileid=2684>
- Traxler, J., & Kukulska-Hulme, A. (2005). *Evaluating Mobile Learning: Reflections on Current Practice*. Paper presented at the mLearn 2005 4th World Conference on mLearning. Capetown, South Africa. Retrieved 12 October 2006 from the World Wide Web: <http://www.mlearn.org.za/papers-full.html>
- Trinder, J. J., Magill, J. V., & Roy, S. (2005). Portable assessment: towards ubiquitous education. *International Journal of Electrical Engineering Education*, 42(1), 73.
- Turner, P., Milne, G., Kubitscheck, M., Penman, I., & Turner, S. (2005). Implementing a wireless network of PDAs in a hospital setting. *Personal and Ubiquitous Computing*, 9(4), 209.
- Vahey, P., & Crawford, V. (2002). Palm™ Education Pioneers Program: Final Evaluation Report. Retrieved 12 October 2006 from the World Wide Web: <http://www.palmgrants.sri.com>
- Vavoula, G. N., & Sharples, M. (2002). *KleOS: A personal, mobile, knowledge and learning organization system*. IEEE Computer Society. Washington, DC: cited in Chen, J., & Kinshuk. (2005). Mobile Technology in Educational Services. *Journal of Educational Multimedia and Hypermedia*, 14(1), 89-107.

Waycott, J., Jones, A., & Scanlon, E. (2005). PDAs as lifelong learning tools: an activity theory based analysis. *Learning, Media and Technology*, 30(2), 107-130.

Waycott, J., & Kukulska-Hulme, A. (2003). Students' experiences with PDAs for reading course materials. *Personal and Ubiquitous Computing*, 7(1), 30 - 43.

Wishart, J., McFarlane, A., & Ramsden, A. (2005). *Using Personal Digital Assistants (PDAs) with Internet Access to Support Initial Teacher Training in the UK*. Paper presented at the mLearn 2005 4th World Conference on mLearning. Capetown, South Africa. Retrieved 12 October 2006 from the World Wide Web: <http://www.mlearn.org.za/papers-full.html>

Tables, figures and appendices for the document are located below

Figure One

<u>Functionality</u>		<u>Mobility</u>		
Computers	Laptop Computers	PDA's Handhelds Palmtops	Smart Phones	Mobile Phones
← E-LEARNING →		← M-LEARNING →		

Figure Two

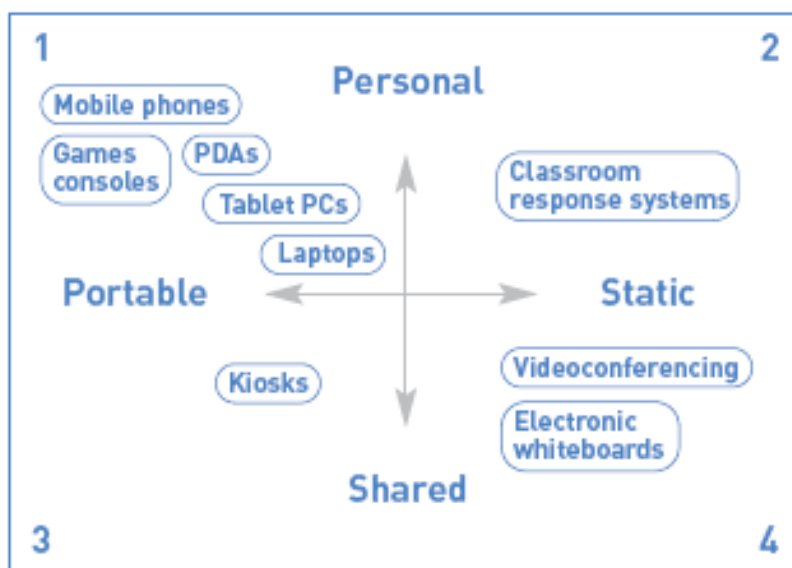


Figure 3

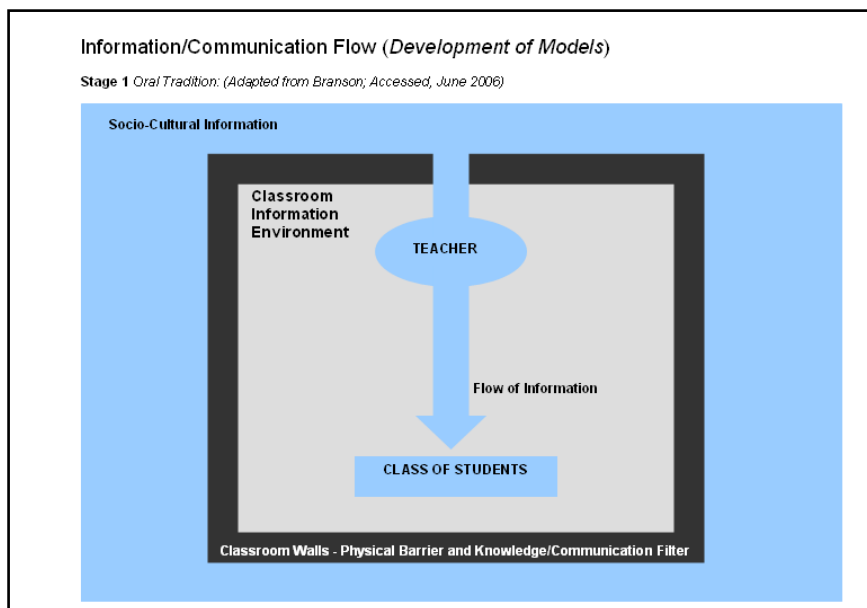


Figure 4

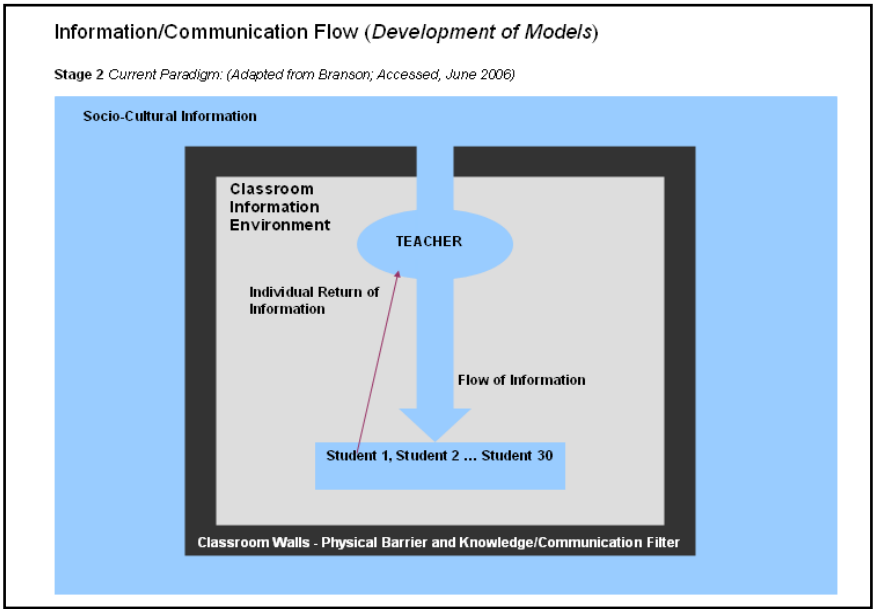


Figure 5

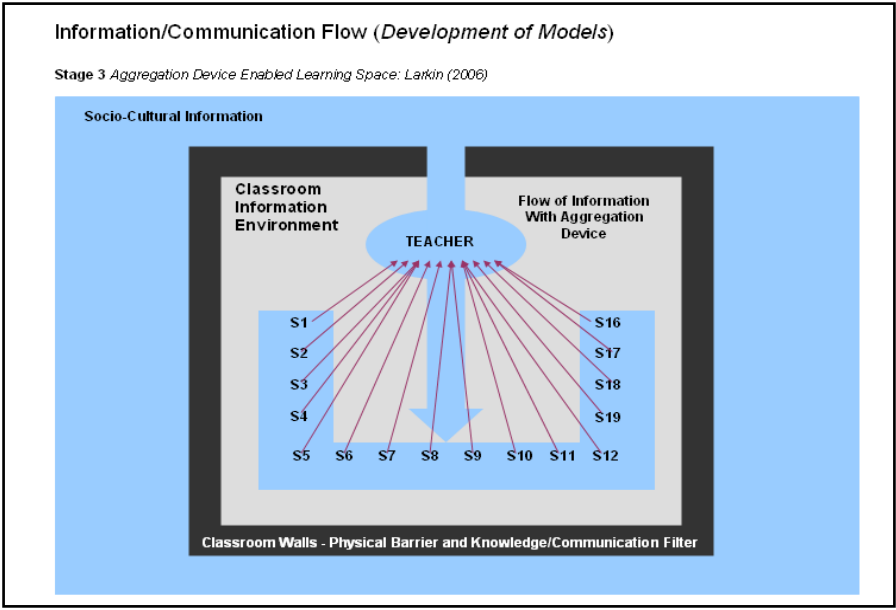


Figure 6

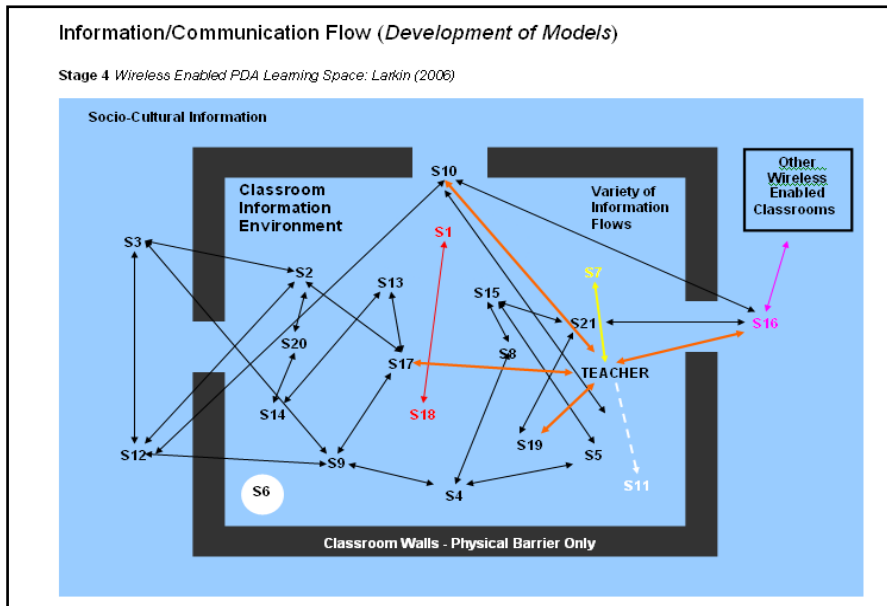


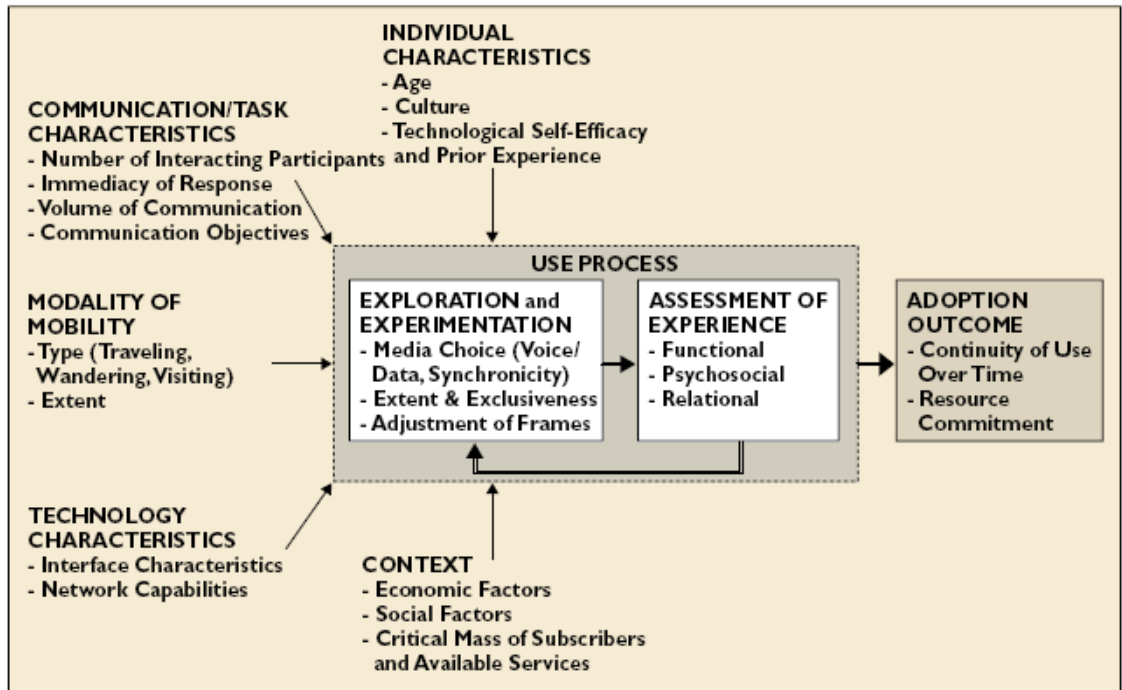
Table One.

Normative	Interpretive	Critical
Society and the social system	The individual	Societies, groups and individuals
Medium / large-scale research	Small-scale research	Small-scale research
Impersonal anonymous forces regulating behaviour	Human actions continuously recreating social life	Political, ideological factors, power and interests shaping behaviour
Model of natural sciences	Non statistical	Ideology critique and action research
‘Objectivity’	‘Subjectivity’	Collectivity
Research conducted ‘from the outside’	Personal involvement of the researcher	Participant researchers, researchers and facilitators
Generalising from the specific	Interpreting the specific	Critiquing the specific
Explaining behaviour seeking causes	Understanding actions / meanings rather than	Understanding, interrogating,

	causes	critiquing, transforming actions and interests
Assuming the taken-for-granted	Investigating the taken-for-granted	Interrogating and critiquing the taken-for-granted
Macro-concepts: society, institutions, norms, positions, roles, expectations	Micro-concepts: individual perspective, personal constructs, negotiated meanings, definitions of situations	Macro- and micro-concepts: political and ideological interests, operations of power
Structuralists	Phenomenologists, symbolic interactionists, ethnomethodologists	Critical theorists, action researchers, practitioner researchers
Technical interest	Practical interest	Emancipatory interest

Table One. Differing approaches to the study of behaviour (Cohen et al., 2002).

Appendix One



Appendix One. An integrated framework for the use and adoption of mobile handheld devices (Sarker et al., 2003, p. 37).