Chapter 1

Introduction

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1. Introduction

The main assumption of this study is that mobile technology can be used to enrich a learning environment by removing some of the limitations imposed by conventional classrooms and conventional teaching methods. This study documents an experiment in which secondary school learners made use of their mobile phones to supplement the information and support that they needed to complete a learning task in physical science devised by the researcher. By using their own mobile phones and a MobilED platform students supported an “audio wiki” that eliminated the physical boundaries of their classroom by allowing them to access essential information and developments at any time of the day and in any place.

2. Background

Mobile phones have the potential to play a major role in the development of the information society in developing countries. The rapid rate of increase in mobile phone usage and ownership in every country that possesses the necessary supportive infrastructure has created a situation in which the mobile phone is currently the most widely used technology for receiving and delivering networked information ("Mobiled ", 2006). In South Africa the popularity, incidence and effectiveness of mobile phones are affected by the limitations of the national power grid, problems of maintenance, the degree of usability of various interfaces, and affordability. While all mobile phones serve their most obvious purpose as high-frequency transmitters of telephonic data, some mobile phones have the capacity to access networked information resources in a routine and non-problematic way. This kind of enhanced capacity makes a mobile phone a potential instrument for the implementation of educational projects and learning experiences of various kinds. In transactions of this kind a mobile phone functions in the same way as a terminal.

At the time of writing no South African school known to the researcher has as yet utilised mobile phones to support learning events. The support and promotion of the instrumentality of the mobile phone for educational purposes in South Africa makes the creation of a local

knowledge base that details the design, implementation and analysis of all initiatives that use mobile phones in teaching and learning an urgent necessity. This study focuses on the second pilot study implemented in a secondary school as part of the MobilED initiative. Although the research was designed and implemented in an advantaged school, the knowledge and experience that accrue from the study will ultimately benefit all sectors of the South African population.

3. Terminology

Audio wiki	Audio call back facilitated by the MobilED platform
Network	A system of connected computers that can share resources
PC	Acronym for "personal computer"
Protocol	A formal, defined set of rules and formats
Server	A computer that offers services on a network
Emoticon	A graphic symbol added to text for the purpose of depicting an emotion
SMS	Acronym for "short message service"
SMS lingo	A variety of abbreviations and terminology used in texting
Usability	The degree to which a product is *usable* refers to its ease of use in practice and how easy it may be for someone to acquire the necessary skills for using it.
WAN	Acronym for "wide area network"; a network that connects computers over a geographic area.
Wiki	A cooperative learning space that is made accessible through the Internet.
FET	Acronym for "Further Education and Training"

4. Rationale for this research.

Current developments in technology have increased the ubiquity of wireless connectivity in our society, and this in turn has created the conditions in which comes feasible to use wireless technology to extend various modes and forms of teaching and learning. It is specifically in the context of educational projects of this kind that Roschelle (2003) suggests that

> research attention should be directed at identifying those simple things that technology does extremely and uniquely well, and to understanding the social practices by which those new affordances become powerful educational interventions (Roschelle, 2003).

This study aims to identify (1) ways in which mobile phones can be used effectively in a mobile technology enriched environment and (2) the relationships and interactions that present themselves at the interfaces between user and technology.

The current literature on this topic is divided between studies that have a technological emphasis and studies that are concerned with pedagogy. In both kinds of study, the mobile technology concerned is conceptualised as a tool or instrument that promotes an educational activity. Researchers argue that a mobile technology such as the mobile phone functions as a virtual extension of the individual who uses it, and that it is personal and individualised precisely because it is mobile. Because of this idiosyncrasy of mobile technologies, the mobile phone (and other mobile technologies) extends the individuality of the user by means of a complex network of personal relationships that are predicated by the technology itself. There is as yet little documentation in the literature about the modes of relationship into which a mobile technology draws its user.

In the literature about the educational uses of mobile technology, the researcher is designated as a "reflective practitioner" who undertakes "research design" (Reeves *et al.*, 2005).

> Theory informing practice is at the heart of the approach, and the creation of design principals and guidelines enables research outcomes to be transformed into educational practice (Reeves *et al*., 2005).

5. Purpose of research

The purpose of this research project was to observe, describe and reflect upon the ways in which learners could use their personally owned mobile phones to enrich their experience of a learning event in physical science in the local secondary school.

Since this research is grounded in activity theory, the mobile phone is regarded as a "tool" for the purpose of accumulating and transmitting knowledge (Nardi, 1996).

In order to understand precisely how mobile phones are used in a learning event of this kind, it is necessary to answer the following critical questions:

1. **How can mobile phones be utilised in teaching and learning?**
2. **How useful was the MobilED wiki for facilitating information access?**

6. MobilED initiative

The MobilED project has four key scientific, technical and developmental objectives:

1. To explore and comprehend the cultural, social and organizational context of young people in and out of school in three developing countries (South Africa, India, Brazil) and in one developed country (Finland) as they utilize their mobile phones.

2. To develop research-based models and scenarios of how mobile phones could be used for teaching, learning and the empowerment of students within and outside the school context.

3. To develop concepts, prototypes and platforms that will facilitate and support the models and scenarios thus developed.

4. To test, evaluate and disseminate the scenarios, models, concepts, prototypes and platforms in the four countries (MobilED, 2005).

The current principle partners in the MobilED initiative are:

- The Meraka Institute of the Council for Scientific and Industrial Research (CSIR), South Africa
- Media Lab of the University of Art and Design Helsinki (UIAH), Finland
- The network of Associated Partners and Advisers (which includes the Centre for Research on Networked Learning and Knowledge Building)
- The University of Helsinki (FI)
- The Tshwane University of Technology (SA)
- The University of Pretoria (SA)

- Escola do Futuro Universidade de São Paulo (BR)
- The WikiMedia Foundation (US)
- The Center for Knowledge Societies (IN)

The initiative is funded by the Department of Science and Technology in South Africa and by the Embassy of Finland in Pretoria, and is sponsored by Nokia.

6.1 Rationale of the MobilED initiative

The MobilED research document defines the rationale of the MobilEd initiative in the following way:

> The aim of MobilED initiative is to enable all members of society (especially those in the developing world) to become active participants in the information society by being contributors and not just passive recipients of information.
>
> The project aims to contribute to the scientific and technical know-how about how groups of young people in and out of school environments are using mobile devices in their everyday knowledge acquisition and problem-solving situations. The project aims to uncover user innovations and concepts around mobile phones through a participatory design process with users. Within the research work the project will implement several prototypes that can be tested and disseminated in real environments, which will include schools, youth clubs and other informal groups. (MobilED, 2005)

6.2 First pilot study conducted at Cornwall Hill College

The first pilot study took place in March 2006, Pretoria, South Africa, and involved an HIV/AIDS project for learners in grade 11 (16-17 years). The platform offered learners access to Wikipedia content by means of an SMS. A learner could contact Wikipedia by sending a query term to the server. The server would then call the learner's mobile phone, and a speech synthesizer would read the article to the learner. Learners could also use simple navigational ploys for jumping from one section to another in the content and for selecting specific headings from the table of content. In order to make the system operational, learners were required to upload an audio cast to the wiki-server with their phones. Five smart mobile phones were used with five speaker sets (Batchelor, 2006; Online, 2006).

Image 1-1: MobilED kit issued per group

Image 1-2: Pupils accessing the MobilED platform

7. The research plan

This research is based on a mobile learning event designed and implemented by the researcher. The researcher collected data for analysis by means of personal observation, and from focus groups, informal interviews, SMS logs, reflective reports, field notes and the results of a questionnaire. The data was analysed by means of qualitative and quantitative forms of data analysis, and Atlas.ti was used to code the transcripts of the interviews.

Table 1-1 below presents a planning matrix for this study. The learning event can be divided into six distinctive stages, each with its own different focus. The six stages are:

Stage 1: Pre-lesson. Introduction of Learning Event and the expected deliverables. Group formation. Structures are put into place.

Stage 2: Research. Evaluation of websites and the identification of link concepts.

Stage 3: Publish the content to the wiki and evaluate feedback from peers and facilitator.

Stage 4: Develop a research methodology, rubric, and interview strategy for an excursion to the theme park.

Stage 5: Go mobile. Choose a ride, research, observe, experiment, experience, record and interview.

Stage 6: Showtime. Write a scientific report and present the findings in a PowerPoint presentation.

Table 1-1: A planning matrix for this study

Stages	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6

	Pre-lesson	Research	Publish	Develop	Go Mobile	Showtime
	Observation; SMS logs; reflective reports; field notes	Observation; SMS logs; reflective reports; field notes	Observation; SMS logs; reflective reports; field notes	Observation; SMS logs; reflective reports; field notes	Observation; SMS logs; reflective reports; field notes	Observation; SMS logs; reflective reports; field notes; focus group interviews; questionnaire

(Adapted from Cohen, Manion *et al.*, 2000)

The six distinct stages of the lesson are aligned to indicate the data collection methods that were used in this study.

8. Limitations of the study

This study explores and documents how mobile phones may be used to enrich and enhance a learning event. It was undertaken under the auspices of a MobilED initiative that aims to contribute to the local (South African) knowledge base about mobile learning. The following limitations are identified:
The research was limited to a specific secondary school in South Africa.
The sample consisted of 54 learners.

These limitations suggest that findings of the study need to be viewed in the context in which it took place. Because of this, the study is not generalizable and practitioners will have to judge the applicability of the findings and recommendations to their own particular circumstances. The implications pertain both to the design of mobile learning events and to instructional strategies used by instructional designers.

9. Ethical considerations

The researcher followed the ethical guidelines recommended by the University of Pretoria for researchers operating under the authority of the university. These are designed to protect the rights of the participants and to ensure that research is conducted in a fair and equitable manner. Throughout this study I kept the interests and the welfare of the participants constantly in mind by adhering to the following principles:

Voluntary participation. This means that participants can withdraw from any given research project at any time without any adverse consequences to themselves and in spite having given their prior consent to participate.

Informed consent. This means that research participants must at all times be fully informed about the research process and purposes. It also means that the researcher must obtain the prior consent of each participant in the research.

Safety in participation. This means that the respondents who have consented to participate in the research should never be placed at risk or in any kind of position in which they may be harmed. Because of their vulnerability, this provision is especially important for research that involves children and adolescents.

Privacy. This means that the *confidentiality* of all participants should be honoured, and that their *anonymity* should be at all times be protected.

Trust. This means that a researcher will never in any way deceive or betray a respondent during the course of the research or in any of its subsequent published outcomes.

10. Ensuring trustworthiness

The design experiment made use of a wide variety of approaches in order to maximise objectivity, validity and the potential application of research (Edelson, 2002; Wang & Hannafin, 2005).

The researcher used the following strategies to increase the trustworthiness of this study:

Credibility. The researcher undertook a prolonged engagement in the research setting. This increased the possibility that the researcher's interpretations are more likely to be correct. The credibility of findings were further enhanced by the triangulation of data collected by other means. Relevant documents and transcripts of interviews have been included in the appendices to this study.

Transferability. "Instructional technologists engaged in development research are above all reflective and humble, cognizant that their designs and conclusions are tentative in even the best of situations" (Reeves, 2000). The conclusions of this research are not exactly transferable to other situations and conditions although the researcher's methodology and the aims of the study may indeed be used in other educational contexts.

Dependability. The researcher increased the likelihood of dependability of the study by collecting data in different ways and at different stages during the study. This was done to compensate for possible inadequacies in individual data collection methods. The researcher also asked her colleagues to perform peer reviews that included scrutiny of the research plan and the methods of implementation. Such activities constitute an accepted way of improving the likelihood of dependability in research**.**

Conformability. The data trail for collected data has been included in this text as appendices.

11. Significance of the study

The researcher has used the study to suggest that an individual user of mobile technology develops a personal relationship with that technology, and that this relationship draws the individual user into a complex reflexive web of relationships with other users, and that these facts have important implications for the design, significance and use of mobile phones as a form of mobile technology in secondary schools and in the private and social lives of secondary school learners. As a pilot study, the research also aims to make a contribution to a local knowledge base that will facilitate the development of prototypes of applications that would best suited to developing countries in general and to South Africa in particular.

12. Organisation of the mini-dissertation

The outlines below describe the content and purpose of the remaining chapters of this study.

Chapter 2 contains a review of relevant literature on mobile learning. It offers a selection of international and local case studies that have used various mobile technologies to describe, identify and expound on elements in enhanced learning environments. This chapter discusses the two emphases that dominate research and implementation in the mobile learning field. This leads on to the development of a conceptual framework.

Chapter 3 offers a description of the project and the research methodology used in this study. The project is described and discussed under the following headings:

- Initial limiting factors in the design
- Context

- Initial preparation and set-up
- MobilED platform
- Support offered to learners

The researcher outlines the research methodology used in the study and justifies the use of the design experiment.

In chapter 4 the researcher presents the research results and discusses the data and outcomes.

In chapter 5 the researcher draws conclusions from the results of the study and makes recommendations for future mobile learning enriched environments that are practically equivalent to those encountered in the study and that are maintained and serviced by similar constraints and technologies.

Chapter 2

Literature Review

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1. Introduction

In this chapter the researcher presents what the literature says about definitions of "mobile learning" and about concepts of the dual nature of mobile learning **(section 2).** The application of mobile learning by means of various mobile devices in countries abroad **(section 3.1)** and in South Africa in particular **(section 3.2)**, are also considered.
The following section describes activity theory **(section 4.1).** Case studies are then analysed in order to elucidate the identifying characteristics of each of the following terms or phrases:

- Tool: mobile technology as a tool **(section 4.2)**
- Rules: protocols, rules and norms; the social practices and unwritten understandings that structure the use of mobile phones **(section 4.3)**
- Division of labour: the functions that are used in the technology-task interface **(section 4.4)**
- Community: the environment in which the activity takes place **(section 4.5)**

Finally, a conceptual framework is presented in **section 5.**

2. Mobile learning

Advances in technology during the past decade have created a worldwide boom in the sale of the kind of technology that permits private individuals to enjoy mobile wireless connectivity (Y. S. Chen *et al.*, 2003a; D. Corlett *et al.*, 2004). The widespread ownership of mobile technology in the form of mobile phones even among young people has created opportunities for educators to develop new educational models that extend mobile connectivity into a variety of educational settings (Chang *et al.*, 2003; Johnson & Maltz, 1996). The essential feature of mobile technology that is relevant to education is that it removes the limitations of time, space and connectivity that characterise the conventional classroom and other forms of teaching and learning. Because it offers the user the capacity to connect to remote information and other resources, a form of technology such as the mobile phone enriches a learning environment. It therefore expands the range of possible connections that a learner might make to remote databases that are normally inaccessible to access. By doing this it eliminates some of the obstacles to learning encountered within the classroom setting and other places in which teaching and learning take place. Mobile Learning may thus be considered to be an "extreme form of flexible learning" (Seppala, 2003).

A review of current literature confirms that writers tend to define mobile learning in terms of their particular research perspective. Technology-driven research tends to define mobile learning in terms of learning by means of mobile devices (Houser *et al.*, 2002; Quinn, 2000; Trifonova & Ronchetti, 2004; Yu-Liang Ting, 2005). This emphasis on technology in this kind of research even influences the definition of learners. Learners are referred to as "m-learners" when they use mobile devices to "acquire and learn through a wireless transmission tool anytime and anywhere" (Y.S. Chen *et al.*, 2003b) .

Research driven by pedagogical concerns defines mobile learning in terms of the extent to which it enriches a particular learning environment (Rochelle, 2003; Rushby, 2006; Young & Vetere, 2005). An editorial in the British Journal of Educational Technology states the case for optimising environmental conditions for learning and for loosening the constraints imposed by physical location (Farooq *et al.*, 2002; Grohmann *et al.*, 2005; Rushby, 2006).

This dual nature of mobile learning creates confusion in some circles as to the applications and focus of research taking place in the mobile learning environment. The different

definitions of mobile learning lead to the assumption that there seems to be some disagreement in the current literature about what mobile learning actually is.(Grohmann et al., 2005)

Grohmann, Hofer and Martin (2005) identify the origin of the disagreement as the duality of research focussing on the one hand, on the changed and enhanced learning environment, and, on the other hand, the development of the technical support for this environment. They ask the question:

> whether a combination of technology-enhanced learning and mobile technology would make sense at all. (p4)

A dual relationship, however, is acknowledged by many researchers and draw on the computer science, information systems, educational research and the emerging field of human-computer interface. (Gerhard Schwabe & Goth, 2005; Sharples *et al.*, 2005; G Zurita & Nussbaum, 2006) These researchers and authors approach mobile learning in an integrated way in contrast to some research that suggests a marginalisation of the technological identity of mobile learning, calling for:

> academic evaluation and solid theoretical framework for the implementation of mobile learning from the view of cognitive science, instead of technological evolution.(Yu-Liang Ting, 2005)

The negating of the importance of the pedagogical implications for a mobile learning environment has proven disastrous and resulted in “the almost zero adoption of technology”(Er & Kay, 2005)

From the literature of reported mobile learning interventions the rationale for the dual identity of research in mobile learning is very apparent. It leads to the conclusions that the pedagogical underpinning and the technology that assist it are interdependent. Focussing on only one of the natures inevitably creates discord as a pedagogically sound mobile intervention cannot take place without acknowledging the technology to support it. In the same way a brilliant technological tool unsupported by sound pedagogic is educationally useless.

A challenge in the field of mobile teaching and learning is currently to accord equal weight and attention to the needs of pedagogy and the requirements of technology. Contributors in both these fields of endeavour need to be acknowledged and encouraged because both are

essential to the future development of sound mobile learning. When defining mobile learning one needs to give equal respect, consideration and recognition to the contribution of technology and to the kind of pedagogical underpinning that makes mobile learning the feasible and sustainable educational activity rather than a passing educational fad or fashion. Human activity supported by sound pedagogy provides a framework and context within which the technological interface can promote and facilitate the kind of social interactions that are characteristic of mobile learning.

3. Application of mobile learning

Table 2-1 comprises an assemblage of international case studies from various conferences and journals. These are tabulated below prior to a discussion about their significance and importance.

International case studies

Table 2.1 provides a summary of the international case studies that I assembled prior to analysing, identifying and documenting the elements of a mobile learning environment.

Table 2-1: International case studies in mobile learning.

Initiative	Institution	Year	
Palm Educators Evaluation Report	SRI International	Sept 2002	Reports on the Palm Initiative (Systematic research into the use of hand-held computation devices in schools). PDA (Vahey *et al.*, 2002).
Scaffolding for practical bird watching	National Chung Chen University, National Dong Hwa University, and the National University of Taiwan	2002	Outdoor learning activity that uses PDA and Wi-Fi network. Learning by means of scaffolding. Wireless ad hoc networking environment. Learners PDA and educator laptop (Y.S. Chen *et al.*, 2003b)
Uniwap I & II	University of Helsinki	2002	WAP-based project environment with a shared database and infrared access. Teaching can be discussed by means of SMSs and digital pictures (Seppala & Alamaki, 2003).
Ad hoc and mobile classrooms. Zoo visit	Tamkang University and National Central University, Taiwan	2003	PDA. Constructed outdoors. Educator and fifth grade class. 10 groups of 3 students each all use eSchoolbags system. Creates classrooms near animals and shares information about these animals. Wireless platform mobile

Initiative	Institution	Year	
			classroom (Chang *et al.,* 2003)
Constructivist mobile learning environment supported by a wireless handheld network	University of Chile	2003	Grade 1 reading. Using syllables. Users may reach consensus before submitting answers. PDA (G. Zurita & Nussbaum, 2004a)
Firefly Watching System	Aletheia University; National Chung Cheng University; Tamkang University	2003	Short-range wireless learning environment. Content-based image retrieval system provides learners with information that enables identification. Firefly database is used in this initiative. PDA also used. (Gwo-Jong *et al.*, 2004)
Mobile Collaborative Concept Mapping	University of Joensuu	2003	Mobile Phones used. SMS-based mobile learning. Communication with structured SMSs. Provides a mobile learning environment that enables collaborative knowledge building. MoCoCoMa – Tool for mobile collaborative concept mapping (Silander *et al.*, 2004).
Wireless Technology-Enhanced Classroom	National Central University, Taiwan	2003	WiTEC supported activities. PDA used. An electronic whiteboard helps to create an interactive classroom. Focuses on project-based learning (Liu *et al.*, 2003).
Constructivist m-Learning scenario	Computer Technology Institute and Hellenic Open University, Greece	2004	Tablet PC. Constructs a multimedia presentation of an archaeology site. Pupils in library can collaborate with pupils onsite (Hadzilacos & Tryfona, 2005).
Enhancement of Student Support, Inclusion and Retention	University of Wolverhampton, United Kingdom	2004	Bulk SMS. Personalised, timely non-spam SMSs to support students. Push technology (Riordan & Traxler, 2005).
Learning on the Move	Kinjo Gakuin University, Japan	2004	Mobile phones used. Short, daily messages to students provide spaced practice of English vocabulary. Few problems (Thornton & Houser, 2005).
LifeBlog	University of Melbourne	2004	Mobile phones. Uses Nokia Life Blog to record formal and informal learning and living. Able to capture and manipulate photo record. Reflective. Used in e-portfolios (Young & Vetere, 2005).
MILO: Mobile Interactive Learning Objects	Graz Medical University, University of Applied Sciences, School of Information Management	2004	Mobile phones. Creates mobile learning platform.Model for application (Holzinger *et al.*, 2005).
m-Learning	University of	2004	Aimed at development of products and

Initiative	Institution	Year	
	Birmingham EU 5th Framework Project Mobilearn		services to engage young adults not enrolled in formal education sector. The initiative is intended to promote literacy and mathematical skills (O'Malley *et al.*, 2003).
Mobile Learning Organiser	University of Birmingham EU 5th Framework Project Mobilearn	2004	Mobile learning organiser gives access to course notes, timetable and communication (SMS & email). Mind mapping tools (Dan Corlett *et al.*, 2005).
Mobilearn Project: Mobile learning with a mobile game	University of Zurich, EU 5th Framework Project Mobilearn	2004	Embedded learning in a natural environment for new students who need to become acquainted with one another and the university. Uses game scenario and PDA and WLAN for positioning (Gerhard Schwabe & Goth, 2005; G. Schwabe *et al.*, 2005).
Speech-enabled Mobile Learning Application	University of Massachusetts	2004	Develops speech-enabled discussion forum that works with PDA and smart phones. Converts messages to text for storage on data base, and text to voice for sending (Motiwalla, 2005).
m-Taiwan	Taiwan Government	2005	Creating a wireless network so that anyone in Taiwan can access the Internet through wireless LAN or mobile phones. Promotes the competition capability of the Taiwan service industry. Enriches the lives of the Taiwanese citizens (Herman, 2006).

The table presents a list of referenced international case studies undertaken between 2002 to 2005 and published in peer reviewed journals or presented at international conferences. In each case, the study, the institution sponsoring the study, the year of the study, and a short description of what the initiative achieved, have been listed. While the list of case studies presented here is by no means comprehensive, it does suggest the nature of the pilot projects and initiatives that have mushroomed in the past few years. Each case study has makes its own unique contribution and emphasises yet another facet of mobile learning.

3.2 South African case studies

Table 2-2 presents the only documented case studies of mobile learning projects in South Africa. These were located after an exhaustive search of data bases and conference proceedings at the time of this study.

Table 2-2: South African case studies in mobile learning

Initiative	Institution	Year	
Ecotourism	Tshwane University of Technology	2005	Uses PDA as alternative to conventional paper-based workbooks (De Crom & De Jages, 2005).
Supporting Distance Learning	University of Pretoria	2005	Transmits administrative SMSs to students. Presents a model for implementation of m-learning in Africa.
SMS Communication	UNISA Institute of Continuing Education; Commonwealth of Learning.	2004	UNISA uses SMSs in this programme to notify students of administrative changes and deadlines (Nonyongo *et al.*, 2005).
DEEP Project (Digital Education Enhancement Project)	Centre for Research and Development in Teacher Education. Open University, UK	2003	PDA. Used by teachers in the rural Eastern Cape. Creates teaching resources, mark lists and other administrative functions. Used as teaching resource. Provides access to email and the Internet (Leach *et al.*, 2005). Is

The table above shows that a very limited amount of research has been undertaken in the field of mobile learning in South Africa. The only research carried out in a school context was the DEEP Project under the auspices of the Open University. Several papers on mobile learning have, however, been presented by South African researchers at conferences.

4. Review of case studies

This study uses activity theory to identify those elements in case studies that warrant consideration before mobile learning projects are planned and implemented. The activity theory as a framework is expounded on and the case studies are analysed under the headings

- Mobile technology as tool
- Tool rules
- Division of tool labour
- Tool community

4.1 Activity theory as a framework

The roots of the activity theory may be located in the 18th century German philosophy of Kant and Hegel. Their work emphasises both the historical development and the active role of human beings in constructing ideas (Jonassen & Rohrer-Murphy, 1999). Activity theory has evolved through three generations of research, two of which are relevant to this review.

The first generation was predicated on the earlier work of L.S. Vygotsky and focuses on the idea of mediation.

> This idea was crystallized in Vygotsky's famous triangular model in which the conditioned direct connection between stimulus (S) and response (R) was transcended by a "complex" mediated act (X) (Engeström, 2001).

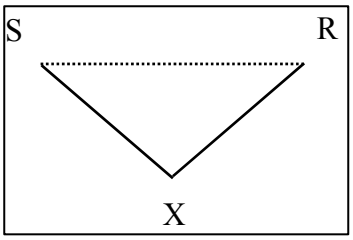

Figure 2-1: Vygotsky's triangular model

The second generation of activity theory, developed by Soviet psychologist, A.N. Leoniev, was based in the earlier work of Vygotsky. Vygotsky developed his theory in reaction to the doctrine that knowledge derives from experience, a tradition that conceptualises human beings as both passive and reactive (Kozulin, 1986).

The activity theory is not a comprehensive metaphysical-ontological theory in the ordinary sense of the word, but rather a set of "basic principles which constitute a general conceptual system which can be used as a foundation for more specific theories" (Bannon, 1985). The basic principles of the theory include the hierarchical structure of activity, object-orientedness, internalisation/externalisation, tool mediation, and the notion of development (Kaptelinin & Nardi, 1997).
In terms of this theory, human activity is attributed to the specific needs that human beings have to accomplish objectives. The activity then is mediated by one or more "tools" and is reflected through people's actions as they interact with their environment.

> An activity is undertaken by a human agent (subject) who is motivated toward the solution of a problem or purpose (object), and mediated by tools (artefacts) in collaboration with others (community). The structure of the activity is constrained by cultural factors including conventions (rules) and social strata (division of labour) within the context (Ryder, 1998).

This distinction between activity, action and operation is the basis of the three-level model of activity described by Leoniev who never undertook to expand to describe or his theory in detail. It was Engeström who extended Vygotshy's original conceptualisation to include the ideas of Leoniev.

This expanded third development of action theory incorporated the idea of *community*. This resulted in two new kinds of relationship: the relationship of community-subject and the relationship of community-object. According to Engeström, the community-subject relationship is mediated by *rules* and the community-object relationship is mediated by a *the division of labour* (Engeström, 1987; Nardi, 1996; Ryder, 1998).

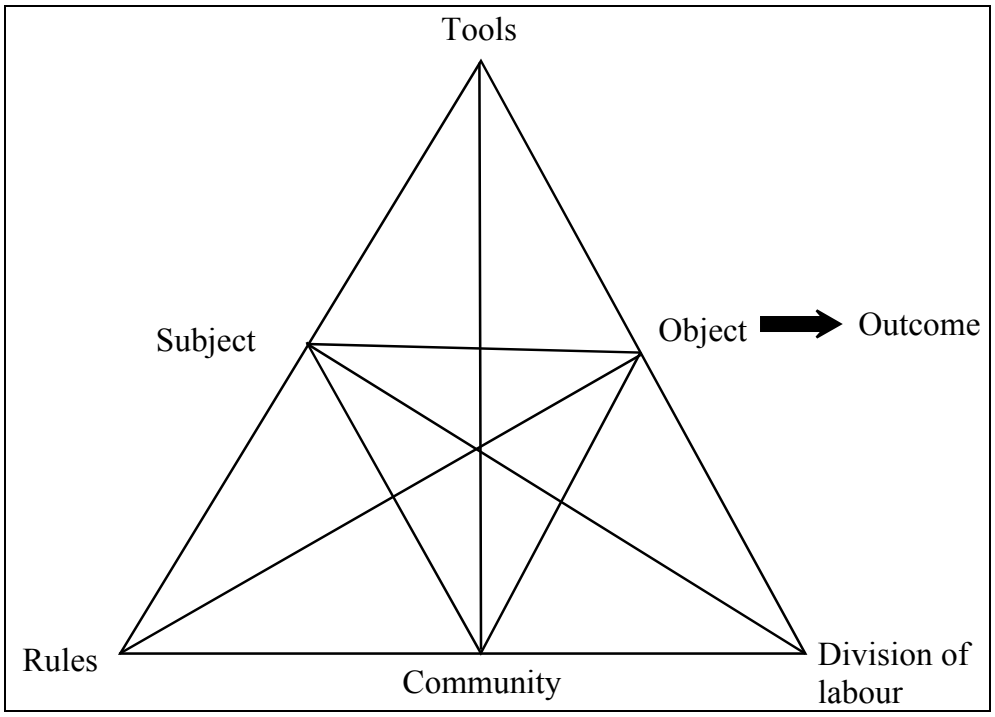

Figure 2-2: Expanded triangle of an activity system

The extended mediated relationship between the subject and the object offers a general model for human activity that reflects the collaborative nature of human actions. The "nodes" taken from Engelström's (1987) model depicted in Figure 2-2, are:

- Subject: This refers to an individual or group.
- Object: This refers to that towards which the activity is directed.
- Tool/s: These may be either external or internal mediating instruments.
- Rules and regulations: These are explicit and implicit regulations, norms or conventions that constrain actions and interactions within an activity.

- Division of labour: This refers to the division of tasks between members as well as to a division of power and status.
- Community: This refers to multiple individuals or subgroups that share the same general object (Engeström, 2000)

Activity theory as a descriptive tool is geared towards practice. For the purposes of this study, the activities in which people engage constitute a functional framework for the analysis of a learning event that is mediated by mobile technology as tool.
Although activity theory states that artefacts are created and transformed and carry with them a particular history of development (Er & Kay, 2005), it fails to address interactions with the tool and the relationships between individuals and the technology within a mediated activity. This limitation persuaded the researcher to adapt activity theory so that it reflects the relationship of the learner to the technology tool.
The case studies are accordingly understood from the point of view of the mobile technology as an integral and active part of the activity.

4.2 Review of case studies

4.2.1 Mobile technology as tool

In activity theory, the analysis of tools includes the actual use to which tools are put as well as the setting in which this process occurs. "For the tool reveals itself to us fully only in use" (Bannon, 1985). Activity theory interprets a tool as an artefact that people use to perform activities. By extension tools may also be understood in terms of the *use* to which they are put. When one examines mobile technology from the point of view of activity theory, one needs to consider the mediating usefulness to which this technology is applied when it is used.

> Furthermore the artefacts have no meaning in isolation; they are given meaning only through their incorporation into social praxis. It is not until they have been incorporated in the praxis that they can be the basis for thought and reflection (Ilyenkov, quoted by Bannon, 1985).

Bannon continues to say that a tool works well if it allows the subject to focus on the object without the subject itself becoming the focus of attention (Bannon, 1985). This approach describes how technology appears to its user *in use* (Nardi, 1996). In the context of education,

a tool only truly becomes a tool when it extends the learning environment beyond the limits and confines of the classroom and class time.
In contrast to the activity theory view of a tool, Marshall McLuhan (quoted by (Robert, 2001) asserts that "the medium is the message". With this famous dictum, he confirmed the indisputable link between the medium used and the user who uses the medium. The idea that the technology influences the way in which learners learn is raised several times by Marc Prensky:

> It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors (Prensky, 2001).

This sentiment is repeated in *Educating the Net Generation* (Oblinger & Oblinger, 2005): "The technologies available as a generation matures influence their behaviours, attitudes, and expectations" (p. 6.2).

This interaction between user and technology can sometimes be so intense that it can even affect the health of users after prolonged or excess of interaction.

> Experts have warned of the dangers of overuse of mobile phones and game consoles in children after a young girl developed repetitive strain injury.
> Isabelle Taylor, aged eight, from St Anne's, Lancashire, noticed pain in her fingers and wrists after sending up to 30 text messages a day ("Rsi danger from excessive texting", 2006).

Technology is not merely a means that allows an activity to take place; the technology contributes to the nature of the activity and ultimately determines the conditions in which the activity will take place. An activity can only manifests once an individual permits a relationship or into action to take place between the individual and the tool or technology. The case studies highlight the following characteristics of interactions between individuals and the technology that they use.

Mobile learning is personal and individual.

The mobile technology integrates into the users' life and becomes a personal extension: "Handhelds … have a sense of belonging since it is of a personal use during the activity" (G Zurita & Nussbaum, 2004b).

There are two ways in which institutions can implement mobile learning. They can either supply learners with mobile devices, or ask learners to use their own mobile devices. When institutions supply mobile devices and fail to acknowledge the importance of the personal relationship between owners and their mobile devices, the mobile devices never become fully integrated into an individual's life and so important dimensions of the learning experience are lost or compromised. The significance of this personal relationship may be deduced from an observation made by Sharples and Corlett. They reported that users who were given a PDA to use for the duration of a year as part of a pilot programme "adapted them to their needs and settled into a personal pattern of use". Significantly, however, "because the devices had to be returned within the year, participants were reluctant to invest much of their own money or time in personalization". They therefore concluded that "ownership is clearly important" (D. Corlett et al., 2004).

In collaborative learning it has been found that learners use such devices to collaborate with others learners, and that this does not detract from the learning event: "Both personal and group learning are most effectively supported when each student has access to a device. The ownership of the devices is thus a key consideration" (Naismith *et al.*, 2004).

Mobile learning is ubiquitous

Mobile learning can take place wherever a person with a mobile device can receive an uninterrupted signal from a wireless network that functions as a conduit to transmit the database and the support structures that scaffold the learning in question. Mobile learning might thus, for example, extend formal education into a forest (Silander et al., 2004) where it could support learners as they experience and study some aspect of nature (Y. S. Chen *et al.*, 2003a; Gwo-Jong *et al.*, 2004; Yuen-Yan *et al.*, 2003; Yuh-Shyan *et al.*, 2004; Yuh-Shyan *et al.*, 2002). Mobile learning can take place wherever mobile connectivity is available.

Not only does mobile learning extend the physical limitations of a classroom; it also transcends conventional barriers of time.

> The wireless connections make them available anytime and anywhere. … Students could easily access and download the entire course content anytime anywhere on their mobile device (Trifonova & Ronchetti, 2004).

Because mobile learning takes place in real time, it is always current and up-to-date.

"Mobile learning operates in real time" (Chi-Hong & Yuen-Yan, 2003). The exchange of information takes place instantly and feedback, contributions and input may all be accessed instantaneously:

> [Mobile learning confers the] ability to annotate pages in real-time, based on comments from fellow students… [It also permits] each member [to] record and simultaneously share observations in real time (DiGiano *et al.*, 2002).

Mobile technology is able to deliver and support a learning need whenever and wherever it might arise. Because the content of mobile learning is delivered in real time, it is always current and up-to-date. "The power of mobile learning is its ability to immediately put form to thought" (Chi-Hong & Yuen-Yan, 2003).

Mobile learning supports collaborative learning

Collaborative learning is concerned with the kind of active collaboration between learners that enables them to share, compare, discuss and assess various aspects of a learning experience with other individuals or in groups. When collaborative learning is functioning in an optimal way, individual participants interact to achieve a common understanding of a concept, a discipline or an area of practice (Mikic & Anido, 2006).

Mobile technology can facilitate the kind of communication and sharing upon which collaborative learning depends because it "…provides this essential means of communication between learners, and between tutor and learners for support and collaborative purposes" (Yu-Liang Ting, 2005).

4.2.2 Tool rules

This refers to various explicit and implicit conventions, understandings, rules, norms and constraints that govern the interaction of individuals and sub-groups who use mobile technology for learning.

The case studies reveal very little about any standard procedures or conditions that govern the behaviour of users using mobile technology -- perhaps because the conventions, understandings and protocols that govern exchanges are informal, unwritten and customary, and probably vary from place to place and from one group of users to another. What these unwritten customs and conventions are, may constitute a fruitful topic for research. One may speculate that the main criterion for effective messaging is "usability". This comments on the ease of use but does not reflect the nuances of use. Roschelle observes what he calls the lack of consideration for social practices at the human computer interface. He surmises from reference to practices between individuals, that by failing to acknowledge social practices, one may presume that they "remain largely unchanged as the technology moves from large 'desktop' interfaces to small handheld ones" (Roschelle, 2003).

This is just as true for the interaction between the individual and the technology. In instances where new technology has been introduced, there are passing references to the training or orientation that learners need to undergo to familiarize themselves with the technology (D. Corlett et al., 2004; Leach et al., 2005). Where there seem to be an acknowledgement of the dual nature of mobile learning, the actual meeting point at which individual interact with the technology, is vastly under-documented.

4.2.3 Division of tool labour

Learners use a great variety of mobile devices to complete assignments, and there are number of different functions, procedures and modes of display on these devices. The documentation about these differences is meagre. Since most pilots deliberately create the same conditions for all users by providing or sanctioning the same kind of technology for each user, there are few variables reported in this regard.

4.2.4 Tool community

The "tool community" refers to the virtual as well as the physical environment that contextualises the activity. From a technological point of view, there are very few detailed descriptions of the various platforms and their proposed uses or their final shortcomings and deficiencies. Most of the case studies are predicated on a structured virtual environment. Where games are utilised as part of the instructional methodology, the virtual and physical environments merge (Gerhard Schwabe & Goth, 2005; G. Schwabe et al., 2005).

5. Conceptual framework

While activity theory defines mobile technology as a mediating tool, it fails to address the particularities in the interactions between the learner and the technology. This form of interaction is dependent upon the kind of technology that supports the learning event and the specific technology that is used in the learning event itself.

The interaction of a learner and the technology is subject to various protocols, rules and norms. It is especially true in the case of mobile technology this because the mobile device becomes an intimate part of the learner's world and because the virtual environment and the real world frequently overlap (Gerhard Schwabe & Goth, 2005; G. Schwabe et al., 2005).

The variables that arise from the interaction between technological tools and other elements in the environment are innumerable because each combination of platform, mobile technology and other technological mediating agents changes the way in which the activity at hand is approached and executed. Although the platform remained constant in this research, each learner used his or her own mobile phone. The mediation of any common activity would thus obviously introduce variables in each new transaction.

Activity theory does not make adequate provision for the interaction of a subject with the mediating technological tool as part of object-related activity. I therefore propose an alternative that incorporates the technological tool as a component in the activity theory.

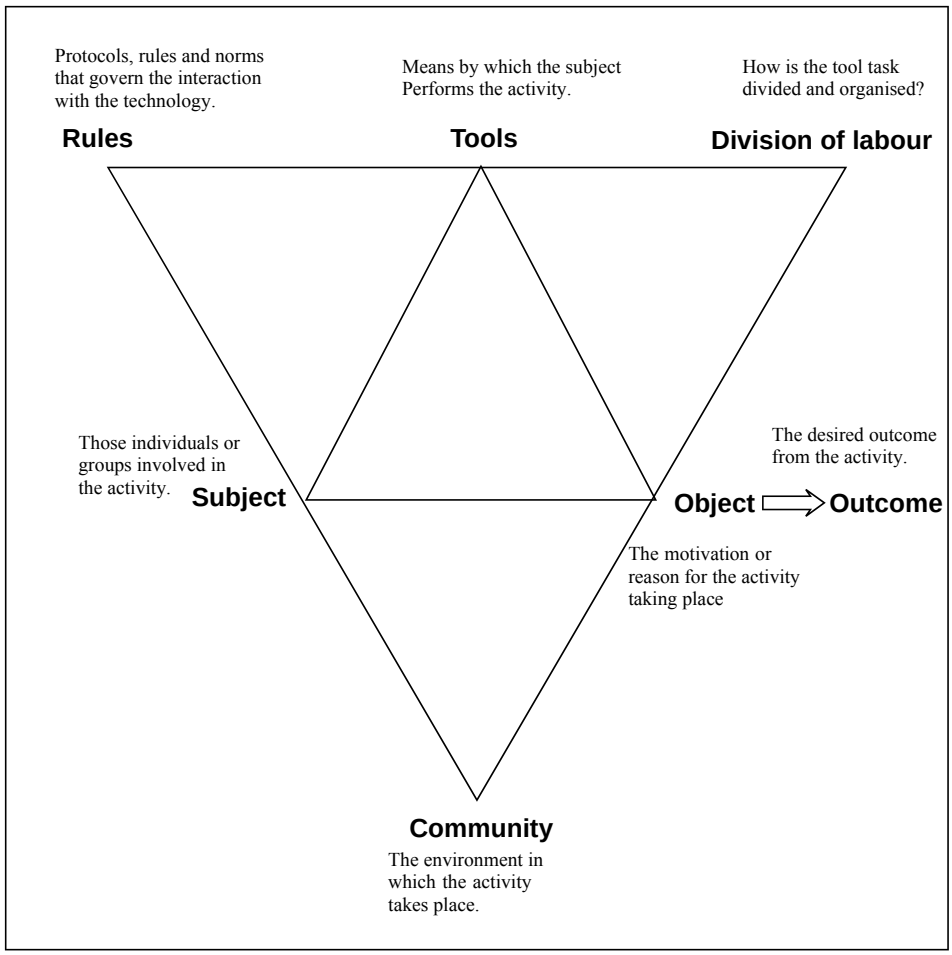

Figure 2-3: The technological tool component with possible new relationships

The figure above contains a representation of this incorporation that focuses on the technology-driven perspective in mobile learning. But this is only one part of the dual nature of mobile learning and should not be considered in isolation.

The **community component** forms part of this framework because mobile technology is not restricted to a specific location or time. The community incorporates the physical or virtual environment in which the activity takes place.

The **technology tool as a component** comprises a single mobile technology or multiple technologies that support the same general object. The new relations that flow from this are:

a subject-tool relationship

an object-tool relationship

These relationships are depicted in figure 2-3.

Subject-tool relationship

The relationship between the subject and the tool is characterised by specific norms, rules and protocols that regulate the user's interaction with the technology tool. These "tool rules" mediate the subject's interaction with the technology. Examples of such rules that govern the use of mobile phones as tools are predictive text for sending SMSs, the typical SMS slang that teenagers and other frequent users employ, and the variants in navigation found in the interfaces of different models of phone. Holzinger states:

> The phenomenal growth in mobile computing, whereby a parallel growth of user sophistication has failed to take place, will increase the need for future research in fully adaptive and sensitive interfaces, aware of the requirements and proficiency of users (Holzinger *et al.*, 2005).

Reflection on this relationship offers the researcher opportunities to incorporate not only the usability of the technology but also the nuances in usage occasioned by each variant form of the technology. This would enable an understanding that acknowledges the user's possible ignorance of an interface or a technology.

Object-tool relationship

The relationship between the tools and the object is characterised by the specific abilities of the technology to achieve its objectives. These "tool labour divisions" enable the navigation of a specific task and mediates the tool's interaction with the object. An example of such mediation would be the use of a video to record an event in cases where another pupil might have had to use a voice recording because their phone does not support a video function. This relationship can thus be interpreted as the specific functions of the tool that can be accessed to reach a specific outcome.

This relationship offers researchers opportunities to reflect on the functions that are available and their adequacy in relation to the object. It would also direct the formation of groups in situations where there are limited resources and a pooling of resources are needed. This would be an important consideration in disadvantaged communities where insufficient funds are available for the financing of educational initiatives.

Expanded activity theory model

As I noted earlier, mobile learning can be divided into two main areas of concern (its "dual nature"), and the technological perspective needs to be complemented by a pedagogical perspective. As such the model expands to the one illustrated below.

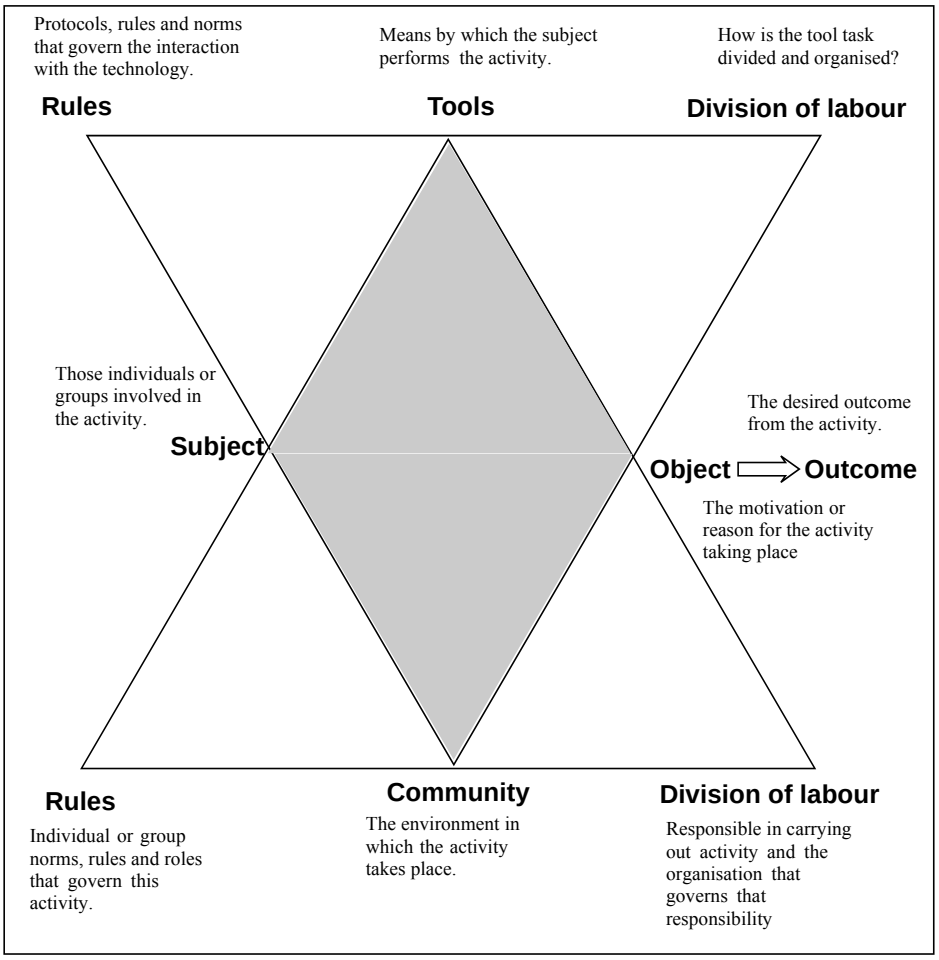

Figure 2-4: Activity theory model expanded to reflect the dual nature of Mobile learning

Figure 2.4 represents the dual perspectives of mobile learning. These two perspectives are considered to complementary to each other in a mobile learning environment. This model indicates that there are five main components that need to be considered when one is evaluating or implementing a mobile learning event.

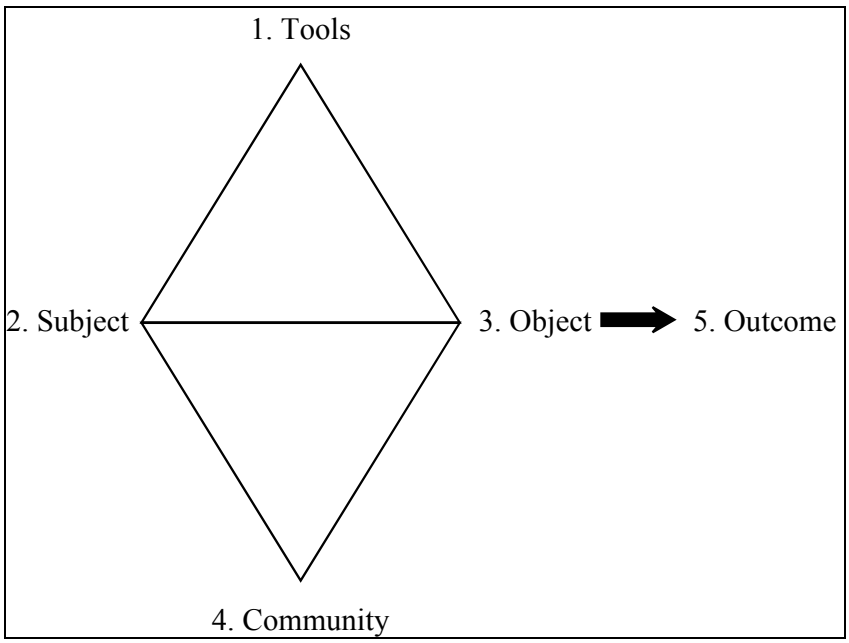

Figure 2-5. Components of conceptual model

The five main components derived from the expanded model are:

1. The tool/s: Tool/s or technology that are used to mediate the activity.
   1.1. Tool rules: Protocols and rules that govern the interaction with the tool.
   1.2. Tool division of labour: the functions of the tool utilised to achieve the outcome.
2. The subject: Groups or individuals involved in the activity.
3. The object: The motivation for the activity to take place.
4. The community: The physical and/or virtual environment/s in which the activity is taking place.
   4.1. Rules: Protocols, norms and rules that govern the community.
   4.2. Division of labour: Who it is that assumes responsibility for what happens in the activity and how participants are organised.
5. The outcome: The desired product of the activity.

The expanded activity theory model of the mobile learning environment forms the conceptual framework for the reflective analysis of the design experiment.

6. Summary

A review of the literature indicates that mobile technology enriched learning environments have the potential to transcend the physical and temporal limitations of conventional classrooms and class schedules. Mobile technology provides a unprecedented means for maintaining personal connectedness to educational information and resources.

The potential of mobile technology to enhanced enrich and extend learning environments is well documented in international case studies and initiatives. As with other educational methodologies, the central focus should be on the pedagogical underpinnings ─ chief among which is an educationally sound instructional design. An added dimension in mobile learning is the dependence or reliance on the technology that facilitates and supports this environment. The technology that supports a mobile learning event and the pedagogic considerations that support it come together to produce a successful learning event. While both reflect a perspective, neither reveals it in isolation. By acknowledging the indispensable relationship between mobile learning and its incorporation into one event, we are able to arrive at an understanding of the ensuing relationships between the individual, the community, the desired outcome and the mediating tool. These relationships are dynamic and change as technology improves and new tools are introduced into mobile learning events.

The factors identified in the literature study were taken into account in the planning and implementation of the mobile learning event that is subsequently outlined in chapter 3.

Chapter 3

Research Design and Methodology

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1. Introduction

Section 2 offers a description of the mobile learning event **(section 2.1)**, the initial limiting factors **(section 2.2)** and the context in which the project took place **(section 2.3).** The structures that were put in place in preparation for the learning event are then discussed **(section 2.4),** the MobilED wiki is explained **(section 2.5**), and the support that was offered to the learners is described **(section 2.6)**.

The research methodology used in this study is outlined **(section 3**), the use of a design experiment is expounded **(section 3.1**), the role of the researcher is clarified (**section 3.2**), and the data collection instruments used in this study are enumerated **(section 3.3)**.

2. Description of the mobile learning event

The researcher in her role as facilitator designed this learning event as a design experiment in mobile learning. A lesson based on Physical Science content was presented to grade 10 students in a secondary school in Pretoria.

2.1 Lesson Overview

Main phases:

Six main phases are distinguishable in the lesson. Table 3-2 below presents a brief description of each phase. The role that the facilitator and technology play in each phase are defined, and the kind of technology used in each phase is described.

Table 3-1. GoMobile learning event

Phase	Learner	Facilitator	Technology
Research	**The learners:** ─ work in groups of two ─ access the Internet and review websites related to the theme ─ collect information about the theme in their groups ─ draw knowledge maps to illustrate the patterns and relationships of the content ─ complete a worksheet for formative assessment ─ record all the events on cell phones for their e-portfolio	**The facilitator:** ─ presents the lesson ─ hands out the notes and worksheet ─ explains the expected event flow ─ describes opportunities for the construction of individual knowledge ─ supported learners with SMSs	**PC with Internet connection** functions as: ─ a tutor ─ a tool **Cell phone:** ─ accesses information from audio wiki ─ records research ─ receives support ─ enables communication with both peers and the facilitator
Publish	Learners publish their contribution to the collective knowledge on the wiki. This helps to	**The facilitator:** ─ identifies misconceptions and provides feedback	**PC with Internet connection** uses wiki as a cooperative learning tool. **Mobile phone:**

Phase	Learner	Facilitator	Technology
	identify misconceptions, and enables an evaluation of individual learner contributions.	─ encourages learners by means of SMSs and wiki	─ records the process ─ receives support ─ enables communication with peers and the facilitator
Develop	**Learners:** ─ plan how they will research an amusement park ride ─ develop a rubric for assessing the "Thrill Factor" of their chosen ride ─ plan an interview ─ devise plan to "go mobile"	**The facilitator:** ─ identifies misconceptions and provides feedback ─ encourages learners by means of SMSs and wiki	**PC with Internet connection** functions as a research tool that investigates: ─ possible rides ─ factors that influence the "Thrill Factor" of a possible ride
Go mobile	**Learners:** ─ choose a ride at the amusement park ─ identify the underlying scientific factors ─ observe physical laws in action ─ experience the effects of the physical laws ─ record observations ─ interview peers to obtain other perspectives ─ log readings	The facilitator acts as a guide.	**Mobile phone:** ─ photographs the ride ─ record interviews ─ accesses information from the audio wiki (the wiki that the learners constructed is also available) ─ enables communication with peers and with the facilitator
Showtime	**Learners:** ─ write a scientific report about the ride's thrill factor and energy	Give guidance, Interact with misconceptions and support learning.	**PC with Internet connection enables:** ─ the typing of a scientific report

Phase	Learner	Facilitator	Technology
	conversions – access information from the cell phones – present their findings with the assistance of a PowerPoint presentation		– the accessing of information from the cell phones – the videoing of interviews – photographs – creates the PowerPoint presentation **Mobile phone:** – accesses information
Reflect	**Learners:** – construct an e-portfolio – reflect on their research and knowledge construction		**PC with Internet connection enables**: – the construction of an e-portfolio **Mobile phone:** – permits access to information that assists reflection

The main phases of the lesson are linked to the implications for the learner, the facilitator and the supporting technology respectively in the table above. Table 3-2 below lays out the planned timeframe of the design experiment.

Table 3-2. GoMobile learning event planned timeframe

Phase	Research	Publish	Develop	Go mobile	Showtime	Reflect
Time-frame	2 single periods of 45 mins each	2 single periods of 45 mins each	2 single periods of 45 mins each	3 hour outing to Gold Reef City	2 single periods of 45 mins each	Double period of 90 mins. (2 x 45 mins = 90 mins)

The timeframe for the lesson is defined for each phase of the lesson. The research consumes ten periods of class time and an excursion to Gold Reef City as indicated in the table above.

2.2. Initial limiting factors

The MobilED Initiative mobile phones were sponsored by an international mobile phone manufacturer who supplied eight smart and eight more phones without smart phone capabilities. It was noticed in the first pilot that the sharing of a single mobile phone in groups of five students engendered specific problems. What happened was that only one student interacted with the phone because of obvious physical limitations. One student therefore dominated the interaction. Because the groups consisted of both boys and girls, the girls tended to disengage from the interaction when this happened. While the use of eight smart phones would have enabled the study to incorporate more functions, it would have meant that the students would not have been able to interact with the technology on a one-to-one basis and that interaction would have necessarily been limited to class time. The trade-off that took place was between functions and access.

While the Meraka Institute was in the process of negotiating funding for the study, there was a need to limit the costs of the learning event. The cost of the bussing the students to the theme park was covered by the school as part of their academic expenditure.

2.2 Context

The context in which the learning event took place is documented under the following headings:

- School
- Curriculum
- Target population
- Mobile phones of students

2.2.1 School

The learning event took place in a secondary private school in Pretoria in South Africa. The school is situated in an affluent area and may be described as privileged. The schooling offered is divided into following phases: the Preschool (Grade 000 to Grade 0), the Junior Preparatory School (Grade 1 to Grade 3), the Senior Preparatory School (Grade 4 to Grade 6), the Middle School (Grade 7 to Grade 9), and the College (Grade 10 to Grade 12). The enrolment in the school stood at about 1600 at the time of research. Of this number, approximately 400 were in the College. Out of a teaching staff of 100, 62 taught in the College.

The Senior Science department consisted of seven members of staff. The science class in which the lessons took place was supplied with five computers (all of which were connected to the Internet), a data projector and a SMART board.

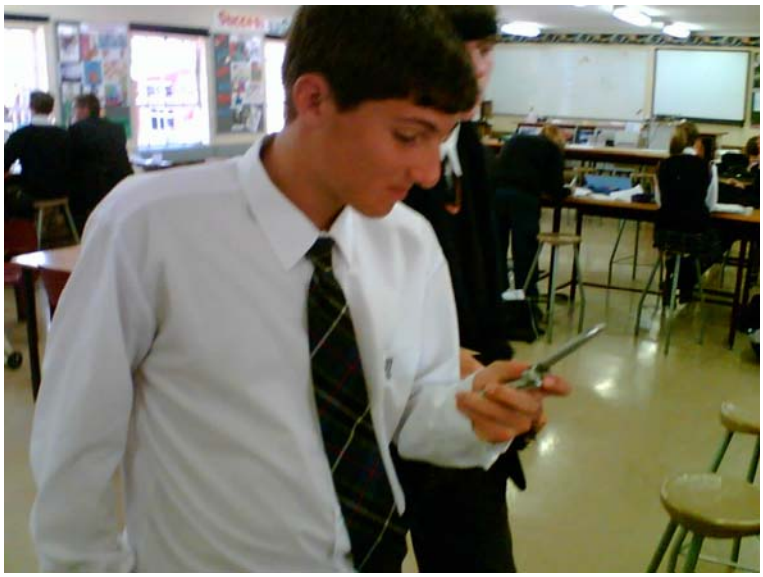

Image 3-1: Student accessing information in the science class from the mobile phone

The College has embraced teaching with technology and may be described as progressive in its thinking. The management of the College encourages the integration of technology into teaching, and was very supportive when the researcher approached them with her plans for a mobile learning intervention.

2.2.2 Curriculum

The learning event was based on subject content from Physical Science, and the concepts explored during the course of the learning event were: energy, kinetic energy, potential energy, the conservation of mechanical energy, the influence of friction, and the force of gravity.

Because the intervention had been planned to take place over a period of two weeks, it was imperative for the lesson outcomes to be aligned with the Learning Outcomes in the FET band for Physical Science. These Learning Outcomes and the Assessment Standards are listed in Table 3-3 below.

Table 3-3: Learning Outcomes and Assessment Standards for Physical Science(Grade 10, FET band)

Learning Outcome 1.	**Scientific enquiry and problem solving**
Assessment Standard 1:	Conducting an investigation
Assessment Standard 2:	Interpreting data to draw conclusions
Assessment Standard 3:	Solving problems
Assessment Standard 4:	Communicating and presenting information and scientific arguments
Learning Outcome 2.	**Construct and apply scientific knowledge**
Gravity and mechanical energy: • weight – force exerted by the earth on an object; (definition, difference between mass and weight, calculation of weight) • acceleration due to gravity – acceleration resulting from the force exerted by the earth; (define gravitational acceleration (g), calculations involving gravitational acceleration) • gravitational potential energy; (simple calculations) • kinetic energy (simple calculations) • mechanical energy – (sum of gravitational potential energy and kinetic energy); (conservation, mechanical energy in a frictionless system, free fall, air resistance) • conservation of mechanical energy – in the absence of dissipative forces (simple calculations)	
Learning Outcome 3.	**Nature of science, society, technology and the environment**.
Assessment Standard 1:	Evaluating knowledge claims
Assessment Standard 2:	Evaluating the impact of science on human development
Assessment Standard 3:	Evaluating the impact of science on the environment and sustainability.

The applicability of the learning outcomes and assessment standards of the FET (Further Education and Training) band for Physical Science, Grade 10, to the content of the learning event are summarised in the table above.

2.2.3 Target population

The target population consisted of 54 Grade 10 students between 15 and 17 years who all took Physical Science as a subject. They were of mixed gender and came from various racial (ethnic) backgrounds.

2.2.4 Mobile phones of students

A survey of the students revealed that they all possessed mobile phones that varied considerably in capacity, capabilities and features. Because a common platform was neither realisable nor feasible, the focus was shifted to common capabilities. While all the phones could both send and receive SMSs, all but two of the phones possessed camera capabilities. The camera imaging capabilities implied that the phones could be connected to a desktop computer by means of Bluetooth, infrared or cable. The two students whose phones did not have this functionality were given sponsored phones to use for the duration of the lessons. These two students asserted their temporary ownership of the phones by inserting their SIM cards into the phones, personalising them with their preferred ring tones, and entering their own contact lists into memory. We thus worked with a varied platform but with common capabilities.

2.3 Initial preparation and set-up

Before the lessons were introduced to the students, the following tasks were performed:

- The students were asked to divide into groups of two students each. This was in accordance with the suggestion by Schwabe *et al.* (2005)
- A random assignment was given to ensure that all the students were capable of interacting with a PC via their mobile phones. This was done because one of the underlying assumptions of the research is that each mobile phone extends the range of a PC by means of remote access capability.
- A bundle of 1200 SMSs was purchased from a local service provider.
- The students phone numbers were loaded onto the researcher's mobile phone and grouped. A text message was sent via the short message service to ensure that the correct numbers had been loaded and that everyone was connected.

Exhibit 3-1 is the transcription of the text message sent to gauge the facilitator's access to the students.

Exhibit 3-1: Text message sent

SMS Sent:
14:00 4 May 2006
< Hi, well I hope you are all on and getting this. 4 2morrow remember R80 and

indemnity form. Website review 4 Monday. Flashdisk 4 e portfolio program. :-) >

The text message was sent on the 4 May at 14:00 served to inform each student that he or she was listed on the facilitator's phone.

2.4 MobilED Platform

MobilED Platform Documentation Version 1.0

The following condensed description of the MobilED Platform was retrieved from the MobilED wiki online at http://fle3.uiah.fi/mediawiki/index.php/Main_Page.
MobilED Platform Documentation Version 1.0.

> The MobilEd platform employs three main technology platforms to achieve its goal: SMS communication interface/gateway, such as Kannel (http://www.kannel.org) or Alamin (http://www.alamin.org/) to send and receive SMS's, the Asterisk Open Source PBX (http://www.asterisk.org/) for audio telephony communications, and a MediaWiki (http://www.mediawiki.org/) server with suitable content, such as en.wikipedia.org" (Aucamp, 2006b).

A typical high-level case of this kind of use of the system is illustrated in Figure 3-1 below.

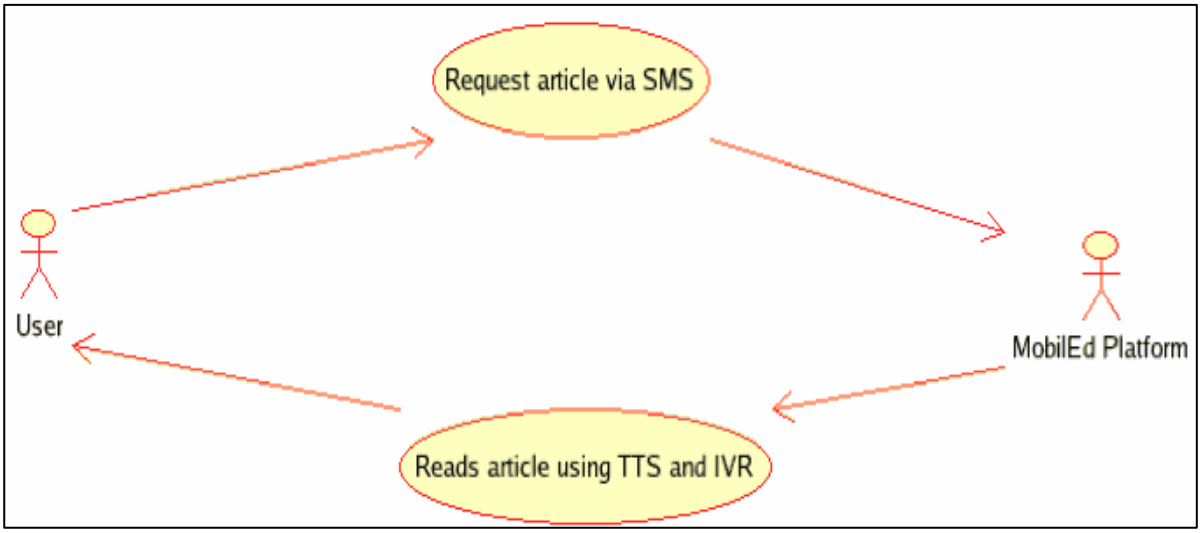

Figure 3-1. Simple high-level usage scenario (from a user's perspective)(Aucamp, 2006)

The user of the system uses the standard text messaging capability of his or her mobile phone (an SMS) to request an article from the MobilED platform by entering the title of the requested article and sending the message to the phone number assigned to the MobilED platform implementation (the phone number is installation-specific).

> The MobilED platform responds by calling the user and delivering the requested article via an audio telephone call. This is accomplished with a platform for interactive voice response applications and human language technology components such as a text-to-speech engine. It reads the article to the user by using a computer-generated voice in combination with pre-recorded voice prompts, and accepts input from the user via DTMF/Touchtone key presses. The user is also allowed to contribute to the information source (local MediaWiki server) by recording his or her voice over the telephone (Aucamp, 2006b).

The Physical Science students in the sample had been working on a collaborative wiki since the beginning of their Grade 10 year. They populated a “Wikispaces” wiki that served as a textbook, a location for revision notes, and for general class communication. They were required to populate a section on the topic of energy (as a Physical Science concept), and this would then be attached to the MobilED platform. They were asked to reduce information to 160 characters where possible, and to make headings descriptive and unique. Because of time constraints, the Technical Practitioners at the Meraka Institute were not able to write code that

would enable the platform to read the Wikispaces wiki. This problem was circumvented by saving the whole content of that section as a text document.

The students had the option of receiving information either in voice mode or in SMS text format. If they wanted, for example, information about "energy", they could text and send < *energy* > to the MobilED platform. They would then receive a call back with text or a synthesised voice that supplied the information. If they wanted the information as a text message they would text and send < *SMS energy* > to the MobilED platform and receive the information via text. If the information consisted of more than 160 characters, they would receive two or more text messages from the MobilED platform.

2.5 Support offered to learners

The text messages sent via the short message server was logged with a program that runs on a smart phone and that can synchronise with a PC desktop. The interactions with the learners are categorised under the following headings and sub-headings:

- Administrative
- Nano-learning
- Helpline
    - General administration
    - Academic
    - Technical
- Chat

2.5.1 Administrative

The text messages that were classified as "administrative" were mostly initiated by the facilitator and driven by prearranged deadlines. Exhibit 3-2 shows an example of a general administrative announcement that was sent to all the students' mobile phones.

Exhibit 3-2: Administrative text message

SMS Sent:
19:48 9 May 2006
< U will NOT be able to use your phones as I cannot control the SMS. You have to have your

rubric PRINTED, 2x web reviews and the research plan 2 use in test .>

The message above is an example of a general administrative message send by the researcher before a test on 9 May.

2.5.2 Nano-learning

Nano-learning describes the maximum 160 character curriculum content that was sent to students to reinforce their recall of facts and to guide them in their own research and meaning attribution.

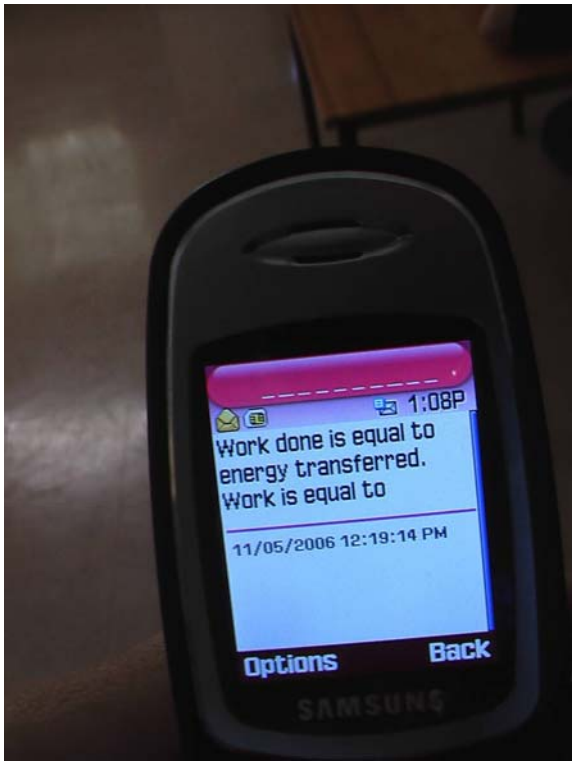

Image 3-2: Nano-learning on a student's phone

Table 3-4 below shows the schedule that was planned for sending nano-learning information to the students.

Table 3-4: Nano-learning content and timeline

Phase	Research	Publish	Develop	Go mobile	Showtime	Reflect

Phase	Research	Publish	Develop	Go mobile	Showtime	Reflect
Time-frame does not include weekends	**Day 1 - 3**	**Day 4**	**Day 5 - 6**	**Day 7**	**Day 8 - 9**	**Day 10 - 11**
Nano-learning content	**Day 1** We consider the energy of an object as its capacity to do work and the doing work as the process of transferring energy from one object to another. 147 characters **Day 1** To do work one must move the object by applying a force with at least a component in the direction of motion. W = F x s F = Force W = Work s = distance 148 characters **Day 2** For work to be done there must	**Day 4** When positive work is done on an object, the system doing the work loses energy. The energy lost by a system is exactly equal to the work done by the system. 157 characters	**Day 5** Law of Conservation of Energy: Energy is never created nor destroyed, but merely transformed from one form to another. 116 characters **Day 6** IN THE ABSENCE OF FRICTION : Work Done = Energy Transferred **IN THE PRESENCE OF FRICTION:** Total Work Done = Useful Work Done + Work Done Against Friction 151 characters	**Day 7** Kinetic energy: Energy of an object due to its motion. The faster an object is moving the greater its kinetic energy. 116 characters **Day 7** Potential energy: energy an object has due to its position or state. As an object falls, its *potential energy* is released & transformed into kinetic energy. 156 characters	**Day 8** **Kinetic energy and potential energy together = mechanical energy**. The total mechanical energy (U) of an object is the sum of its kinetic and potential energies 159 characters **Day 9** ***AT SCHOOL WE WORK WITHOUT FRICTION !!*** How can you minimize friction near you? 76 characters	**Day 10** Reflect: To give evidence of the characteristics or qualities of someone or something. To think seriously. To express carefully considered thoughts 138 characters **Day 11** **Conservation of Mechanical Energy:** In the absence of friction, the total mechanical energy of an object is conserved. 117 characters

Phase	Research	Publish	Develop	Go mobile	Showtime	Reflect
	be a component of the applied force in the direction of motion. Forces perpendicular to the direction do no work. Cn u c a x-mpl? 160 characters. **Day 3** Definition: 1 joule is the work done when an objct is moved 1m inder the application of 1N in the direction of motion. 118 characters					

The table above depicts the nano-learning content that was planned for each of the six distinct main phases of the learning event. The nano-learning messages are reproduced above exactly as they were sent, and the number of characters used in each SMS is indicated.

2.5.3 Helpline

The helpline function was organised to answer students queries about:

- general administration
- academic-related questions
- technical issues that arose outside the boundaries of the physical classroom

When a student phoned with the query, the call was directed to the facilitator. Exhibit is an example of a student-initiated interaction using the helpline function.

Exhibit 3-3: Student initiated helpline interaction

SMS Received:
13:50 9 May 2006
<What should a rubric include >
SMS Sent:
13:50 9 May 2006
<Google rubric and thrill factor>

A student texts an academic query requesting help with a concept to the facilitator. The facilitator responds with a clue that should lead the student to find the requested information.

2.5.4 Chat

The exchange of text messages other than for academic, technical or administrative requests for assistance were classified as "chat". The text messages directed from the facilitator to individual students were intended to motivate and encourage them. The text messages also served to keep the lines of communication between facilitator and students open and to monitor individuals at risk

3. Research methodology

I implemented a variety of methods in order to answer the research questions adequately. I also used triangulation to increase the reliability of the study. The study was therefore designed so that each question would be answered in a number of different ways.

This study uses a design experiment as its primary research strategy. The section defines *design experiment* and explains the researcher's motivation for using the design experiment for this research. This section also clarifies the role of the researcher and documents the data collection and analysis.

3.1 Design experiment

In the section I explain what a design experiment is and why its applicability to this study is justifiable.

3.1.1 Concept

A "design experiment" (Brown, 1992; Collins *et al.*, 2004) may also be called "applied research" (Reeves, 2000), "development research" (Reeves et al., 2005; van den Akker, 1999) or "design-based research" (Wang & Hannafin, 2005). In this research the term "design experiment" first proposed by Reeves (2005) will be used to refer to this kind of research ─ although the terms "design research" and "design experiment" may sometimes be used interchangeably (Collins *et al.*, 2004).

Design experiments describes research that places educational experiments in real-world settings so as to find out what works in practice in such real-world conditions. The feedback from the research then guides the design process. After each iteration of the research process, modifications suggested by the feedback may be undertaken (Collins *et al.*, 2004). Hannifin and Wang define design-based research (design experiment) as:

> a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories (Wang & Hannafin, 2005).

Design experiments support the view that "learning, cognition, knowing, and context are irreducibly co-constituted and cannot be treated as isolated entities or processes" (Barab & Squire, 2004).

3.1.2 Design experiment for this study

This study is grounded in real-world situations in which the participants interact socially with one another and within design settings rather than in artificially constructed laboratory settings (Cohen *et al.*, 2000; Wang & Hannafin, 2005). This design experiment is predicated on collaboration between the participants (the students), the facilitator (the researcher), and other stakeholders (Meraka Institute of the CSIR) throughout the process (Cohen *et al.*, 2000; Edelson, 2002; Wang & Hannafin, 2005). The iterative nature of the research is based on the

assumption that outcomes from earlier design experiments will provide frameworks for new designs and design experiments. The research results are a product of both the design process and the setting in which the research was conducted. Because of this, the findings or results of the research may take many forms.

3.2. The role of the researchers in this study

As a "reflective practitioner" (Reeves *et al.*, 2005) the researcher is also the facilitator and instructional designer. Because this research takes the form of a design experiment, the researcher needs to take responsibility for various roles. One of these is to manage the research processes in collaboration with various other participants.

> The researcher will design and implement interventions systematically to refine and improve initial designs and will ultimately seek to advance both pragmatic and theoretical aims affecting practices…. Researchers assume the functions of both designer and researcher… (Wang & Hannafin, 2005).

At no stage during the research process was the researcher detached. On the contrary, she used the interventions that she needed to make as opportunities (Barab & Squire, 2004). While it may be argued that such interventions taint the research context, Kelly (2000) notes that: "Researcher bias is inevitable" (Kelly, 2004).

Barab and Squire (2004), however, state that rather than "seeming as though the independence of the researcher is not operative in design based research, the systematic experimentation is what makes design experiments a useful methodological approach for learning sciences".

It is therefore the responsibility of the researcher to draw on methodological practices that are consistent with other qualitative methods to convince others of the "trustworthiness and credibility of claims advanced" (Barab & Squire, 2004).

3.3 Data collection and analysis

The study will make use of the collection of both qualitative and quantitative data and other analytical methods to gain understanding and insight and to improve the reliability of

conclusions by triangulating the results to each of the research questions. Table 3-5 below relates the research questions to data collection.

Table 3-5: Data collection methods used in this study

Research question	Observation	SMS logs	Reflective reports	Interviews	Field notes	Questionnaire
How can mobile phones be utilised in teaching and learning?	X	X	X	X	X	X
How useful was the MobilED wiki in facilitating information access?	X	X	X	X	X	X

This table shows that all of the five methods listed above were used to answer the two research questions. The research methods included observation, SMS logs, reflective reports, interviews, field notes and questionnaires. I shall now discuss each of these methods below.

3.3.1 Observation

The researcher observed interactions with the mobile phone by sight, by video and by means of photographs. By observing and analysing what the students said, the researcher was able to obtain useful information about the research phenomenon. The researcher's observations were at all times guided by the critical questions of the study. The researcher recorded her more significant observations and published them to the reflective reports. Such observations served to contextualise and triangulate conclusions.

3.3.2 SMS logs

Two SMS logs were recorded. One that was logged from the facilitator's phone recorded interactions between the students and the facilitator. One that was logged from the MobilED platform recorded interactions between students and the platform.

The communication between the facilitator and the students was logged under the following headings:

- SMS sent and received from facilitator's phone

- Time
- Date
- Initiator

As the quantification of the texting interactions only provides a narrow view of the nature of these interactions and how they are embedded in the learning environment, the researcher supplemented the qualitative analysis methods with additional insights into the social practices that is underlie them.

The content of the text messages will be coded by using Atlas.ti and analysed qualitatively. The quantification of both logs will be analysed using quantitative methods.
These logs are recorded in Appendix 1 and Appendix 2.

3.3.3 Reflective reports

Reflective reports were sent to the international MobilED mailing list and were saved. The reports were transcribed and coded with Atlas.ti and then analysed qualitatively.

3.3.4 Interviews

The goal of the interviews that the researcher undertook were exploratory and explanatory (Saunders *et al.*, 2000). The interviews were used to explore, explain and validate themes that emerged from the observations, from SMS logs and from documents. The interviews were videotaped and the themes were decided on in advance. The responses were transcribed and coded with Atlas.ti and then analysed qualitatively.

3.3.5 Field notes

Reflections on the lesson events, observations, themes and noted incidents were recorded as filed notes so that the data from other sources could be contextualized and verified. These notes served to contextualise and triangulate the conclusions.

3.3.6 Questionnaire

The questionnaire consists of eight questions, each of which contained subsections. Table 3-6 below describes the questions and the method of analysis.

Table 3-6: Questionnaire

Question	Information sought	Comment	Analysis method
1 - 2	Biographical information	To link other forms of the data collection to specific questionnaires	Quantitative analysis
3.1	Personal mobile phone		Quantitative analysis
3.2	Do students consider their mobile phones to be technology?	Students had to respond by saying either yes or no.	Quantitative analysis
3.3	What do the students understand by the concept *technology*?	This question was an open-ended question and the answers were transcribed and coded with Atlas.ti.	Qualitative analysis
4	Functions of personal mobile phone used and functions on mobile phones that are available.	Two columns were provided so that students could respond by ticking a relevant option. They were asked to indicate what functions their phone had and what functions they habitually used.	Quantitative analysis
5.1 – 5.5	Usefulness of facilitator and student initiated interactions	Students were asked to select one of the following options: Very useful; Useful; Useless.	Quantitative analysis
5.6 – 5.7	To gauge student reactions to receiving a text message on their mobile phones	This question was a open-ended question and the answers were transcribed and	Qualitative analysis

Question	Information sought	Comment	Analysis method
		coded with Atlas.ti.	
6.1	To gain an understanding of how the students used their mobile-phone to assign meaning to content	This question was a open-ended question and the answers were transcribed and coded with Atlas.ti.	Qualitative analysis
6.2	Indicating whether or not students preferred to use the predictive text input to the PC keyboard	Students were given two options and had to choose one.	Quantitative analysis
6.3 – 6.4	Determining patterns of information sharing among students	Students were given a number of options and had to indicate their personal response by making a tick.	Quantitative analysis
7.1 -7.9	Access and interacting with the MobilED platform in general and with the MobilED wiki used in this interaction in particular	Students were asked to choose one of the following three options: Very useful; Useful; Useless.	Quantitative analysis

The questions in the questionnaire were analysed qualitatively and quantitatively (depending on the nature of the question as characterised in the preceding table).

4. Summary

The mobile learning event described in this chapter focuses of the subject Physical Science within the FET band in a secondary school. Components of the lesson include:

- formal classroom interaction
- extended mobile technology-enriched interaction
- helpline for administrative, academic and technical queries
- 160 character nano-learning content sent via SMSs
- mobile wiki supported by the MobilED platform

- constructivist and collaborative assignment

These components were monitored, documented, evaluated and analysed by the methods and procedures described in this chapter in order to answer the research questions stated in chapter 1. The findings are documented in the next chapter (chapter 4).

Chapter 4

The Research Findings

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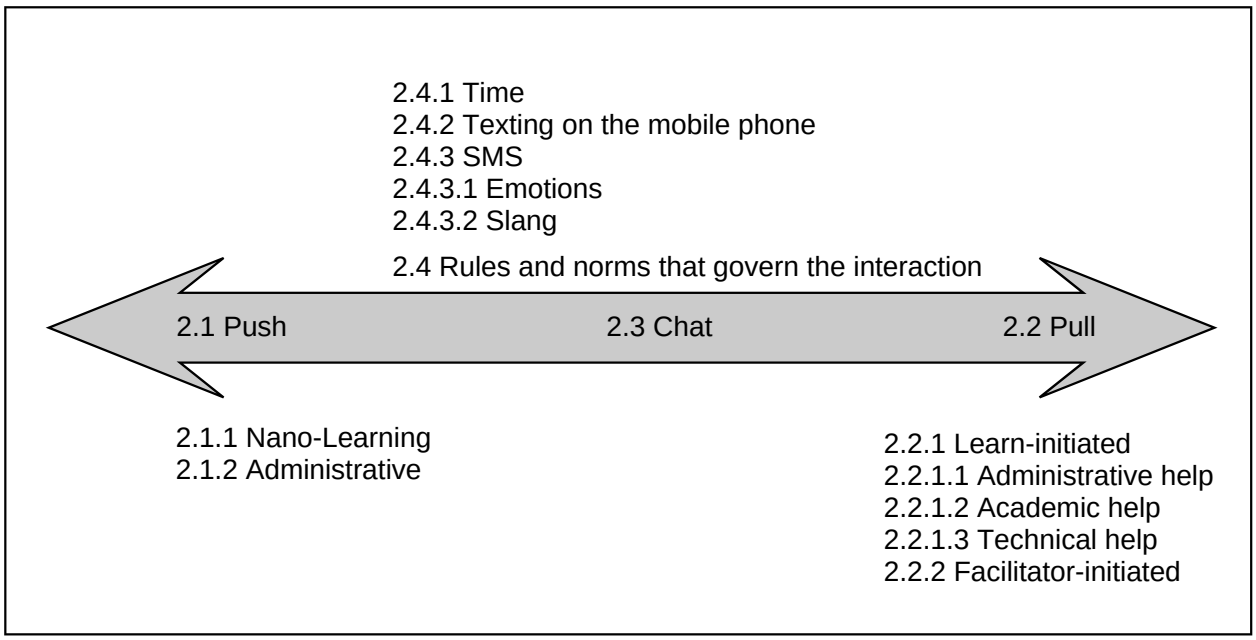
1. Introduction

This chapter documents the research findings of the mobile learning event. The first critical question was:

How can mobile phones be utilised in teaching and learning?

In order to answer this question **(section 2)**, the use of the mobile phones in the learning event was documented on a continuum representing a push feature on one extreme and a pull feature on the other extreme. This is illustrated in figure.1 below.

Figure 4-1: Pull and push continuum in the use of the mobile phone



The second critical question was:

How useful was the MobilED wiki in facilitating information access?

This was answered by documenting the student's experiences **(section 3.1)** and their recommendations for the improvement of the wiki **(section 3.2).**

Illustrative quotations in this chapter were taken verbatim from the SMS logs and the transcripts of the interviews.

2. How can mobile phones be utilised in teaching and learning?

Image 4-1: Students in the interview

The researcher monitored and documented the various components of the learning event as part of her exploration of the use of the mobile phone in teaching and learning. She made observations both inside and outside of formal classroom events, and photographed, videotaped and recorded these transactions wherever possible. She recorded both formal and informal interviews on video and then transcribed and coded them so as to link identified trends and tendencies.

Informal interviews were held wherever relevant incidences were observed. Other more formal interviews were held in the science class. The students who took part in the formal interviews were numbered so that their individual contributions could be identified whereas students taking part in the informal interviews were identified only by means of their initials so that their privacy might be protected.

Reflective reports were written and distributed to the international MobilED mailing list so that partners in other countries and localities could be kept abreast of day-to-day observations and findings. Field notes were collected and incidents were recorded to enhance

understanding and draw conclusions. The questionnaire which was designed to capture and record student insights and impressions, was handed to students as the learning event was drawing to its close.

Contextual data from the facilitator and MobilED SMS logs are quoted verbatim and explanations are added so that some record of the context of the insertion exists. Where relevant, a student's contributions are identified with his or her own initials. This is done to protect the student's privacy.

A vast amount of data was accumulated during the course of research. All the data was transcribed into electronic format. Atlas.ti was used to code contextual data and quantifiable data was analysed by means of Excel. Tendencies were identified, conclusions were verified from different data sources, and these were then documented in this chapter.
The uses of the mobile phones is discussed under the following headings:

- push
- pull
- chat
- rules and protocols that govern the interaction

2.1 Push

Push actions arose from the facilitator's directing impulses, information or actions being transmitted to students by means of their mobile phones. The two push factors that were identified are nano-learning and deadline-driven administration. The students identified the push action of the directed texting but experienced it as motivating (as indicated in exhibit 4-1 below).

Exhibit 4-1: Push action directed towards students

2	*:*	*We didn't think we would be able to do it*
Researcher	*:*	*Why was that, was it because of the terminology that was used?*
3	*:*	*Probably because it was new and totally different. But as we were pushed along, we realized that it wasn't that bad.*
Researcher	*:*	*Tell me about the pushing, who did the pushing?*
3	*:*	*Basically it was motivation and not pushing*

Researcher	*:*	*By who?*
3	*:*	*Ms B###*

Students indicated that they experienced the push action of the facilitator as a motivating force that initiated interactions.

The 160 character nano-learning content and the deadline-driven administrative reminders were not experienced as invasive by the students. They opened them, read them and saved them until the due date had passed (as may be seen from the following replies in the questionnaire to the question):

How did you decide to keep some messages and erase others?

"*When the information was not needed anymore, or it was old.*"

"*The ones I saved in my outbox and the others that are reminders that I've completed I erase them.*"

"*I erased the reminders about school work once I had handed in the work. The nano-learning snippets I still have.*"

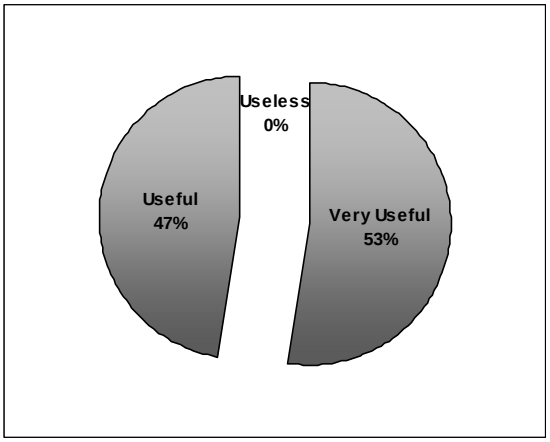
"*If they were only reminders and once that day had passed I would erase it. The information concerning the work I saved and kept.*"

"*Saved it and used it as a reminder as I had access to it easily. I found them very useful and easy to remember and understand.*"

2.1.1 Nano-learning

The students responded very favourably to the idea of nano-learning content being sent to their mobile phones by SMS. Figure 4-2 illustrates the responses they made when they were asked how useful they thought nano-learning was.

Figure 4-2: Usefulness of nano-learning



I made the following observations about the student's interactions with the nano-learning content:

- The students stated that they liked to receive the nano-learning content**.**

When they received text messages, they read them and then saved most of them. Although they claimed that they wouldn't have minded receiving more content in that way, they felt that the length made them just long enough to remember. Exhibit 4-2 shows that students stated that receiving the content in this way reinforced the work and made it easier for them to remember.

Exhibit 4-2: Students use of nano-learning

Researcher	*:*	*And the nano-learning? (Did you use the nano-learning)*
Girl-2	*:*	*Yes, especially for studying for tests on Saturday nights*
Researcher	*:*	*Did you save them or erase them?*
Girl-2	*:*	*We saved them in folders*

This extract corresponds confirms findings gathered from the questionnaire. The evidence above shows that students saved the nano-learning content to their mobile phones.

- Nano-learning content was reliable and trustworthy because of its origin.

The students did not check on the content or the correctness of the nano-learning because they saw that it came from a reliable source. They saw that it was a summary of work that they had done or to which they had contributed when populating the wiki (as illustrated in exhibit 4-3 below).

Exhibit 4-3: Reliability of nano-learning content

Researcher	*:*	*Tell me, do you use that stuff that they've sent you? The nano snippets, do you use them?*
4	*:*	*Yes, it summarizes everything rather than going through bunches of notes.*
3	*:*	*And making your own notes.*
Researcher	*:*	*Did you ever go and check what was said, what I sent you?*
4	*:*	*Not really, because we knew that stuff.*
3	*:*	*And we edited the wiki contributions.*
Researcher	*:*	*So the stuff that came from the wiki and the stuff that I sent you, that's what you kept eventually?*
1-4	*:*	*Yes*

Exhibit 4-4 below suggests that because students regarded content that originated from peers as coming from an unreliable source, they erased it.

Exhibit 4-4: Content from peers

Researcher	*:*	*Okay. If your friend sends you information, like eg. Remember kinetic energy, would you have kept that?*
1-4	*:*	*No*
Researcher	*:*	*Why not?*
1	*:*	*Because maybe they are wrong.*

Students indicated that because information they received from their peers was not "branded", they viewed it as unreliable.

- Students took the limitations of the storage capacity (physical memory capability) of their mobile phones into consideration when they saved content to their mobile phones for later retrieval.

Students cited the limitations of the storage capacity (physical memory capability) of their mobile phones as the main reason why they deleted the nano-learning content (exhibit 4-5).

Exhibit 4-5: Storage space on students mobile phones

Researcher	*:*	*How do you decide what do you save and what do you erase because your cell phone can only take so much?*
4	*:*	*You have space for your inbox – your daily messages and you then can save it in another folder. So, you make an assigned folder and then you can save the messages you want in there and then you still have space for other SMS'es*
Researcher	*:*	*So they are still on your cell phone?*
1-4	*:*	*Yes*
2	*:*	*But memory is not really a big problem*
2	*:*	*So they are still on there.*
4	*:*	*Well mine is not.*
Researcher	*:*	*Why did you erase them?*
2		*No, it's not like I erased them; it's just that my phone memory is big enough that I can keep everything.*

Students whose phones possessed a large memory capacity stored all the information they received and were thus less selective in erasing received text messages than students who had to weigh the importance of incoming content because of their limited storage capacity.

- Students did not experience nano-learning content as invasive.

Exhibit 4-6 shows that students did not perceive nano-learning content as invasive and did not therefore mind receiving the text messages.

Exhibit 4-6: Nano-learning texting was not invasive.

Researcher	*:*	*So even though we haven't spent that much time on it you understand it?*
4	*:*	*Yes, because it's very basic and we've done it for a while and the nano makes it easier to understand.*
Researcher	*:*	*You didn't resent the stuff (nano-learning) that was coming through?*
1-4	*:*	*No.*

All the students in this interview agreed that they did not mind receiving the text messages that contained the nano-learning content.

Image 4-2: Student using his mobile phone in class

2.1.2 Deadline-driven administration

Deadline-driven administration can be considered a push action because it is intended to spur students into activity. Administrative announcements of this kind originated from the facilitator and were sent by SMS to all the students.

Table 4-1 below gives examples of administrative messages of this kind.

Table 4-1: Examples of deadline-driven administrative text messages

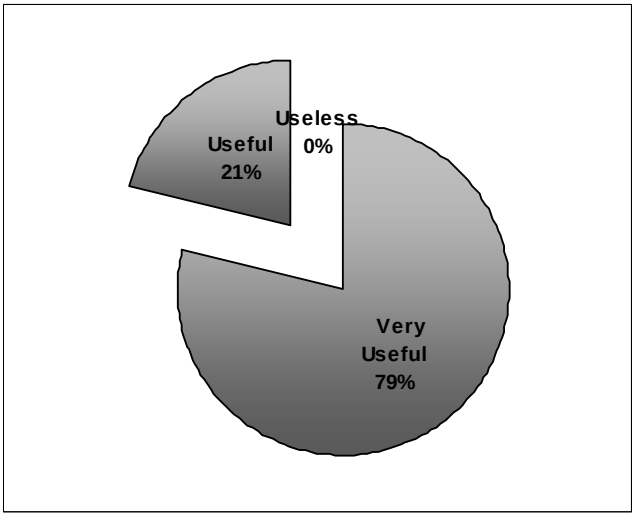
Content
< Hi, well I hope you are all on and getting this. 4 2morrow remember R80 and indemnity form. Website review 4 Monday. Flashdisk 4 e portfolio program :-) >
< To Do: Indemnity form & money. RESEARCH: Website reviews. PUBLISH Wiki DEVELOP: Rubric. Plan for your observation, interview. REMEMBER to log all your research! >
< U will NOT be able to use your phones as I cannot control the SMS. You have to have your rubric PRINTED, 2x web reviews and the research plan 2 use in test >
< Monday: PPT presentation, Report (typed! no handwritten reports) Research Indemnity

form, TEST 29th May >
< st 29 May: Basic concepts n wrk n NRG. Mechanical NRG Kinetic NRG n Potential NRG + simpl Calculations >
< We leave at 7am sharp. Remember money to buy snack >

These examples of deadline-driven administrative texting are all considered to be push actions. The examples above showed that they are concerned with realising predetermined gaols in a not-too-distant future. All the examples above are verbatim transcripts of what was actually sent to students.

Figure 4-3 below illustrates the perceived usefulness of the administrative function of the helpline from the point of view of the students.

Figure 4-3: The usefulness of deadline-driven administrative text messages



79% of the students experienced these reminders as *Very useful.* None of the students characterised these administrative reminders as *Useless*.

The students characterised their interactions with the administrative content in the following ways:

- Students experienced the administrative reminders as helpful.

Exhibit 4-7 illustrates student's responses to the administrative reminders.

Exhibit 4-7: Administrative reminders

Researcher	*:*	*And the reminders that I sent you?*
2	*:*	*Those are good*
Researcher	*:*	*Didn't you find that irritating?*
1-4	*:*	*No*
2	*:*	*I need reminders*
3	*:*	*"7 o'clock we leave for Gold Reef City" was helpful because I would have been late.*

These responses confirm that the students in this interview experienced the administrative reminders as helpful. None of them experienced the reminders as "irritating".

- The students referred back to these reminders.

Exhibit 4-8 contains two student responses that indicate how students used the administrative reminders.

Exhibit 4-8: Use of administrative reminders

"If they were only reminders and once that day had passes I would erase it. The information concerning the work I saved and kept."
"Saved it and used it as a reminder as I had access to it easily. I found them very useful and easy to remember and understand."

One may deduce from these responses that students did not erase the reminders until their relevance had passed. They stored them to their phones and referred to them when necessary until the deadline had passed. Some students saved the messages to their calendars and added reminders to their phones.

2.2 Pull

The pull factor mostly enabled learners with specific problems. They also conveyed generally relevant additional observations or explanatory comments in response to learners questions or situations. They also sometimes contained remarks or observations about current assignments. This section documents the pull function of the mobile phones under the following headings:

- Learner-initiated interactions:

This subheading deals with interactions that were initiated by students and responded to by the facilitator. These transactions were in the nature of one-on-one interactions between the facilitator and a specific student. There following three interactions are discussed:

- Administrative requests for assistance
- Academic requests for assistance
- Technical requests for assistance

- Facilitator-reactive interactions:

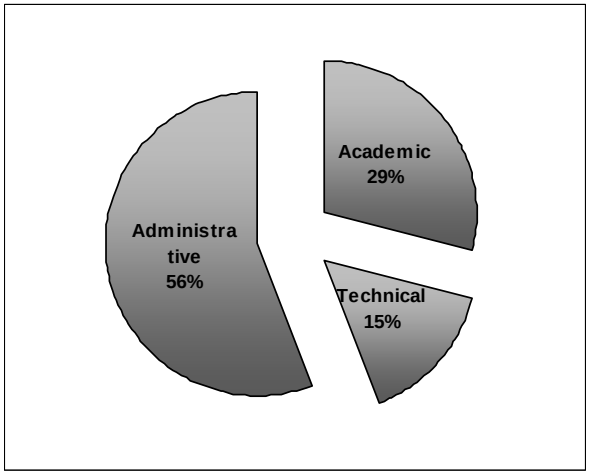
This subheading deals with the reactions of the facilitator to a number of student requests that contained a common theme.

2.2.1 Learner-initiated interaction: The Helpline

The "Helpline" was instituted so that the facilitator could answer the students' SMS queries about administrative, academic and technical matters arising outside the physical classroom.

The initiative for engagement in these cases originated with the students. Figure 4-4 shows the distribution of student-initiated interactions.

Figure 4-4: Learner-initiated interactions



Of the total number of student-initiated interactions not falling into the category of "chat", 56% concerned administrative issues, 15% concerned technical matters, and 29% were about academic matters. This is illustrated in figure 4-6 above.

The distribution of students perceived the usefulness of the functions of the helpline is illustrated below in figure 4-5.

Figure 4-5: Usefulness of the "Helpline"

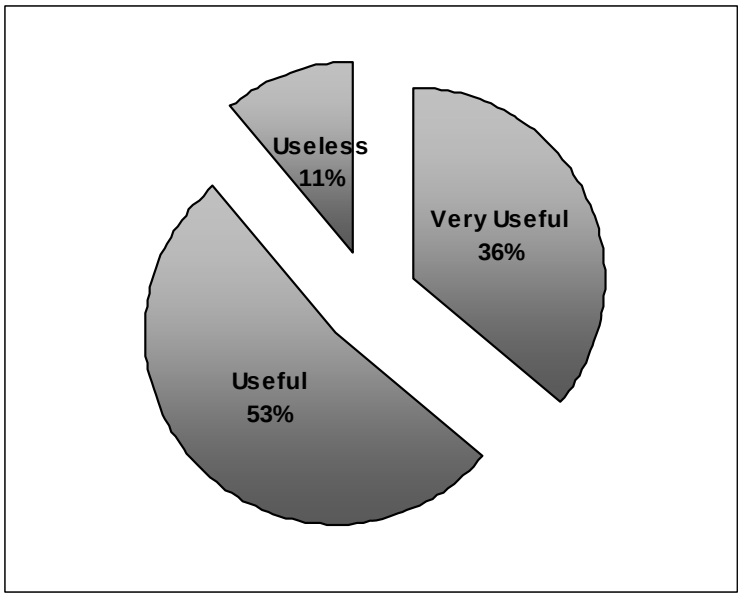


Figure 4-5 above shows that most of the students indicated that they found the ability to access help *Useful*. 11% of students found it *Useless*, 53% of students indicated it was *Useful*, and 36% indicated that they found it *Very useful*. This data is drawn from those students who had accessed the helpline at least once to ask for assistance in some form or another.

The use of the mobile phone makes mobile learning possible at any time and in whatever place students may happen to be. The help that students needed during the course of the study was therefore made available to them by the instrumentality of the cell phone without any limitations space and time. This kind of availability is borne out by the distribution of texting to and from the facilitator throughout the duration of the learning event. Figure 4-6 graphically illustrates the flow of text messages that took place during the learning event.

Figure 4-6: Distribution of text messages

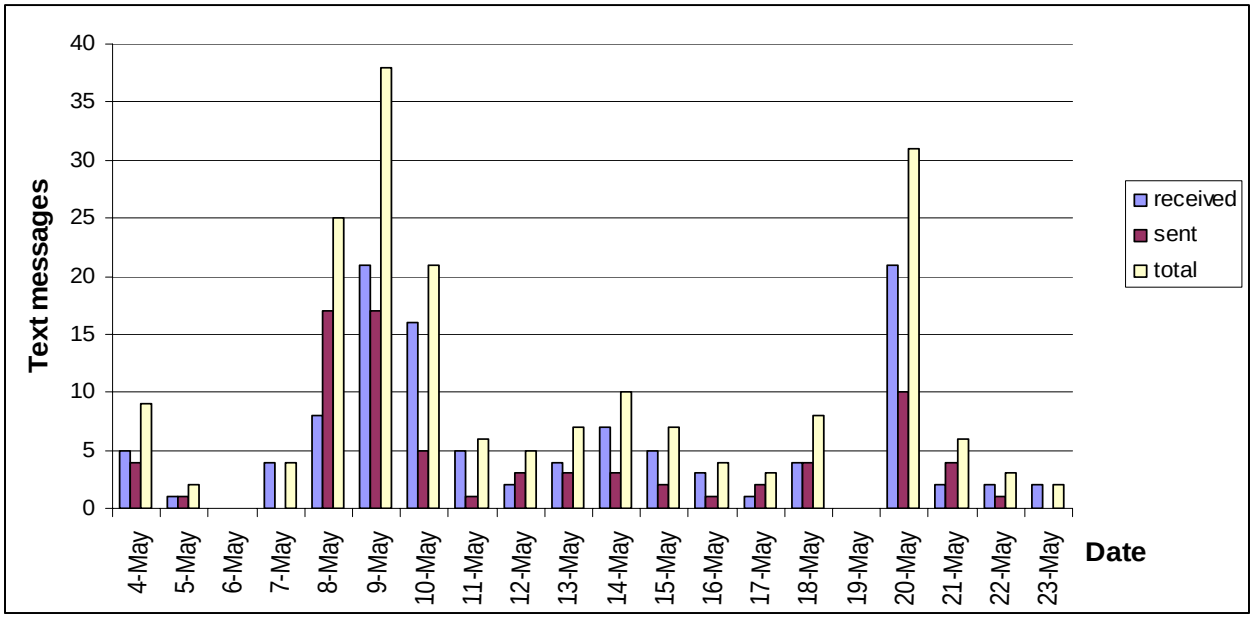


Figure 4-6 shows that a mobile learning environment can extend the kind of assistance normally available only in a physical classroom in ways that accommodate students' personal timeframes. The only two days on which no messages were sent were Saturday, 6 May, and Friday, 19 May.

The students indicated that they preferred not to receive text messages on Fridays because they usually went out on Fridays and it was considered very "uncool" to receive text messages from one's science teacher on such occasions.

> "Had a very interesting conversation with one of the students. Seems like a SMS after 4 pm on a Friday about school work is a BIG no no. They go out and when they sit around put their mobile phones on the table or visible. Getting a SMS from your science teacher scored a funk factor of -3" (Reflective Report Wednesday 10 May).

The greatest traffic in texting took place on Tuesday, 9 May. This coincides with the students' anticipation of the science test that they wrote on Wednesday 10 May. An average of 9,9 messages were sent to and from the Helpline every day, with a significant increase occurring on Saturday 20 May (when a total exchange of 31 text messages took place).

2.2.1.1 Administrative request

Exhibit 4-9 shows one example of the 29 instances of help that were requested by means of directed text to the facilitator. (This example was taken from the facilitator's SMS log.)

Exhibit 4-9: Administrative request

JL	:	*< Goblin, what time do we get back from gold reef on thur? Some of the guys have a rugby match on thur @ 15:30. J### >*
		(Goblin refers to the virtual identity of the facilitator)
Facilitator	:	*< Planning so that we will be back at 2 at the latest >*
JL	:	*< That would work out then, thank you. J### >*

This exchange shows an example of a learner-initiated request for administrative help (in this case, a request for important information about scheduled times). Because the students could contact the facilitator whenever they wanted to, they tended to do so as their needs arose. The student in the example above extended the class wiki on which the facilitator had been assigned the virtual name of "Goblin" to this interaction on the mobile phone.

Table 4-2 lists other examples of learner-initiated interactions according to theme.

Table 4-2: Examples of student-initiated administrative text messages

Theme	Text Message
Appointment	*< Hey mrs. B. What time would be convenient for me to come see you today? During/after school? I've gotta go by 3 though. Thanks, Stn>*
Contact Information	*< Mam do u hav p##l v## H####'s Cell no. I need to contact him about our science thanx. >*
	< Hi mam, cn u plez send me da no, 4 wiki audio?>
Excursion	*< Hi, mam! i just want to know what time we leaving 4 goldreef city tomorrow? thanx :-) >*
	< Hi mam sorry to bother so late but wat time are we leaving 2morrow and wat time wil we be back? R we stil allwd 2 wear jeans and our tracsuit tops? :-) >
	< Mrs B### i'v gt a prob abt the time we cumin bac 2mo, bcaus the hocky bus leavs at 1 to were we playn.i dnt knw hw 2gt there if im

Theme	Text Message
	cumn bac at 2? >
	< Hi!jus thought i'd let u know that the hockey girls' bus leaves from school at 1 tmrw.... C u tmrw morning!:-) >
MobilED wiki	*< Can we SMS to that number or do we phone and how do we post ?>*
	<Are we alowed to call this number 2 ask questions? J###>
Test	*< So can we use our phones in the test tomorrow>*
	< Cn we use our cell phone 2morro in the test period to use for information? Thnx>
	< Do we only have to study the things you SMSed us or the rest aswell>
	< Hey mam r we gonna b able 2 use phones in da test??>
	< Mam were do we write science..? >
	< Helo mam! Um i'v been lukn 4 ya afta skul so i cn ur printa 2 print out my review. I tried bt it neva wntd 2 print. So wat must i do? >

Most of these text messages made extensive use of the kind of SMS lingo that incorporates idiosyncratic formatting, contractions and abbreviations that young people customarily use in SMSs. All of these interactions were initiated by students and took place outside the physical constraints of the classroom. This confirms just how feasible interactivity is even when it is between student and teacher. The readiness of students to use this kind of medium confirms the value of the extended nature of the mobile learning environment.

2.2.1.2 Academic help

The student-initiated requests for academic help were not content-related but dealt rather with issues of structure and what they needed to include in their assignments.
Table 4-3 below lists examples (sorted by theme) of the learner-initiated requests for academic help.

Table 4-3: Examples of student-initiated academic text messages

Theme	Text Message
Content	*< Hi mam, sorry to bother u but i've tried looking everywhere on the websites i was assigned to review and the majority info cant be found... M### and Ma###### :-) >*
	< What do we need in our research plan>
	< Mam i hav a prob , i only hav 1 review complete an the ada i cudnt gt the rite info an i dnt hav internet at home. I use the skul comp wen i hav C.A.T only. So wat do i do? >
	< Mam im really confused with this experiment thing!can it be on anything,like:how long will the ride be if ur coaster travels at a certain speed?or does it >
	< Is the narative report bout the thrill factor testin or our whole experience- usin phones, wiki Etc. ?>
	< What exactly is the scientific report about?is it work, energy, gold reef city, our ride we chose..?me and Ciska are lost.. >
	< But what should i put in give an example please >
Rubric	*< What should a rubric include >*
Test	*< Do we only have to study the things you SMSed us or the rest aswel >*
	< Mam do we need to no all those SMS u sent us for the test? and wat should b in our experiment planning? i forgot? >
	< Whats in the test? >
Understand	*< Hi its b###.. Can u pls help me with the following headings for the web site reviews for science. I dont undertand: keywords, all the headings under review, and identifier URL. please help. I tried to get hold of v#### but the message didnt go through. >*
	< Ma'am i don't understand what i am purpose to do in the other section of the review where you are meant to fill in the currency, innovative use of the medium and the authority. >
	< I dont understand the review authority content organization currency search engine graphic design innovative use of the medium >
	< Can you please explain the research plan to me? >

The table above shows that the kind of requests received from students concerned:

- what they were expected to include in the content of reports, rubrics and other documents that they had to complete
- their understanding (or lack of understanding) of concepts and terminology used in the instruction documents
- issues about some forthcoming test

Most of the topics that concerned those who sent SMSs were actually dealt with in scheduled class times. The nature and manner of these requests, in which students focus on their personal concerns and in which they ask for help to complete their assignments, indicate rather graphically how extremely personalized the atmosphere of a mobile learning environment can become. The students who sent his SMSs could just as well have asked for help from their peers. The fact that they asked the facilitator for help confirms that they preferred an authentic facilitator interaction and intervention.

2.2.1.3 Technical help

The students did not ask for technical help to the same extent to which they asked for academic and administrative help. Students who had been helped got together in groups and helped one another (as may be seen from the exert from an interview below in exhibit 4-10).

Exhibit 4-10: Acquiring new technology skills

Researcher	*:*	*How did you find the mastering of all these new techniques because you said that in the beginning it was quite daunting?*
3	*:*	*Well we just put our mind to it and thought of the best way that we could tackle this problem. Then we just worked on it together at a friend's house.*

Exhibit 4-10 shows the peer teaching takes place more frequently when students acquire new technical skills. This may explain why the students requested less help with technical issues than with administrative and academic problems.

Students indicated that they found new mobile phones easy to navigate and use. In exhibit 4-11 students explain how they would go about interacting with new mobile technology.

Exhibit 4-11: How students master new mobile technology

Researcher	*:*	*How long would you say does it take to get used to a new phone?*
2	*:*	*You just play around with it and go into various files.*
3	*:*	*You go to your settings, your games, your menu. It you don't know what something is, you just click on it and figure it out.*
Researcher	*:*	*Is it easier to use than a computer?*
3	*:*	*Yes it's much easier*

This indicates that when students are confronted by a new mobile phone, they will familiarise themselves with it by exploring its various features. Exhibit 4-11 shows that students experiment by opening various files, games and settings to see how they work ("You just figure it out"). They seem to prefer a trial-and-error approach to an instruction manual for getting to know how a new mobile phone works. Because a mobile phone operates more with single functions and because it also has a simpler user interface, students find it easier to navigate than the much more complicated input interface of a personal computer.

Only one severe technical malfunction occurred during the whole course of the study. The aftermath to this experience made it evident to me that it would in future be easier to help students sort out problems of this kind with visual contact because it required a lengthy exchange before the problem could be diagnosed. The interaction is related in exhibit 4-12 below.

Exhibit 4-12: Technical problem shooting

R	*:*	*<Hi mrs b### the mobiled phone wont go into da galery wat can i try and do? >*
Facilitator	*:*	*Dont think it is on! Why u want access? >*
R	*:*	*<No the galery on my phone da mobiled phone u gave to me it wont go in to da gallery>*
Facilitator	*:*	*<Try putting of and restarting>*
	:	*<If you have been using life blog there wont be pix on phone all on pc>*
R	*:*	*<I could nt get al of them off>*
Facilitator	*:*	*<Exit all put all off and try again>*
	:	*<Hi gogga. Did u manage. If pix very missing i have very many u can use. >*

R	:	*<Thanx im tryin to get a card reader to c if it work! >*
Facilitator	:	*<I have one if crises. Dear boy u are technologically jinxed :-) >*
R	:	*<Im nt it is da card!Thanx>*
Facilitator	:	*<Ok. Let me know if u need help. Have most things to get u going. Enjoy.>*

This was the only instance in which a student needed technical assistance from the facilitator. Exhibit 4-12 shows that the student did not rely solely on the facilitator for a solution. He enlisted the aid of his peers who suggested that he try a card reader to solve his problem (access the photographs on his phone).

Table 4-4 below lists the learner-initiated requests for technical help (sorted by theme).

Table 4-4: Examples of student-initiated technical text messages.

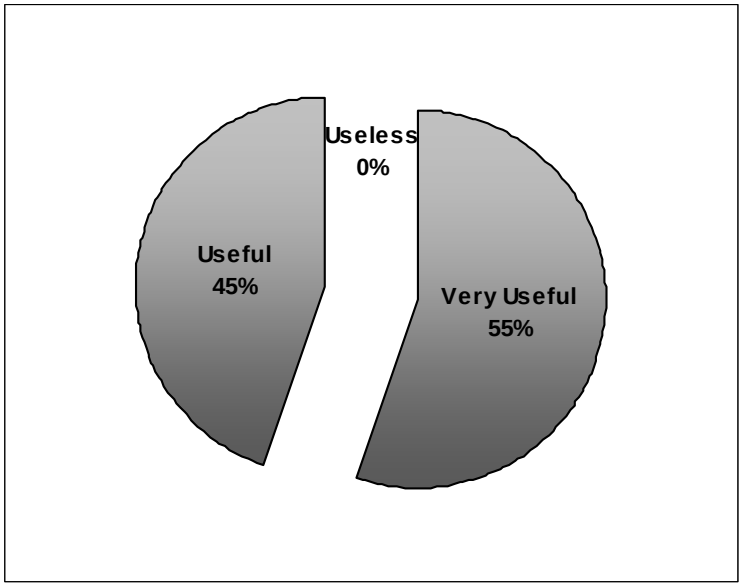
Theme	Text Message
Text received	*< Mam i still get two messages of everything u send. Oops!! >*
Web	*< Mam the first web site on the list of reviews doesnt want to open. Keeps giving me a error. . Can i pls get v####s no. to ask if theses another one to do >*
PC	*< Mam, what is ur laptops cd drive called? C-drive etc j### >*

These examples of requested help in table 4-4 suggest that students use their mobile phones confidently, that they prefer to find their own solutions by means of trial and error, and that they prefer to ask their peers rather than the facilitator for help. It is also noticeable that they assisted one another in more informal groups during and after classes.

2.2.2 Facilitator-reactive interaction

The facilitator's responses were not driven by deadlines, but were more general in nature and given in response to a cumulative number of similar queries. Figure 4-9 shows the distribution of student perceptions of the usefulness of general class announcements.

Figure 4-7: Usefulness of general class announcements



55% of the students described the general class notices as *Very useful*. 45% of them described them as *Useful*, and none of them perceived them as *Useless*. These results are illustrated in figure 4-7.

Once the facilitator had seen a pattern emerge in the incidence of general queries and requests for help, she sent an SMS as a general personal announcement. Because the facilitator did not want to invade the student's privacy, she did not send many of these SMSs. The table below lists examples of the general learner-initiated facilitator information sent to students. The messages focused on information relevant to work currently being performed by students (see table 4-5 below).

Table 4-5: Examples of facilitator-initiated general text messages

Text Message
< Organisation:site from university/school or other institution. Content:What is is primarely about.Authority: is site verified(financial sites mostly) Currency: What currency does the site trade in. Search engine: Does it use google, yahoo ect Grqaphic design: look and feel. Innovative use of medium: Graphics, sound, similations ect. Enjoy>
< A good website to review about rollercoasters is Amusement Park Physics: Roller Coaster http://www.learner.org/exhibits/parkphysics/coaster.html >
< 0128412225 MobilED wiki number. You can give it a try before tomorrow. >

Text Message
< Scientific rprt: Aim Hypothesis, Metode, rslts, Discussion. rprt bac on observations n Xperiences on chosen ride. Narrative rprt. w@ I did, w@ wrkD, w@ didn't wrk, w@ I learnt n w@ Id do diFrent .cncntrate on D ride u xperiencd n ur rubric. mak sure D scienfific principals r clr n explained. >
< Make sure you bck up ur pix! >

The examples in table 4-5 show that when information that is sent to students in general class announcements is both appropriate and relevant, it can enhance the personal nature of mobile learning interventions in a most acceptable way.

2.3 Chat

Text messages of this kind were individual in nature and served to motivate and encourage individuals. They frequently also gave rise to multiple text interactions. Interactions of this kind helped to keep lines of communication open. They also helped the facilitator to monitor individuals at risk. The following quotation from the facilitator's SMS log (see exhibit 4-13) are examples of exchanges that the facilitator initiated for the purpose of monitoring an at-risk student.

Exhibit 4-13: Motivational text exchange

Facilitator	*:*	*< Good Evening gogga. How are you coping did you manage to get all the things done. Please dont stress about things. We will cut you some slack till you get up to speed!. Go and have a nice bath and get in bed early. A### B### >*
DN	*:*	*< Gud evenin maam. I did was not able to get the 2 web reviews since i dont have a computer yet and i tried to do it today in lesson but did not have enough time. D### >*

The exchange above was initiated by the facilitator in order to encourage a new student who does not possess all the technological skills she needed to perform the tasks in hand.

The exchanges in exhibit 4-14 are from the facilitator's SMS logs. They took place after a text message had been misdirected.

Exhibit 4-14: Misdirected text message

MM (Misdirected)	:	*< Hey starc! Plz print 2 reasearch pages, 1 4 ea. Of us. Wil print u a rubric :-) nyt nyt xox o and its ur lunch day 2mro! Mwa >*
Facilitator	:	*< Good evening..You misdirected your SMS to print things and the lunch episode... Please make sure your arrangements for the content you need is watertight. >*
MM	:	*< Ok thanks mam was just unsure about what to study (next time the school must get a jammer that jams everything including bluetooth)>*
Facilitator	:	*< Hi. Make sure the content you would like to be able to access remotely (from Gold Reef City) is on the wiki. That is all. Enjoy. >*
MM	:	*< Thank u mam, sorry :-) goodnyt >*

Exhibit 4-15 is but one example of how students shared their sense of achievement with the facilitator when they master technical challenges.

Exhibit 4-15: Sharing a student's triumph

BPM	:	*< mam you wont believe where i am, i have the mobile thing, my fone is connnected with the computer. and im writing this message off of my fone. so so so cool.;-) >*
Facilitator	:	*< U am so proud of u! What a star >*

The student quoted in exhibit 4-15 had managed to connect her phone to her PC and text me from her PC through the medium of the phone. Her delight in sharing this triumph with the facilitator is obvious.

Mobile phones are able to extend the range of class discussions after the conclusion of formal class gatherings. Exhibit 4-16 shows one example of how this can happen.

Exhibit 4-16: Extended class time

AB	*:*	*< Hey mam r we gonna b able 2 use phones in da test?? >*
F	*:*	*< So can we use our phones in the test tomorrow >*
J	*:*	*< Cn we use our cell phone 2morro in the test period to use for information? Thnx >*
Facilitator (to all students)	*:*	*< U will NOT be able to use your phones as I cannot control the SMS. You have to have your rubric PRINTED, 2x web reviews and the research plan 2 use in test. >*
JK	*:*	*< Why would we smp eachother if all the info is on ur phone? Hehe>*

A discussion started in class about the possibility of using mobile phones as a resource in a test was carried over to the mobile phones themselves. The lack of clear directive about whether or not this should happen elicited a general administrative announcement from the facilitator to all the students.

The fact that students often use their phones to communicate with one another is confirmed by the following extract from an interview (exhibit 4-17).

Exhibit 4-17: Communication by mobile phones

Researcher	*:*	*Where else do you use it (the mobile phone)?*
1 – 4	*:*	*Everywhere.*
3	*:*	*Every other class.*
4	*:*	*Everywhere that we can get a chance – I used it this morning at the bus stop.*
Researcher	*:*	*What do you do with it?*
1 – 4	*:*	*Send SMS'es.*
Researcher	*:*	*To communicate with each other?*
1 – 4	*:*	*Yes.*

Exhibit 4-17 confirms that students frequently SMS one another as part of their ongoing social interactions. This incidentally explains why some student interactions seem to transmit messages that contain apparently irrelevant information and sentiments.

The following text message was logged after the test. There was nothing that the facilitator could do and no expectation of action from the student. It was a virtual touch for reassurance as the student's group had left their rubric at home and the student improvised during the test.

< Mam i didnt have my rubric. My group member had it so i drew one and the question on the weight was confusing >

2.4 Rules and norms that govern the interactions

These interactions take place within a particular context in which commonly understood rules, norms, customs and conventions govern the interactions

2.4.1 Time

One of the advantages of mobile learning is that one can get help when one most needs it. And because an SMS is not as personally invasive as a telephone call, it may be sent at any time without disturbing the routines, privacy and schedules of the recipient. The students were of the opinion that being able to receive correct up-to-date personal information when it was most needed was a very positive aspect of the learning initiative. From our point of view of the facilitator, however, messages did not always arrive at convenient moments (as the example in exhibit 4-18 illustrates).

Exhibit 4-18: Inopportune request for information

Date: Monday 8 May **Time :** 16:07		
AT	*:*	*< I dont understand the review authority content organization currency search engine graphic design innovative use of the medium >*
Facilitator	*:*	*< Its a generic form. Change it to suit u >*

AT	*:*	*< But what should i put in give an example please >*
Facilitator	*:*	*< Driving.. Urgent? >*
AT	*:*	*< Later >*

The exchange documented in exhibit 4-18 was taken from the facilitator's SMS log. It was not convenient facilitator to respond to the student-initiated request for assistance at that precise moment because she was driving and could not immediately answer the query to the satisfaction of the learner. The student accommodated the facilitator by agreeing to wait for an answer to his query.

In the example below (exhibit 4-19), the facilitator did not have the information that the student was needed.

Exhibit 4-19: Requesting information that the facilitator does not immediately have at her disposal

Date: Monday 15 May **Time :** 16:18		
PH	*:*	*< Can you plse e-mail me the ppt template >*
Facilitator	*:*	*< not hme. Pls phone V#### and ask her 2 forward hers. >*
PH	*:*	*< Do u hve her number please mam? >*

The log shows that the facilitator suggested that the student contact another student for the information. The student then politely requested the phone number of person to whom he was directed.

The following example (exhibit 4-20) records an interaction that took place on a Sunday evening.

Exhibit 4-20: Sunday evening request

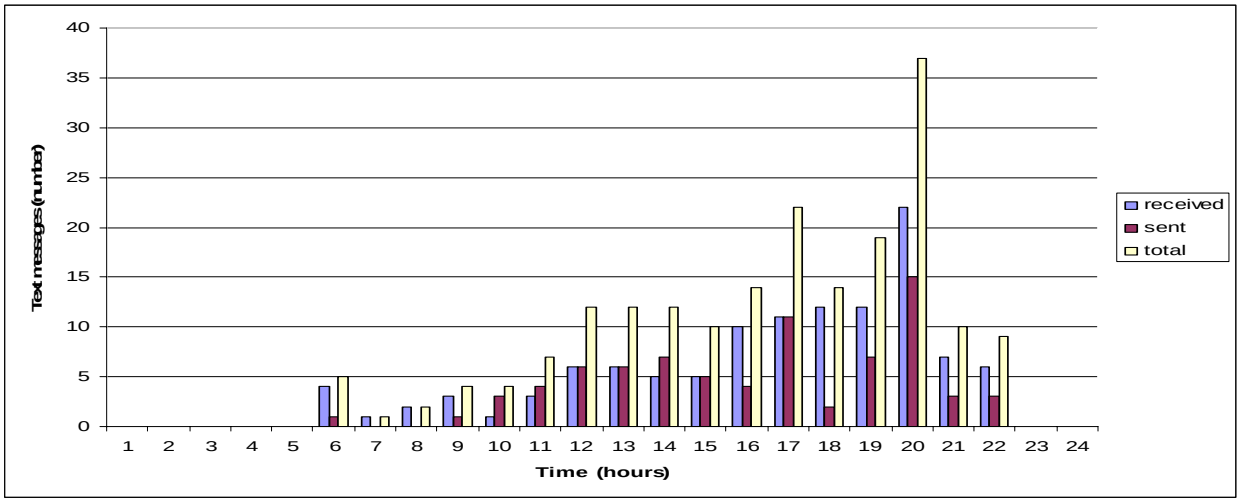
Date: Sunday 14 May **Time :** 20:13		
TM	*:*	*< Hi. I am still not allowed onto our wiki mam, I don't know what is wrong but I cannot log on. >*
Facilitator	*:*	*< T### cn ths stay 4 mnday? Urgent? >*
TM	*:*	*< Pls mam. >*
Facilitator	*:*	*< Give me half hour. >*

TM	:	*< TX >*
TM	:	*< Hi mam I managed to log on >*

Exhibit 4-20 records an interaction with a student who needed to log the class wiki on a Sunday evening. Because it was not exactly convenient for the facilitator to respond at that time, she asked whether he could wait for Monday for the information that he needed. Because he was obviously rather desperate, the facilitator asked him to give her half an hour to find the information that he needed. This exchange ended with the student receiving information that he so desperately needed. This kind of transaction demonstrates how students can get relevant and current information in a mobile learning environment ─ information that would not have been so readily accessible if students had had to rely on other forms of modern technology such as telephones or e-mails.

Figure 4-8 depicts the time distribution of text interactions to and from the facilitator.

Figure 4-8: Graph of the time distribution of text messages

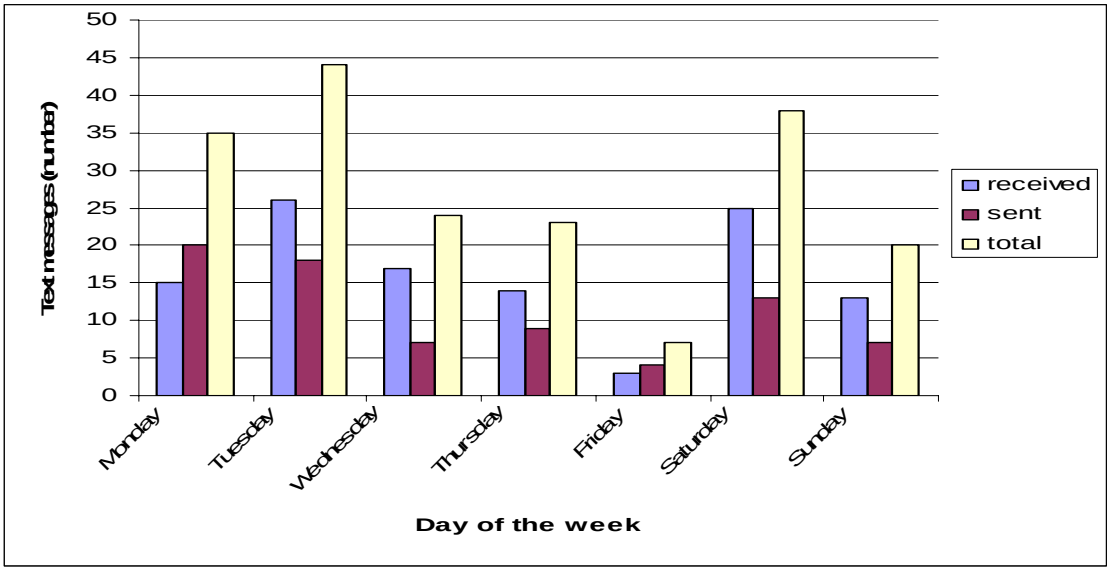


The graph above plots the number of messages received and sent by the facilitator against the timeframe in which this occurred. The x-axis divides the timeframe intervals into hours whereas the y-axis records the total number of text messages (messages sent and the messages received). It is significant to note that the largest volume of exchanges took place between 20:00 pm to 21:00 pm. The most extreme times were logged at 6.03 am and 22:45 pm

Image 4-3: Student accessing information

Students sent more text messages (in total) to the facilitator on a Saturday than on any other day of the week except for Tuesday. This may be explained by the fact that because students write tests on a Wednesday, they needed information about the work most urgently on a Tuesday.

Figure 4-9: Graph of the daily distribution of text messages

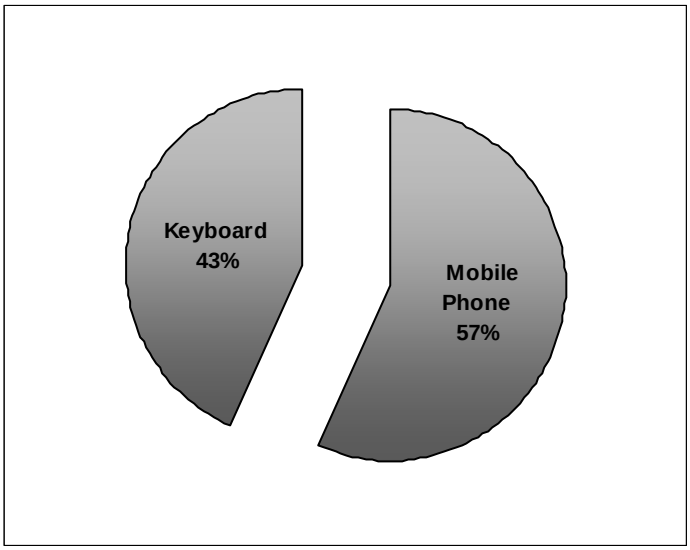


The graph in figure 4-9 shows how text messages were distributed over a three-week period. The total number of text messages that the facilitator sent and received are shown on the y-axis while the days of the week are represented on the x-axis. The graph also shows that the only day on which the students interacted significantly less than on other days was on Fridays.

2.4.2 Texting on the mobile phone

In the literature survey in chapter 2 mention was made of the fact that cell phones are perceived to be restricted with regard to their text input capabilities. Figure 4-10 nevertheless shows the distribution of the proportion of student *preference* for entering text either on a conventional computer keyboard or on a mobile phone interface.

Figure 4-10: Student preference for text-entering interface



Students indicated that they do not experience the mobile phone interface as a constraint to entering text. Of the students who completed the questionnaire, 43% indicated that they found it easier to type on a computer keyboard while the majority of the students (57%) indicated they found it easier to use the predictive text to enter text into their mobile phones. The distribution of preferences is illustrated in figure 4-10.

This was confirmed in an interview where one of the students stated that he preferred to type his work on his phone by using the predictive text capability before Bluetooth-ing it to his computer. In the context of a student interview, he said:

> "It's a lot easier to type an SMS than it is to write on the computer. It takes like 30 seconds to type a 160 character SMS because it's all in alphabetical order where with a keypad… they are not in alphabetical key system. So it takes far less time to type and beam it to your computer than it does to sit and fiddle on your computer."

This was confirmed by the following exchange from a group interview (exhibit 4-21).

Exhibit 4-21: Perceptions of the relative difficulty of entering text with a mobile phone and with a computer keyboard

Researcher	*:*	*Someone else said to me, what they are doing is, they are typing their stuff on the cell phone and then beaming it to their computer to write reports faster.*
1-4	*:*	*Yes.*
3	*:*	*They do that with essays.*
Researcher	*:*	*But you don't do it, do you?*
1-4	*:*	*No.*
2	*:*	*The typing on computers is for a lot of us really a problem.*
	:	*So you rather just type it on your phone.*
Researcher	*:*	*So the whole concept of typing on the phone is a minor problem to you?*
1-4	*:*	*Yes, no problem.*
3	*:*	*We're so used to it because of all the SMS'es.*
4	*:*	*We SMS every day.*
3	*:*	*We type a minimum of five SMS'es a day.*

Some students found that they could enter text more quickly by using a mobile phone's keypad than by typing on a conventional computer keyboard. Exhibit 4-22 illustrates this assertion on the part of the students.

Exhibit 4-22: Student's assertions about being able to type text more quickly on the keypad of a mobile phone than on a computer

Researcher	*:*	*It's not a daunting thing for you to type on your phones while only using your thumbs?*
1, 2, 3	*:*	*No.*
2	*:*	*It's actually quicker than typing on the computer.*

Exhibits 4-20, 4-21 and 4-22 record the students assertions that they do not consider entering text on a mobile phone to be as limiting as typing on a conventional computer keyboard.

2.4.3 Using the short message service

2.4.3.1 Emotions

Emotions are indicated in texts by the insertion of emoticons. Emoticons are horizontal images that form a rudimentary face from keyboard symbols. Each one is used to express a different emotion.

The emotions added are listed in table 4-6 below.

Table 4-6: Emotions that are added to text messages

Emoticon	To mean
c",)	Smile (upright)
:-)	Happy
;-)	Wink
:-(	Unhappy
:-S	Worried
:-/	Confused

The emotions indicated by the emoticons in table 4-6 serve to personalise text messages by adding an emotional dimension to a message.

2.3.3.2 SMS lingo

Students use SMS lingo (also called texting lingo) to communicate to one another in an abbreviated form. Examples of SMS lingo messages and what they mean in ordinary English are included in table 4-7 below.

Table 4-7: Example of SMS lingo

Sms lingo	Translation
< Helo mam! Um i'v been lukn 4 ya afta skul so i cn ur printa 2 print out my review. I tried bt it neva wntd 2 print. So wat must i do? >	Hello mam! I have been looking for you after school so that I can use your printer to print out my review. I tried but it never wanted to print. So what must I do?
< Mam i hav a prob , i only hav 1 review	Mam I have a problem. I only have one

Sms lingo	Translation
complete an the ada i cudnt gt the rite info an i dnt hav internet at home. I use the skul comp wen i hav C.A.T only. So wat do i do? >	review complete and the other one I couldn't get the right information and I don't have internet at home, I used the school computer when I have C.A.T only. So what do I do?
< Hey s####! Plz print 2 reasearch pages, 1 4 ea. Of us. Wil print u a rubric :-) nyt nyt xox o and its ur lunch day 2mro! M## >	Hey S###! Please print two research pages, one for each of us. I will print a rubric. (happy) Night night, hugs and kisses and its your turn to bring lunch tomorrow. M###
< Scientific rprt: Aim Hypothesis, Metode, rslts, Discussion. rprt bac on observations n Xperiences on chosen ride. Narrative rprt. w@ I did, w@ wrkD, w@ didn't wrk, w@ I learnt n w@ Id do diFrent .cncntrate on D ride u xperiencd n ur rubric. mak sure D scienfific principals r clr n explained. >	Scientific Report: Aim, Hypothesis, Method, Results, Discussion. Report back on observations and experiences on the chosen ride. Narrative report: What I did, what worked, what didn't work, what I learnt and what I would do different. Concentrate on the ride you experienced and your rubric. Make sure the scientific principals are clear and explained.

Because an SMS message only permits the use of 160 characters in any single SMS message, the abbreviated form of writing known as SMS lingo allows users to pack more thoughts into a single message. Students who have grown up with mobile phones are sometimes extraordinarily proficient in the manipulation of SMS lingo. The students always used SMS lingo in their texting to the facilitator. Table 4-7 above contains a selection of examples of SMS lingo and a translation of what they mean into ordinary English.

The facilitator's version of the SMS lingo was not always considered to be quite "correct" ─ as the following exchange the exchange in exhibit 4.23 shows.

Exhibit 4-23: Student opinions about the researchers idiosyncratic SMS lingo

Researcher	*:*	*Could you understand the slang? (the facilitators SMS lingo)*
1	*:*	*Yes*
Researcher	*:*	*Do you communicate with each other in that type of language?*

1	*:*	*Yes, in slang*
Researcher	*:*	*No, I mean in perfect English*
1	*:*	*No, it takes to long to type*
Researcher	*:*	*So did Ms B### communicate to you in proper English*
1,2,3	*:*	*Yes*
1	*:*	*And when she did write in slang, it's not what we're used to, like for example a sentence like: I will see you tomorrow – we would type: I'll c u 2morrow. Or she would write can as cn where as we would write out can.*
Researcher	*:*	*Would you get used to that?*
1	*:*	*Yes, you should just read it slowly at first*

While a student agreed in exhibit 4-23 that they could understand the facilitator's version of SMS slang, they said that they would have to "just read it slowly at first". They agreed that they would eventually get used to it.

The students did, however, make concessions to the facilitator's apparently limited grasp of "advanced SMS lingo" by using a simplified form of this lingo when they communicated with her. When writing to one another, they apparently use a more advanced form of SMS lingo.

3. How useful was the MobilED wiki in facilitating information access?

The MobilED platform was made available to the students on the day of the excursion to the theme park. The information that was made available to them was the same information with which they had populated the class wiki.

Image 4-4: Information received in the form of a text message

The students could choose to receive information either by having it appear in an SMS format on their cell phones or by having a synthesised voice read it to them onn their phones. Either of these options could be requested by texting a request to the MobilED platform. The SMS option could be chosen by texting:

< SMS-request >

The voice option could be chosen by texting:

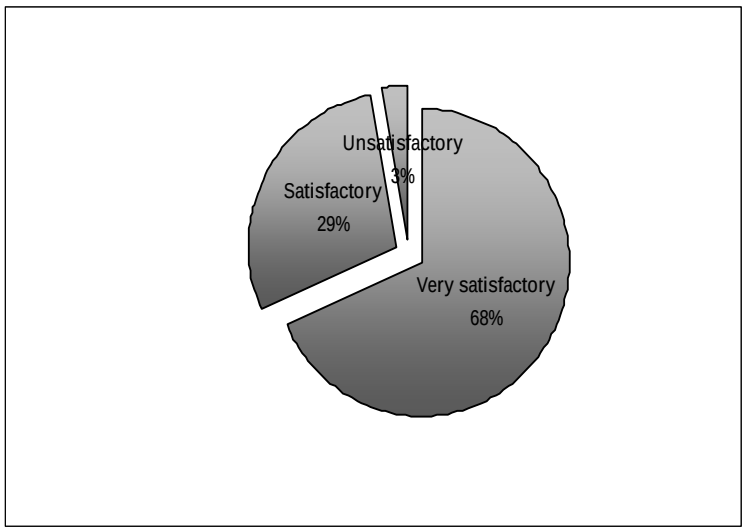
< request >

The request, time and number were logged, and comments were added where applicable (Aucamp, 2006a). The relevant report is attached as Appendix 2.

3.1 Student experience with the MobilED wiki

The students did not have any prior training in using the MobilED platform because they were all proficient in texting. Figure 4-11 illustrates the distribution of student satisfaction and dissatisfaction with the MobilED wiki.

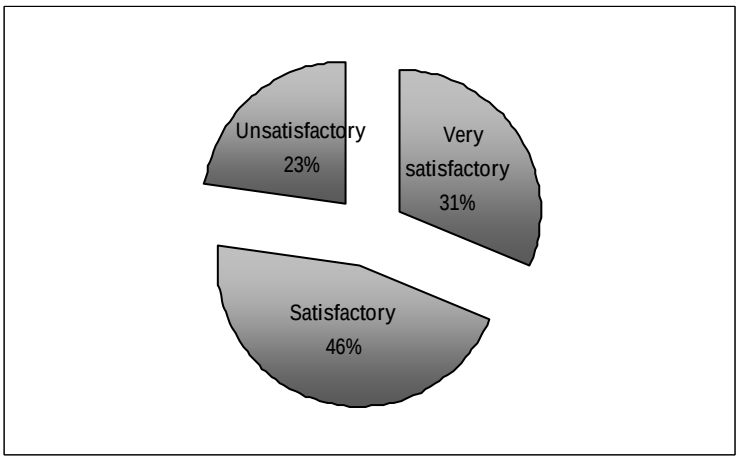
Figure 4-11: Distribution of student satisfaction and dissatisfaction with the is MobilED wiki



The majority of students (68%) indicated that they experienced the MobilED wiki as *Very satisfactory*. 29% indicated that they thought it was *Satisfactory*. Only 3% found it to be *Unsatisfactory*.

The distribution of student and dissatisfaction with regard to access to the wiki is illustrated in figure 4-12 below.

Figure 4-12: Student attitudes to wiki access with a mobile phone

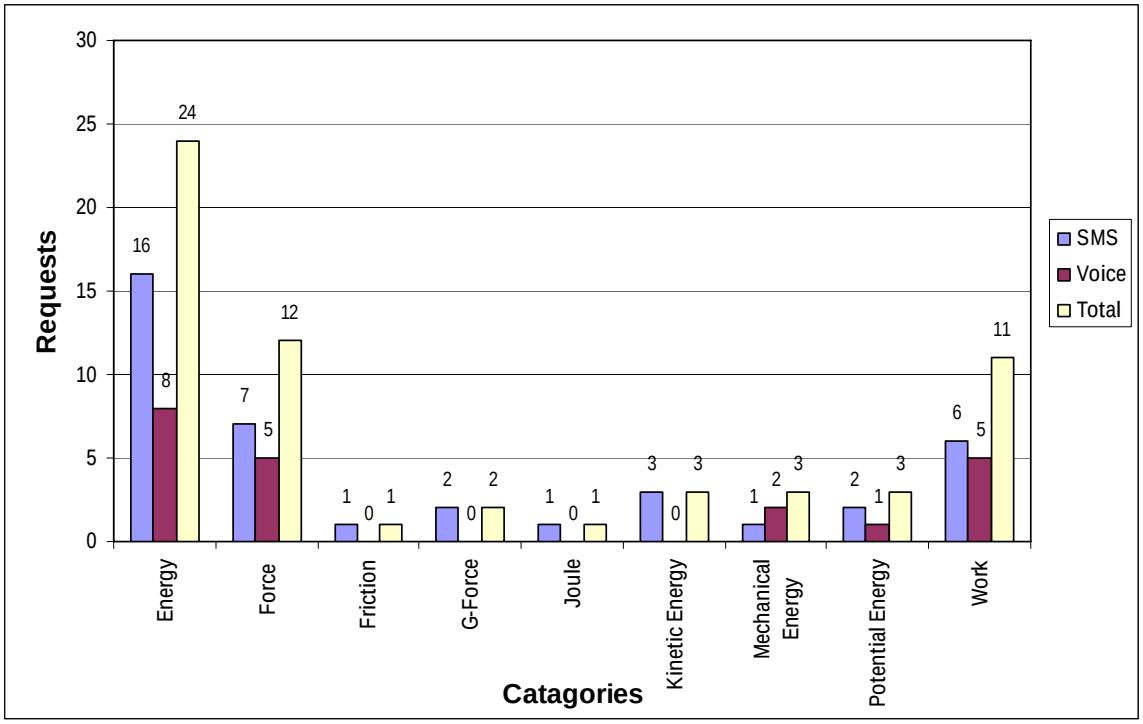


Most of the students indicated that they had experienced few problems when accessing the MobilED platform from their mobile phones (figure 4-12). 23% of the students, however, found the access *Unsatisfactory*. This might be attributable to the fact that they had had no time to familiarise themselves with connection procedures before they needed to do so.

3.1.1 Information access

The requests that the MobilED wiki receive from students are tabulated in figure 4-13. The administrator added some additional topics following requests from the students (the additional topics were: *friction*, *g-force* and *joule*).

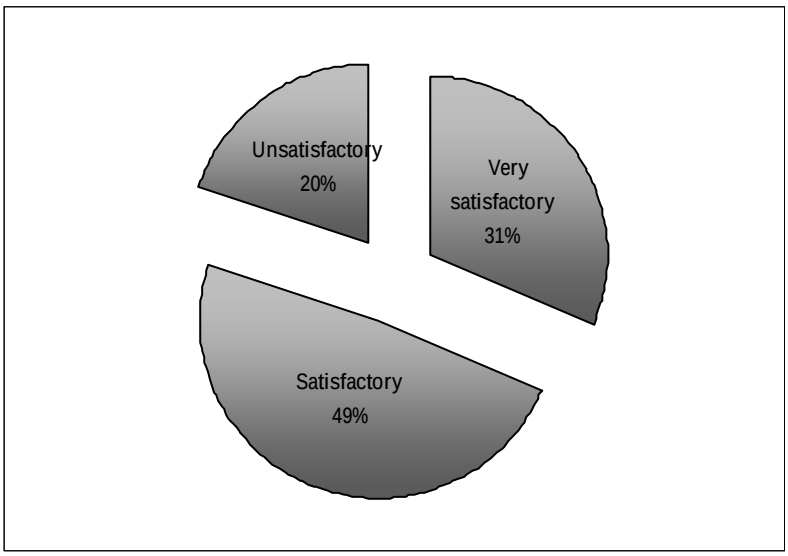
Figure 4-13: Distribution of requests that the MobilED platform received from students



The greatest number of requests was for the article on *energy*. The greatest number of requests after that was for the articles on *force* and *work*. Fewer students requested information to be relayed by means of the synthesised voice than those who requested the information in an SMS format. No students requested articles about *kinetic energy* or *joule*.

The distribution of student satisfaction or dissatisfaction about access to the requested information is reflected in figure 4-14 below.

Figure 4-14: Finding information



The students indicated that 49% of them found the accessing of the requested information *Satisfactory*, and that 20% indicated that they found it *Unsatisfactory*.

The access to information dependent on the correct requisition of the information and the availability of the requested information from the tags that the students loaded themselves. The invalid requests logged on the MobilED platform are shown in table 4-8 below.

Table 4-8: Invalid requests logged on MobilED platform

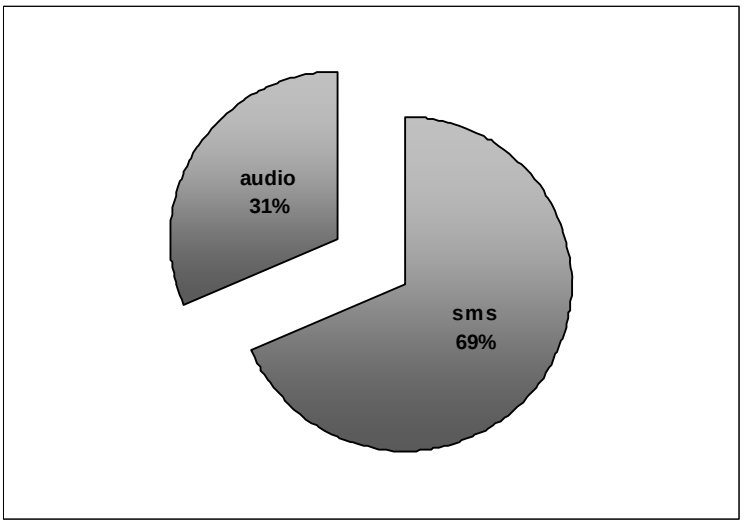
Invalid request logged	**Occurrence**	**Comment**
Invalid Topic	10	3 Topics were added. 1 Topic was mapped to an existing topic.
Spelling	2	• < *SMS Kenetic energy* >
Request protocols	6	• < *Sms- Mechanical Energy?* > Hyphen and question mark added by student. • < *Energy SMS* > Word order. • < *Force+work* > Plus sign added. • < *What r the 2 types of mechanical energy.*> Question asked instead of keyword. • < *Formula for potential energy* > Sentence instead of keyword.

Of the 71 requests received, only four were denied access because of gross protocol request irregularities. Server-side corrections to protocols were made to invalid topic requests, spelling and request protocols. The MobilED platform was made available to the students while they were on their excursion. Between 8:00 am to 13:00 pm on the day of their excursion, 69 successful interactions and 6 misdirected or protocol breaches were logged. Six of the returns were sent in the form of multiple SMSs because the message contained more than 160 characters.

3.1.2 Audio vs text requests

Figure 4-15 shows the distribution of audio requests as opposed to SMS requests sent to the MobilED wiki.

Figure 4-15: Distribution of audio and SMS requests



While they were 21 requests for audio return, 46 requests were made for SMS text return of information (as shown in figure 4-15). This distribution indicates that the students preferred text SMS returns to voice returns.

Figure 4:16 shows time distribution of the requests logged to the MobilED wiki.

Figure 4-16: Distribution of requests by hour

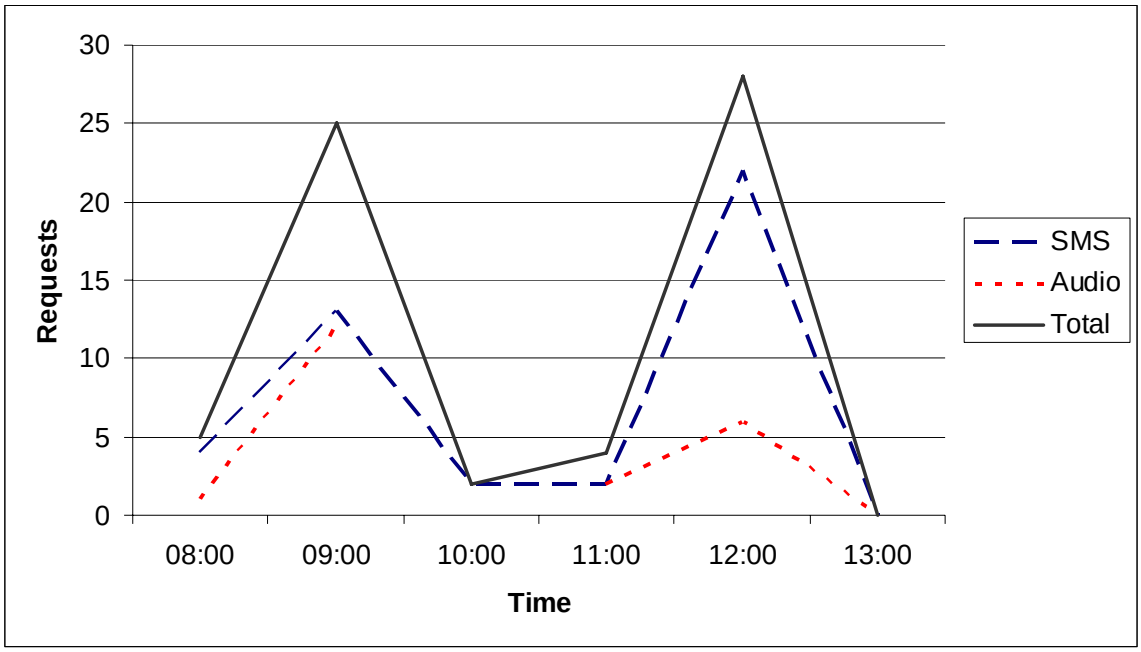


Figure 4-16 shows that a total of 25 requests were logged between 9:00 and 10:00 am on the day of the student excursion. This corresponds to the time when the students were on the bus en route to the theme park. The 12:00 to 13:00 peak corresponds to the time just before the learners left the theme park. There were no requests for audio returns between 9:27 and 11:15. This corresponds to the time when the students were in the theme park itself and going on rides.

Image 4-5: Student requisitioning information on the bus

Figures 4-18 and 4-19 below indicates the distribution of student perceptions of the relative satisfactoriness or otherwise of the audio retrieval format and the SMS text retrieval format.

Figure 4-17: Satisfaction with audio retrieval

Figure 4-18: Satisfaction with content SMS text retrieval

From these distributions it can be seen that the audio retrieval of information was designated *Unsatisfactory* by 40% of the students while the text retrieval format was termed *Very satisfactory* by 46% of the students. This is supported by exhibits 4-24 and 4-25 below, which contain extracts from the interviews.

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Exhibit 4-24: Audio content retrieval

Researcher	*:*	*The dial-up Wiki, did you use it?*
2	*:*	*Only for SMS'es.*
3	*:*	*The audio is so bad you can hardly hear it.*

Exhibit 4-25: Audio content retrieval

Researcher	*:*	*Did you place anything on the wiki that you can access now?*
4	*:*	*Yes, we have already accessed it.*
5	*:*	*The energy and force equations, we got it from other internet sites and then I just put an easy definition for the energy.*
Researcher	*:*	*Have you tried to access it?*
5	*:*	*Yes.*
Researcher	*:*	*And did you get a reply?*
5	*:*	*Yes. It called but you can't really hear the voice.*
Researcher	*:*	*How would you describe the voice?*
5	*:*	*It's a type of computer voice with an American tone.*

Researcher	*:*	*Did you hear the voice?*
5	*:*	*Yes, it's very stuttery, like word, stop, word, stop.*

The students found the synthesized voice difficult to understand because to them it sounded erratic and somewhat foreign (it used an American accent). One student described the voice as "stuttery" (see exhibits 4-24 and 4-25 above). Another student detected artificial-sounding intervals between words in the computer-generated voice. He describes this interval as "stop" in the extract from the interview above.

Other deceived problems that students experienced with the text retrieval were:

- Its response time (the time taken before a return call arrived from the MobilED platform)
- The transmission of incomplete text messages
- Occasions when no return messages were received

The MobilED log and the SMS log show that most of the problems that occurred can be tracked to the user's interface with the platform's protocols. Students sometimes directed calls to the wrong number, they would use the helpline instead of the wiki number, and they sometimes phrased requests incorrectly.

Not all the students, however, thought that the audio call back was unsatisfactory. This is supported by quotations from exhibit 4-25 (below).

Exhibit 4-25: Positive perceptions of the audio voice

MK	*:*	*This (text wiki) is kind of not exactly useful; it takes 2 – 3 messages for him to take his point through to you.*
Researcher	*:*	*What is the alternative?*
MK	*:*	*Well, phoning, doing the wiki phone*
Researcher	*:*	*The audio thing?*
MK	*:*	*Ja. (Yes)*
Researcher	*:*	*Have you tried it?*
MK	*:*	*Ja. (Yes)*
Researcher	*:*	*And?*
MK	*:*	*It's a little bit better, it's quicker and it saves your inbox space.*

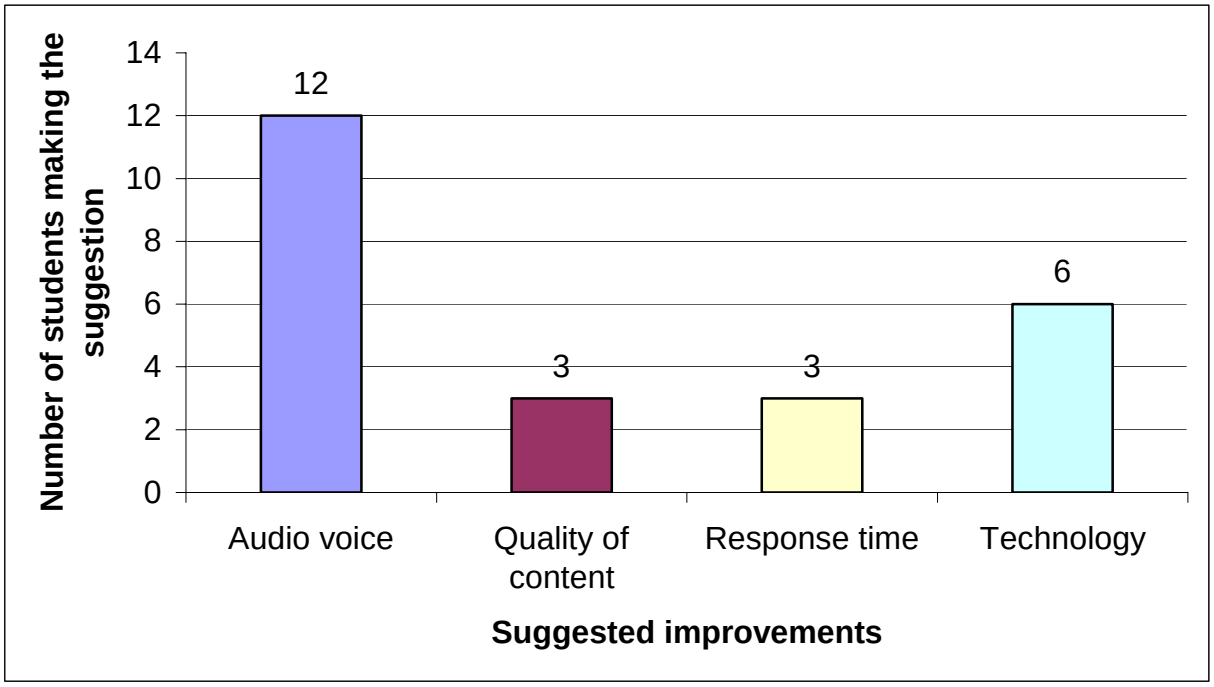
Researcher	:	*And the voice?*
MK	:	*Well, that is a whole lot easier to understand*

It is evident therefore that some of the students preferred the audio voice. They felt that the multiple text messages that they received took up too much space in their In Boxes, and that too many messages had to be transmitted to cover a single idea adequately.

3.2 Student suggestions for improving the MobilED wiki

The students were asked to suggest ways in which the MobilED wiki could be improved. The respondents suggestions are sorted by theme and presented in figure 4-19 below.

Figure 4-19: Students' suggestions for making improvements to the MobilED wiki



The suggested improvements focused on:

- **The audio voice.** The majority of respondents suggested that the audio voice could be improved. Students suggested that the voice be made to sound "more exiting". This obviously refers to the unattractive flat monotone with which the synthesised voice speaks.
- **Quality of content.** This suggestion contained an implied criticism of the students themselves because they were the ones who populated the wiki with the information

that they wanted. It is also possible that the students did not load all the information that they needed because they had had no prior experience of what it was that they would want to access.

- **Response time.** Students also asked that the time lapse before they received a return call be shortened. This is a matter that concerns the service provider and not the MobilED platform. Although shortening this interval would be technically possible, it would cost much more to access high-priority text.
- **Improvement of the technology.** The origins of this suggestion can no doubt be traced to the student's perceptions of no returns and the half returns that they received. As was noted above, the cause for these difficulties were traceable to user errors. These issues have nevertheless been noted and attended to in preparation for the pilot 3.

4. Summary

The results documented here suggest that it is possible to use the basic functions on mobile phones to support a learning event. The SMS communications facilitated the reinforcement of content by means of nano-learning information snippets, and this supported an extended collaborative learning environment. The communication channels that were thus established were extensively used by the students to solicit information and exchange ideas amongst themselves. The facilitator also used this form of communication to instigate student action and provide information in response to requests for assistance.

The text communications used were enriched with emoticons and reflected the colourful use of SMS lingo. By using the MobilED platform, the participants were able to access information beyond the temporal and spatial constraints of the physical classroom. They then applied these theoretical concepts to real-live experiences and events. The participants became more and more efficient in using their mobile phones for these purposes as the research progressed, and they were able to transfer the skills they had acquired during the course of the study to other areas of their lives.

An evaluation of the use of mobile phones to facilitate this learning event suggests that the students responded favourably to the use of mobile phones in the design research setting, and that they could use SMS texting as tools for learning and communication.

Chapter 5

Conclusion

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1. Introduction

This study explored the use of mobile phones as a technology and tool to facilitate a learning event. The main components of the mobile learning event, the elements of the design and the research results are now further reviewed in **section 2**.

What follows then is a discussion **(section 3)** that reflects on how the choice of a design experiment as a methodology influenced the results and the compromises that this research negotiated **(section 3.1).** This research is then compared with relevant research into mobile technology enhanced learning environments in **section 3.2.** The researcher then engages in a scientific reflection, and highlights the proposed contribution to a knowledge base **(section 3.3).**

The chapter concludes with recommendations **(section 4)** for policy and practice **(section 4.1)** and for further research **(section 4.2).**

2. Summary

The purpose of this research project was to explore how mobile phones could contribute to the success of a learning event in Physical Science in a local secondary school in South Africa. The study set out to identify the things that mobile phones do "extremely and uniquely well and to understand the social practices by which those new affordances become powerful educational interventions" (Rochelle, 2003, p. 268).

The literature study reviewed the use of mobile technology from pedagogical and technological perspectives, and a conceptual framework was proposed to integrate these perspectives into the learning event. The following main components of a mobile learning event were identified:

- the technology used to mediate the activity
    - tool rules ─ the protocols that govern interaction with the technology
    - tool division of labour ─ the functions of the technology that would be used
- the groups and individuals taking part in the activity
- the motivation for the activity to take place
- the community that supports the activity
    - rules – protocols that govern the community
    - division of labour ─ assumed responsibility and the organisation
- the outcome or desired product of the activity

These elements were used to design and contextualise the learning event. The learning event was designed to investigate (1) the effectiveness of mobile phones in the context of a carefully controlled learning event, and (2) the quality of support that could be offered by the MobilED wiki. The components of the lesson included:

- formal classroom interaction that took place during the normal scheduled lessons of the College in the physical space of the classroom
- the mobile phone interactions that eliminated the physical barriers of classroom and enables learning to take place in any place and at any time
- the continuous student support facilitated by the use of mobile phones
- the content delivered to the students
- the facilities of the mobile wiki supported by the MobilED platform

- the constructivist and collaborative nature of the assignment

The research methodology was a design experiment (Reeves, 2000) because it described the kind of research that situated theory in a real-world setting in order to establish what would work in practice.

The research results documented in chapter 4 were obtained by using qualitative and quantitative methods. The themes that emerged were grouped together and the results were documented and interpreted by the researcher as a reflective practitioner. In order to ensure the validity of the data, the researcher triangulated the data by using sources from different data collection methods. The following conclusions about the use of mobile phones in a learning event emerged from the data:

- Mobile phones can create an inexpensive, reliable, one-to-one personal learning environment for students. The technology is sufficiently portable and powerful to sustain a link to trustworthy source of information and assistance (in this case, the researcher) at literally any time of day or night. The researcher relayed information to the students whenever they requested it in an authentic real-world setting. By doing this the researcher eliminated the spatial and temporal constraints imposed by the conventional physical classroom.
- The personal engagement of the students with the information they required engendered autonomous learning as students devised new and ingenious ways of storing, accessing and utilising the information they needed to further their learning.
- Mobile phones extended and enriched the collaborative activities of students. Students extended their collaboration to outside the formal classroom and added a dimension of technical collaboration as they strove to compensate for the limitations of individual mobile phones.
- Mobile phones proved to be a reliable and convenient technology for communicating essential information to the students. They also proved to be an effective medium for small-scale content delivery that reinforced learning and supported student learning activities. The nano-learning content was saved onto the students' phones and was used for reference purposes.
- Mobile phones integrated effectively and seamlessly with existing technology and enhanced the capabilities of desktop technology. The relationship between the students and the technology was mediated and regulated by distinctive rules, customs,

conventions and “folk” protocols that are unique to student culture (and the culture of young people who use cell phones).

- The skills that the students acquired were easily and effectively transferred to other areas of their live. These skills enriched the students appreciation of how a technology of this kind can be used to achieve desired personal and school-related outcomes.
- The quality of the personal communication that was facilitated by the mobile phones altered the students’ perception of the facilitator's position in the formal structure of the learning event. The researcher therefore progressed from being an *instructor* in the student's eyes to being a *participant* in the learning process. As this inversion of roles became more and more comfortable and natural to the students, they began to see themselves as co-experts who could also “teach” their teacher. This set the stage for students accepting a greater responsibility for their learning.

The integration of mobile phones in a learning event not only demonstrated the potential of the technology as an aid in teaching and learning. It also demonstrated its capacity to function as *motivational tool* that enhanced learning by creating, extending and enriching a collaborative learning environment.

3. Discussion

3.1 Methodological reflection

The iterative nature of the design experiment as methodology allowed the researcher as facilitator to change and adapt the circumstance and components of the lesson so that they could combine to produce the most successful and desired outcomes. In this way the researcher achieved a design that optimised all the nuances of the learning event and a refinement of the theories contribute to the success of the implementation, evaluation and planning of future mobile technology-enriched learning events.

The role of the researcher as a facilitator, researcher and (to some extent) perceived participant in the learning process necessitated a certain degree of caution in the interpretation of the results and in drawing conclusions from the data. Because of the intimate relationship that developed between researcher, the events and the student participants, it was necessary to verify events by using data obtained from various sources and by asking participants to comment on the interpretations that the researcher had made and the conclusions that she had drawn. In furtherance of this objective, the research also submitted her results and conclusions

to peer review at various times. This verification process enabled the researcher to augment her interpretation of events and her conclusions by supplementing them with insights obtained from colleagues and from the students themselves.

3.2 Substantive reflection

The results and conclusions drawn from this learning event are comparable to other similar mobile technology enriched learning events and environments described in the literature and to the kind of integration reviewed in chapter 2. Although the mobile technology utilised in this study was the mobile phone (rather than the often-cited examples of more complex and powerful forms of technology), the unique qualities of the mobile phone as a form of technology (its personal ownership, its portability, its convenience and its efficiency) are given their due in many of the case studies in the literature.

The two different emphases (the dual nature) of current research into the mobile learning event that is identified in the literature was also clearly evident in this research. The available technology guided, enhanced and also hindered the extent to which pedagogical underpinning could unfold. The perceived limitations of the MobilED voice and the availability of the platform complicated the anticipated easy and ubiquitous access to information. Access to the class wiki was dependent on the technology and would not have taken place at all were the capabilities of the mobile phone not supported by the technology. The students not only *accessed* the technology: they are also *interacted* with it. This kind of interaction was much more complex and personal than (say) the interaction between a hammer as a tool and the person who uses it. The interaction between the students and their mobile phones was much more personal and intimate than that which takes place when people interact with the static and impersonal form of technology. Students were observed to have what can only be described as a nurturing and proprietorial attitude towards their cell phones. It was clear (although this is beyond the scope of this research) that students were unconsciously projecting a whole range of complex emotions and attitudes onto their cell phones. The mobility, interactivity and personal nature of the mobile phone makes it more than an instrument for personal interaction. Students spend a great deal of time personalising the features of their phones, and it is clear that cell phones have become the focus of certain ritualised social interactions between young people such as the students who took part in this research. As features of cell phone technology such as mobility and complexity become more advanced, so, it seems, do the interactions between the cell phone and its user and between

the user and other users of the technology. In this way the cell phone graduates from being a mere tool of convenience to an instrument that becomes the mediator of complex social interactions, attitudes and information.
This dimension of the cell phone should not be ignored in the planning and implementation of events and research that utilise mobile technology and other "intelligent" technologies.

3.3 Scientific reflection

This section reflects on what the research has achieved in supplementing existing knowledge and understanding of the products and processes that the researcher utilised in the study.

This research has made a case for:

- **the dual nature of mobile technology enriched learning environments**

For the successful application of even the most basic functions of mobile phones with support from a third-party server, the limitations and opportunities inherent in the extension of learning beyond the classroom and the curriculum is dependent and reliant on the extent to which the technology is able to support the pedagogy.

- **technology as a partner in the event**

This research has described and documented how the mobile phone can enrich personal interactions, and has demonstrated how the mobile phone is unique in the way in which it is able to foster relationships and enrich transactions between human beings. This research has shown how the mobile phone has an enormous potential to transcend its initial basic instrumentality as a telephone that connects two speakers. This added dimension was shown to be mediated by the protocols, rules, customs and conventions that individuals consent to as they pursue interactions and assign symbolic significance to the technology itself. Because the tool has a whole range of uses other than its most obvious one, the capabilities and limitations of the functions utilised by the individual to accomplish tasks were demonstrated.

- **the simplicity of basic functions for enhancing learning events**

In using the most basic function of mobile phones (that of sending and receiving text in the form of SMSs), the researcher utilised the capabilities of the technology that is easy to use and reliable, and that possesses a proven integrated role. This research utilised accessible technology that can be recreated and duplicated without prohibitive expenditure. The

MobilED wiki is an open source script that can be utilised free of charge, and the texting ability of mobile phones is a basic capability of all entrance-model mobile phones.

4. Recommendations

4.1 Recommendations for policy and practice

Will mobile technology transform the way in which teaching and learning will take place? It certainly has the potential to enhance existing practices and extend the capabilities of currently established forms of technology without any special redesigning of the basic tool. Because the students at this particular secondary school had already integrated mobile technology into their lives, extending it to incorporate a particular learning project was accomplished with confidence and ease.

Before implementing mobile learning at a secondary school, it would be advisable to take the following factors into account before embarking on any project.

It should be remembered that they parents of students are not necessary technologically proficient. Communicating the intended structure and learning outcomes to parents, staff and other interested parties is imperative because mobile phones have not yet been widely accepted as part of the arsenal of educational tools ─ and are in fact often perceived to play more of a recreational role in the lives of young people rather than an educational one. Miscommunication and misunderstandings can be avoided if the researcher is conscientious about involving the parent community in the goals, processes and achievements of the research.

The management of the school will have to sanction an intervention of this kind in cases where the school's policy prohibits the use of mobile phones in the school itself. Clear objectives and usage policies agreed upon by all parties concerned will avert a possible conflict of interests in which the students might be caught in the middle.

Complexity of functions and advanced programming are not a prerequisite for a mobile learning event. The framework that will support mobile learning need be accessible, reliable

and simple to use. Reliability and access to systems and relevant information is imperative for the success of a mobile technology enriched learning environment
A plan needs to be drawn up in for the incorporation of the unique capabilities that become available when mobile technology is utilised. These unique capabilities include, for example, authentic learning, the extension of classroom boundaries, and personal experience

The facilitation of a mobile learning event has to acknowledge the need of students for real-time interactions. This is not always convenient because sooner or later it is bound to transgress the researcher's personal boundaries of space and time.

The Meraka Institute as partner in the pilot is advised of the following factors to be taken into consideration for planning and implementing of the third pilot.

Although this research has documented the fact that the students in the study found the synthesised voice somewhat difficult to comprehend, a case has been made for the utility of this feature. It is recommended that an alternative voice be used or alternative methods of voice production be made available.

The participants have indicated that the response times before requests are processed are too long. A desirable characteristic of a mobile learning environment is real-time access to information. The response time therefore needs to be reduced to an acceptable level.

Since the navigation of available articles remains unclear, students are not able to access the information that they need. It is recommended that some advanced organisers that list and describe available articles according to theme, be incorporated.

A "no" response from the platform occasioned by a protocol breach or non-existent content needs to be communicated to the user. This will prompt an initiative from the user's side ─ either another request using the correct protocols or a request for another article.

The suggestion has been made that the platform be made available well before it is needed in the learning events. This will give both facilitators and participants opportunities to familiarise themselves with protocols for interaction.

The recommendations listed above derive only from the present study which involved 54 participants over a three-week period. The field is therefore wide open for further research into mobile learning in the South African context and related methodologies.

4.2 Recommendations for further research

Contribution of this research

This is the second documented study to use mobile phones in a learning event in a South Africa secondary school. The researcher hopes therefore that this research will make a useful contribution to the local knowledge base. The researcher also hopes that this research will stimulate and support other investigators by mapping the territory, pointing out possible obstacles, making the advantages of experience available to prospective researchers. Although this research was carried out in an "advantaged" school in South Africa, it utilised the most basic functions of any available mobile phone with minimal cost implications for the institution and the students. The research has attempted to show that mobile phones can be successfully used to enhance a learning event as students access information from remote sites. One of the aims of this research was to give educators yet another tool with which to engage student interest and enthusiasm.

Further research

The research was contextualised within an affluent private school. The following factors would warrant further study in this context:

- The scalability of mobile learning
- The sustainability of mobile learning
- The adaptability of mobile learning to other ages and communities
- The social dynamics of the enhanced and extended cooperative learning that resulted from the mobile learning environment
- The development and characteristics of a virtual identity when the virtual world is personally mobile

5. Closure

Technological advances and innovations in mobile technology have made mobile learning possible. Worldwide pilot programmes have been launched to test and report on the feasibility of certain kinds of technology for educational purposes. As a result a clearer definition of conditions in the field, an application base for mobile learning with all its unique opportunities and limitations is emerging.

This study has shown that mobile phones can successfully be utilised to enhance and facilitate teaching and learning in a secondary school. These findings present lessons learnt and recommendations for implementing mobile learning. The participants in this study have been unwilling to abandon the facilities that the mobile learning environment afforded them, and they still entertain a strong desire to be able to access the features that were put in place for them for the purposes of the research. This desire on the part of the students to remain involved with this technology for educational purposes provides strong testimony to the possibilities of this medium for educating a new generation of scholars