Examining the Role of Mobile Phones in Minimising Knowledge Transfer Impediments in Students' Project Teams

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Abstract

Knowledge transfer is the most important process in knowledge management. In order for knowledge to be used, it has to be transferred from one knowledge source to the other. Knowledge transfer is not a smooth process. There are a lot of impediments that prevent the transfer of knowledge. Four knowledge transfer impediments were identified: nature of knowledge, social ties, time and motivation. These four were selected because literature shows that they affect project teams in academic and non-academic organisations.

However the development of mobile phones and mobile technologies is promising to address this issue. Students use mobile phones to communicate with each other thus sharing knowledge.

This research investigated the role that mobile phones play in minimising knowledge transfer impediments in students' project teams. A quantitative approach was used to collect data from participants to test hypothesis drawn from literature. A total of 176 responses were obtained from three groups of students doing projects.

The study provides several interesting findings. The study found that, mobile phones minimise three of the four knowledge transfer impediments identified. These are motivation, social ties and time impediments. It was discovered that, a mobile phone motivates team members to share knowledge during a project. Team members with strong social ties use their mobile phones more often to share knowledge on their project. It takes less time to acquire knowledge from previous team members when a mobile phone is used. A mobile phone does not help project teams to transfer tacit knowledge. The study did not find any evidence that suggest that gender and race play a role in knowledge transfer using a mobile phone. It was found that project teams from different departments transfer different forms of explicit knowledge. The study also discovered that students do not only use their mobile phones to transfer knowledge, but also use their mobile phones to create knowledge.

The study reveals that mobile phones promise to bring a new era of mobile learning. Higher education institutions should cease this opportunity and introduce new interactive ways of learning. Students on the other hand should use mobile phones more often for knowledge creation and transfer to improve their academic work.

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Abbreviations and Acronyms

1G.....1ST Generation

2G.....2nd Generation

3G.....3rd Generation

4G.....4th Generation

BBS..... Bulletin Boards Systems

CBR..... Case Based Reasoning

CDMA..... Code Division Multiple Access

E-learning..... Electronic Learning

E-mail..... Electronic Mail

GPS..... Global Positioning System

GSM..... Global System for Mobile Communication

HSDPA..... High-Speed Downlink Packet Access

ICT..... Information Communication Technology

IS..... Information Systems

M-banking..... Mobile Banking

M-commerce..... Mobile Commerce

M-government..... Mobile Government

M-learning..... Mobile Learning

MMS..... Multimedia Messaging Service

MNO..... Mobile Network Operator

PBL..... Project Based Learning

PC..... Personal Computer

PDA..... Personal Digital Assistant

SABC..... South African Broadcasting Corporation

SECI..... Socialisation Externalisation Combination internalisation

SMS..... Short Messaging Service

TDMA..... Time Division Multiple Access

TV..... Television

UCT..... University of Cape Town

VR..... Virtual Reality

WAP.....Wireless Access Protocol

WML.....Wireless Markup Language

Wi-Fi..... Wireless Fidelity

Chapter 1: Introduction and Background to Research

1.1. Introduction

Alavi and Leidner (2001) are of the opinion that knowledge transfer is an important process in knowledge management. The same sentiments are shared by Nonaka (1994) who states that knowledge transfer is an important aspect of knowledge management. "Knowledge transfer is the conveyance of knowledge from one place, person, and ownership to another" (Major & Cordey –Hayes, 2000, p.412). Huber and Nonaka (as cited in Alavi & Leidner 2001) define knowledge as a belief that has been justified. That belief increases the entity's capacity for effective action.

The knowledge transfer process is fraught with difficulties. There are impediments that prevent the smooth transfer of knowledge. Four knowledge transfer impediments have been identified in the literature. They are social ties, motivation, the nature of knowledge and time. These impediments affect knowledge transfer in project based organisations and student project teams (Ajmal & Koskinen, 2008; Gammelgard, Husted & Machailova, 2004; Senaratne, Kagioglou, Amaratunga, Aouad & Bowden, 2005). The study was based on the four major knowledge transfer impediments because of their effects on students' project teams.

College and universities are increasingly adopting collaborative (project based) learning techniques. These techniques enable rapid transfer of knowledge and knowledge integration across students' teams (Colbeck, Campbell & Bjorklund, 2000). The knowledge transfer impediments prevent the advantages of project based learning to be fully utilised. These impediments make it difficult for students to transfer knowledge among project team members thus preventing them from successfully completing their projects.

However, the development of mobile phones and mobile technologies has made it possible to minimise or break such impediments. Modern mobile phones have features and services that can transfer knowledge between team members easily.

Knowledge transfer has been studied extensively by academics and students. Deetz (1996) states that knowledge transfer is a highly researched area. On the contrary, there are few studies conducted on the role played by mobile phones in minimising knowledge transfer impediments in students' project teams. Therefore there is a need to conduct more studies that combine the two fields, especially in academic environments. The present study aims to fill this gap by examining knowledge transfer challenges and processes between students in project teams and the extent to which mobile phones could address these problems. The study addresses the following question: can mobile phones minimise knowledge transfer impediments in students' project teams?

This study provides suggestions on how academic institutions, students, mobile network operators and lecturers can improve knowledge transfer in students' project teams.

1.2. Background

Knowledge transfer impediments between project teams are a concern to many organisations. Ruuska and Vartiainen (2005) state that project organisations are faced with challenges in knowledge sharing. Fernie, Green, Weller and Newcomb (2003) state that the nature of knowledge is an impediment to knowledge transfer in project teams. . For example, project team members might not comprehend ideas of a other group members. In such situations, phone graphics can be conveyed into visual format which can be easily understood by group members. In this context, tacit knowledge is converted to explicit knowledge, making it easy to share.

They also state that social networks play an important role in the transfer of knowledge in project teams Most of the time students form project groups based on friendship. Friends have social ties. In a project group, friends are free to engage each other without fear. Such engagements provide a platform to share, and refine project ideas for the project which leads to improved knowledge transfer.

Schindler and Eppler (2003) identify motivation as a major impediment to knowledge transfer. For example, the researcher has observed that geographically dispersed teams seldom work without proper and advanced technology. In universities, students face a similar predicament. Project work stops when students are geographically dispersed (e.g. on camp versus off camp students). Knowledge transfer is impossible in such situations. A mobile phone comes into play in such situations by motivating students to share knowledge when they are physically apart.

Eppler and Sukowski (2000) identify time as a major impediment to knowledge transfer. That view is also shared by Disterer (2002) who states that knowledge gained in past projects is not easily acquired because of time constrains. For example, students always complain about lack of time during their projects. They spend a lot of time on scheduling and meeting. There is less time to acquire knowledge from past projects. That is, less time to consult knowledge sources such as documents and people involved in past projects. A mobile phone comes handy in such situations. The team can use their mobile phones to acquire knowledge from past teams and access other sources quickly.

The introduction and growth of mobile phones over the last decade has positive prospects for the future. The introduction of pre-paid billing in the late-1990s saw massive growth in the sector and mobile phones have become a ubiquitous feature of South African society (South African ICT Sector Performance Review, 2007)

According to the review, there were about 30 million mobile phone subscribers in South Africa in 2006. Today, there are about 39 million mobile phone subscribers in South Africa or nearly 80% of the population (South African Telecommunications, 2008). There are three mobile network operators (MNO) in South Africa. They are MTN South Africa, Vodacom and Cell C. A new entrant Virgin Mobile provides virtual network, but operates in partnership with Cell C. Vodacom and MTN are the dominant players in the industry.

Vodacom has 59% of the South African market share, followed by MTN with 32.5% and lastly Cell C with 8.5%. In terms of network access, Vodacom and MTN cover more than 90% of their subscribers in South Africa, while Cell C covers only 85% (South African ICT Sector Performance Review, 2007).

Students in tertiary institutions are among the 39 million subscribers. No statistics are available on the use of mobile phones in tertiary institutions in South Africa, but through the researcher's observation, it can be concluded that many students in tertiary institutions own mobile phones. No study has been found on the use of mobile phones for knowledge transfer purposes in tertiary institutions in South African. Research on mobile learning has been conducted though in other parts of the world. Mobile devices like PDAs, mobile phones and other mobile devices have been used in such studies. Benta, Cremene and Padurean (2004) used the mobile phone in a class environment. The students had to identify a plant and give a short description of it and send the answers through SMS and MMS to the lecturer. Nakahara, Yaegashi, Hisamatsu, and Yamauchi (2003) conducted a study to investigate whether students are motivated to participate in learning when using mobile phones. The study revealed that mobile phones highly motivate students to learn. During the learning process, students transfer knowledge using such mobile devices. Therefore the study was conducted to examine the role that mobile phones play in minimising knowledge transfer impediments in students' project teams.

1.3. Research Problem

Project teams are confronted with knowledge transfer impediments during the course of their projects. Time and budget constraints, individual and social barriers, and motivation affect knowledge transfer in project teams (Ajmal & Koskinen, 2008). The nature of knowledge (knowledge being tacit or explicit) is an impediment to knowledge transfer (Gammelgaard et al., 2004). Students' project teams are also affected by these impediments. Odom, Stefanone & Gay (n. d.) state that students with more social network ties have higher performance that those with less social net work ties. Senaratne et al. (2005) state that lack of motivation is a common student knowledge transfer impediment. Yamane (1996) states that students complain about the lack of time to complete their projects.

However the development of mobile phones and mobile technologies is promising to address this issue. Today's mobile phones have features and services that can enable the transfer of knowledge. Students use mobile phones in their everyday life, but the extent to which they use mobile phones to transfer knowledge during projects is unknown and the role that mobile phones play in minimising knowledge transfer impediments in students' project teams is unknown.

1.4. Research objectives

The main objective of the study therefore, was to investigate the role that a mobile phone can play in minimising knowledge transfer impediments in students' project teams. The study aimed at providing an insight on how mobile phone's features and services help minimise knowledge transfer impediments. The study also aimed at providing insights on how students, lectures, academic institutions and mobile network operators can help to improve knowledge transfer in students' project groups using mobile phones.

1.5. Importance of research

Literature shows that mobile phones are used for learning purposes. The learning process involves the transfer of knowledge. It was therefore important to investigate how mobile phones can address knowledge transfer impediments in students' project teams. That provided solutions to students and lecturers on how to make good use of mobile phones during team projects. The study provided insights on how mobile technology intervenes and breaks knowledge transfer impediments.

The study combined two fields of study: knowledge management and information technology. This combination provided solutions on how technology can be used in knowledge management to promote knowledge transfer and knowledge creation. The study has implications to the knowledge management field, information technology, information systems fields and academic institutions.

1.6. Structure of the report

The dissertation starts by introducing the study and background. This is followed by a review of literature on knowledge, knowledge transfer, project based learning and mobile phones (m-learning). This conceptual contribution is then followed by the research design and methodology. This is followed by the findings and discussions. The dissertation then concludes by providing theoretical and practical implications and suggestions for future research. Below is a brief overview of the structure of the dissertation.

Chapter 1

Chapter one presents the introduction, background, research problem and objectives, and the importance of the study. The background offers a brief summary on knowledge transfer challenges faced by students' project teams and the mobile phone industry in South Africa.

Chapter 2

Chapter 2 presents the reviewed literature. This chapter discusses in detail knowledge, knowledge transfer and knowledge transfer impediments, and project based learning.

Chapter 3

Chapter three further discusses the literature. Specifically, chapter three discusses literature on mobile phones. This chapter discusses mobile phone studies that have been conducted in academic environments.

Chapter 4

Chapter four discusses the theoretical underpinnings of the study. It introduces the research framework and the research hypothesis.

Chapter 5

This chapter discusses in detail how the study was conducted. It discusses the research methods, data collection techniques, data collection procedure, the population, the research purpose and the philosophical perspectives guiding the study.

Chapter 6

Chapter six presents the findings and discussions. This chapter provides the key findings of the study. It also discusses the findings and compares the findings to the available literature.

Chapter 7

Chapter seven presents the study conclusions. This is a summary of what the study has achieved and the implications it has on the field of information systems. This chapter also presents the limitations of the study and recommendation for further research.

Chapter 2: Literature Review

Introduction

Chapters two and three present the review of the literature relevant to the study. Chapter two presents literature on knowledge transfer, knowledge transfer impediments and project based learning. Chapter three presents literature on mobile phones.

2. Knowledge transfer and Project Based Learning

Chapter two begins with the definitions of data, information and knowledge. These terms are often used interchangeably, therefore it is important to clearly define them in the context of the study. The second part of the chapter will present literature on knowledge transfer and knowledge transfer impediments which will be followed by project based learning

2.1. Definition of data, information and knowledge

It is of paramount importance to distinguish and discuss data, information, and knowledge. These terms are often confused by readers and have created some problems among researchers. Tuomi (2000) states that the knowledge management literature emphasizes the importance of distinguishing between data, information, and knowledge. Data can have different meanings in different disciplines. For example, in the Mathematics discipline, data is interpreted as raw numbers or figures. In the Computer Science discipline data is interpreted as electronic figures, words, sentences and characters without any meaning. Many researchers agree that these terms stem from one another, but the hierarchy has not been agreed upon (Tuomi, 2000). Literature shows that some researchers believe that information and knowledge stems from data, yet others believe that data and information stems from knowledge. Therefore it is important for the literature review to clearly define these three

terms so that they are not used interchangeable in the study. The following section will define and discuss data, information and knowledge.

2.1.1. Data

Hey (2004) states that data has a lot of definitions and that it depends on the context of its use how one defines it. He states that in the field of Information Science, it is defined as unprocessed information. In the Computer Science field data are streams or pockets of data. Data is conceptualized as a resource and as an object that can be manipulated. According Rumizen (2004) data are bits and numbers, data are discrete, have no meaning, self-contained and in isolation. Tiwana (2002) describes data as a set of objectives facts about an event or just structured records of a transaction. Tiwana further describes data as meaningless figures, digits, sentences and phrases that cannot be used for decision making. In the field of information systems data is regarded as unprocessed information or as computer data stored in binary format. Researchers are guided by their respective studies to choose the correct definition. For the purposes of this study, Tiwana's definition of data has been adopted. Tiwana's definition is broad and not biased towards any field.

2.1.2. Information

Data that has been processed into a useful purpose and can be used for decision making is information. Chaffey and Wood (2005) describe information as data with value to the understanding of a subject and in context. They further state that information is the basis of knowledge. Vance (as cited in Alavi & Leinder, 2002) defines information as data that is interpreted into a meaningful framework. Drucker (as cited in Tiwana, 2002, p. 40) describes information "as data endowed with relevance and purpose." The literature does not give any conflicting definitions of information. Most authors state that information is used for decision making. For the purposes of the study Drucker's definition of information was adopted.

2.1.3. Knowledge

Knowledge is an abstract notion. Literature gives different definitions of knowledge. There are two opposing hierarchical structures on how knowledge is generated. One shows that knowledge stems from data, and information (Bierly, Kessler & Christensen, 2000), and the other shows that knowledge does not stem from either data or information, but that data and information come from knowledge (Braganza, 2004). Proponents of the former, argue that data (raw facts without meaning) is acquired first and then processed to information (data endowed with relevance) and then knowledge (justified belief that makes a person to take effective action). Proponents of the latter state that knowledge has always been available. Therefore people use their knowledge to generate information and data (figure1 shows the two approaches).

Huber and Nonaka (as cited by Alavi & Leidner 2001, p. 109) define knowledge as "a justified belief that increases an entity's capacity for effective action". Alavi and Leidner (2001, p. 109) describe knowledge as "information possessed in the mind of individuals: it is personal information related to facts, procedures, concepts, interpretations, ideas, observation and judgment". They further state that knowledge is thus the result of cognitive processing triggered by the inflow of new stimuli. They posit that information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, graphics, works, words or other symbolic forms.

In Alavi and Leidner's view, knowledge form several perspectives, namely: a state of mind, an object, a process, a condition of having access to information or a capability. Schubert et al. (as cited by Alavi & Leidner 2001, p. 109) states that knowledge has been described as a state or fact of knowing "with knowing being a condition of understanding gained through experience or study; the sum or range of what has been perceived, discovered, or learned".

According to Gupta, Sharma and Hsu (2004) knowledge is the full utilization of information and data coupled with the potential of people's skills, competencies, ideas, intuitions, commitments and motivations. They further state that a holistic view considers knowledge to be the present ideas, judgments, talents, root causes, relationships, perspectives and concepts. They also state that knowledge is stored in the individual brain or encoded in organization's processes, documents, products, services, facilities and systems.

Drucker (as cited in Sung, 2006) states that, knowledge is the primary resource for economic development in the new economy. Spender (as cited in Mendes, Gomes & Batiz-Lazo, 2004) states that knowledge is an asset that can be managed just as human and material resources. Kim (as cited in Mendez, Gomes & Batiz-Lazo, 2004) is of the view that knowledge can only be understood within a social system, in which the individual is its core element. Kim further states that in such a social network, knowledge is transferred from the individual to organization and back to the individual through the collaboration dynamics between all parties involved in a business process. Knowledge includes, structured experience, value, judgement, comments and other values (Tsai, Chang & Chen, 2006)

Zander and Kogut (1995) state that in general, knowledge in a firm can be categorized into know how and information. They state that knowledge consists of competence of individuals and the organizing principles by which a relationship among individuals, teams and industrial network members are structured and coordinated. Drawing from the literature, the study

adopted Alavi and Leidner definition of knowledge. For the purposes of the study, knowledge was viewed as a process and as an object that can be stored, manipulated and transferred.

Drawing from the literature, it seems difficult to agree on the definition of knowledge. It is therefore concluded that knowledge is categorized into individual knowledge and organizational knowledge. Individual knowledge is defined as knowledge that is being possessed by an individual. The individual uses that knowledge in his/her daily activities. Organizational knowledge is knowledge that an organization possesses and is used as a competitive advantage for the organization. For example patents, trademarks, manuals, procedures and processes. Organizational knowledge can be kept in the organization's memory and can reside in the minds of employees.

The following diagram illustrates the two knowledge hierarchies.

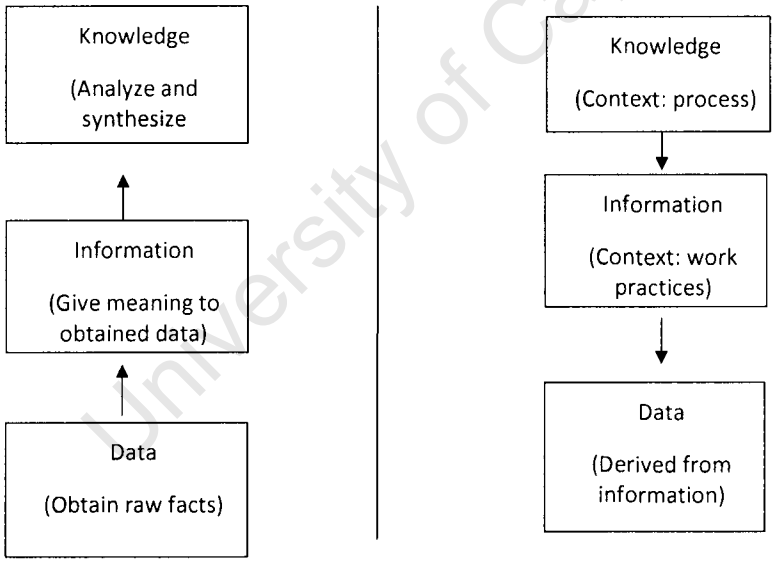


Figure 1.*data information knowledge hierarchy* *knowledge, information, data hierarchy*

On the left is the data, information, knowledge approach and on the right is the knowledge, information, data approach.

The study adopted the data, information, and knowledge hierarchy. Many Information Systems and Knowledge Management studies adopted the data, information, knowledge hierarchy and so is the study. The study touches both fields. There is no need to differ from past studies. It is stated in literature that knowledge can take two forms: tacit and explicit. The following section will discuss the different types of knowledge.

2.2. Types of knowledge

It is stated in literature that Polanyi was the first person to differentiate between two types of knowledge which are tacit and explicit knowledge. The following subsection will discuss the two types of knowledge. Nonaka and Kanno (1998) concur with Polanyi that there are two types of knowledge; tacit and explicit. They state that explicit knowledge is readily transmitted between individuals formally and systematically. They state that tacit knowledge is highly personal, therefore making it difficult to communicate and share with others

2.2.1. Tacit Knowledge

Nonaka (as cited in Marwick, 2001, p. 814) states that "tacit knowledge is what the knower knows, which is derived from experience and embodies beliefs and values. Tacit knowledge is actionable knowledge, and therefore the most valuable." Furthermore, Nonaka states that tacit knowledge is the basis for the generation of new knowledge. Nonaka and Kanno (1998) state that there are two dimensions of tacit knowledge: the technical dimension and the cognitive dimension. The former encompasses informal personal skills and craft often referred to as know-how and the latter consist of beliefs, values, mental models and ideals which are deeply ingrained in human beings and are often unnoticed or taken for granted.

Gladstone (2000) gives the definition of tacit knowledge as what an individual knows. Gladstone further states that, the reason why it is called tacit knowledge is because it is personally held and it is sometimes not recognized by the holder that it is knowledge. Gladstone also states that, it includes subjective know-how, insights and intuitions. Tacit knowledge is a dynamic flow, ever-changing with experience of its processor.

Tacit knowledge is connected and depended on the individual and the individual's understanding and experiences of the concept or phenomenon. They further state that, it is personal and difficult to formalize, making it difficult to communicate and share with others (Elfving & Funk, 2006).

Tacit knowledge is elusive and subjective awareness of individuals that cannot be articulated in words. They further state that, it hard and useless to communicate tacit knowledge among people with different levels of knowledge (Li & Gao, 2003).

Tacit knowledge is mostly applicable in problem solving, problem finding and predictions and anticipation. They argue that experts can solve problems better than novices because they have patterns of born experiences in mind, which they can use to tackle a certain problem. They further state that tacit knowledge enables individuals to frame problems, thus allowing individuals to reject obvious answers to a problem and allows them to ask different questions Leonard and Sensiper (1998). Tacit knowledge provides a "deep study of phenomena and understanding of how something works, allowing the individual to anticipate and predict occurrences that are explored consciously." (Leonard & Sensiper 1998, p. 115)

From all these different definitions, it can be deduced that tacit knowledge is knowledge that is hidden in the people's heads. It is not easy to pass it over to other people. It is not measurable; it's intangible and very important in the life of the holder. It enables the holder to

make decisions. Tacit knowledge is gained over time and through experiences. For the purposes of the study, tacit knowledge was the students' ideas transmitted through mobile phones voice services. The ideas can be instructions, opinions, and discussions transmitted through a mobile phone.

2.2.2. Explicit Knowledge

Nonaka (as cited in Marwick, 2001) states that explicit knowledge is represented by some artefact, such as a document or a video, which has typically been created with the goal of communicating with another person.

Gladstone (2000) on the other hand describes explicit knowledge as knowledge held formally in the form of reports, equations, formulae and specifications. It is easily transmitted between individuals and teams. Elfving and Funk (2006) state that explicit knowledge is easily transmitted, processed and shared. They also state that explicit knowledge can be exchanged during face-to-face communication in seminars and gatherings.

Nickols (2000) states that explicit knowledge is knowledge that has been articulated and, more often than not, captured in the form of text, tables, diagrams, and product specifications. Nickols further describes explicit knowledge as formal and systematic. Nickols gives product specifications, scientific formulas and computer programs as examples of explicit knowledge.

Nonaka (1997) gives the definition of explicit knowledge as objective and rational knowledge that can be expanded in words, sentences, numbers or formulas. He further states that it includes theoretical approaches, problem solving, manuals and databases. Sambamurthy and Subramani (2005) state that explicit knowledge refers to the codified component that can be disembodied and transmitted.

Rice and Rice (n. d.), state that explicit knowledge is easily transmitted, processed and shared. It may be exchanged during face-to-face communication at seminars, and gatherings. They further state that explicit knowledge may be transferred into tacit knowledge through an active process of learning. It can be deduced from the literature that explicit knowledge is knowledge that has been documented, and can be easily shared. Explicit knowledge can be stored in a number of sources like, paper and electronic databases.

The knowledge management literature emphasises on tacit and explicit knowledge. Stenmark (2001) names researchers such as Choo who has added cultural knowledge, Spender who has added individual and group knowledge and Blacker who speaks of embodied, embrained, embedded and encultured and encoded knowledge. Stenmark says that they all build from Polanyi's notion of tacit knowledge. The study will adopt the two widely used types; tacit and explicit knowledge.

Drawing from the literature, explicit knowledge in a nutshell is described as codified knowledge that can been stored in different sources and formats. For the purposes of the study, explicit knowledge is students' ideas that have been documented in SMSs, Emails, MMS, and graphic messages.

There is a lot of debate about the importance of tacit knowledge and explicit knowledge. Researchers such as Nonaka and Polanyi emphasize on tacit knowledge. They are of the opinion that explicit knowledge is derived from tacit knowledge. Researchers such as Tsoukas (1996) say that separating tacit knowledge and explicit knowledge is missing the point. Tacit knowledge and explicit knowledge are complementary. Tacit knowledge is difficult to articulate, and transfer. If the knowledge is not transferrable then it will only be useful to the holder.

The researcher agrees with Nonaka that explicit knowledge is derived from tacit knowledge. Explicit knowledge is articulated tacit knowledge. That means that without tacit knowledge there will be no explicit knowledge. On the other hand the researcher supports Tsoukas' notion that the two must not be separated, they are complementary. Without tacit knowledge, there would be no explicit knowledge.

In order for knowledge to be used, it has to be transferred. The following section will discuss how knowledge is transferred in organisation.

2.3. Knowledge transfer

Knowledge transfer plays a major role in teaching and research in institutions of higher learning. According to Major and Cordey –Hayes (2000, p.412) "Knowledge transfer is the conveyance of knowledge from one place, person, ownership to another." They state that more than one party is involved in the knowledge transfer process. There must be a source and a recipient for knowledge transfer to take place. Li and Gao (2003) give a business definition of knowledge transfer as associated with the emulation and continuous learning from competitors in market or licensed from investors. O'Dell and Grayson (as cited in Goh 2002) suggest that transferring knowledge can yield enormous benefits to an organization. Nonaka (as cited in Sarker, Sarker, Nicholson & Joshi, 2002) suggest that one important aspect of knowledge management is the transfer of knowledge from one set of individuals to another.

Szulanski (as cited in Sarker et al., 2002) defines the process as where complex, causally ambiguous set of routines are recreated and maintained in a new setting. Argot and Ingram (as cited in Sarker et al., 2002) define knowledge transfer as a process in which a unit (e.g group, department, or division) is affected by the experiences of another. Knowledge transfer can occur across multiple levels, such as between individuals, teams, and organizations. It

can be argued that with the increase in globalization, knowledge transfer may also occur between individuals, teams and organizations that are separated by geographic distances and nation's cultures.

Knowledge transfer researchers have attempted to investigate knowledge transfer at all the three levels, though mostly within local settings, and seldom across cultures (Sarker et al., 2002). Goh (2002) identifies three important factors that enable knowledge transfer in organizations; organizational culture, knowledge recipient and support structures. It is stated by Goh that co-operation and collaboration are critical knowledge transfer cultural dimensions. Goh further states that the knowledge transfer process requires the willingness of a group of individuals to work with others and share knowledge to their mutual benefits. Goh also states that support structures are important in the transfer of knowledge, that is a proper infrastructure is required for knowledge to be transferred. One solution suggested is that organizations must develop horizontal communication flows, which goes beyond technology. Goh states that cross functional teams and team work in the organization can be encouraged as an approach to develop horizontal communication.

The recipient of the knowledge also plays a role in the knowledge transfer process. If the recipient is not willing to accept the knowledge being transferred, the process comes to a stop. Goh (2000) states that a recipients lack of motivation, absorptive capacity, and retentive capacity can lead to poor knowledge transfer. Roberts (as cited in Foos, Schun & Rothenberg, 2006) suggest that an important factor in the tacit knowledge exchange process is trust. Roberts contends that the levels of risk uncertainty that are associated with the transfer of tacit knowledge are decreased by a relationship based on trust.

Oldenkamp (2001), states that knowledge sharing can be encouraged by motivating employees to share knowledge. Motivation can come in a number of ways. He states that one way is rewarding employees for sharing knowledge. He is of the opinion that a durable foundation is laid when organizations persuade their staff that knowledge sharing is useful. Oldenkamp also believes that knowledge sharing can be encouraged by increasing the skills for knowledge sharing. He states that, that can be achieved by improving the skills they need for knowledge exchange through technically oriented training courses and by management competence. He also states that improving the opportunities for knowledge sharing and broadening the perceptions for knowledge sharing through coaching can encourage knowledge transfer.

Argot and Ingram (2000) provide a perfect definition of knowledge transfer that relates to the study. They don't only talk about organisational knowledge transfer but also talk about knowledge transfer between individual and teams. In the study, knowledge transfer happens between students doing team work. When students are engaged in a project, they share ideas, beliefs, and experiences. They consult written sources such as books and the Internet to gain more knowledge on their project. During these processes, they transfer knowledge within the project team.

The knowledge that they transfer is important for the completion of their project tasks. Most researchers agree on the fact that for knowledge to be transferred there has to be a sender and receiver and a communication medium. The study used a mobile phone as a knowledge transfer medium.

Knowledge transfer researchers have come up with models that explain how knowledge is transferred between individuals, teams and organizations. These models form two categories; epistemological and ontological. The following section will discuss three knowledge transfer models. These models are important to the study because they an insight how knowledge is transferred between individuals.

2.4. Knowledge Transfer Models

Knowledge transfer models found in the knowledge transfer literature explain how knowledge is transferred from the source to the recipient. These models also explain how knowledge is transferred at different levels of the organization and between individuals. The following subsection will discuss three knowledge transfer models that are relevant to the study. No model is used the study, but they are discussed only to guide the study on how knowledge is transferred.

2.4.1. Nonaka's SECI model

It is assumed that knowledge is created through the conversion of tacit and explicit knowledge in four modes of knowledge conversion; from tacit to tacit, from tacit to explicit, from explicit to explicit, and from explicit to tacit (Nonaka, 1994). These four modes are called socialization, externalization, combination, and internalization (SECI). According to McAdam and MaCreedy (1999) the SECI model assumes that tacit knowledge can be transferred through a process of socialization into tacit knowledge and that tacit knowledge can be transferred to explicit knowledge is a process of externalization. Explicit knowledge can be converted to explicit knowledge is a process of combination. Explicit knowledge can also be converted to tacit knowledge in a process of internalization. Nonaka (1994, p.20) states that "there are various triggers that induce the shifts between different modes of knowledge conversion." The first mode, socialization starts with the building of a team or a

field of interaction. The second mode, externalization is triggered by rounds of successive meaningful dialogue. The third is triggered by coordination between team members and other sections of the organization and the documentation of existing knowledge. The last mode, internalization is triggered by the learning and doing process (Nonaka, 1994).

2.4.2. Hedlund's N-Form Corporation Model

According to Hedlund (1994) the N-Form model emphasises on the interplay between articulated (explicit) knowledge and tacit knowledge at four different levels: the individual, the small group, the organization, and the inter-organizational domain. The model first distinguishes between tacit and articulated knowledge, and then distinguish between the four different levels of carriers of knowledge: the individual, the small group, the organization, and the inter-organizational domain (Hedlund, 1994).

The model distinguishes between three aspects of knowledge: cognitive knowledge, skills and embodied knowledge. The model provides processes in which knowledge can be transferred within the organization. It shows that articulated knowledge can be transferred to tacit knowledge in a process of internalization, and that tacit knowledge can be transferred to articulated knowledge in a process of articulation. Hedlund (1994) states that articulation is important in facilitating information transfer, and its expansion and improvement because it allows close scrutiny and critical testing. The model shows that knowledge can also be transferred from lower to higher levels in explicit or tacit form through a process called extension. The model also shows how organizations teach new employees about their products and indoctrinates them on the organizational culture in a process of appropriation. The interaction of extension and appropriation is called dialogue, and it takes place at the tacit level. Lastly the model shows the inputs and outputs of knowledge which are articulated or tacit in a process of assimilation and dissemination (Hedlund, 1994).

2.4.3. Sarker's four Cs Framework

Sarker et al. (2002) developed the four Cs (capability, credibility, communication, culture) framework. The framework states that a knowledge source (capable source) has the ability to transfer knowledge than a source that has limited ability. The framework also emphasizes on credibility. It states that a trusted source with a high reputation will easily transfer knowledge than a source that is considered untrustworthy. Communication and culture also play a vital role in knowledge transfer. The model states that communication alleviates anxiety caused by misinformation and facilitates interaction between individuals, which assist in the creation of a shared meaning within which the transfer process can be facilitated.

The SECI and the N-Form models are almost similar because they both focus on the interplay between tacit and explicit knowledge. The difference is that, the SECI model focuses on how knowledge is created and transferred. It focuses on the organization, individuals and teams. The N-form model focuses on teams, individuals, organization, and inter-organizational domain. The four Cs framework is different from the two. It is not concerned about the interplay between tacit and explicit knowledge but focuses on the sender and recipient of knowledge. It focuses on the factors that influence both the sender and recipient to transfer knowledge. All three models are relevant to the study, but the N-form is more appropriate because it focuses on team knowledge transfer.

The knowledge transfer process is not without problems. At times knowledge is not transferred the way the source and the recipient anticipate it to be transferred. There are impediments that prevent the smooth transfer of knowledge to be transferred. Four knowledge impediments are discussed in the following section. These impediments are the major impediments that affect project teams.

2.5. Impediments to Knowledge Transfer

The knowledge transfer process is however fraught with difficulties (Gammelgaard, Husted and Michailova, 2004). Earlier studies have identified various impediments to knowledge transfer. For instance, impediments caused by: knowledge characteristics (Kogut and Zander, 1992); participant characteristics (Cohen and Levinthal, 1999); context in which transfer takes place (O'Dell and Grayson, 1998), and many others. However, not much work has been done to investigate the impact of these impeding factors on knowledge transfer in specific settings, e.g. student project teams where mobile phones are used.

One of the main objectives of group learning is to enable students construct their own knowledge landscapes through sharing, collaboration and communication of ideas (Blumenfeld et al, 1991; Disterer, 2002; Frank et al, 2003). In order to achieve this objective, there must be strong relationships that encourage intrinsic motivation to cooperate (Osterloh and Frey, 2000). Cooperation and willingness to transfer knowledge is also influenced by the nature of knowledge and the strength of social ties between the parties (Levin and Cross, 2004). Furthermore, recent reports on students' attitude about transfer of learning suggest that time pressure and the need to meet the demands of instructors can inhibit effective transfer of acquired knowledge (Lightner, Benander and Kramer, 2008). In the present study, the researchers will investigate the extent to which the nature of knowledge transferred, social ties, motivation and time can be minimised by the use of mobile phones. These impediments are discussed in more detail below.

2.5.1. Nature of knowledge Impediment

The nature of knowledge is the interplay between tacit and explicit knowledge. Literature states that tacit knowledge is not easy to share because it is buried in people's minds and thus hard to articulate. Explicit knowledge on the other hand is easy to share. Gammelgaard et al., (2004) states that, a well-described impediment for efficient knowledge sharing is related to

the differences between tacit and explicit knowledge. This is because tacit knowledge is more sticky and difficult to share than articulated knowledge. Fernie et al. (2003) state that sharing tacit knowledge in projects is more complex because it is difficult to extract from the knower. That means the knowledge being tacit causes an impediment to knowledge transfer.

2.5.2. Time Impediment

Disterer (2002) states that only a few organizations manage to identify and transfer valuable knowledge from completed projects to following projects. He states that project knowledge is rarely captured or retained so that people who were not part of the project can retrieve and apply it to future tasks. He states that, it is because project work normally is pressed by time, therefore team members are sometimes required to immediately join other project teams after the completion of the project. These sentiments are shared by Eppler and Sukowski (2000) who state that collective knowledge creation and transfer is often difficult due to time.

In universities, students always complain about having little time to complete their projects (Yamane, 1996). With limited time, they are unable to share more useful knowledge among themselves. They rush to finish their projects because of deadlines. Even after finishing their projects, they don't have time to evaluate their project and share the knowledge gained from that project. The lack of time also prevents them from acquiring knowledge gained from past projects. Therefore time becomes an impediment to knowledge transfer.

2.5.3. Social Ties Impediment

Disterer (2002) also states that individual and social barriers exist to articulating and documenting individual knowledge, thus making it difficult for project knowledge to be articulated and documented. Fernie et al. (2003) highlights social network linkages as enablers of knowledge transfer in project teams. But on the other hand they can become

impediments to knowledge transfer if social ties are weak. This is in line with Szulanski's (1996) assertion that an arduous relationship is an impediment to knowledge transfer.

2.5.4. Motivation Impediment

Schindler and Eppler (2003) identify motivation as a major impediment to knowledge transfer. They state that lack of motivation prevents the transfer of knowledge in organisations. Lack of motivation affects the smooth transfer of knowledge (Manno & Walker, 2006). Motivation can come in different ways: incentives, image, social ties and power. Individuals will share knowledge if they are motivated (Wasko & Faray, 2005).

Jewels and Ford (2006) state that individuals will be motivated to share knowledge if they believe that it will contribute to team success and project practices. These knowledge transfer impediments affect student project teams. Students fail to share knowledge because of lack of motivation, time constrains, weak social ties and being unable to express themselves clearly.

Theories can be used in investigating knowledge transfer impediments. The interdependence theory can be used to study knowledge transfer impediments. The theory was developed by Kelley and Thibaut in 1978. The theory distinguishes between two individuals acting alone and exchange between them who are influenced by their social and organizational context (Constant, Kiesler & Sproull, 1994). The theory states that when two individuals acting alone share information, their behaviour is predicted by reciprocity and rational self interest. The individuals help each other because they have been helped before. People acting on social and organizational context, are less likely to retaliate negative behaviour because they are concerned about their future relationships with others, the balance of power, how others see them, and the impact of their behaviour on other desirable goals. The theory can shed light on how group members influenced by social and academic context share knowledge among themselves.

The study did not adopt any existing theory to guide it. This is because; a theory was developed from literature. The following section will discuss project based learning. The project based learning literature sheds light on how projects are carried out in universities.

2.6. Project based Learning

Students engaged in projects, create, transfer, and apply knowledge in their projects. The knowledge that is created during those projects can be transferred and applied in the university and in other organizations. This section will discuss project based learning.

Chinowsky, Brown, Szajnman and Realph (2006) states that project-based learning (PBL) is based on the concept that students should not be passive recipient of knowledge. Therefore, universities should provide students with a conducive environment to construct their own knowledge landscapes.

Thomas (as cited in Frank, Lavy & Elata, 2003) states that PBL is a model that organizes learning around projects. According to Blumenfeld, et al. (1991), PBL is a focused on teaching by engaging students in investigation. Students pursue solutions to nontrivial problems by asking and refining questions, drawing conclusions, communicating their ideas and finding to others, and creating artefact. Rhem (1998) defines PBL as learning that results from working with problems. He states that officially PBL is described as a strategy in which students confront contextualized, ill structured problems and strive to find meaningful solutions.

Thomas (as cited in Frank et al., 2003) emphasizes that in the PBL environment, students investigate solutions to a problem. He states that students build their own knowledge by learning actively, interacting with the environment, work independently, or collaborating in teams, while the teacher directs and guides, as they make a real product.

Gil and Julia (2006) state that the main goal of the methodology is that students pose a problem and find a solution strategy by themselves.

Krajcik et al. (as cited in Frank et al., 2003) suggest four benefits for the student. Firstly, learners develop deep integrated understanding of content and processes. Secondly, students learn to work together to solve problems. Thirdly, Krajcik argues that this approach encourages independent learning. Lastly, it engages students in various types of tasks, thereby meeting learning needs of many different students.

The pillar of project based learning is students' teams. In universities most projects are conducted by teams of students. The following section will discuss team learning.

2.7 Team Learning

More higher education institutions are assigning students to work in teams to solve real world problems (Gamson, as cited in Colbeck, Campbell & Bjorklund, 2000). The trend has been stimulated by potential employers of graduates, accrediting agencies and educators who support cooperative learning (Gamson, as cited in Colbeck et al., 2000). Organisations emphasise on teamwork because they rely more on teams to improve productivity. Ulloa and Adams (2004) state that the business sector has encouraged higher education institutions to prepare students to be effective team players.

There are two main types of team learning in schools; collaborative learning and cooperative learning. Haller, Gallagher, Weldon and Felder (2000) state that cooperative learning is based on the premise that students learn better if they interact with one another rather than through a one way learning process. The term 'collaborative learning' is usually used to explain group learning. Bruffee (as cited in Yamane, 1996) states that collaborative learning is a form of

indirect teaching whereby the teacher sets the problem and organises the students to work it out collaboratively.

Springer, Stanne and Donovan (1999) differentiates between collaborative learning and cooperative learning. They state that cooperative learning is structured and systematic instructional strategy in which teams work together to achieve a common goal. Haller et al. (2000) states that cooperative learning is based on the notion that learning is best achieved when there is interaction rather than when there is one way transmission. When students form team, they apply one of the methods of group learning.

Team learning theories

There are a number of theories developed for team learning. The social constructivist theory and the small group learning theory are relevant to the study. These theories highlight the importance of students' social ties in learning environment. Social ties can be an enabler or impediment to knowledge transfer. It is important to understand these theories because they explain how social ties help students learn. The theories are discussed in the following section.

2.7.1. The Social Constructivist Theory

The social constructivist theory is presented by Kenneth Bruffee in his writing on collaborative learning (Bruffee, 1984). In the theory, Bruffee states that human beings are distinguished from other animals by their ability to participate in unending conversation. He states that conversation is reflective thought. That means, when human beings engage in conversation, they are expressing their thought. He argues that human thought is "consummately social: social in its origins, social in its functions, social in its forms and social in its applications (Bruffee 1984, p. 639)". It is further stated by Bruffee that reflexive

thought is related causally to social conversation (that is, people learn from others). The learning is being facilitated by the social relationship that people have with each other.

The theory further state that when people think collectively, they form social communities that promote the same thinking for all members. The communities act as a catalyst to knowledge creation. Because people are socially connected in these communities, they are able to converse. Bruffee then suggests that teachers must engage students in conversation among themselves thus forming communities to create knowledge. Through this process students will learn collaboratively. He argues that "collaborative learning provides a social context in which students can experience and practice the kinds of conversations valued by teachers". He further argues that "Collaborative classroom work guided by a careful designated task makes students aware that writing is a social artefact, and that it also provides "a particular kind of social context for conversation, a particular kind of community- a community of status equals: peers" (Bruffee 1984, p. 642). That is, student teams doing collaborative work form small communities of knowledgeable peers. This community is guided by the same paradigms, values and assumptions.

2.7.2. Small Group learning theory

Smith and McGregor (1992, p. 1) state that, "collaborative learning is a joint intellectual effort by students, or students and teachers together," In their theory of small group learning, they assume that, learning can take a variety of forms. They assume that the learning process is an active, constructive process. They state that students must actively learn by combining new material with what they already know and create new knowledge. They further assume that learning depends on rich context. That is, students must immerse themselves in a specific context and solve problems collaboratively. The theory also assumes that learners are diverse therefore they bring multiple perspectives to the classroom. Lastly the theory assumes that

learning is social. Students talk to each other, and it is this talking that enables them to learn (Smith & McGregor, 1992).

These theories provide assumptions about how student teams learn cooperatively and collaboratively. They provide different assumptions of course which can be tested using empirical data. All three theories discussed above provide very important assumptions. The literature shows that social ties are very important in knowledge transfer. The stronger they are the better knowledge is transferred. That is possible in student project teams. It has observed that student are more comfortable doing group work with their peers. Therefore the social constructivist theory raises important assumption on how teams must the formed.

University students' project teams face the same knowledge transfer impediments that are faced by project teams in other organisation. When students fail to transfer knowledge, their work is affected. This leads to poor quality work or unsuccessful completion of their projects. However technology and other technological devices can help project teams to overcome these challenges. A mobile phone is one such device. The following section will discuss in detail mobile phones and how their features and services have been used in learning environments for knowledge transfer purposes.

2.3. Summary

The chapter provided a distinction between data, information and knowledge. It has been observed from the literature that different fields interpret data, information and knowledge differently. Knowledge transfer and four knowledge transfer models were also discussed. These models shed light on how tacit and explicit knowledge is transferred at individual, group and organisational levels. Four knowledge transfer impediments were discussed; social ties, motivation, nature of knowledge, and time. Lastly, the chapter discussed project based learning and group learning theories.

Chapter 3: Mobile phones (Cell phones)

3. Introduction

This section will discuss mobile phones and how they can be used in knowledge transfer. It is believed that mobile technologies and modern mobile phones can play a role in knowledge transfer. The following section will discuss instances where mobile phones have been used for knowledge transfer. The focus will be on the use of mobile phones for learning purposes.

The mobile phone is not used only as a communication device, but it can also be used in knowledge transfer. Some features and services (text, graphics and voice) of the mobile phone support knowledge transfer. If these features can support knowledge transfer, it means they can help minimise knowledge transfer barriers. The mobile phone is a communication device that is widely used in South Africa. It is therefore assumed that it is also widely used by students. Students use their mobile phones for different purposes; therefore it is possible to use them in their projects. The following section will discuss the mobile and phone its features and services that can support knowledge transfer.

Mobile phones are devices that establish voice (sound), text and graphic links between people in order to exchange information and in this way can give support to the teaching and learning process. This means getting information from a source; putting questions to and getting answers from a tutor; and exchanging ideas between students. (Benta , Cremene & Padurean, 2004)

Laudon and Laudon (2006) state that mobile telephones work by using radio waves to communicate with radio antennas placed within adjacent geographic areas called cells. They further state that a telephone message is transmitted to the local cell by the mobile telephone

and then passed from antenna to antenna – cell to cell until it reaches its destination, where it is transmitted to the receiving telephone. Older cellular systems were analog and newer systems are digital.

Mobile phone technologies have been available for three generations. The 1st generation (1G) mobile phone technology was invented in the early 1980s. From then to the end of the 1980s mobile phones grew in popularity due to the innovations in cellular networks. Most mobile phones weren't made to be carried; they were made for car installations. (http://www.tech-faq.com/history-of-cell-phones.html)

Second generation (2G) mobile phone technology came in the early 90s. They are able to work on mobile phone systems such as the Global System for Mobile Communication (GSM), time division multiple access (TDMA) and code division multiple access (CDMA). Digital mobile networks were used in the United States and Europe in 1990 and 1991. 2G mobile phones use digital circuit switched transmissions. They enable quicker network signalling, lowering the amount of dropped calls and increase call quality. (What is the History of Cell phones, n. d.)

3G is the technology that is currently available today for mobile phones. 3G enabled mobile phones include innovations to receive much more than phone calls, for instance SMS text is available, MMS, e-mail and Internet access. Currently 3G technologies are continuing to improve and new innovations such as streaming radio and television, as well as WiFi are currently breaking into the market. 3G enabled mobile phones can fully support knowledge management (What is the History of Cellphones, n. d.). This technology does not provide quick communication, but also enables users to create and share knowledge.

The following section will discuss major mobile phone features and services that support knowledge transfer. The section will also discuss how these features and services have been used for knowledge transfer purposes.

3.1. Major Mobile Phone features and services

Mobile phones' features and services have been extensively developed since the first mobile phones were used. Today's 3G enabled mobile phones have features and services that fully support the knowledge transfer process. These features play a vital role in the transfer of both tacit and explicit knowledge. Literature shows that the mobile phone has been used in learning environments which includes knowledge transfer.

3.1.1. Voice

Earlier mobile phones we invented to transmit voice only. Today mobile phones have a number of voice functions embedded into them. 3G enabled phones have voice capabilities like, the voice mail, whereby a mobile phone records voice messages when the user has switched off the mobile phone. Prensky (2004) states that students can learn languages, literature, public speaking, writing, storytelling and a lot of other subjects that are adaptable to voice technology. Other voice services include the push to talk technology and speaker phone.

These services can be used to transfer knowledge tacit knowledge in project teams. A group can hold a mini-conference with another group that is in another location with the help of the voice. They can brainstorm and share ideas over the phone. Voice services could help to minimise the nature of knowledge impediment by allowing teams to share tacit knowledge.

3.1.2. Messaging services (SMS and MMS)

Another feature that can support the knowledge transfer process is the text messaging service. Mobile phones offer a number of text messaging services. The short messaging service (SMS) and the multimedia messaging service (MMS) are the most common. Mobile email is also gaining popularity. A SMS is a text message that can be sent to a recipient. SMSs are popular because they provide a simple and cheap way of communication. MMS allows text, colourful images, video and voice clips and animations to be sent with a text message (Prensky, 2004).

Prensky (2004) is of the opinion that in schools (and universities), SMS and MMS can be used to conduct pop-up quizzes, spelling test, math test, to notify students about current events and even to tutor students. There are a lot of SMS and MMS based services being provided by the private and public organizations in South Africa. Such services include news, dating, mobile-banking (m-banking), job applications and health services (Goldstuck, 2007). What mobile phone users have to do is to SMS a certain number to the services provider and acquire that service. For example, a user can SMS a certain number to the South African Broadcasting Corporation (SABC) and get the latest news. SMS and MMS and email can be used to transfer explicit knowledge.

Students have used such services to share knowledge. Through video conferencing, they can discuss and share ideas over the phone. Pictures are also used to convey knowledge. Pictures are taken by students using their mobile phones for further analysis. Like voice services, they could be used to minimise the nature of knowledge impediment but transferring explicit knowledge.

3.1.3. Downloadable Programs

Prensky is also of the view that mobile phones are capable of downloading programs. It means a new learning world has been opened. Music is the most downloaded product by mobile phone users. Programs including browsers, fax senders, programming languages can be downloaded to a mobile phone and used for learning purposes.

3.1.4. Internet Browsers

3G enabled mobile phones have the ability to browse the Internet. Prensky states that having a browser in the cell phone enables students to access Internet resources like dictionaries, thesauruses, and encyclopedias. Mobile phone browsers enable knowledge creation and transfer. Students have access to search engines where they can search for more information and create knowledge. Internet browsers allow information to be transferred over the internet in less time. Emails, chatting services, blogs, and discussion forums allows the quick transfer of knowledge, thanks to web browsers. Internet browsers can minimise the time impediment.

3.1.5. Cameras and Video clips

Prensky argues that, a mobile phone with a camera can provide possible tools for scientific data collection, documentation, and visual journalism. It allows students to gather evidence, collect images and follow progress overtime. Prensky also states that creative mobile phones can inspire students, to write creatively via caption or story contests, and that phones can be placed at strategic places and operated remotely and observe where a human being could have not been able to observe. Explicit and tacit knowledge can be transferred easily by using cameras and video. The camera transfers explicit knowledge and the video both. Recorded lectures and discussion forums can be recorded and passed over to group members by video.

3.1.6. Global Positioning System (GPS)

GPS is a satellite navigation system that is capable of giving precise directions and locations. Prensky states that this feature allows mobile phones to precisely specify any location. It is stated that students can use their mobile phones to get information about wherever they are – in the city, campus, countryside, township or in the bush. This technology has clear applications in geography, archaeology, architecture, mathematics, science and other subjects. The GPS is an important service especially for geography students. It is used for providing directions. It can be used to transfer explicit knowledge in the form of maps. Maps provide deep knowledge about the environment. Such knowledge can be shared by using GPS. The nature of knowledge impediment can be addressed by using GPs.

All the discussed mobile phone features play a very important role in the knowledge transfer process. These features can support the creation, transfer, storage and application of both tacit and explicit knowledge. In a learning environment, students can exploit such features to create and transfer knowledge thus minimising of knowledge transfer impediments. The following section will briefly discuss the use of the mobile phone in a learning environment. The section is important because it will help bring to attention how the mobile phone has been used for learning purposes. Learning involves knowledge creation and transfer (Newell, 2005).

The above discussed mobile phone features and services can help minimise knowledge transfer barriers. The nature of knowledge impediment can be addressed by voice services because they can transfer tacit knowledge. Time, motivation, and social ties can be addressed by a combination of all the other features and services.

3.2. Studies conducted using the Mobile Phone in a learning environment

Several studies have been conducted on mobile learning. Most of the studies, mobile phones were used as primary learning tools .The following section will discuss a few studies that have been conducted in learning environments where the mobile phone was used as a learning tool. This section is important for the study because it will shed light on how other researchers have used the mobile phone in learning the environments.

Research has been conducted in mobile commerce (M-commerce), mobile learning (M-learning), and to some extent mobile government (M-government). Benta, Cremene and Padurean (2004) conducted a study in a biology lesson in which a class of students had to recognize a plant. A text description of the plan was submitted by SMS and the picture of the plant was submitted by MMS. The students were required to access an encyclopedia and send a plant picture to an artificial intelligence image service that detected the plant. Students were using the Wireless Application Protocol (WAP), and MMS enabled mobile phones to access information. The aim of the study was to present a new mobile-learning service allowing interactivity between the students and access to information sources via WML and MMS.

Nakahara et al. (2003) conducted a study to investigate whether iTree (a Java application that encourages learners to participate in online bulletin boards systems forums) does indeed motivate learners to be more involved in collaborative learning. They stated that because of the high mobile phone penetration rate, many educators believe that mobile phones have the potential to be learning tools. They further state that some educators have incorporated mobile learning into their curricular. They state that there are categories of mobile phone usages in learning: students send course evaluations and comments via a mobile phone.

Secondly mobile phones are now capable of running language study materials, such as drills and educational game applications. Thirdly, they cited Yamaoka stating that, schools

distribute to students official notices regarding class cancellations, scheduling changes or job seminars via mobile phones. Their study found that the program encourages learners to engage in forum exchange in a positive light, and that may learners have come to regard the program as a useful learning tool. Citing Gutwin, Stack and Greenber, they further state that previous research has showed that learners do not only share knowledge but also get the awareness information about status interaction.

Nonyongo, Mabusela and Monene (2005) also carried out a study based on the SMS service. They investigated whether communication is possible between distance education students and their university using SMS. Their study found that students would be very pleased if their institution would communicate to them through SMSs.

Lindquist, Denning, Kelly, Malani, Griswold, and Simon (2007) states that mobile phones have become ubiquitous on university campuses, and it is natural to ask whether they can be used to improve education. They further state that, mobile phones seem to hold promise for enabling large scale participatory learning. They state that the SMS and MMS can be used to support text and photo messaging for in-class communication. The researchers conducted a study to investigate the effectiveness of using a mobile phone on learning. Students submitted their tasks using SMS and MMS. The SMS was used for text only submissions and MMS for photo submission. During the study, students were given multiple choice questions, short answer problems, mathematical problems, code writing, and diagrammatic problems of which they all submitted their solutions through the mobile phone.

Derballa and Pousttchi (2004) conducted a study that examined the capabilities and limitations of mobile technology usage in order to support knowledge management. They identified mobile devices that can be employed in knowledge management. Such devices include tablet PCs, PDAs, and mobile phones. They state that mobile technology can be

applied in a number of situations in knowledge management including knowledge transfer. It can be used in mobile information exchange which includes data transfer and information transfer, as well as operational systems used in organizations.

They further state that mobile technology can also be used in mobile business intelligence which refers to the access of processed enterprise data using mobile devices, and lastly in mobile communication techniques in conjunction with mobile devices that are employed for the creation, validation, presentation, distribution and application of knowledge. They identify four cases in which mobile technology can be applied. It can be applied in knowledge creation through virtual teamwork, knowledge validation in the case of lessons learned database, knowledge distribution through case based reasoning (CBR), and knowledge application with virtual reality (VR).

3.4. Summary

Chapter three provides literature on mobile phones. The chapter discusses how mobile phones are used in academic environments for knowledge transfer purposes. First, the chapter defines mobile phones and provides the history of mobile phones. Then it proceeds to discuss mobile phone features that have been used in academic environments and how they have been used. Lastly it reviews literature on studies conducted using mobile phones in academic environments.

Chapter 4: Research Theory

4. Introduction

Literature shows that there are impediments to knowledge transfer in project teams (Disterer, 2002; Eppler & Sukowski, 2002; Gammelgaard et al., 2004; Schindler & Eppler, 2003). These impediments interfere with the successful completion of projects because they prevent knowledge from being shared by team members. There are many impediments to knowledge transfer. For the purposes of the study four impediments are included in the research framework. They are: the nature of the knowledge transferred (tacit or explicit), social ties, time, and motivation. These impediments were selected because it emerged from the literature that they affect project teams in academic and non academic organisations. The nature of knowledge transferred refers to the tacitness and explicitness of the knowledge. These four knowledge transfer impediments have been chosen because they affect mostly project teams.

The researcher has observed over the years that students chose their friends when forming project teams. That means students with strong social ties prefer to work together than those with weak social ties. There is never enough time for students to finish their projects (Yamane, 1996). They also hurry to meet deadlines. Motivation is another factor that contributes to easy knowledge transfer in students' project teams. If excellent project are rewarded with extra marks and praise, student would be highly motivated to complete their projects. Literature shows that these two types of knowledge are transferred at different speeds. Tacit knowledge is said to be sticky and therefore difficult to articulate and transfer. Explicit knowledge on the other hand is said to be easily articulated and easy to transfer (Szulanski, 1996).

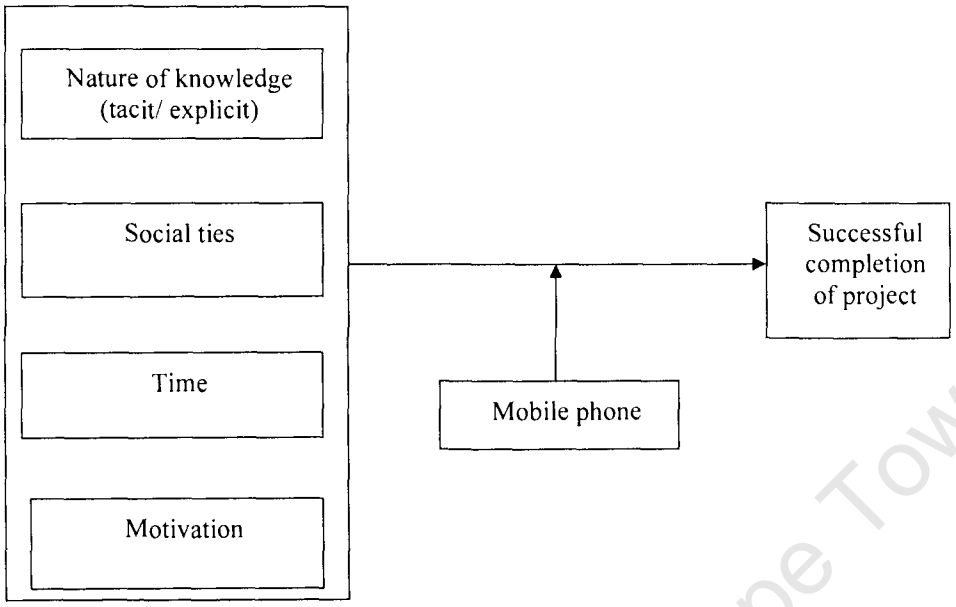
Social ties play a very important role in the transfer of knowledge between group members. Strong social ties influence knowledge transfer and weak social ties are said to impede on knowledge transfer (Disterer, 2002). Time is also important in the knowledge transfer process. If project teams have more time to complete projects, it would be possible to document lessons learned for future purposes. They would also not rush to meet deadlines thus allowing more time to conduct a post mortem of the project where experiences can be shared. Motivation also plays an important role in the knowledge transfer process. High motivation leads to knowledge transfer and low motivation acts as an impediment to knowledge transfer (Manno & Walker, 2006).

The development of mobile technology and mobile devices such as mobile phones has improved the level of communication. It is therefore assumed that improved communication improves knowledge transfer. As a communication device, it is also assumed that a mobile phone can play a major role in improving knowledge transfer in students' project teams by minimising knowledge transfer impediments.

The research model is depicted in figure 2. The diagram shows the knowledge transfer impediments. The mobile phone used to try and minimise the knowledge transfer impediments. The intervention of the mobile phone leads to improved knowledge transfer. Improved knowledge transfer leads to the successful completion of projects.

4.1. Research Model

Figure 2: Research Model



4.2. Research Hypothesis

Drawing from the knowledge transfer literature the following hypothesis were developed. These hypothesis are going to be tested by empirical data to find out if a mobile phone indeed can help in breaking knowledge transfer impediments. The results are presented in chapter 4.

H1: Strong social ties encourage the use of mobile phones to transfer knowledge.

Learning begins with individuals, then to team, to the organisation and at inter-organizational level (Sun & Scott, 2005). Learning occurs in the organisation as a social process (Bawden & Zuber-Skerritt, 2002). Learning involves knowledge transfer. Knowledge sharing is not only encouraged by technological factors but also by relationship factors. Employees with good social ties share knowledge voluntarily, and unconditionally. A bad relationship between employees leads to conditional knowledge transfer, or no knowledge transfer at all (Liao, Chang, Cheng & Kuo, 2004). Social ties play a very important role in knowledge transfer. A social context includes relationships, awareness, common ground, and incentives (Thomas, Kellogg & Erickson, 2001). They further state that such social ties factors affect knowledge transfer.

Mobile phones on the other hand have revolutionized the way people operate within their social networks, with family, friends, and colleagues. Mobile telephony grants people including students, new communication access. Mobile phones in social networks support relationships and increased access and relevance of membership in a network of social relationships and the expansion of these social networks (Palen, 2002).

H2: Students who use mobile phones during a project are motivated to participate in knowledge sharing with their peers.

Lack of motivation affects the smooth transfer of knowledge (Manno & Walker, 2006).. Individuals will share knowledge if they are motivated (Wasko & Faray, 2005). Jewels and Ford (2006) state that individuals will be motivated to share knowledge if they believe that it will contribute to team success and project practices.

A mobile phone plays a role in motivating students to learn. The ease of use of the mobile phone also motivates students to use it for information and knowledge transfer purposes. Specific areas related to ease of use are: ease of phone navigation, clarity of text on the display screen and understanding how to operate the handset when purchased (Polack, 2006).

Nakahara et al. (2003) conducted a study whereby students had to use their mobile phones to identify a plant, take a picture of that plant, explain it and send the answers by mobile phone. They found that "when a learner gets a message from others, they feel like checking it and feel confident that their messages are relevant and useful for others (Nakahara et al.. 2003, p. 477)." A study of undergraduate students using the mobile phone to ask questions from each other found a "heightened student motivation". By this a learner is motivated to participate in online discussion (Lindquist et al., p. 384). Based on the findings of Nakahara and Lindquist studies, the researcher therefore hypothesises that students who use mobile phones during a project group are motivated to share knowledge. The fact that they can communicate with their group members at any time motivates them to use their mobile phones to share knowledge.

H3: Students who use mobile phones in project teams will articulate and transfer tacit knowledge easily

Tacit knowledge is personal and difficult to formalise, making it difficult to communicate and share with others (Eflving & Funk, 2006). Tacit knowledge is elusive and subjective awareness that is difficult to articulate (Li & Gao, 2003). Students in a project group face a similar predicament. When they share tacit knowledge (ideas, instructions) they are not properly understood by the recipients. The sender has to articulate the knowledge first before it is understood and used by the recipient.

A mobile phone can help overcome such impediments. Services such as SMS, MMS and features like video and camera can be useful in the articulation of tacit knowledge to explicit knowledge. Lindquist, et al. (2007) state that services such as the SMS and MMS support text and photo messaging for in class communication. They further state that mobile phones are promising to support classroom active learning.

H4: A mobile phone can help transfer knowledge between group members in less time than face-to-face-interaction

Project teams are usually temporal. They are disbanded after finishing their respective projects. Project teams lack time to transfer knowledge because they have to meet deadlines and teams are disbanded and integrated to other project teams. This causes individuals to lack time to contact and interact with others thus making it difficult for knowledge to be transferred (Riege, 2005). After a project team has been disbanded, team members take their new experiences with them, making those experiences available only in informal networks (Schindler & Eppler, 2003).

A mobile phone can overcome such barriers to knowledge transfer. It can be used to share that knowledge that has gone with the individuals. The ability of the mobile phone to be ubiquitous can help students to overcome this impediment to knowledge transfer. Ubiquity is the possibility to send and receive data anytime and anywhere and thus eliminating spatiotemporal restriction (Deballa & Pousttchi, 2004). They are of the opinion that mobile devices such as the mobile phone accompany their user nearly anytime and anywhere which affects reaction time and convenience aspects of services. They further state that in a case whereby team members cannot meet face to face, can make use of mobile technology with a combination of video conferencing and work out solutions together while dispersed thus creating new knowledge in that process.

4.3. Summary

The research theory provides four knowledge transfer impediments. These four knowledge transfer impediments affect the transfer of knowledge between project group members. However the use of the mobile phone minimises the impediments. Minimising the impediments leads to the successful completion of projects.

Chapter 5: Research Design and Methodology

5.1. Introduction

This chapter presents in detail how the study was conducted. It presents the research paradigm that guided the study, the research methodology, data collection procedure, and research approach and data collection instrument. Research design involves a series of rational decision-making choices (Cavana, Delahaye & Sekaran, 2000). The chapter starts with the research paradigm of the study.

5.2. Research paradigm

A paradigm is a set of assumptions about knowledge and how it is acquired, and about the physical and social world (Hirschheim & Klein, 1989). A paradigm is also described as a set of philosophical beliefs about the nature of the world. It is a set of guidelines and principles concerning the way research is conducted. (Ticehurst & Veal, as cited in Cavana et al., 2000).

5.2.1. Philosophical perspectives

Adopting Deetz's (1996) framework, Schultzer and Leidner (2002) identify four scientific discourses to study knowledge management in organisations. They are normative, the critical, the interpretive, and the dialogic discourses (Schultzer & Leidner, 2002). These discourses have different research focuses, different metaphors of knowledge, different theoretical foundations, and different implications to knowledge management research. The research focus for the normative is the discovery of technology solutions. The metaphor is that of knowledge as an object that can be stored and manipulated in the absence of the human knower and can be transferable to others. Normative implications for IS research are specific design recommendations.

Research in the interpretive discourse focuses on the role of knowledge in organisational transformation and the role of technologies in supporting knowledge work (Schultzer & Leidner 2002). The knowledge metaphor is that of knowledge as a culture, knowledge as a situational practice, and knowledge as a symbolic capital.

The research focus on the critical discourse is on power relations in organisations. The knowledge metaphor is knowledge as a commodity. The implications for IS research is that system development methodologies and the IS professionals who apply it are not neutral (Schultzer & Leidner, 2002).

The research focus of the dialogic discourse is the dynamically intertwined and conflicting nature of organisational memory and organisational forgetting, as well as the implications of memory and forgetting on identity, visibility, and power. The knowledge metaphor is knowledge as a discipline. The implications for IS research include the role that technology plays in making invisible work visible, and the stakes that are involved in achieving this feat (Schultzer & Leidner, 2002).

Four research paradigms are given by Chua (1986). They are functionalist, interpretive, radical humanist, and radical structuralist. These paradigms emanate from the Burrell and Morgan framework (Chua, 1986). Hirschheim and Klein (1989) state that there are four research paradigms in IS research: functionalism, social relativism, radical structuralism, and radical humanism.

In their study of information systems research publications from 1983 to 1988, Olikowsky and Baroudi (1991) identified three main paradigms used in information systems research; the positivist, interpretive, and critical paradigms.

The main purpose of positivistic research is to test theory. Positivistic studies have formal hypothesis, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about phenomena from a sampled population (Olikowski & Baroudi, 1991). Epistemologically, positivistic research is premised on the existence of a priori fixed relationship within phenomena that is capable of being identified and tested via hypothetic-deductive logic of analysis (Pare, 2004).

Interpretive studies have gained a lot of attention in recent years as an alternative to positivist studies (Lee, 1991). Interpretive researchers take the position that people create physical reality examined by natural science. Interpretivism does not define dependant and independent variables (Myers, 1999).

Critical theory is a form of historical materialism and it is influenced by issues of class, ethnicity, and gender. It views situations through a lens of local domination by powers with the potential for local resistance (Brooke, 2002). Critical research is conducted by engaging with hermeneutic, critical theories, and qualitative methods. Specific causes such as feminism, environmentalism usually influence critical researchers (McGrath, 2005).

Five levels differentiate positivist and interpretive studies. The differences are at paradigm, ontological, epistemological, methodological, and axiological levels (Fitzgerald & Howcroft, 1998). Weber (2004) identifies seven differences between positivist and interpretive research namely ontology, epistemology, research object, method, theory of truths, validity, and reliability.

The study adopted Olikoswki's positivist framework. This framework helped the researcher to become an independent observer of phenomena by not interfering with research settings and the research objects. Positivistic studies aim at developing theory and test it using empirical data. A theoretical framework was developed from existing literature and tested using empirical data which is a requirement for a positivistic study.

5.3. Research approach

Two research approaches are common in information systems research; deduction and induction. Deduction involves developing a theory that is subjected to rigorous testing. It involves deducing hypotheses from theory, expressing the hypotheses in operational terms, testing the hypotheses, examining the specific outcome of the inquiry and modifying the theory if necessary (Saunders, Lewis & Thornhill, 2007). Inductive research approach is a study in which theory is developed from the observation of empirical reality, thus general inferences are induced from particular instances. (Collis & Hussey, 2003).

A deductive approach was adopted for developing a theoretical framework that guided the study. The framework was carefully developed from the knowledge transfer literature. Independent and dependent variables were identified, and hypothesis were formulated and tested with empirical data

5.4. Research methodology

Research methods in information systems are chosen depending on whether the study is qualitative or quantitative. Quantitative research methods are used to collect and analyse quantitative data. They include surveys, and laboratory experiments. Qualitative research methods include case studies, actions research, and grounded theory.

Pinsonnealt and Kraemer (1993) differentiate between a survey and survey research. They state that a survey collects information about the characteristics, actions, or opinions of a large group. Survey research on the other hand is a quantitative method, requiring specific information from or about the subjects being studied. The main method for collecting data is asking people structured and predefined questions. The data collected is collected from a general fraction of the study population (Pinsonnealt & Kraemer, 1993). A survey research is an investigation where systematic measurements are conducted over a series of cases, and where variables are analysed to see if they show any patterns. Survey analysis involves making casual inferences (Marsh, 1982).

Surveys research is undertaken for a wide variety of reasons. A survey research might be used to describe the characteristics of a population or research or search out relationships between variables, and testing hypothesis. Surveys can also be used to study various aspects of human behaviour (Sonquist & Dunkelberg, 1977).

The study adopted the survey research method. This is because specific information about how students use their mobile phones was to be collected. The questionnaire had structured questions to obtain such information.

5.5. Sampling Procedure

A sample is a fraction of a population. A population is the universe of inquiry. It could be people, organisations, events or items that are relevant to the research problem (McGiven, 2006). Two types of sampling techniques are common in information systems research; probability sampling and non-probability sampling. In probability sampling, the elements have a known chance of being selected (Proctor, 2005). In non-probability sampling, the probability of elements being selected is not known because the researcher might choose a particular element consciously or unconsciously (McGiven, 2006). Non-probability sampling

techniques include judgemental, convenience, purposive, and quota sampling. Probability sampling techniques include simple random, stratified, systematic, and cluster sampling (Tustin, Ligthelm, Martins & van Syk, 2005).

The study applied probability sampling techniques. Stratified sampling was used. Stratified sampling allows the grouping of the population into homogenous teams. The strata were formed from four departments. The departments were: information systems, computer science, civil engineering and construction economics and management. These departments were specially selected because there are a lot of team projects taking place. Team projects are started as early as first year in these departments. By the time students reach third and fourth year, they have a lot of experience in project work. That's why the study involved these departments.

5.6. Population

The population was students from the University of Cape Town (UCT). It comprised specifically, students doing project team work and students who had previously done project team work. The researcher selected third year and fourth year students. This was because some were presently engaged in projects or had done project work earlier. The population was students from the information systems, computer science, civil engineering and construction economics and management departments.

From the IS and construction economics and management strata, third year and honours (forth year) students were targeted. From the computer science department, third and fourth year students were targeted, but only third year students were actually involved in the study. This is because the honours group was not attending lectures. It became difficult to reach them individually. From the civil engineering stratum, only third year students participated in the study. This is because they were engaged with some group work at that time.

5.6.1. The Project Groups

The following section will briefly describe the teams that were included in the study. It is worth mentioning that each group consisted of many homogenous teams. The teams were divided according to their projects and departments. Computer science students who participated in the study were not doing any group work when data was collected. The researcher decided to collect data from them because they indicated that, they had done group work earlier. This also applies to some construction economics and management students. What is most important is that all respondents had done team work either during the data collection phase or earlier.

5.6.1.1. Group A

Group A consisted of students from the construction economics and management department. This was a combination of two courses: New Venture Planning and Professional communication studies. In these courses students were divided into teams of four (4). The class had around 200 students but only 50 students participated in the study. The students' project required them to come up with a business plan. The project team had to design, prepare and present the business plan at the end of the semester. They started by brainstorming ideas and sharing knowledge about the whole project. That entailed choosing the best idea and conducting some research on that idea. That included carrying out concept analysis, customer analysis, market analysis, and financial analysis. This was done in a space of five to six weeks. The group also had to produce a poster advertising the business idea. At the end, the whole idea was to be presented in class. This group mentioned that they had conducted a lot of construction related projects in their department. So their responses were based on past and present experiences.

5.6.1.2. Group B

Group B consisted of students from civil engineering third year. This course introduced civil engineering students to the dynamics of both urban transportation and human settlement. The course brings factors that influence the patterns at which the population of a city tends to spread as one moves out of the central business district. Most importantly it attempts to explore the dynamics involved in urban transportation. The students had to work in teams of five, where they had to research on which implementations can be employed by city municipalities and government bodies in the pursuit of providing an efficient transport system; that is environmentally friendly.

5.6.1.3. Group C

This group consisted of students majoring in information systems and computer science. It was a systems development project. The course combines the theoretical elements of project management with the practical implementation of these concepts through the completion of a systems development team project, integrating practical and theoretical elements obtained and developed during other undergraduate and postgraduate IS and computer science courses. The practical part of this course involves the application and implementation of these concepts following the full life cycle of a project.

5.7. Research instrument

In most positivistic studies, questionnaires, interviews and observation are popular research instruments. Interviews are data collection methods in which participants are asked questions in order to find out what they do, think or feel. Positivistic studies prefer closed questions (Hussey & Hussey, 1997). A questionnaire is a set of pre-formulated questions to which respondents record their answers (Cavana et al., 2000). Observation collects data associated with either positivistic or interpretive studies (Hussey & Hussey, 1997).

The study used a questionnaire as a research instrument. The main reasons for using a questionnaire was that, a questionnaire easily collects quantitative data and is easy to administer.

The questionnaire had thirty five (35) questions. It consisted of five (5) sections. Section A collected data on the respondents demographics, and social ties. Section A had open ended questions. Section B collected data on student's use of mobile phones. Section C collected data on student's motivation. Section D collected data on time spent of projects and section E collected data on the success of the student's project. Sections B to E had close ended questions.

In information systems research, instrument validation should precede other core empirical validities (Cook & Campbell, 1979, as cited in Straub & Carlson, 1989). Five heuristics for validating research instruments in information systems are given by Straub, Boudreau and Gefen (2004) as content validity, construct validity, reliability, manipulation validity and statistical conclusion validity.

In the study, content validity was achieved by pre-testing and piloting the research instrument. The pilot study was conducted on three academics (including the supervisor) and five Masters Students. First it was given to a group of five Masters Students who had done team projects earlier. After obtaining responses and comments from them, the researcher made some corrections and sent it to two academics in the department of information systems.

The academics where to check the relevance of the questions and the structure of the questionnaire. After getting feedback from the academics, the researcher made the recommended corrections. Lastly it was given to the supervisor who recommended some changes. After making those corrections, it was administered to students. Construct validity was achieved by factor analysis. Cronbach Alpha was used to test reliability. (See appendix for research instrument)

5.8. Data collection

Two approaches to data collection are used in information systems research; qualitative and quantitative approaches. A qualitative approach is used for investigating social phenomena (Hazzan, Dubinsky, Eidelman, Sakhnini, & Teif, 2006). It involves the use of qualitative data. Qualitative data can be collected using interviews, field notes, and other written data sources (Myers, 1997). Qualitative research is often used when a researcher wants to learn about environments, situations, and processes that cannot be interpreted quantitatively. It focuses at an entire environment or context and finds patterns within it. It chooses samples from a population that is most likely to contribute to an understanding of the problem (Medley, 2001).

Quantitative research assumes that human behaviour can be explained by social facts which can be investigated by utilising the deductive logic of natural science methodologies. It is defined as extreme empiricism in which theories are justified by an application of facts acquired (Amaratunga, Baldry, Sarshar, and Newton, 2002). Quantitative data collection techniques include surveys, interviews, transcript analysis, and objective measure (Straub, Gefen & Boudreau, 2004). The major "weakness of the quantitative approach is that it decontextualizes human behaviour in a way that removes the event from its real world setting and ignores the effects of variables that have not been included in the model (Weinreich, 1996)."

Qualitative and quantitative data were collected. Qualitative data were collected on demographics. The rest of the sections collected quantitative data. There was only one section that collected qualitative data. For group A, data was collected at the end of their project. In fact this group was presenting their project. For group B, data was collected at an advanced stage of their project. For group C, data was collected at an early stage of their project. Members of this group indicated that, they have completed other projects at lower levels.

5.8.1. Data collection procedure

Quantitative and qualitative data were collected through questionnaires. The researcher asked for permission first to distribute the questionnaires in classes from the concerned lecturers. This was done through email and face-to-face meetings. After permission had been granted, the researcher then administered the questionnaires during class time whereby students responded to it and returned them to the researcher during that class period. It took about thirty minutes to complete the questionnaires. The researcher collected data in eight (8) classes. It took ten working days to collect the data. In all, a hundred and seventy six (176) questionnaires were collected.

5.8.2. Data analysis

Data was analyzed using two software packages; Statistica 8.0 and Microsoft Excel 2007. Statistica 8.0 was the main data analysis software. It was used for simple descriptive (means and percentage) and inferential statistics (factor analysis).

5.9. Access, Privacy, Confidentiality and Ethics

Every researcher is expected to consider research ethics as he/she conducts research. In an academic institution, research ethics have to be practiced not only to protect the respondents, but also to protect the name of the institution. The University of Cape Town has a code of research ethics that it expects every researcher to follow. The researcher read and understood the code of ethics and swore to strictly adhere to the code of ethics. All data collected were

used for the purpose of the study only. No data was used for personal or any other unscrupulous purposes. The participants remained absolutely anonymous.

An ethics form was submitted to the ethics committee of the department of information systems for approval. The information systems research committee then submitted the form to the faculty of commerce research ethics committee. The form was approved and a letter of approval was sent to the researcher. The research report will not be confidential. It will be available to any person who requests it after it has been marked, and approved for public use.

5.10. Research horizons and research time frame

Two research time horizons are common in research; cross-sectional and longitudinal time horizons (Hussey & Hussey, 1997). Cross-sectional studies collect data just once over a period of time. Longitudinal studies collect data more than once, over time. The study applied the cross-sectional research horizon.

5.11. Summary

The chapter presented the research design and methodology of the study. The study adopted the positivist paradigm. The researcher was an observer who did not interfere with the research settings. A survey research method was used in the study. Questionnaires were used to collect data. They had closed ended and open ended questions. The population comprised of three groups from four departments. These groups were selected because of the amount of project work they do. A total of 176 questionnaires were collected and analysed.

Chapter 6: Data Analysis, Findings and Discussions

Introduction

Chapter 4 presents the findings and discussions of the study. The data were analysed using statistica 8.0 and Microsoft Excel 2007softwares.

6.1. Demographics

The respondents were required to indicate their demographic affiliation. The main purpose of collecting demographic data was to investigate mobile phone ownership and usage by different gender and race groups. Gender plays a role in the use of technology. Females interact differently with technology compared to their male counterparts (Bower, as cited in Tanno, 2003; Zulu, 2005).

There were 120 male students and 56 female students. The representation is illustrated in the diagram below.

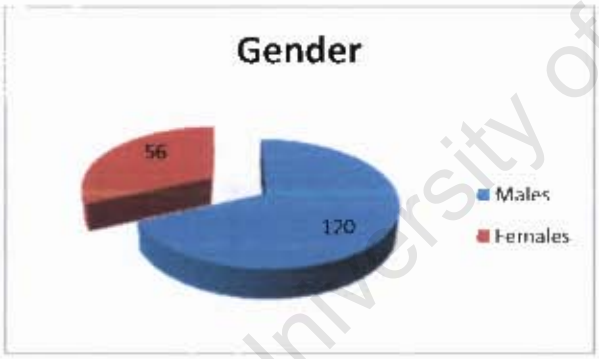
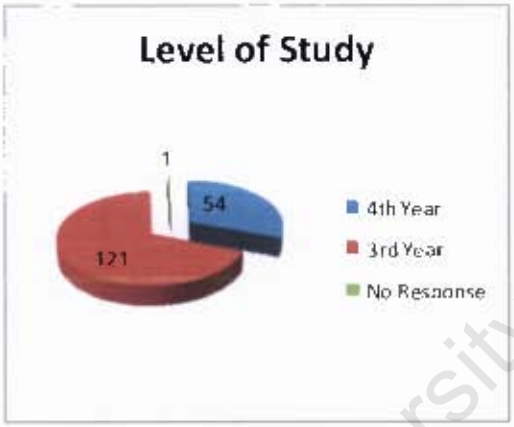


Figure3: Gender Representation

Similar to gender, race also plays a role in the use of technology. Tanno (2003) states that technology is not ethnic or race neutral. That means different race groups use technology differently. Race data were collected to determine the use and ownership of mobile phones by

provided for race. This problem prevented the researcher from accurately measuring mobile phone ownership and the extent to which different races use the mobile phone for knowledge transfer purposes.

Respondents were also asked to indicate their level of study and departmental affiliation. There were 54 honours and 121 third year students who participated in the study. One respondent did not indicate the level of study. The respondents were from the Information Systems (44), Computer Science (19) Civil Engineering (31) and Construction Economics and Management (81) departments. Figures 3 and 4 illustrate the level of study and departments.



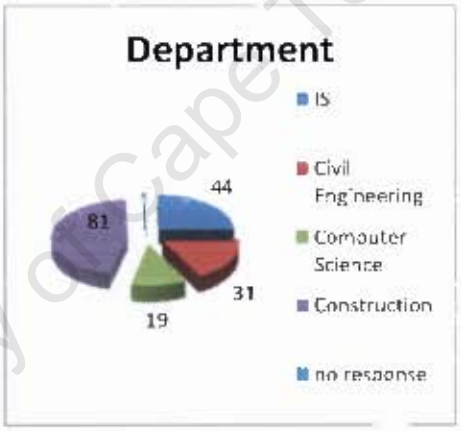


Figure 5: Level of Study *figure 6: Departments*

The departments of Construction Economics and Information Systems had both honours and undergraduate (3rd year) respondents. The departments of Computer Science and Civil Engineering had 3rd year students only. The level of study and department had to be included because students in different levels of study have different project experiences, hence different levels of knowledge transfer. Students from different departments transfer knowledge differently.

6.2. Social Ties

To investigate whether social ties play a role in knowledge transfer in a team project using a mobile phone, the respondents were required to indicate who allocated them into project teams and the criteria used to allocate them into different project teams. The researcher assumed that students who grouped themselves on the basis of friendship have closer social ties. Therefore that affects knowledge transfer. Knowledge sharing is not only encouraged by technological factors but also by relationship factors (Liao et al., 2004). The results indicate that students from Computer Science, Information Systems, and Construction Economics departments allocated themselves into project teams and that friendship was used as a criterion. Students from Civil Engineering were allocated by their lecturer into project teams and they did not know the criteria used. Table illustrates the results.

Table 1: Criteria for allocations to teams

Group	**allocation**	**criterion**
Civil Engineering	lecturer	don't know
Computer Science	themselves	friendship
Construction Economics	themselves	friendship
Information Systems	themselves	friendship

6.3. Mobile phone user experience

User experience can be defined as all the aspects of how people use interactive products. That is, the way those products feel in their hands, how well they understand how they work, how they feel when using them, how well they serve their purpose and how they fit in the entire context in which they are using them (Alben, as cited in Roto, 2006). User experience can affect the way users interact with their devices. The way they interaction with their mobile phones can affect the way they transfer knowledge using them.

In the study, user experience was measured by the number of years the respondents have been using a mobile phone. Respondents were asked to indicate the number of years they have been using mobile phones. A scale of less than one year to more than four years experience was used. This scale was used because on average students spend four years at university.

The results show that 167 (95%) of respondents have been using mobile phone for more than four years. This implies that most students are comfortable using mobile phones. They have experience in using basic and advanced features and services that can transfer knowledge. It means they are capable of using their mobile phones to share knowledge. That also means the study was carried out with a homogeneous group; a group of experienced mobile phone users. Table 2 illustrates the results.

Table 2: Number of years using a mobile phone

Group	Valid N	Mean	Std Deviation
Information Systems	44	5.0	0.15
Engineering (Civil and Construction)	113	5.0	0.31
Computer Science	19	5.0	0.31
Average	176	5.0	0.30

The table shows the mean results of the responses. A scale of one (less than one year) to five (more than four years) was used to measure the mean and standard deviation. A mean of five was obtained for all groups. This means that, most respondents had been using mobile phones for more than four years.

6.4. Purposes of using a mobile phone

Respondents were asked to state the purposes of using their mobile phones. They were required to choose from four main purposes: academic, entertainment, social and communication purposes. Academic purposes meant any school work completed with the help of a mobile phone. It could be using basic features and services such as SMS and voice to advanced features and services such as Email and mobile phone video conferencing for the purposes of completing an academic task. Entertainment meant playing games, playing music, surfing the Internet and watching TV using a mobile phone. Social purposes meant the exchange of messages with people closer to the user. It could be parents, friends and spouses. Communication meant the general exchange of information between mobile phone users. This question required students to choose more than one answer. The responses were then tallied to produce the number of times each response was chosen. The question aimed at

providing a summary of what students use their mobile phones for in general. The results are illustrated in figure 7.

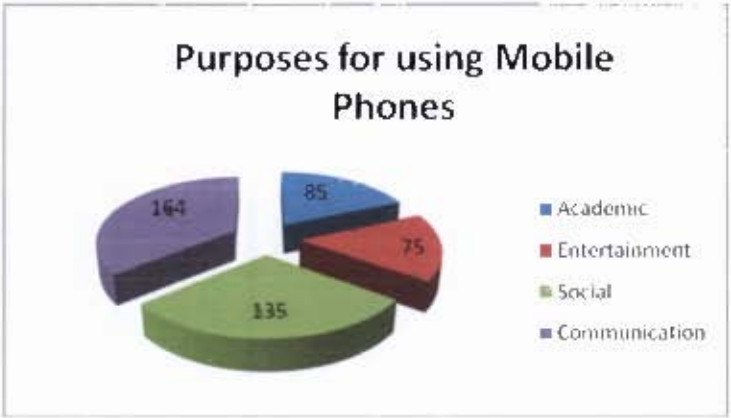


Figure 7: Purposes for using mobile phones

It is illustrated on the figure that communication was selected 164 times, social purposes 135 times, academic purposes 85 times and entertainment 75 times. That means most students use their mobile phones for communication purposes and for social purposes. These results can be linked to the notion that social ties play a crucial role in communication and knowledge transfer. Previous results have indicated that students use friendship as a criterion to allocate themselves into teams. Friendship is associated with strong social ties.

6.5. Mobile phone features and services

Different mobile phone models have different features and services. Mobile phone features are the physical components of the device. Physical components such as the camera and video recorder are examples of features. Services are the intangible functions of the mobile phone. Four mobile phone services are available: text, voice, graphics and a combination of the three (text, graphics and voice). Examples of text services are the SMS, email and Chat

services. Voice services include simple voice calling, speaker phone and push-to-talk. Video is an example of a combination of all the features. Graphics examples are MMS and GPS.

Respondents were required to indicate the features and services supported by their mobile phones. This question was important because old models have few functions and features and support few services. This question was aimed at determining the importance different features have on knowledge transfer.

The results indicate that all respondents' mobile phones supported SMS and simple voice calling (100% for all teams). It was also discovered that most respondents' mobile phones had access to the Internet (83%). The results also indicate that the speaker phone was embedded in most of the respondents' mobile phones. Other mobile phones features and services that were supported by most respondents' mobile phones were MMS, Camera, and E-mail. It was interesting to discover that some mobile phones supported advanced features and services like video calling, word processing, GPS, Live TV and chatting services.

The following table illustrates the features and services supported by students' mobile phones.

Table 3: functions and features supported by students' mobile phones

Valid N	Functions/Features
98	Chatting
10	GPS
3	Word Processing
5	Video Calling
30	Bluetooth
12	Live TV
98	Video
130	Email
110	MMS
119	Camera
139	Speaker Phone
146	Internet
176	SMS
176	Voice

The respondents were asked to indicate the mobile phone features and services that they use or have used to transfer knowledge during a project apart from the traditional methods (SMS/MMS) and simple voice calling. The students provided answers by filling in the responses themselves. Some of the responses did not amount to knowledge transfer but simple to data/information sharing. The researcher carefully selected those services that

amounted to knowledge transfer according to the definition adopted by the study, which is provided in the literature.

The following features and services were given by respondents:

Table 4: Advanced features and services supported by students' mobile phones

Feature/service	Type of knowledge transferred
Instant messaging/Mxit/Gtalk mobile	explicit
Video recording	tacit/explicit
Camera for pictures	explicit
Chatting and forums	explicit
Mobile email	explicit
Memory	explicit

The table illustrates advanced features and services that students use to transfer knowledge during a project. One service that seems to be popular among the students is Mxit. According to the Mxit website, Mxit is a free mobile and P.C. instant messaging software. It enables users to send and receive text messages over the Internet using GPRS or 3G technologies. Mxit can allow the transfer of explicit knowledge.

Respondents from the department of Construction Economics and Management indicated that they use video recording features and camera to transfer knowledge in project teams. This is done by taking pictures of diagrams and sending them to group members for presentations and analysis. They also use their mobile phone cameras and videos to take pictures of buildings and other properties to send them to their team members for analysis. They also

indicated that they use their mobile phones for Internet chatting and Internet forums to share knowledge. Students use such services to exchange explicit knowledge with experts and other students. They use such explicit knowledge for their projects. Respondents from Construction and Economics also indicted that they use their mobile phone memory to store explicit knowledge. This knowledge comes in the form of already prepared word and excel files. At times they use their mobile phones to store explicit knowledge and then transfer it to their PCs for further processing.

The researcher expected Civil Engineering teams to emulate their Construction Economics counterparts in terms of using other advanced features to share knowledge because of the nature of their projects. Both groups have field projects which require them to collect data from the field. Civil Engineering teams did not indicate that they use advanced features like Construction Economics teams. The reason might be the nature of their project during the data collection phase. The project (as explained in chapter 3) did not require any field data.

Project teams from Information Systems and Computer Science indicated that they use they use mobile email for knowledge transfer. Mobile email also transmits explicit knowledge. They simple send each other ideas about the project and work while they are physically apart.

The nature of knowledge impediment is highlighted by these features and services, but not minimised. The features and services that all teams use support the transfer of explicit knowledge. They do not support the transfer of tacit knowledge. The results confirm literature (Wilson, 2002) which states that tacit knowledge is hard to share. The time impediment is addressed in the Information Systems and Computer Science cases. By sharing knowledge when they are physically apart saves them a lot of time. They don't have to wait for hours or days before they meet and share knowledge on the project.

The results also indicate that students from do not only use such mobile features for knowledge transfer only, but also for knowledge creation. They create knowledge through a process called internalisation. Nonaka and Takeuchi (1994) state that internalisation is a process whereby explicit knowledge is transferred into tacit knowledge. When students share the explicit knowledge (text messages, graphics) they also analyse and refine them into tacit knowledge. The problem is that the tacit knowledge is not shared but remains in the minds of the individuals.

In summary, the results indicate that mobile features that support text and graphics are widely used by students doing project team work. These features and services support the transfer of explicit knowledge. Explicit knowledge can be pictures, graphs, video clips, and text messages in a form of project ideas and instructions. Tacit knowledge can be transmitted by voice services. These are speaker phone, push-to talk and simply voice calling. The study has discovered that voice services are not widely used for knowledge transfer in students' project teams in all groups. One reason can be that, voice services are expensive than text services. Although not all text services are cheap, but most are far cheaper than voice services (See appendix for rates). In conclusion, this section indicates that, the mobile phone does not minimise the nature of knowledge impediment. It minimises the time impediment.

6.6. Contact with project group members

To test the motivation of team members to share knowledge, they were required to state the number of team members they contact and get contacted by with their mobile phones. The mean scores indicate that most team members contact each other. The results are shown in tables 5 and 6.

Table 5: Number of group members contacted

Group	Valid N	Mean	Std Deviation
IS	44	4.02	1.19
Construction	82	3.51	1.29
Civil Eng.	31	2.61	1.69
CSc	18	2.6	1.97

Table 6: Number of group members who contact each other

Group	Valid N	Mean	Std Deviation
IS	44	3.79	1.23
Construction	82	3.64	1.39
Civil Eng.	31	2.41	1.56
CSc	18	2.88	1.96

6.7. Construct Validity and Reliability

6.7.1. Reliability

Item validity was measured by Cronbach alpha scores. The results are illustrated in table 7. The results indicate a good measure of internal validity for all variables. Hair, Black, Babin, Anderson and Tatham (2006, p.137) state that "the generally agreed upon limit for Cronbach alpha is 0.70 although it may decrease to 0.60 in exploratory research." The measures indicate that construct nature of knowledge has alpha greater that 0.70 which makes the construct reliable. Construct success and time are above 0.65. Construct motivation has below minimum measure. This can be attributed to the fact that only a few items (three) were used to measure the construct. Overall the constructs are reliable.

Table 7: Reliability scores

Variable	Reliability
Nature of knowledge	0.76
Social ties	0.63
Motivation	0.59
Time	0.65
Success	0.68

6.7.2. Construct validity

Construct validity was measured by factor analysis. There are two objectives of factor analysis: data reduction and data summarisation (Hair et al., 2006). Principal factor analysis was conducted to reduce the data into a set of six (6) factors. The varimax rotation of the statistical package Statistica 8.0 was used. "A factor is a combination of variables and expresses the common element that cuts across the combined variables (Kyobe, 2004, p. 144)". According to Hair et al. (2006) the level of significance in factor analysis depends on the sample size. The bigger the sample size the lower the level of significance required. The study had a total of 176 respondents. That made it proper to use factor loading of 4.5 (according to Hair et al.) but the researcher chose a higher loading of 0.5 as a cut off point. Table 8 illustrates the factor loadings. The complete factor loadings table is found in Appendix D.

Table 8: factor loadings

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
UoMP 1	*0.858330*					
UoMP 2	*0.815816*					
UoMP 6	*0.610127*					
UoMP 9	*0.702420*					
UoMP 5		*0.822991*				
UoMP 7		*0.866642*				
UoMP 8		*0.687679*				
Success 1(a)			*0.631290*			
Success 1(b)			*0.834838*			
Success 1(c)			*0.751892*			
UoMP 3				*0.856150*		
UoMP 4				*0.854387*		
Motivation 3					*0.624728*	
Time 4					*0.738882*	
Motivation 1						*0.633585*
Motivation 2						*0.744281*
Time 1						*0.630007*
Time 2						*0.648365*
Time 3						*0.540700*
Success 2						*0.692119*
Expl. Var	2.807209	2.176825	1.967738	1.786368	1.391656	3.014065
Prp. Totl	0.140360	0.108841	0.098387	0.089318	0.069583	0.150703

Factor 1

UoMP1 – sending ideas using SMS and MMS

UoMP2 – receiving ideas from group through SMS and MMS

UoMP6 – calling group members to share ideas

UoMP9 – sharing ideas in future using mobile phones

Four items loaded on factor 1 : UoMP1, UoMP2, UoMP6, UoMP9. Items UoMP1 and UoMp2 have a very high factor loading of 0.85 and 0.81 respectively. These two items loaded highly because previous results (see table 3) indicated that the SMS and MMS are widely used services by project teams. Goldstuck (2007) supports the findings. It is stated by Goldstuck (2007) that the SMS is widely used in South Africa for a number of purposes. It is used for job applications, to check ones health, directions and many other purposes. The SMS is the cheapest communication service offered by mobile phone network operators (see appendix for rates). Therefore people tend to use SMS more that other mobile phone services. The SMS and MMS have the ability to transfer explicit knowledge. Earlier results (section 4.5) indicated that students transfer explicit knowledge more than tacit knowledge. That might have also contributed to the high factor loadings of the two items.

Benta, Cremene & Padurean (2004) used the SMS and MMS services in a biology class to transfer explicit knowledge. Students used a combination of the two to send test answers to their lecturer. Nonyongo et al. (2005) states that distance learning students are pleased to communicate with their lecturers about their academic work through SMS. The above examples show how popular SMS and MMS are among mobile phone users.

The other items (UoMP6 and UoMP9) loaded lower than the two. This is attributed to the fact that students use SMS more than voice services to transfer knowledge. Voice services are more expensive than SMS and MMS especially during the day when most projects take place (see appendix for rates). That might have contributed to items UoMP6 and UoMP9 loading lower than UoMP1 and UoMP2.

Factor 2

UoMP5 – using video conferencing to share ideas

UoMP7 – using push-to-talk to share project ideas

UoMP8 – using speaker phone to share project ideas

Three items loaded on factor 2: UoMP5, UoMP7, and UoMP8. This factor contains items that measured the use of mobile phones to transfer tacit knowledge. Mobile phones transfer tacit knowledge through the voice service. Two items (UoMp7 and UoMP8) were aimed at measuring how students use the voice to transfer tacit knowledge. Item UoMP5 measured both tacit and explicit knowledge transfer. Items UoMP5 and UoMP7 have high factor loadings of 0.86 and 0.82 respectively. UoMP8 has a loading of 0.68.

Item UoMP5 loaded highly because students indicated that their mobile phones support video services. Some indicated that they have used mobile video conferencing during their projects. One hundred respondents indicated that there are video functions on their mobile phones. This item therefore explains that students might be using video services on mobile phones during their project. The other two items loaded highly as well. Items UoMP7 and UoMP8 measured the use of voice features and services for knowledge transfer. These items loaded highly because students indicated that they have both features embedded on their phone. The problem is that, they don't use them for knowledge transfer purposes.

Factor 3

Success 1(a) - results of completed project

Success1 (b) – performance of project group

Success1(c) – project rating

Three items loaded on factor 3: Success1 (a), Success 1(b) and Success 1(c). All three items were aimed at measuring the success rate of students in their projects. Success 1(a) measured marks teams have obtained from their completed projects. The results were in percentages. Success 1(b) measures the general performance of the teams in relation to their project. Respondents were required to rate results from poor to excellent. Success 1 (c) was similar to success 1(b). The difference was that success (c) required students to rate their project progress at that moment in time for those who had not finished their projects. Items success1 (a) has a high factor loading of 0.83. This means students were happy with marks they obtained for their project. The mean also indicated that most students passed their project work. Item Success 1(c) also loaded highly. Item success 1 (c) was aimed at confirming the responses from success 1 (a). The reason why it loaded highly as well was the confirmation that students were happy with their project results. Item success 1(b) loaded low because it measured the progress of continuing projects. Most students had finished their projects by that time.

Factor 4

UoMp3 – Emailing project ideas to group member

UoMP4 – receiving through email project ideas

Two items loaded on Factor 4: UoMP3 and UoMP4. These two items have very high factor loadings of 0.85 each. These two items measured the use of mobile email for knowledge transfer purposes. The loading indicate that the questions were structured correctly. The factor indicates that students use their mobile email to transfer explicit knowledge. This confirms earlier findings in section 4.5 that students use email to transfer knowledge. Information Systems and Computer Science teams clearly indicated that. Like other text messages, the email is very convenient to students. The mobile email can transmit longer messages than simply SMSs. Another reason is that an email can be sent to and from other devices to mobile phones. It can be sent from PCs, and other mobile devices.

Factor 5

Motivation 3 – using the mobile phone to share project ideas when physically apart

Time 4 – text messages take long time to transfer

Factor 5 was made off two completely different items. These two items, Motivation3 and Time3 measured different concepts. Item motivation3 measured whether or not students were motivated by owning a mobile phone to share ideas with team members who are physically apart. Item time3 measured if it takes long or less time to transfer knowledge using text services. The structure of the questions might have made it possible for these items to load on one factor. Otherwise, there is no relationship between the two factors.

Factor 6

Motivation 1 – encouraging the use of mobile phones to share knowledge

Motivation2 – the convenience of using the mobile phones to share knowledge

Time1- less time to finish project

Time2 – using mobile phones to transfer knowledge acquired in past projects

Time3 – less time is taken to share knowledge using voice messages

Success2 – overall success of project

Factor 6 comprises of six (6) items which measured different concepts. These items can be grouped into three. Group one, which is the first two, consists of items measuring motivation. Group2 (time1, time2, time3) consists of items measuring time. Success2 measured overall success of the project.

All but one (time3) have high loadings of above 0.6. This cluster indicates that construct validity was not measured correctly. This might be attributed to a number of reasons. Firstly, the respondents might have misunderstood the questions. Secondly, the questions might have not been structured well. This factor could be divided into three factors if the items loaded according to expectations. The data analysis software was adjusted in an attempt to separate the items by adjusting the number of expected factors to eight. That did not yield any good results.

To test the strength of the relationships between the variables, a correlation matrix was compiled. See Appendix C.

6.8. Hypothesis testing

6.8.1. *Strong social ties encourage the use of mobile phones to transfer knowledge.*

Hypothesis one states that a mobile phone can be used to transfer knowledge between project team members with strong social ties. Literature shows that social ties play a vital role in the transfer of knowledge. Odom, Stefanone and Gay (n. d.) state that students with more social network ties have higher performance than those with less social net work ties. The results indicate that students teams in Computer Science, Information Systems and Construction Economics (groups A and C), allocated themselves to the project teams. Students from these departments used friendship as a criterion for allocating themselves to project teams. By allocating themselves and using friendship as a criterion means they have strong social ties.

Two variables we used in a chi-square test to measure the association between social ties and the use of mobile phones. Variable GQ9 measured social ties and variable UoMP1 measured the use of mobile phones for knowledge transfer in project teams. The results are shown in the following table.

Table 9: chi-square tests for strong social ties and the use of mobile phones

Variable 1	**variable 1**	**chi-square tests**	**df**	**p**
GQ9	UOMP1	277.3333	175	0.000001

The results indicate that there is a relationship between strong social ties and the use of mobile phones for knowledge transfer in project teams. The value of $p<0.05$ indicates the significance of the results.

The results mean that students in a project group with strong social ties use the mobile phone to share knowledge. Earlier results indicated that they use mostly text services such as the SMS, MMS and Email to share knowledge with their group members.

Students from Civil Engineering were allocated by their lecturer to project teams. It is assumed that such teams had weak social ties because they did not comprise friends. A chi-square test was conducted for this group of students to determine if a group with weak social ties transfer knowledge using a mobile phone. Two variables were used to test if weak social ties influence knowledge transfer using a mobile phone. Variables GQ8 and UoMP1 were used in the test. GQ8 measured lecturer allocations and UoMP1 measured the use of mobile phones for knowledge transfer in a team project. The results are illustrated in the following table.

Table 10: chi-square tests for weak social ties and the use of mobile phones

Variable 1	**Variable 2**	**Chi-square test**	**df**	**p**
GQ8	UoMP1	156.0833	175	0.0844671

The results indicate that there is no association between the use of mobile phones for knowledge transfer in teams with weak social ties. This is proven by the $p>0.05$.

The results confirm earlier findings that show that strong social ties influence knowledge transfer. Bawden & Zuber-Skerrit (2002) state that learning in organisations occurs as a social process. A social context includes relationships, awareness, common ground and incentives (Thomas, Kellogg & Erickson, 2001). A bad relationship leads to conditional knowledge transfer or no transfer at all (Liao et al., 2001). Palen (2002) is of the view that mobile phones in social networks support relationships and increased access and relevance of membership in a network of social relationships and the expansion of these social networks.

In a university environment, such networks are students' teams. Students form formal and informal teams to share knowledge.

Bruffee (1984) explains that knowledge transfer and social ties in his social constructivist theory. The theory states that human beings form social communities. Through these social communities they are able to converse thereby creating knowledge. In universities, such communities are students' teams. The tests therefore confirm that a team that is composed of members with strong social ties will transfer knowledge using a mobile phone. Therefore impediment social ties is minimised by the use of mobile phones. Hypothesis one is therefore supported.

6.8.2. Students who use mobile phones during a project are motivated to participate in knowledge sharing with their peers.

Hypothesis two states that, team members who use mobile phones during a project are motivated to participate in knowledge sharing with their peers. This hypothesis was measured by first determining mobile phone communication between team members. On average, there were four members in a team for all groups. Results on the number of team numbers contacted by mobile phones are indicated in tables 5&6. The results indicate that all Information Systems and Construction Economics team members contacted each other. This is indicated by the mean scores. Computer Science and Civil Engineering teams contact three out of four members. The team members contact each other to share knowledge.

Chi-Square tests were conducted to determine whether a mobile phone motivates team members to contact each other to share knowledge. The first test was conducted for the Information Systems and Construction Economics teams. These teams indicated that they contact every member of their teams to share knowledge. Two variables were used: variable GQ13 and variable motivation3. Variable GQ13 measured team members contacted with mobile phones for knowledge transfer. Variable motivation3 measured motivation to transfer knowledge using a mobile phone. The results are indicated in table 11.

Table 11: chi-square test for motivation and the use of a mobile phone for knowledge transfer

Variable 1	variable 2	chi-square tests	df	p
GQ13	Motivation3	123.2833	175	0.00001

The results indicate that mobile phones motivate team members to contact each other and share knowledge. This is confirmed by the value of $p<0.05$. The results confirm that teams from Information Systems and Construction Economics are motivated by their mobile phones to contact team members using their mobile phones to share knowledge.

Civil Engineering and Computer Science teams indicated that they contact three out of the four members. A chi-square test was conducted to test if there was a different motivation level between teams that contact all members and teams that do not contact all members. Two variables were used in the tests: variable GQ14 and variable motivation3. Variable GQ14 measured the number of team members who contacted the respondent. Variable motivation3 measured motivation to transfer knowledge using a mobile phone.

The results are illustrated in the table 12.

Table 12: chi-square test for motivation and the use of a mobile phone for knowledge transfer

Variable 1	variable 2	chi-square tests	df	p
GQ14	Motivation3	176.8333	175	0.000153

The results indicate that even teams that do not contact all members are motivated by the mobile phone to contact those they contact. This is confirmed by the value of $p<0.05$. To summarise, team members from Information Systems are motivated by mobile phones to contact all team members to share project knowledge. Although teams from Civil Engineering and Computer Science do not contact all their team members, those that do are also motivated by the mobile phone to contact them and share knowledge.

The results are confirmed b y literature which states that motivation enables knowledge transfer. Wasko and Faray (2008) state that individuals will share knowledge it they are motivated. Jewels and Ford (2006) state that individuals will be motivated to share knowledge if they believe that it will contribute to team success and project practices. Lindquist et al. (2007) found a heightened student motivation when using a mobile phone for learning purposes. The results therefore indicate that impediment motivation is minimised by the use of mobile phones. Hypothesis two is therefore supported.

6.8.3. Students who use mobile phones in a project group will transfer tacit knowledge easily

Hypothesis three states that mobile phones help students to articulate and transfer tacit knowledge easily. Tacit knowledge is said to be sticky and therefore difficult to articulate and share (Szulanski, 1996). Pervious results (section 4.5) indicated that generally all teams use their mobile phones to transfer explicit knowledge. It was discovered that Construction and

Economics students transfer explicit knowledge in a form of graphics. Information Systems and Computer Science students transfer knowledge in a form of text messages. It was also discovered that services that support the transfer of tacit knowledge such as the voice are rarely used. A chi-square test was conducted to test the hypothesis. The tests were conducted for all groups because results indicate that they all transfer explicit knowledge. Two variables were used in the test: UoMP7 and UoMP8. Both variables measured the transfer of tacit knowledge using a mobile phone. The results are illustrated in table 13.

Table 13: chi-square tests for nature of knowledge

Variable 1	**Variable 2**	**Chi-Square test**	**df**	**p**
UoMP7	UoMP8	86.500000	174	1.000000

The results indicate that a mobile phone does not help in the transfer of tacit knowledge. This is confirmed by the value of $p>0.05$. The chi-square test confirms the previous findings. There are many reasons why mobile phones are not used in the transfer of tacit knowledge.

One major reason might be costs. Voice calling is more expensive than text messages. According to all three network operators: MTN, Vodacom and Cell C, it costs between R2.85- R 3.00 to make a call during peak hours (during the day). For all three network operators, it costs between 0.60c – 0.80c to send a test message (SMS, MMS) during peak hours. That's about four times (400%) less than making a voice call. That explains the reason why, student project teams do not use mobile phones to transfer tacit knowledge, which can be shared only by voice services. The second reason is the sticky nature of tacit knowledge.

Wilson (2002) states that tacit knowledge can never be shared because it is buried in the heads of those who posse it. Wilson is supported by Fernie et al. (2003) who state that sharing tacit knowledge in projects is more complex because it is difficult to extract from the

knower. Elfving and Funk (2006) concur with them. They state that tacit knowledge is personal and difficult to formalise, making it difficult to communicate and share with others. That means, even if students' project teams can try to use mobile phones to share tacit knowledge, they would fail because of its sticky nature. It is buried in the minds of students therefore it is not transferable. In conclusion, impediment nature of knowledge is not minimised by the use of mobile phones. Therefore hypothesis three is not supported.

6.8.4. *a mobile phone can help transfer knowledge between group members in less time than face-to-face-interaction*

Hypothesis four state that, a lot of time is saved when a mobile phone is used to share knowledge in a project team. Time is a very scarce resource. Students always complain about the lack of time to complete their projects (Yamane, 1996). Two variables were used in a chi-square test to test for associations. They are variable Time2 which measured time spent on acquiring knowledge from previous team members using a mobile phone. Variable UoMP8 measured the use of a mobile phone for knowledge transfer purposes. The tests were conducted for all groups. The results are illustrated in the table below.

Table 14: chi-square tests for time spent on acquiring knowledge using a mobile phone

Variable1	**Variable2**	**Chi-Square Tests**	**df**	**p**
Time2	UoMP8	408.3833	175	0.000000

The results indicate that students who use mobile phones in their projects take less time to transfer knowledge between group members. It also takes less time acquire knowledge from previous projects when a mobile phone is used. This knowledge is acquired from past group members using a mobile phone.

The results indicate that students don't have enough time to complete their projects and therefore using the mobile phone to transfer project knowledge has helped them to cover more in less time.

The results indicate that there a relationship between time saving and the use of mobile phones. That means a mobile phone enables them to save more time thus sharing more knowledge. This is confirmed in the literature. Yamane (1996) states that students doing group work usually complain about lack of time to finish their projects. Riege (2005) states that individuals lack time to contact and interact with each other thus making it difficult for knowledge to be transferred. This is because project teams are usually under pressure to meet deadlines. Impediment time is minimised by the use of a mobile phone. Therefore hypothesis four is supported.

Table 15 illustrates the summary of the tested hypothesis. The results indicate that all but one (hypothesis 3) were proven to be true.

Table 15: Summary of the findings of the research

Hypothesis	Results	Outcome
$H_0 1$	A mobile phones improves knowledge transfer in teams with strong social ties	*supported*
$H_0 2$	A mobile phone motivates students to share knowledge	*supported*
$H_0 3$	A mobile phones helps students tacit knowledge	*not supported*
$H_0 4$	It takes a short period of time to transfer knowledge by a mobile phone	*supported*

6.9. Project Success

Students were required to indicate their project success. The purpose of the question was to determine whether mobile phones played a role in the success of their projects. This question was a simple question, not a hypothesis. The aim was not to test and prove it statistically. The aim was to first find out the success rate of projects and then link the success to the use of mobile phones. Those who had finished their projects were required to indicate the final marks they had obtained for the project. Those whose projects were still in progress were required to indicate their progress report and rate it out of a scale of 50-100%. Table 16 presents the results of completed projects.

Table 16: results of completed projects

Group	Results	Comments
Civil Engineering	61-70%	Good
Computer Science	50-60%	Fair
Construction Economics	61-70%	Good
Information Systems	71-80%	Very Good

The results indicate that teams from Civil Engineering and Construction Economics obtained a range of 61-70% for their projects. Computer Science teams obtained a range of 50-60% and Information Systems obtained a range of 70-80%.

Teams whose projects were still in progress were rated fair by all groups. When the teams were asked whether or not a mobile phone contributed to the project success, they all indicated that it did not. There reason for that might be that students ignored the role played by their mobile phones. They were not aware that by sending the messages, making calls, taking pictures and video clips might have helped in the completion of their projects. They might have thought that by success in this context would mean absolute contribution.

6.10. Further Discussions

The study found no evidence that suggests that gender plays a role in knowledge transfer using mobile phones in project teams. Both gender groups indicated that they have used mobile phone features and services to transfer knowledge the same way. There was no distinct way in which females transferred knowledge differently from their male counterparts.

There was also no evidence that suggested that different race groups transfer knowledge differently. It was difficult to come up with accurate statistics because of the 23% that did not respond to the question or provided incorrect information. Qualitative data indicates that all race groups have modern mobile phones and they have transferred knowledge the same way.

There is evidence that project teams from different departments transfer knowledge differently. The study discovered that all teams transfer explicit knowledge more than tacit knowledge. The form of explicit knowledge that they transfer differs according to department and projects. Project teams from Construction Economics usually transfer graphics and video explicit knowledge. This is because of the nature of their projects. Projects from Construction Economics require students to analyse building and properties. Therefore the kind of explicit knowledge that they share is related to that.

The nature of projects done by Computer Science and Information Systems is different from Civil Engineering and Construction Economics. They rely mostly on text messages to share knowledge. This is done by SMS, chatting and email.

User experience is important in knowledge sharing using a mobile phone. Novice mobile phone users cannot fully exploit the features and services that mobile phones have. On the other hand, experienced users make good use of their mobile phones. The teams that were studied were experienced mobile phone users. This means that they were able to use their

mobile phones perfectly. This had an impact on the study's findings. The results that were obtained can be relied on because a homogenous group of experienced users was studied. If there was another group of novices, there results could have been different. There could have been results for two different groups.

Respondents indicated that they use their mobile phones more for communication and social purposes. The question was not aimed specifically at school, but generally in life. It is clear that they use their mobile phones for communication and social purposes. That does not mean that they do not use it for sharing academic knowledge. The results have indicated that they use their mobile phones for academic purposes when it is necessary to do so. The fact that communication and social purposes were selected the most means social ties are very important in communication and knowledge transfer. That means the stronger the social ties, there more people communicate, which also leads to more knowledge transfer.

Two main services are used to transfer knowledge in students' project teams. Those are text and graphics services. SMS, email, chatting are widely used text services. The camera is a widely used feature. All these features and services support the transfer of explicit knowledge. One reason is that, voice services are expensive than text services. Although not all text services are cheap, but most are far cheaper than voice services (See appendix for rates). Voice services are rarely used by project teams to share knowledge. Previous results indicate that, most students' mobile phones support the different voice services such as speaker phone. But the reason why they are not used to transfer knowledge is not known. A qualitative question could have helped in this regard. The issue of costs might be the main reason for that.

It was also discovered that students are happy with the marks they obtained for their completed projects. Teams from Construction Economics and Civil Engineering obtained marks between 61-70%. Teams from Computer Science obtained 51-61%, and Information Systems teams obtained 71-80% for their projects. The study discovered that all teams do not agree that their success was attributed to the use of mobile phones.

Chapter 7: Conclusions, limitations and recommendations for future research

7.1. Conclusion

The study investigated the role that a mobile phone plays in minimising knowledge transfer impediments in students' project teams. Four knowledge transfer impediments were identified: social ties, nature of knowledge, motivation and time. Mobile phones motivate team members to share knowledge. Team members with strong social ties transfer more knowledge using their mobile phones than those with weak social ties. It takes less time to acquire knowledge from previous team members when a mobile phone is used. Unfortunately, a mobile phone does not enable team members to transfer tacit knowledge. In short, the study found that a mobile phone minimises the time, social ties and motivation impediments. The nature of knowledge impediment is not minimised.

A new model was developed to depict the findings of the study. The model is illustrated in figure 8.

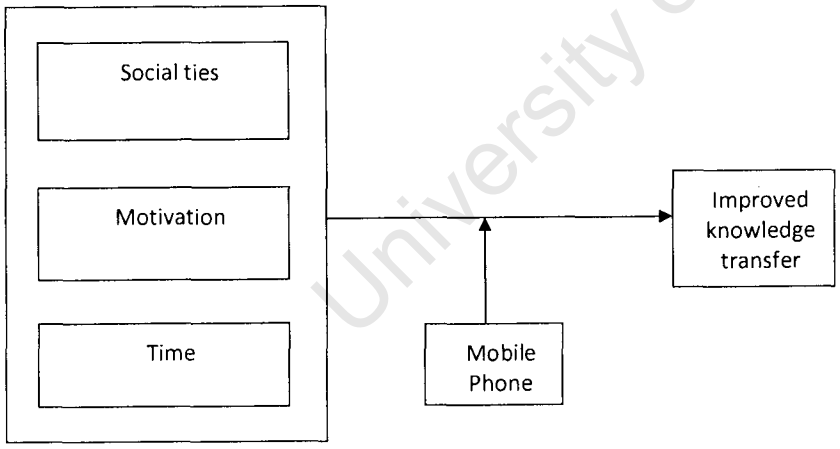


Figure: 8 modified model

The model indicates that three knowledge transfer impediments are successfully minimised by using a mobile phone in students' project teams. A mobile phone improves knowledge transfer in teams with strong social ties. It also motivates students to engage in active learning with leads to improved knowledge transfer. The mobile phone also enables team members to acquire knowledge in less time. The minimisation of these impediments leads to improved knowledge transfer in students' project teams.

The study signifies that a mobile phone is used and can be further used for educational purposes. Academic institutions, lecturers, students and mobile network operators have a responsibility to promote the use of mobile phones for learning purposes which will lead to the adoption of mobile learning. It is evident that mobile phones can be used beyond the borders of universities; in communities. Mobile phones can play a vital role in adult education in developing countries. Adults, especially females can learn in the comfort of their homes with their families. Mobile phones can also help to provide basic rural education in rural areas where there is limited electricity to operate computers and other ICTs. Academic institutions, students, lecturers, mobile network providers have a responsibility to promote mobile learning to improve literacy in South Africa. A question that arises from the study therefore is: who has to take the responsibility to promote mobile learning? Is it academic institutions, students, teachers or the government?

In conclusion, the study found that the mobile phone minimises knowledge transfer impediments in students' project teams. It also provides insights on how mobile phones can be used to improve education. Therefore the objects of the study were achieved.

7.2. Limitations

The study investigated the role that mobile phones play in minimising knowledge transfer impediments in students' project teams. The study has its limitations. One limitation of the study includes the fact that the researcher did not have an advanced modern mobile phone when the study was conducted. This affected the design of the questionnaire. The researcher was not aware and had never used some of the advanced functions of a modern state of the art mobile phone. This includes function like browsing the Internet, accessing email, recording videos and using the speaker phone. Knowing these capabilities was going to help the researcher to obtain detailed information and to structure the questions better.

The respondents themselves had different mobile phone models. Some had old models and others had new advanced models. The difference in models affected the overall results of the study. This is attributed to the fact that old models have fewer functions that support knowledge transfer. New models have more improved functions that support knowledge transfer. For example old models do not have access to the Internet and email. New models have access to the Internet and email and other advanced functions such as video calling and push-to-talk. That means the results were obtained from two different teams. One group had most of the mobile phone features and services that support knowledge transfer and the other had less. For that reason, it is difficult to generalise the results.

The study could have been more interesting if more qualitative data were collected. If the respondents were given the opportunity to express their feeling and elaborate more on how they use their mobile phones, the study could have discovered more on how students transfer knowledge with their mobile phones.

Respondents were not asked whether they have changed mobile phones over the years. This is important because different models transfer knowledge differently. As mentioned earlier new models have got more functions than old models. The quality and quantity of the

knowledge also differs according models. New models are user friendly and old models are difficult to use. That means users transfer knowledge differently with different models phones. Therefore it was important to find out if respondents have changed phones over the years.

The study was conducted on only four departments. The results might have been different if all departments were included. The sample size was also too small for the results to be generalised for the whole university.

7.3. Implications, Recommendations and further research

The findings have implications to students' project teams, lecturers, universities and mobile network operators. Students should fully use utilise the features and services that allow them to share knowledge. These features and services allow active interaction that can lead to refined and better project ideas. That would lead to improved knowledge transfer and better results. Lecturers as well can make use of such a services to share knowledge with students. Teams can hold informal conferences/meetings over their mobile phones with their mentors. That can save a lot of time and energy for the both parties. Mobile network operators can exploit this by promoting other chatting and messaging services to improve learning. That would generate more money for them. Academic institutions can use mobile phones to motivate students to improve their learning capabilities.

It is therefore recommended that academic institutions should promote the use of mobile phones for learning purposes to promote knowledge transfer between student and lecturers. Lecturers should encourage a culture of knowledge sharing using a mobile phone between them and students. This culture can be encouraged by allowing students to call and/or send messages to their lectures asking questions, making suggestions and submitting assignments with their mobile phones. That would create a good platform to share knowledge with a

mobile phone. At present student rarely exchange knowledge with their lecturers by mobile phones. A mobile phone is still regarded as private; therefore lecturers are not comfortable with receiving calls and messages from students.

Further research should be conducted in South Africa on using the mobile phone for knowledge transfer and knowledge creation. Students use this device to create and transfer academic knowledge. At present there are few studies on using the mobile phone for knowledge transfer and knowledge creation purposes. Research should also be conducted to determine the academic fields that can benefit the most by using mobile phones for learning. Research should also be conducted to investigate the mobile phone penetration in universities in South Africa. That will determine the possibility of adopting mobile learning in South African universities. Research should also be conducted to determine why students' project teams do not use their mobile phones to transfer tacit knowledge. Research should be conducted to determine if it is because of costs or other issues.

7.4. Summary

The chapter presented the concluding points of the study. The conclusion highlighted the main findings of the study. The chapter also presented to implication of the study to project teams, lecturers, academic institutions and mobile network providers. The limitation of the study were also highlighted and finally recommendations for further research.

8. References

Ajmal, M.M., & Koskinen, K.U. (2008). Knowledge transfer in Project-Based Organisations: an Organisational Culture Perspective. *Project Management Journal*, 39(1), 7-15.

Alavi, M., & Leaidner, D.E. (2002). Knowledge Management Systems: issues, challenges and benefits. In S. Barnes, *Knowledge Management Systems Theory and Practice*, (pp 15-32). Oxford: Thompson Learning.

Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and Qualitative research in the built Environment: application of mixed research approach. *Work Study*, 51(1), 17-31.

Argot, L. & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes*, 82(1), 1550-169.

Bawden, R., & Zuber-Skerritt, O. (2002). The Concept of Process Management. *The Learning Organisation,* 9 (3), 132-138.

Benta, K.L., Cremene, M., & Padurean, R. (2004, October). Multimedia m-learning using Mobile Phones. *Paper presented at the 4th Conference on Mobile Learning, Cape Town, South Africa.*

Bierly, P.E., Kessler, E.H., & Christensen, E.W. (2000). Organizational Learning, Knowledge and Wisdom. *Journal of Organizational Change Management,* 13(6), 595 - 618.

Blumenfeld, P.C., Soloway, E., Marx R.W., Krajcik, J.S., Gudzdial, M., & Palincsar, A. (1991). Motivating Project Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist,* 26 (3&4), 369-398.

Braganza, A. (2004). Rethinking the Data – Information – Knowledge Hierarchy: towards a case-based model. *International Journal of Information Management*, 24, 347 – 356.

Brooke, C. (2002). Editorial: Critical Research in Information Systems: Issue1. *Journal of Information Technology,* 17, 45-47.

Bruffe, K.A. (1984). Collaborative Learning and the Conversation of Mankind. *College English,* 46(7), 635-652.

Cavana, R.Y., Delahaye, B. L. & Sekaran, U. (2000). *Applied Business Research: Qualitative and Quantitative Methods*. Australia: John Wiley & Sons Ltd

Cell C Boosts Revenue and Subscriber Numbers. (n. d.). Retrieved May 10, 2007, from http://www.cellc.co.za/common/includes/news_headlines_detail.asp?cl_pkiArticleNo=125

Chaffey, D., & Wood, S. (2005). *Business Information Management: Improving Performance Using Information Systems.* London: Pearson Education Limited.

Chinowsky, P.S., Brown, H., Szajnman, A., & Realph, A. (2006). Developing Knowledge Landscapes through Project- Based Learning. *The journal of Issues in Engineering Education and Practice,* 132 (2), 118-124.

Chua, W.F.C. (1986). Radical Developments in Accounting thought. *The Accounting Review,* 61(4), 601-632.

Cohen, W.M., & Levinthal, D.A.(1999). Reply to "Comments on 'Fortune Favors the Prepared Firm'". *Management Science.* 43(10),1463-1468.

Colbeck, C.L., Campbell, S.E., & Bjorklund, S.A. (2000). Grouping in the Dark: What college Students Learn from Group Projects. *The Journal of Higher Education,* 7 (1), 60-83.

Collis, J., & Hussey, R. (2003). *Business research: A practical guide for undergraduate and postgraduate students* (2nd ed.). London: Palgrave MacMillan.

Constant, D., Kiesler, S., & Sproull, L. (1994). What's Mine is Ours, or is it? A study of attitudes about information sharing. *Information Systems Research, 4(*5), 400-421.

Cook (2009). Urban Planning Education In Context With Mobile Phones. Retrieved May 25, 2009, from http://www.slideshare.net/johnnigelcook/urban-planning-education-in-context-with-mobile-phones.

Deetz, S. (1996). Describing Differences in Approaches to Organization Science: Rethinking Burell and Morgan and their Legacy. *Organization Science,* 7 (2), 191-207.

Derballa, V., & Pousttchi, K. (2004, October). Extending Knowledge Management to Mobile Workplaces. *Paper presented at the International Conference on Electronic Commerce, Delft, Netherlands.*

Disterer, G. (2002). Management of Project Knowledge and Experiences. *Journal of Knowledge Management,* 6(5), 512-520.

Elfving, S., Funk, P. (2006, January). Enabling Knowledge Transfer in Product Development and Production – Methods and Techniques from Artificial Intelligence. *Paper presented at the 1st Nordic Conference on Product Lifecycle Management, Goteborg, Sweden.*

Eppler, M.J. & Sukowski, O. (2000). Managing team knowledge: Core Processes, Tools and enabling factors. *European Management Journal,* 18(3), 334-341.

Fernie, S., Green, S.D., Weller, S.J., & Newcomb, R. (2003). Knowledge Sharing: Content, Confusion and Controversy. *International Journal of Project Management,* 21, 177-187.

Fitzgerald, B., & Howcroft, D.C. (1998). Competing dichotomies in information systems research and possible strategies for resolution. *Proceedings of the international conference on information systems, Helsinki, Finland, 1998.*

Foos, T., Schum, G., & Rothenberg, S. (2006). Tacit Knowledge Transfer and the Knowledge Disconnect. *Journal of Knowledge Management* 10(1), 6-18.

Frank, M., Lavy, I., & Elata, D. (2003). Implementing the Project Based Learning Approach in an Academic Engineering Course. *International Journal of Technology and Design Education,* 13(3), 273-288.

Gammelgaard, J., Husted, K., & Machailova, S. (2004). Knowledge Sharing Behaviour and Post Acquisition Integration Failure. *CKG Working Paper 6/2004.*

Gho, S.C. (2002). Managing Effective Knowledge transfer: An Integrative Framework and some practice Implications. *Journal of Knowledge Management,* 6(1), 23-30.

Gil, E.M.D., & Julia, C. (2006). A Project Based Learning Experience in the Teaching of Computer Graphics. *Computer Graphics Forum,* 25(1), 95-103.

Gladstone B. (2000), *From Know-How to Knowledge*, USA: J.W. Arrow Smith.

Goldstuck, A. (2007). *The Hichhiker's Guide to going mobile*. Cape Town: Double Story Books.

Group Profiles: MTN South Africa. (n. d). Retrieved May 10 2007, from http://www.mtn.com/mtn.group.web/investor/profile/southafrica.asp

Gupta, J.N.D., Sharma, S.K., & Hsu, J. (2004). An Overview of Knowledge Management. Retrieved July 16, 2008, from https://www.idea-group.com/downloads/excerpts/1591401623E.pdf

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. & Tatham, R.L. (2006). *Multivariate Data Analysis (6th ed).* New Jersey: Pearson Prentice Hall.

Haller, C.R., Gallagher, V.J., Weldom, T.L., & Felder, R.M. (2000). Dynamics of Peer education in cooperative learning work teams. *Journal of Engineering Education*, 89(3), 285-293.

Hazzan, O., Dubinsky, Y., Eidelman, l., Sakhnini, V., & Teif, M. (2006). Qualitative Research in Computer Science Education. *SCGCSE*, 38(1), 408-412.

Hedlund, G. (1994). A model of knowledge management and the n-form corporation, *Strategic Management Journal*, 15(2), 73-90.

Hey J. (2004). The Data, Information, Knowledge, Wisdom Chain. Retrieved July 16, 2008, from http://scholar.google.co.za/scholar?q=The+Data,+Information,+Knowledge,+Wisdom+Chain+%2Bhey+2004&hl=en&um=1&ie=UTF-8&oi=scholart

Hirschheim, R., & Klein, H.K. (1989). Four Paradigms of Information Systems Development. *Communication of the ACM*, 32(10), 1-15.

Hussey, J., & Hussey, R. (1997). *Business research: A practical guide for undergraduate and postgraduate students*. London: McMillian Publishers.

Jewels, T., & Ford, M. (2006). Factors influencing Knowledge sharing in Information Technology project. *E-Journal,* 99-117.

Kyobe, M. (2004). Investigating the Strategic Utilisation of IT Resources in the Small and Medium-sized Firms of the Eastern Free State Province. *International Small Business Journal*, 22(2), 131-158.

Laudon, K., & Laudon, J.P. (2006). *Management Information Systems: Managing the Digital Firm.* USA: Pearson Prentice Hall.

Lee, A.S. (1991). Integrating Positivist and Interpretive approaches to Organisational Research. *Organisational Science,* 2(4), 242-365.

Leonard, D., & Sensiper, S. (1998). The role of tacit knowledge in group Innovation. *Californian Management Review,* 40 (3), 112 – 132.

Levin, D.Z., & Cross, R. (2004). "The strength of weak ties you can trust: the mediating role of trust in effective knowledge transfer". *Management Science*, 20, 1477-90

Li, M., & Gao, F. (2003). Why Nonaka highlights Tacit Knowledge: a Critical Review. *Journal of Knowledge Management,* 7(4), 6-14.

Liao, S-H., Chang, J-C., Cheng, S-C., & Kuo, C-M. (2004). Employee relationship and knowledge sharing: A case study of a Taiwanese finance and securities firm. *Knowledge Management Research & Practice,* 21, 24-34.

Lightner, R., Benander, R., & Kramer, E.F. (2008). Faculty and Student Attitudes about Transfer of Learning. **Journal of scholarly Teaching**, 8(2008).

Lindquist, D., Denning, T., Kelly, M., Malani, R., Griswold, W.G, & Simon, B. (2007, March). Exploring the Potential of Mobile Phones for Active Learning in the Classroom. *Paper presented at the Technical Symposium on Computer Science Education Conference, Kentucky, USA.*

Major, E., & Cordey-Hayes, M. (2000). Knowledge Translation: A new Perspective on Knowledge Transfer and foresight. *The Journal of Future Studies, Strategic Thinking and Policy,* 2(4), 413-423.

Manno, C., & Walker, D.H.T. (2006). Making Sense of knowledge transfer and social capital generation from a Pacific Island Aid infrastructure project. *The Learning Organisation,* 13(5), 475 - 494.

Marsh, C. (1982). *The Survey Method: The contribution of Surveys to Sociological Explanation.* London: George Allen & Unwin Publishing.

Marwick, A.D. (2001). Knowledge Management Technology. *IBM Systems Journal*, 40(4), 814-830.

McAdam, R. & McCreedy. S. (1999). A Critical Review of Knowledge Management Models. *The Learning Organization,* 6(3), 91-100.

McGiven, Y. (2006). *The practice of Marketing and Social Research: An Introduction* (2nd ed.). England: Prentice Hall.

McGrath, K. (2005). Doing Critical Research in Information Systems: A case of theory and practice not informing each other. *Information Systems Journal,* 15, 85-101.

Medley, M.D. (2001). Using Qualitative Research Software for Computer Science education research. *ITICSE,* 33(3), 141-144.

Mendez, M.M., Gomes, J.F.S., & Batiz-Lazo B. (2004). Management of Knowledge in New Product Development in Portuguese Higher Education. In J.N.D. Gupta & S.K. Sharma, *Creating Knowledge Based Organisations* (pp. 149-168), London: Idea Group Inc.

Mxit Join the Revolution. (n. d.). Retrieved July 16, 2008, from http://www.mxit.co.za/web/index.htm

Myers, M.D. (1997). Qualitative Research in information Systems. *MIS Quarterly,* 21(2), 241-242.

Nakahara, J., Yaegashi, K., Hisamatsu, S., & Yamauchi, Y. (2003). iTree: Does the Mobile Phone encourage Learners to be more Involved in Collaborative Learning? *Paper presented in World Conference on Educational Multimedia, Hypermedia and Telecommunications, Chesapeake, VA.*

Newell, S. (2005). Knowledge Transfer and Learning: Problems of knowledge transfer Associated with trying to short-circuit the Learning cycle. *Journal of Information Systems and Technology Management,* 2(3), 275-290.

Nickols, F. W. (2000). The knowledge in knowledge management. In J.W. Cortada & J.A. Woods (Eds.), *The knowledge management yearbook 2000-2001* (pp. 12-21). Boston, MA: Butterworth-Heinemann.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organizational Science,* (5)1, 14-37.

Nonaka, I. (1997, November). Organisational Knowledge Creation. *Paper presented at the Knowledge Advantage Conference, USA.*

Nonaka, I., & Kanno, N. (1998). The concept of "BA": Building a foundation for knowledge creation. *California Management Review,* 40(3), 40-54.

Nonaka, I., & Takeuchi, H. (1994). *The Knowledge –Creating Company: How Japanese Companies Create the Dynamics of Innovation.* Oxford: Oxford University Press.

Nonyongo, E., Mabusela, K., & Monene, V. (2005, October). Effectiveness of SMS Communication between University and Students. *Paper presented at the 4th Conference on Mobile Learning, Cape Town, South Africa.*

O'Dell, C., & Grayson, C. (1998). If Only We Knew What We Know: Identification And Transfer of Internal Best Practices. *California Management Review*, 40(3), 154-174.

Odom, P. Stefanone, M., & Gay, G. (n. d.). Social Ties: Yes the Really Matter. Retrieved January 27, 2009, from http://www.allacademic.com//meta/p_mla_apa_research_citation/1/1/3/3/5/pages113359/p113359-3.php

Oldenkamp, J.H. (2001). Limitations of Managing Knowledge Sharing. In Remenyi D. (ed.), *Second European Conference on Knowledge Management* (pp. 61-75), Bled, Slovenia.

Olikowsky, W. J. & Baroudi, J.J. (1991). Studying Information Technology in Organisations: Research approaches and assumptions. *Information Systems research,* 2(1), 1-28.

Osterloh, M., & Frey, B. S. (2000). Motivation, Knowledge Transfer, and Organizational Forms. *Organisation Science*, 11(5), 538-550.

Palen, L. (2002). Mobile Telephony in a connected life. *Communication of the ACM,* 45(3), 78-82.

Pare, G. (2004). Investigating Information Systems with Positivist Case Study Research. *Communication of the Association for Information Systems, 13,* 233-264.

Pinsonneault, A., & Kraema, K. L. (1993). Survey Research Methodology in Management Information Systems: An assessment. *Journal of Management Information Systems,* 10(2), 75-105.

Pollack, J. (2006). The New Media Landscape: 2006. Retrieved August 23, 2008, from http://newmedialandscape.com/e107/e107_files/downloads/pmc/PMC_02.06.2006.pdf

Prensky, M. (2004, October). What can you Learn from a Cell Phone? Almost Anything. *Paper presented at the 4th Conference on Mobile Learning, Cape Town, South Africa.*

Proctor, T. (2005). *Essentials of Marketing Research* (4th ed.). England: Prentice Hall.

Profile Overview. (n. d.). Retrieved 10 May 10, 2007, from http://www.vodacom.co.za/about/profile_overview.jsp

Rhem, J. (1998). Problem-Based Learning: An Introduction. *The National Teaching and Learning Forum*, 8(1), 1-4.

Rice, J.L., & Rice, B.S. (n. d.). The Applicability of the SECI Model to Multi-Organisational Endeavours: An Integrated Review. *International Journal of Organizational Behaviour,* 9(8), 671-682.

Riege, A. (2005). Three-dozen Knowledge sharing barriers managers must consider. *Journal of Knowledge Management,* 9 (3), 18-35.

Roto, V. (2006). Web Browsing on Mobile Phones- Characteristics of user experience. Unpublished Doctoral Dissertation. Retrieved September 22, 2008, from http://www.lib.tkk.fi/diss/2006/isbn95/2284707/isbn95122847071.pdf

Rumizen, M.C. (2004). *The Complete Idiot's Guide to Knowledge Management.* USA: CWL Publishing Enterprise.

Ruuska, J., & Vartiainen, M. (2005). Characteristics of Knowledge Sharing Communities in Project Organizations. *International Journal of Project Management*, 23, 374 – 379.

Sambamurthy, V., & Subramani, M. (2005). Special Issues on Information Technologies and Knowledge Management. *MIS Quarterly,* 29 (1), 1-7.

Sarker, S., Sarker, S., Nicholson, D., & Joshi, K. (2002, January). Knowledge transfer in Virtual Information Systems Development Team: an Empirical Examination of Key Enablers. *Papers presented at the 36th Hawaii International Conference on Systems Science, Big Island, Hawaii, USA*.

Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research Methods for Business students* (4th ed.). London: Prentice Hall.

Schindler, M., & Eppler, M.J. (2003). Harvesting Project knowledge: A review of project learning methods and success factors. *International Journal of Project Management,* 21, 219 – 228.

Schultzer, U., & Leidner, D.E. (2002). Studying Knowledge Management in Information Systems Research: Discourses and Theoretical assumptions. *MIS Quarterly*, 26(3), 213-242.

Senaratne, S. Kagioglou, M. Amaratunga, D., Aouad, G. & Bowden, A. (2005). Research Knowledge transfer into teaching in the built environment. *Engineering Construction and Architectural Management*, 12 (6), 587-600.

Smith, B.L., & McGregor, J.T. (1992). *What is collaborative Learning*? Washington Centre for improving the quality of undergraduate education.

Sonquist, J.A., & Dunkenlberg, W.C. (1977). *Survey and Opinion Research: Procedures for processing and analysis.* New Jersey: Prentice Hall.

South African ICT Sector Performance Review. (2007). Retrieved May 06, 2008, from http://www.lirneasia.net/wp-content/uploads/2007/02/ria-africa.pdf

South African Telecommunications. (2008). Retrieved September 17, 2008, from http:www.southafrica.info/business/economy/infrastructure/telecoms.htm.

Springer, L. Stanne, M.E., & Donovan, S.S. (1999). Effects of Small-Group Learning on undergraduate in Science. *Mathematics Engineering and Technology,* 69(1), 21-51.

Stenmark, D. (2001). Leveraging tacit Organizational Knowledge. *Journal of Management Information Systems,* 17(3), 9 – 24.

Straub, D., & Carlson, C.L. (1989). Validating Instruments in MIS Research. *MIS Quarterly, 13(2), 147-169.*

Straub, D., Boudreau, M-C., & Gefen, D. (2004). Validation Guidelines for Positivist Research. *Communication of the Association for Information Systems*, 13, 380-427.

Straub, D., Gefen, D., & Boudreau, M-L .(2004). Quantitative, Positivist Research Methods Website, (Eds) In Dennis. Galletta, http://www.dstraub.cis.gsu.edu:88/quant/ last updated: January 7, 2005.

Sun, P. & Scott, J.C. (2005). An Investigation of barriers to knowledge transfer. *Journal of knowledge Management,* 9(2), 75-90.

Sung, A.G.L. (2006). A Strategic Framework for leverage Knowledge Innovation. *International Journal of the Computer, the Internet and Management,* 14(3), 32-49.

Szulanski, G. (1996). Exploring Internal Stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal,* 17, 27- 43.

Tanno, D. V. (2003). When Education Media and Technology Converge: What do Latino/ A student gain. *Journal of Latinos and Education*, 2 (1), 39-46.

Thomas, J.C. Kellogg, W.A., & Erickson, T. (2001). The Knowledge Management puzzle: Human and Social factors in Knowledge Management. *IBM Systems Journal,* 40(4), 863-884.

Tiwana, A. (2002). *The Knowledge Management Toolkit.* New Jersey: Pearson Education Inc.

Tsai, C.H., Chang, C.L., & Chen, L. (2006). A case Study of Knowledge Management Implementation for Information Consulting Company. *International Journal of the Computer, the Internet and Management,* 14(3), 60-78.

Tsoukas, H. (1996). The Firm as a Distributed Knowledge System: A constructionist approach. *Strategic Management Journal*, 17, 11-25.

Tuomi, I. (2000). Data is more than Knowledge: Implications of the reversed knowledge hierarchy for Knowledge Management and Organizational memory. *Journal of Management Information Systems,* 16 (3), 103 – 117.

Tustin, M., Ligthelm, J.K., Martins,M., & van Syk, G. (2006). *Marketing Research in Practice*. Pretoria: Unisa Press.

Ulloa, B.C.R. & Adams, S.G. (2004). Attitude towards team work and effective teaming. *Team Performance Management,* 10(7/8), 145-151.

Wasko, M.M., & Faray, S. (2005). Why should I share? Examining Social Capital and Knowledge contribution in electronic networks of practice. *MIS Quarterly,* 29(1), 55-57.

Weber, R. (2004). The rhetoric of Positivism versus Interpretivism: A personal view. *MIS Quarterly,* 28(1), iii-xii.

Weinreich, N.K. (1996). Integrating Quantitative and Qualitative Methods in Social Marketing Research. Retrieved November 11, 2007, from http://www.social-marketing.com/research.html

What is the History of Cellphones. (n. d.). Retrieved May 12, 2007, from http://www.tech-faq.com/history-of-cell-phones.html

Wilson, T.D. (2002). The Nonsense of Knowledge Management, *Information Research*, 8(1).

Yamane, D. (1996). Collaboration and its discontents: steps towards overcoming barriers to successful group projects. *Teaching Sociology,* 24 (4), 378-383.

Zander, U., & Kogut, B. (1995). Knowledge and the Speed of the Transfer and Imitation of Organisational Capabilities: An Empirical Test. *Organisational Science,* 6(1), 76-92.

Zulu, B. (2005). ICT Gender Issues past, present and future. Retrieved July 16, 2008, from http://www.genderit.org/en/index.shtml?w=a&x=91918

Appendix A: Survey instrument

Questionnaire

Section A.

General Questions

Section A contains general questions about you, your project group and your use of a mobile phone .If you do not belong to a project group currently your responses should be based on your previous experience in a project group.

1. Year of study.....
2. What are your major subjects.....
3. Faculty.....
4. Department.....
5. Gender.....
6. Race.....

From question 7-14, please mark with an X where appropriate.

7. How many members are in your group?

Two members	Three members	Four members	Five members	More than 5members

8. Who allocated you into project teams?

Lecturer	Ourselves	Class representative	Course administrator	I don't know

9. What criteria were used to allocate you into project teams?

No criteria	Class list	Friendship	Random selection	I don't know

10. For how long have you been using a mobile phone?

Less than a year	One year	Two years	Three years	More than four years

11. For what purposes do you usually use your mobile phone (you can mark more than one answer)?

Academic	Entertainment	Social	Communication	Other(please specify)

12. Please mark with an X all the functions supported by your mobile phone.

SMS	MMS	Camera	Video	Live TV
Internet	Email	Push to talk	Speaker phone	Other (please specify)

13. How many group members do you usually contact using your mobile phone?

1	2	3	4	5 or more

14. From how many group member do you receive calls/messages (SMS, MMS, email)

1	2	3	4	All of them

Section B

Use of mobile phones

Please indicate your agreement/disagreement with the following statements about using a mobile phone to share ideas during a project. Circle the most appropriate answer.

1= strongly disagree 2=disagree 3= neither disagree or agree
4=agree 5= strongly agree.

1. I usually SMS/MMS ideas to my groupmates. 1 2 3 4 5
2. Other group members share project ideas with me through SMS/MMS. 1 2 3 4 5
3. I usually email project ideas to my groupmates using my mobile phone. 1 2 3 4 5
4. My groupmates also email project ideas to me. 1 2 3 4 5
5. The project group has used video conferencing to share project ideas. 1 2 3 4 5
6. I usually call my groupmates to share project ideas. 1 2 3 4 5
7. The project group has used push-to-talk to share project ideas. 1 2 3 4 5
8. The project group has used the speaker phone to share project ideas 1 2 3 4 5
9. I intend to use my mobile phone to share ideas with group members in future.

   1 2 3 4 5
10. What other mobile phone functionalities have you used to share project ideas with your groupmates

    .....
    .....
    .....
    .....
    .....
    .....

Section C

Motivation

Please indicate your agreement/disagreement with the following statements. Circle the most appropriate answer.

1= strongly disagree	2=disagree	3= neither disagree or agree
4=agree	5= strongly agree.	

1. I encourage my groupmates to use their mobile phones more often to share project ideas. 1 2 3 4 5
2. Group members are comfortable sharing ideas through their mobile phones. 1 2 3 4 5
3. If I did not have a mobile phone, I would not share ideas with my groupmates when we are physically apart. 1 2 3 4 5

Section D

The following statements are about time saved in your project group by using a mobile phone. Please indicate your agreement/disagreement with the following statements by circling the most appropriate answer.

1= strongly disagree	2=disagree	3= neither disagree or agree
4=agree	5= strongly agree.	

1. There isn't enough time for the project, but using my mobile phone to share ideas with my groupmates has enabled the group to cover more work in less time. 1 2 3 4 5
2. Knowledge acquired in previous projects can be transferred in less time by using a mobile phone rather than using other methods (face-to-face, email, etc). 1 2 3 4 5
3. It takes less time to share knowledge by using the voice function (calling, speaker phone, push to talk) of mobile phone. 1 2 3 4 5

4. It takes much longer to transfer knowledge by using text messages (SMS/MMS/Email). 1 2 3 4 5

Section E

The following questions relate to the outcome of your project. Please mark with an X the most appropriate answer to the following questions. If the project has been completed answer 1(a), (b) and 2. If the project is not complete, answer (1b and 1c).

1. (a) What are the results of your recently completed project?

Less than50%	50-60%	61-70%	71-80%	More than 80%

(b) Comment on the general performance of your group in the project?

Poor	Fair	Good	Very Good	Excellent

(c) How would you rate your project at the moment?

Poor	Fair	Good	Very Good	excellent

2. Did sharing ideas through mobile phones contribute to the success of your project?

1 2 3 4 5

Appendix B: Mobile Phone Voice and Data Rates

MTN Zone

MTN introduces MTN Zone, a new per second billing price plan that offers you up to 95% discounts on all calls to all networks.

Call Rates	Peak	Standard	Off-Peak
MTN to MTN	R 2.50	R 2.50	R 2.50
MTN to Telkom	R 3.00	R 3.00	R 3.00
MTN to Other	R 3.00	R 3.00	R 3.00

Calls are charged per minute for any part

3G-Video Call Rates	Peak	Standard	Off-Peak
MTN to MTN	R 3.00	R 3.00	R 3.00
MTN to Vodacom	R 3.00	R 3.00	R 3.00

Messaging Rates	Peak	Standard	Off-Peak
Local SMS	R 0.75	R 0.75	R 0.35
International SMS	R 1.60	R 1.60	R 1.60

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Vodacom Prepaid Packages

Vodacom 4U

Domestic Calls	
General Service calls (Off-Peak)	1.12
General Service calls (Peak)	2.85
Happy Hours 5pm to 8pm	1.49
Value-Added Services (Off-Peak)	1.12
Value Added Services (Peak)	2.85
Vodacom to MTN / Cell C (Off Peak)	1.30
Vodacom to MTN / Cell C (Peak)	2.99
Vodacom to Telkom (Peak)	2.85
Vodacom to Vodacom (Peak)	2.85
Vodacom to Vodacom / Telkom (Off-Peak)	1.12
International Calls (Per minute)	
Prepaid Call costs	As per Zone
SMS & MMS	
International SMS (Vodacom African Networks)*	1.00
MMS (All day)	0.80 per 30KB
SMS (Off-Peak per message)	0.35
SMS (Peak per message)	0.50
SMS Premium rated Tariff Bands (Bearer & content charged per message)	R0.90 - R50.00
SMS sent to International Number (Per message)	1.74
Video Calls	
Video Call Vodacom to MTN (Off-Peak)	2.99
Video Call Vodacom to MTN (Peak)	2.99
Video Call Vodacom to Vodacom (Off-Peak)	1.12
Video Call Vodacom to Vodacom (Peak)	2.85
Voicemail	
Voicemail Retrieval (121)	FREE

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Deleted: ¶

Cell C Prepaid Easy Chat Standard

Voice Calls: Peak Time

Cell C to Cell C	R 2.50
Cell C to other mobile	R 2.85
Cell C to Telkom	R 2.50

Off Peak Time

Cell C to Cell C	R 1.40
Cell C to other mobile	R 1.60
Cell C to Telkom	R 1.40
SMS charged at	R .34

Easy Chat All day

Peak Time

Cell C to Cell C	R 2.00
Cell C to other mobile	R 2.00
Cell C to telkom	R 2.00
SMS per message	R 0.60

Off peak call p/m

Cell C to Cell C	R 2.00
Cell C to other mobile	R 2.00
Cell C to Telkom	R 2.00
SMS per message	R 0.60

Appendix C: Correlation Matrix

	Mean	Std devi	UoMP1	UoMP2	UoMP3	UoMP4	UoMP5	UoMP6	UoMP7	UoMP8	UoMP9	Motivation1	Motivation2	Motivation3	Time1	Time2	Time3	Time4	Success1(a)	Success1(b)	Success1(c)	Success2
UoMP1	2.965714	1.321342	1.000000	0.725334	0.114866	0.148672	0.051726	0.466511	0.131454	0.139382	0.546887	0.360882	0.416106	0.167152	0.403215	0.238782	0.252031	0.087850	0.021770	0.044615	-0.026868	0.234538
UoMP2	2.777143	1.287224	0.725334	1.000000	0.193457	0.090237	0.076122	0.357430	0.036877	0.104985	0.484108	0.343477	0.406228	0.093427	0.410515	0.218948	0.243274	0.014129	0.004328	0.089680	0.037718	0.256796
UoMP3	1.742857	1.153278	0.114866	0.193457	1.000000	0.663828	0.381923	0.076645	0.294880	0.185019	0.160454	0.210670	0.164478	0.060662	0.219013	0.076865	-0.064994	-0.058919	0.167407	0.171757	0.125865	0.251098
UoMP4	2.017143	1.319501	0.148672	0.090237	0.663828	1.000000	0.187321	0.112617	0.195960	0.193136	0.137359	0.181646	0.181150	0.081940	0.221582	0.057576	-0.044047	0.014316	0.187955	0.234446	0.167923	0.210161
UoMP5	1.245714	0.796668	0.051726	0.076122	0.381923	0.187321	1.000000	0.041963	0.695390	0.385422	0.003634	0.216478	0.105328	0.079106	0.166279	0.199072	-0.010916	-0.099734	0.204772	0.182495	0.137750	0.185406
UoMP6	3.034286	1.465689	0.466511	0.357430	0.076645	0.112617	0.041963	1.000000	0.213747	0.268244	0.574926	0.439331	0.453671	0.169625	0.460952	0.297527	0.267812	0.229728	0.203598	0.166703	0.083453	0.370996
UoMP7	1.445714	1.014930	0.131454	0.036877	0.294880	0.195960	0.695390	0.213747	1.000000	0.443442	0.049791	0.303140	0.166460	0.117922	0.261221	0.257408	-0.011184	0.016137	0.215633	0.122705	0.134904	0.214677
UoMP8	1.628571	1.085053	0.139382	0.104985	0.185019	0.193136	0.385422	0.268244	0.443442	1.000000	0.216140	0.142173	0.160180	0.066607	0.168308	0.193564	0.122202	0.033337	0.233463	0.164214	0.103564	0.216595
UoMP9	3.354286	1.520047	0.546887	0.484108	0.160454	0.137359	0.003634	0.574926	0.049791	0.216140	1.000000	0.425492	0.558304	0.190185	0.482484	0.297259	0.346830	0.163325	0.036740	0.162488	0.065867	0.379241
Motivation	2.702857	1.292215	0.360882	0.343477	0.210670	0.181646	0.216478	0.439331	0.303140	0.142173	0.425492	1.000000	0.656450	0.123044	0.522974	0.293167	0.254640	0.201335	0.140283	0.177787	0.122146	0.493165
Motivation.	3.280000	1.230083	0.416106	0.406228	0.164478	0.181150	0.105328	0.453671	0.166460	0.160180	0.558304	0.656450	1.000000	0.217155	0.590457	0.438736	0.481076	0.155530	0.164539	0.243630	0.093528	0.476855
Motivation.	2.428571	1.420007	0.167152	0.093427	0.060662	0.081940	0.079106	0.169625	0.117922	0.066607	0.190185	0.123044	0.217155	1.000000	0.329515	0.217617	0.154441	0.140636	0.018250	0.016686	0.081262	0.095707
Time1	2.880000	1.265093	0.403215	0.410515	0.219013	0.221582	0.166279	0.460952	0.261221	0.168308	0.482484	0.522974	0.590457	0.329515	1.000000	0.463545	0.402019	0.242962	0.233218	0.269851	0.176270	0.458512
Time2	2.474286	1.254038	0.238782	0.218948	0.076865	0.057576	0.199072	0.297527	0.257408	0.193564	0.297259	0.293167	0.438736	0.217617	0.463545	1.000000	0.385262	0.107108	0.191567	0.155236	0.181935	0.386536
Time3	3.045714	1.299059	0.252031	0.243274	-0.064994	-0.044047	-0.010916	0.267812	-0.011184	0.122202	0.346830	0.254640	0.481076	0.154441	0.402019	0.385262	1.000000	0.335441	0.055259	0.138913	0.019974	0.254600
Time4	3.234286	1.307349	0.087850	0.014129	-0.058919	0.014316	-0.099734	0.229728	0.016137	0.033337	0.163325	0.201335	0.155530	0.140636	0.242962	0.107108	0.335441	1.000000	0.050349	0.112948	0.203849	0.043511
Success1(a	2.480000	1.774144	0.021770	0.004328	0.167407	0.187955	0.204772	0.203598	0.215633	0.233463	0.036740	0.140283	0.164539	0.018250	0.233218	0.191567	0.055259	0.050349	1.000000	0.472351	0.243983	0.386487
Success1(b	3.240000	1.212767	0.044615	0.089680	0.171757	0.234446	0.182495	0.166703	0.122705	0.164214	0.162488	0.177787	0.243630	0.016686	0.269851	0.155236	0.138913	0.112948	0.472351	1.000000	0.562830	0.260324
Success1(c	2.765714	1.522616	-0.026868	0.037718	0.125865	0.167923	0.137750	0.083453	0.134904	0.103564	0.065867	0.122146	0.093528	0.081262	0.176270	0.181935	0.019974	0.203849	0.243983	0.562830	1.000000	0.228716
Success2	2.445714	1.588816	0.234538	0.256796	0.251098	0.210161	0.185406	0.370996	0.214677	0.216595	0.379241	0.493165	0.476855	0.095707	0.458512	0.386536	0.254600	0.043511	0.386487	0.260324	0.228716	1.000000

Appendix D: Complete Table of Factor Loadings

The red font indicates items with high factor loading.

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
UoMP 1	*0.858330*	0.060720	-0.061980	0.073768	0.048423	0.143415
UoMP 2	*0.815816*	-0.007737	-0.015548	0.110898	-0.064881	0.160570
UoMP 3	0.086231	0.223279	0.059831	*0.856150*	-0.062891	0.089508
UoMP 4	0.084827	0.076402	0.165636	*0.854387*	0.051606	0.053591
UoMP 5	-0.046941	*0.822991*	0.047104	0.219890	-0.071978	0.095651
UoMP 6	*0.610127*	0.161317	0.176722	-0.070407	0.153684	0.320088
UoMP 7	0.020190	*0.866642*	0.034102	0.139183	0.045115	0.140071
UoMP 8	0.246345	*0.687679*	0.198037	-0.027794	0.039376	-0.012458
UoMP 9	*0.702420*	-0.018212	0.067087	0.063308	0.139384	0.363905
Motivation 1	0.326965	0.146970	0.050172	0.166777	0.036092	*0.633585*
Motivation 2	0.382351	0.022820	0.060375	0.103284	0.103455	*0.744281*
Motivation 3	0.026769	0.123837	-0.157087	0.170266	*0.624728*	0.215584
Time 1	0.343556	0.125564	0.131342	0.175084	0.286837	*0.630007*
Time 2	0.074576	0.251573	0.071486	-0.087979	0.156777	*0.648365*
Time 3	0.201286	-0.046674	0.036713	-0.229766	0.369575	*0.540700*
Time 4	0.092805	-0.071642	0.238331	-0.103637	*0.738882*	0.066517
Success 1(a)	-0.066831	0.213891	*0.631290*	0.048390	-0.200930	0.282072
Success 1(b)	0.061110	0.052256	*0.834838*	0.133110	0.029870	0.135875
Success 1(c)	-0.028425	0.057254	*0.751892*	0.128017	0.237860	0.006402
Success 2	0.160625	0.119028	0.286593	0.149493	-0.192743	*0.692119*
Expl. Var	2.807209	2.176825	1.967738	1.786368	1.391656	3.014065
Prp. Totl	0.140360	0.108841	0.098387	0.089318	0.069583	0.150703