

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

Investigating the extent to which students share tacit knowledge using mobile phones in group projects

A DISSERTATION PRESENTED TO THE

DEPARTMENT OF INFORMATION SYSTEMS



UNIVERSITY OF CAPE TOWN

BY

CHIEDZA KHUMBULA

SEPTEMBER 2011

In partial fulfilment of the requirements for the Masters in Information Systems

Plagiarism Declaration

I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

I have used the American Psychological Association (APA) convention for citation and referencing throughout the dissertation. Each contribution to and quotation in this dissertation "**Investigating the Extent to which Students Share Tacit Knowledge using Mobile Phones in Group Projects**" from the work(s) of other people has/have been attributed and has been cited and referenced.

This dissertation "**Investigating the Extent to which Students Share Tacit Knowledge using Mobile Phones in Group Projects**" is my own work.

I have not allowed and will not allow anyone to copy my work with the intention of passing it off as his or her own work.

I acknowledge that copying someone else's dissertation, or part of it, is wrong and declare that this is my own work.

Signature..... Date:..09/...09/...2011

Full Name of Student: Chiedza Khumbula

Student Number: KHMCHI001

Abstract

The benefit of group-learning to enhance the sharing of knowledge among students in group projects is increasingly preferred over traditional methods. However, there are still many challenges facing students learning in groups. These include: lack of leadership, time and scheduling of workload, free riding, individual and social barriers, lack of team development, lack of social interaction, lack of motivation, inadequate rewards, skills and attitude problems or social loafing. The integration of the mobile context and technologies in group-learning can assist in minimizing some of these barriers. Information Communication Technologies (ICTs) are believed to transform teaching and learning processes through the facilitation of communication and interaction among teachers and learners. Researchers have also found that tacit knowledge has much greater importance to industry and academia. For instance, it allows individuals to achieve goals they personally value. It can be used to measure or predict job performance and those possessing it have been found to manage themselves and others better.

This research investigates the extent to which students share tacit knowledge using the mobile phone in group projects, and examines if they achieve better performance with this technology. One hundred and fifty (150) undergraduate students from (four) different disciplines i.e. Computer Science (CS), Civil Engineering (CE), Information Systems (IS) and Psychology (PSY) participated in the survey. The results confirm that while many students do not share tacit knowledge using mobile technology, IS students shared more knowledge than their counterparts and their performance in group projects was good. CE students shared the least of the tacit knowledge measured in this study.

The researcher also determined if discipline has some effect on the sharing of tacit knowledge in a mobile environment. The results suggest that this is possible where tacit knowledge is shared through discussions on project tasks and allocation of responsibilities (TK1) and also where the knowledge shared relates to theoretical principles (TK2). However, discipline does not appear to have any influence on sharing of tacit knowledge by seeking clarification from Professors (TK3). Therefore the lack of tacit knowledge sharing observed

in Civil Engineering and Psychology groups can be attributed to factors other than the nature of these disciplines.

The present study also confirms that when mobile technology is leveraged to share the much needed tacit knowledge, students' performance in group projects is enhanced.

University of Cape Town

Acknowledgements

I wish to extend my sincere gratitude to my supervisor Professor Michael Kyobe for his consistent support and assistance through useful comments and suggestions. Your visit to the IS masters lab was inspiring and will never be forgotten. I am also grateful to the Masters 2010 class for all the help and encouragement which I have received.

University of Cape Town

Dedication

I dedicate this dissertation to the Khumbula family, mostly my mum and dad, Mrs Violet Khumbula and Mr Davis Khumbula. It would be very unfair if I do not dedicate this dissertation to you my dear sister Mrs Gracious Khumbula Masara (as you always called it your Masters). Thank you for showing me some love and support.

University of Cape Town

List of Common Acronyms

1G.....	First Generation
2G.....	Second Generation
3G.....	Third Generation
BBM.....	Black Berry Messenger
CE.....	Civil Engineering
CS.....	Computer Science
DIKW.....	Data Information Knowledge Wisdom
E-mail.....	Electronic Mail
FB.....	Facebook
GPS.....	Global Positioning System
ICT.....	Information Communication Technology
IM.....	Instant Messaging
IS.....	Information Systems
IT.....	Information Technology
MMS.....	Multimedia Messaging Service
MLearning.....	Mobile Learning
PSY.....	Psychology
SMS.....	Short Messaging Service
SD/Std.....	Standard Deviation
TK.....	Tacit Knowledge
EK.....	Explicit Knowledge
Other.....	Web-based learning features: Vula, MXit and Google Documents
UCT.....	University of Cape Town

Table of Contents

Plagiarism Declaration	i
Abstract.....	ii
Acknowledgements.....	iv
Dedication	v
List of Common Acronyms.....	vi
List of Tables	xi
List of Figures	xii
CHAPTER 1: INTRODUCTION.....	1
1.1 Background and Problem Definition.....	1
1.2 Objectives and Research Question	3
1.3 Relevance of the Research.....	4
1.4 Limitations of the Research	4
1.5 Dissertation Overview.....	5
CHAPTER 2: LITERATURE REVIEW	7
2.1 Knowledge, Knowledge Management and Knowledge Transfer.....	8
2.1.1 Knowledge.....	8
2.1.2 Knowledge Management.....	9
2.1.3 Knowledge Transfer	12
2.1.4 Knowledge Transfer Processes	15
2.2 Impediments to Knowledge Transfer	16
2.2.1 Nature of Knowledge	17
2.3 Transfer of Knowledge in Group Projects.....	20
2.3.1 Problems with Group Projects	21
2.4 The Impact of Technology.....	23
2.4.1 Impediments to Effective Adoption and Use of ICT.....	23

2.5	The Role and Limitations of ICT in Education	24
2.5.1	Limitations of ICT in Education	26
2.6	Mobile Learning	27
2.6.1	How Technology Facilitates the Transfer of Tacit and Explicit Knowledge.....	28
2.7	Summary of the Literature Review	29
2.7.1	Conceptual Model.....	30
2.8	Research Hypotheses.....	31
CHAPTER 3: RESEARCH DESIGN		33
3.1	Introduction	33
3.2	Philosophical Assumptions	33
3.3	Research Methodology	34
3.3.1	Research Purpose.....	35
3.3.2	Research Paradigms.....	35
3.3.3	Research Timeframe	37
3.3.4	Research Instrument.....	37
3.3.5	Target and Sample Population.....	39
3.3.6	Research Strategy	41
3.3.7	Data Collection.....	46
3.3.8	Data Analysis.....	48
3.4	Confidentiality and Ethics	50
3.5	Summary of the Chapter.....	51
CHAPTER 4: RESULTS AND DISCUSSION.....		52
4.1	Introduction	52
4.2	Reliability and Validity Testing	53
4.2.1	Reliability Testing	53
4.2.2	Discriminant Validity	53

4.2.3	Reliability of Qualitative Analysis.....	54
4.3	Demographic Analysis.....	54
4.3.1	Gender	55
4.3.2	Participants	55
4.3.3	Group Members.....	55
4.3.4	Group Allocation	57
4.4	Sharing of Tacit Knowledge.....	57
4.5	Sharing of Explicit Knowledge.....	64
4.6	Responses to Open Ended Questions	66
4.6.1	Purpose of using Mobile Phones in Group Projects.....	66
4.6.2	Functions on Student Mobile Phones.....	69
4.6.3	Mobile Functions Used Regularly by Students	69
4.6.4	Perceived Usefulness of the Mobile Phone in Group Projects	71
4.7	Outcome of Group Projects (Performance).....	72
4.7.1	Results of Student Self-Assessment.....	72
4.7.2	Sharing of Tacit Knowledge and Performance.....	74
4.7.3	Influence of Discipline on Tacit Knowledge Shared.....	74
4.8	Hypothesis Testing.....	76
4.8.1	Hypothesis 1.....	76
4.8.2	Hypothesis 2.....	79
CHAPTER 5:	CONCLUSION AND RECOMMENDATIONS.....	80
5.1	Conclusion.....	80
5.2	Limitations.....	81
5.3	Recommendations	81
5.3.1	Policy and Practice	81
5.3.2	Future Research	82

REFERENCES	83
APPENDIX A: COMPUTER SCIENCE QUESTIONNAIRE	96
APPENDIX B: CIVIL ENGINEERING QUESTIONNAIRE	98
APPENDIX C: INFORMATION SYSTEMS QUESTIONNAIRE	100
APPENDIX D: PSYCHOLOGY QUESTIONNAIRE.....	102
APPENDIX E: TACIT AND EXPLICIT KNOWLEDGE CASES.....	104
APPENDIX F: ETHICS FORM	105
APPENDIX G: RESEARCH ACCESS FORM.....	108

University of Cape Town

List of Tables

Table 1: Performance Scale.....	38
Table 2: Five-point Likert Scale	39
Table 3: Summary of Qualitative and Quantitative Measurement	46
Table 4: Respondents Background (N=150).....	48
Table 5: Research Methodology Summary	51
Table 6: Reliability Scores.....	53
Table 7: Discriminant Validity Scores	54
Table 8: Knowledge Shared Using Mobile Phones by Computer Science Students	58
Table 9: Knowledge Shared Using Mobile Phones by Civil Engineering Students	60
Table 10: Knowledge shared using Mobile Phones by Information Systems Students.....	62
Table 11: Knowledge Shared Using Mobile Phones by Psychology Students.....	63
Table 12: Explicit Knowledge Shared Using Mobile Phones by Students	65
Table 13: Results of Analysis of Variance (ANOVA)	75
Table 14: Mean Comparisons.....	75
Table 15: T-test Results Comparing Tacit Knowledge and Performance Mean Scores	79
Table 16: Summary of Research Findings	79
Table 17: Tacit and Explicit Knowledge Measures in Computer Science.....	104
Table 18: Tacit and Explicit Knowledge Measures in Civil Engineering	104
Table 19: Tacit and Explicit Knowledge Measures in Information Systems	104
Table 20: Tacit and Explicit Knowledge Measures in Psychology	104

List of Figures

Figure 1: DIKW Hierarchy	9
Figure 2: Knowledge Management Cycle.....	10
Figure 3: People-centred Knowledge Management	11
Figure 4: Representative IS Solutions Mapped against Knowledge Processes they Augment.....	12
Figure 5: Four Processes of Knowledge Conversion	15
Figure 6: Conceptual Model	31
Figure 7: Distribution of Students in the Four Disciplines	55
Figure 8: Number of Members in a Group Project	56
Figure 9: Number of Groups Found in each Discipline	56
Figure 10: Group Allocation	57
Figure 11: Purposes for Using the Mobile Phones in Group Projects.....	66
Figure 12: Mobile Phone Functions	69
Figure 13: Mobile Functions Used.....	70
Figure 14: Perceived Usefulness in Group Projects	71
Figure 15: Student Self-Assessment.....	73
Figure 16: Students who Shared Tacit Knowledge and Performed Well: Analysis by Discipline ...	74
Figure 17: Tacit and Explicit Knowledge Measures in Computer Science	77
Figure 18: Tacit and Explicit Knowledge Measures in Civil Engineering	77
Figure 19: Tacit and Explicit Knowledge Measures in Information Systems	78
Figure 20: Tacit and Explicit Knowledge Measures in Psychology	78

CHAPTER 1: INTRODUCTION

1.1 Background and Problem Definition

Students improve understanding, sharing of knowledge and critical thinking in group learning (Levine, 2002; McCorkle, Reardon, Alexander, Kling, Harris & Vishwanathan, 1999; McGhee & Kozma, 2003; McKenzie, 2001). Many educational institutions are therefore, adopting group learning as an alternative to traditional methods (Lam, 2008). However, there are still many challenges facing students learning in groups. These include lack of leadership, time and scheduling of workload, free riding, individual and social barriers, lack of team development, lack of social interaction, lack of motivation, inadequate rewards, skills and attitude problems or social loafing (Burdett & Hastie, 2009; Hansen, 2006; Kreijns, Kirschner & Jochems, 2003; McCorkle et al., 1999; Shongwe, 2009). These problems encourage alternative strategies i.e. the introduction of ICTs to teaching and learning processes.

Recent studies show that the integration of the mobile context and technologies in group learning can assist in minimising some of these barriers (Kim, Mims & Holmes, 2006; Sharples, Taylor & Vavoula, 2005). In a study that investigated the impact of mobile technology on knowledge transfer in student groups, Shongwe (2009) found that mobile technology can minimize social barriers, time constraints and motivate students. However, Shongwe's (2009) study mainly focused on explicit than tacit knowledge. Fernie, Green, Weller and Newcomb (2003) indicate that the nature of knowledge is still a major challenge to the transfer of knowledge in groups.

Tacit knowledge is personal, context specific, difficult to formalize, difficult to communicate and transfer due to its complexity. Explicit knowledge on the other hand, can be articulated in formal language, duplicated and stored in databases or libraries, though it may also prove difficult to transfer due to syntax and semantic limitations (Foray & Hargreaves, 2003). Research into the use of mobile technologies for knowledge transfer appears to focus mainly on explicit knowledge (Kindberg, Spasojevic, Fleck & Sellen, 2005, p.1; Puikkonen, Hakkila, Ballagas & Mantyjärvi, 2009; Taylor & Harper, 2003, p.7). Very little is known about

the role of mobile phones in resolving the barriers created by tacit knowledge. Indeed, Li and Wang (2007) concur that, the essential facts on knowledge management using the mobile phone have not been studied in depth.

It is well established that tacit knowledge is of great importance to industry and academia (Somech & Bolger, 1999). It allows individuals to achieve goals they personally value; it is used to measure or predict job performance (a notable component of job success and performance). For example, students acquire tacit knowledge through discussions with tutors, lecturers, administrative staff and consulting peers about course requirements and expectations (Somech & Bolger, 1999, p.605).

Somech and Bogler (1999) analysed the characteristics of tacit knowledge in academia. They cite Sternberg, Wagner, Williams and Horvath (1995) who argue that tacit knowledge is a notable component of job success, performance, management and present one aspect of practical intelligence (i.e. peoples' ability to apply components of intelligence to daily life). Wagner and Sternberg (1990) maintain that persons who possess tacit knowledge can manage themselves (self-motivated and organised); can manage other people (e.g. lower and upper level employees and peers); and can manage tasks (i.e. possess strong management skills). While most research on tacit knowledge has been conducted in non-academic settings, Somech and Bogler (1999) argue that such knowledge features greatly in academia and is important at tertiary level. They argue further that, students with tacit knowledge would apply practical knowledge throughout their learning experiences and processes to improve their academic achievement.

Since tacit knowledge is not easily articulated or codified, some researchers argue that there are limited opportunities for its transfer by way of digital codes and electronic communication (Hildrum, 2009; Howells, 1996; Maskell & Malmberg, 1999; Salter & Gann, 2003). These claims are however, challenged by Prensky (2004); Weininger and Shield (2001), and Jacobson (2009), who show that the availability of tools like voice (e.g. making phone calls, chatting, etc) and video (e.g. video conferencing and listening to video clips) enable the transfer of tacit knowledge.

Tacit knowledge is believed to be shared through traditional methods e.g. discussions, social interactions, formal meetings or chance meetings in corridors (Jacobson, 2009). However, in the current technological environment, it is possible to share tacit knowledge using collaborative tools and mobile phone features as suggested above. Jacobson (2009) states that social networking is being used by companies to access tacit knowledge through collaboration tools e.g. IdeaStorm launched by Dell. In addition, Dourish (2001) and Shen (2003) also report that context and rationale in problem solving processes can be captured using mobile phones. Hejazinia and Razzazi (2010, p.6) show that people can also use mobile technology to share their experiences and knowledge while Norris, Mason, Robson, Lefrere and Collier (2003, p.16) argue that in e-knowing (e-knowledge commerce environment), transactions based on sharing of knowledge take place. They state that these transactions involve the exchange of digital content/context and tacit knowledge through interactivity.

However, due to the dearth of research in this area, the effectiveness of these tools in facilitating tacit knowledge transfer (especially in a learning environment) has not been tested. It is also unclear whether learners use these tools to share valuable tacit knowledge for better performance. Past research on tacit knowledge has mainly focused on non-academic environment (Sternberg et al., 1995). Therefore, the present research intends to find out if students perform better when they share tacit knowledge with their mobile phones.

1.2 Objectives and Research Question

The objectives of the research are:

1. To investigate the extent to which students share tacit knowledge using the mobile phone in group projects.
2. To examine whether students who share tacit knowledge achieve better performance in group projects.

The research questions are:

1. Do students use mobile phones to share tacit knowledge in their group projects?
2. Do students who share tacit knowledge using mobile phones improve their group performance?

1.3 Importance of the Research

Literature shows that the nature of knowledge is still a major impediment to the transfer of knowledge in groups. It is also revealed that technology can facilitate the sharing of knowledge. However, limited studies have investigated the role of mobile technology in resolving the barrier created by tacit knowledge sharing in academia.

This study shades more light on sharing of tacit knowledge using mobile technology in academia. It shows that by leveraging this technology students can enhance their understanding and performance. The study also refutes earlier notions that technology only supports explicit knowledge. The findings confirm that technology can indeed facilitate the transfer and sharing of tacit knowledge. In addition, the instrument used in this study can be adopted by the industry in order to measure the levels of tacit knowledge shared in work teams.

The study is essential since there is limited research which tested the effectiveness of mobile technology features to facilitate knowledge transfer in a learning environment. In addition, it tests whether learners use these features to share valuable tacit knowledge for better performance.

1.4 Limitations of the Research

A major drawback was lack of actual student grades from all the departments to verify the results with the self-assessment performance indicated on the survey. And as such, caution should be exercised when interpreting the results. Marks were subject to change for students with incomplete projects thereby, giving different results of their performance.

In some disciplines, students conducted group projects in the second semester hence, it was impossible to obtain a big sample. The research was constrained to the period students had lectures thus, it restricted extensive feedback. This affected the generalization of results.

The findings of the present research should have been compared to that of a control group consisting of students who do not use mobile technology to share tacit knowledge. This would have assisted in establishing exactly whether the improvement in performance of the students was as a result of the use of technology or not.

Another problem was lack of functionality on mobile phones possessed by students. For example, limited storage and display capabilities resulted in problematic retrieval of messages. It therefore influenced sharing of knowledge among students including the results obtained in this research.

Voice call rates were pricy and not affordable to students for project discussions. In Psychology, students conceptualised knowledge through face-to-face discussions. It mooted that if costs were lower, they could use mobile phones to conduct project discussions.

1.5 Dissertation Overview

The rest of the dissertation is organised as follows:

Chapter 2: provides a review of literature on knowledge management, knowledge transfer, nature of knowledge (tacit and explicit) including, impediments to their transfer. It also provides an in-depth discussion on transfer of knowledge in group projects as well as the benefits and challenges involved. The literature review expatiates on theories of impact of technology, role and limitations of ICT in education and mobile learning. A conceptual model that illustrates the relationships between concepts of interest summarises the chapter. Lastly, research propositions that assisted in answering the research question will be presented. *Chapter 3:* outlines the research design which encompasses philosophical assumptions, research methodology consisting of research purpose, paradigm, time frame, instrument, target sample and population, strategy and data collection and analysis techniques. Finally, research confidentiality and ethics will be presented. *Chapter 4:*

presents results of the data analysis, discussion of findings and a conclusion. *Chapter 5:* presents a conclusion of the dissertation which consists of recommendations, theoretical and practical implications including suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

Rapid expansion of technology is forcing classroom or traditional learning methods to be phased away. According to Lam (2008), several institutions of higher learning are adopting group learning as an alternative to traditional learning. Technology through use of mobile phones can overcome the problems being faced in group learning and enhance student performance. The mobile phone supports institutional learning and enables students to transfer knowledge (Jones & Issroff, 2007).

This chapter provides a review of literature on knowledge sharing concepts in both group projects and mobile environment. It is organised as follows: *Section 2.1* clarifies the concepts underlying knowledge and encompasses the knowledge hierarchy, epistemological, ontological notions and key knowledge transfer processes. *Section 2.2* outlines the impediments to knowledge transfer. *Section 2.3* discusses knowledge transfer in group projects and the challenges involved. *Section 2.4* outlines a detailed discussion on the foundations of ICT mediated work and impediments to effective adoption and use of ICT while, *Section 2.5* provides insight into the role and limitations of ICT in education. *Section 2.6* elaborates concepts of mobile learning e.g. benefits and challenges involved and how technology can facilitate the transfer of tacit and explicit knowledge. *Section 2.7* summarises the literature review with a conceptual model that shows the key elements and relationships that emerged from literature review. The model acts as a framework for investigating the current research problem. *Section 2.8* presents the research propositions to be evaluated in response to the research question.

2.1 Knowledge, Knowledge Management and Knowledge Transfer

2.1.1 Knowledge

Knowledge is defined in several ways depending on the situation at hand. Evidence in literature depicts that knowledge is a complex concept that comprises of deep meanings (Nonaka, 1994) and is difficult to define (Hlupic, Pouloudi & Rzevski, 2002). However, despite these discrepancies, Nonaka and Takeuchi (1995, p.58) describe knowledge as “a process of justifying true beliefs”. They also observe that knowledge embraces beliefs, commitments and actions. Moteleb and Woodman (2007, p.60) define knowledge as “what an individual claims to have and is of great value”. On the other hand, Bierly, Kessler and Christensen (2000, p.600) refer to it as “a symbol of clear understanding of information and their patterns”. Most definitions perceive knowledge as information and beliefs possessed by individuals (Dretske, 1981; Polanyi, 1966a; Roberts, 2000). Individuals acquire and transfer knowledge through experience and learning processes. Thus, through experience and learning they become knowledgeable and are able to transfer knowledge among their peers.

2.1.1.1 Data, Information, Knowledge and Wisdom (DIKW) Hierarchy

There are two schools that explain knowledge generation. In the first school Bierly et al. (2000), claim that knowledge comes from data and information. Raw facts are acquired first, processed into information and transformed into knowledge. On the other hand, the second school proposes that both data and information originate from knowledge, i.e. knowledge has always been in existence for generations (Braganza, 2004). While such differences exist, most researchers have adopted the earlier view that knowledge is generated from data and information. The researcher adopts a similar view since; the study will also examine how students interact in group projects, gather data and generate knowledge which they then share with others using mobile phones.

The DIKW hierarchy in Figure 1 shows the stages in the contextualization of data to information, knowledge and wisdom. Stenmark (2002) believes that there is not much difference between data, information and knowledge. However, there are clear distinctions

between them (Davenport & Prusak, 1998; Nonaka & Takeuchi, 1995; Tuomi, 2000). Data is a set of discrete facts about certain events (Davenport & Prusak, 1998), raw facts (Bierly et al., 2000; Faucher, Everett & Lawson, 2008), while Davenport (1997) view data as simple observations. When such facts are put into a context and combined within a structure, information emerges. Thus, information is meaningful and useful data (Bierly et al., 2000; Nonaka & Takeuchi, 1995; Faucher et al., 2008). Knowledge is derived from information while, information derives from data (Davenport & Prusak, 1998). Although knowledge is not completely different from information, Alavi and Leidner (1999) argue that, both information and knowledge are context specific and are created during social interactions. Thus, knowledge depends upon people, information and methods for its creation (Nonaka & Takeuchi, 1995). Lastly, wisdom is viewed as knowledge processed in a meaningful way (Faucher et al., 2008, p.5). The whole process of collecting data, converting it into knowledge and sharing it in an organization is referred to as knowledge management and is discussed in the next section.

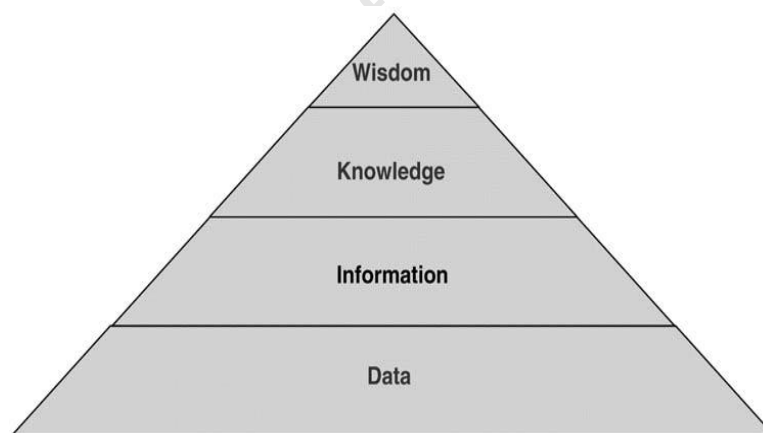


Figure 1: DIKW Hierarchy (Rowley, 2007, p.164)

2.1.2 Knowledge Management

Internal and external pressures are forcing organizations to manage their knowledge resources. This has in a way resulted in several strategies for knowledge management hence; the different definitions of the knowledge management concept.

Knowledge management may be described as a formal or directed process determining how information possessed by an organisation can be made available to benefit employees (Liss,

1999, p.1). Alavi and Leidner (2001, p.131) on the other hand, consider knowledge management as a “dynamic and continuous organizational phenomenon that consists of knowledge creation, storage and retrieval, transfer and application processes”. Davenport and Prusak (1998) add that for effective knowledge management to occur, organizations do not only require efficient collection, distribution but, also use of knowledge resources

Fischer and Ostwald (2001) emphasise another interesting aspect of knowledge management, i.e. its cyclical nature. These authors argue that, knowledge management is a cyclic process involving creation, integration and dissemination of knowledge as shown in Figure 2. In the first activity, workers create knowledge while, in the second activity, information repositories and organizational memories are integrated into work processes and social practices of the community that constructs them. Finally, the third activity; dissemination, allows the availability of information to workers or groups from organizational memory through classroom training, printed reference documents or electronic mail. After dissemination, the processes are considered to repeat again.

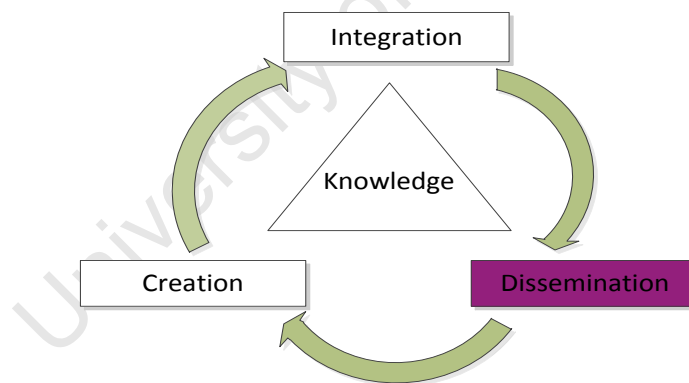


Figure 2: Knowledge Management Cycle (Fischer & Ostwald, 2001, p.61)

Knowledge management has also been categorised as people-centred and technology-centred (Silver & Shakshuki, 2002) as follows:

The people-centred school is supported by organizational theorists who possess backgrounds in psychology, human development, cognition, organizational behaviour, group dynamics and sociology. They believe that the key to organization success lies in the human intellect, people organization and management skills. As a result, they consider the

main objective of knowledge management to be knowledge transfer within an organization and its external partners. Figure 3 shows the main processes of people centred knowledge management: knowledge creation, knowledge integration and knowledge sharing.

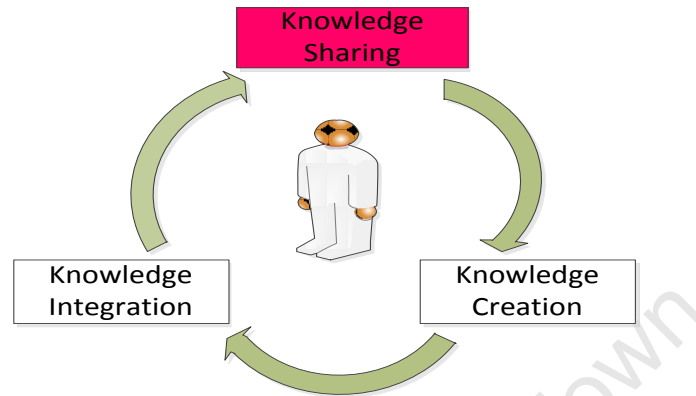


Figure 3: People-centred Knowledge Management

Traditional healers for example, demonstrate people-centred knowledge management in the sense that, they share knowledge among themselves through explicit teaching and apprenticeship (Thornton, 2009). Also, they conduct practice and evaluations of therapies through discussions and observations. Therefore, they view themselves as members of a distinct intellectual tradition that undergoes critique, modification and change in the light of experience and myriad influences.

Technology centred knowledge management describes the creation, filtering, incorporation and development of knowledge and reuse of knowledge through ICT tools e.g. expert systems, infrastructure (networks, internets and intranets) Skyrme (1998). According to Silver and Shakshuki (2002), technology theorists argue that, knowledge management consists of IT (Information Technology) enthusiasts possessing backgrounds in IT, Computer Science, data communication and data analysis. Furthermore, they state that there are similarities between knowledge and objects that are encoded, stored, transmitted and processed by IT systems. As a result, this group maintains that IT solutions are vital for providing answers to problems experienced in knowledge management. Figure 4 outlines the knowledge processes (i.e. identifying, creating, collection/codification and diffusion of

knowledge) and appropriate ICT tools (networks, internets and intranets) that can be mapped into the various processes of knowledge.

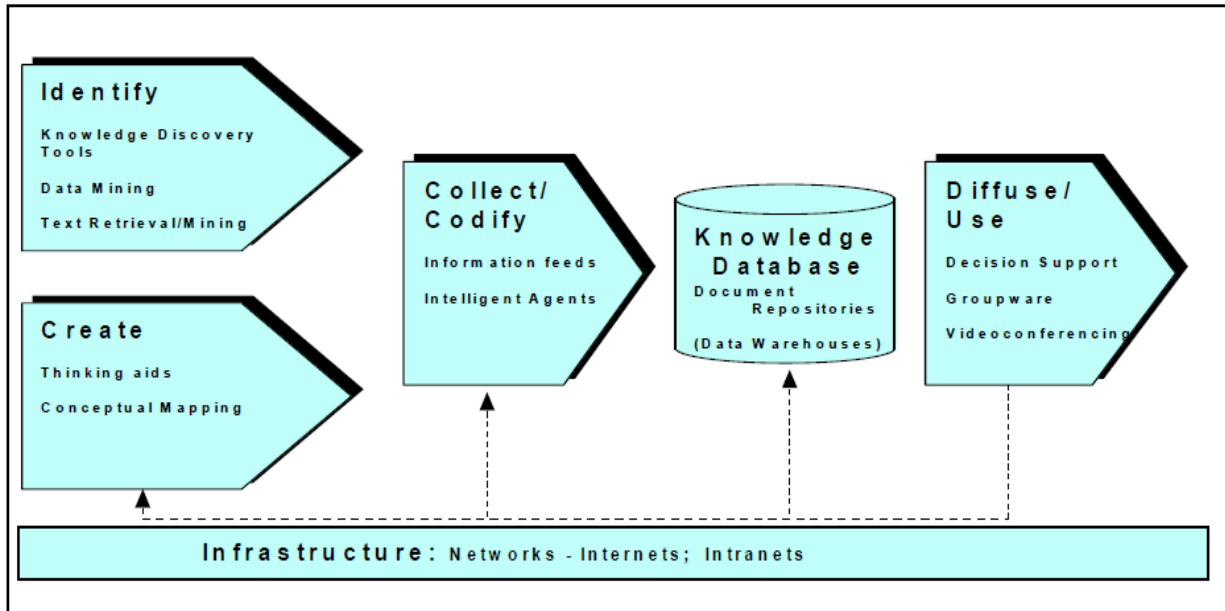


Figure 4: Representative IS Solutions Mapped against Knowledge Processes they Augment (Skyrme, 1998)

In the present digital environment, it may be difficult to draw a clear line between what is people centred and what is technology centred since; people and technology are both increasingly involved in all the stages of knowledge management (Silver & Shakshuki, 2002). The present study looks at the knowledge management process that involves people (e.g. students) and technology (e.g. mobile phone). It therefore, examines both people and technology aspects of knowledge management. However, since the study relates to tacit knowledge transfer, there will be much focus on the knowledge dissemination stage.

2.1.3 Knowledge Transfer

There are many definitions of knowledge transfer. Argote (1999) defines it as a procedure through which one unit involving an individual, group or division is affected by the experience of another. According to Roberts (2000, p.429), knowledge transfer refers to “the application and productive use of information”. Knowledge transfer involves the transmission of a message from a source to the intended recipient within a particular context (Szulanski, 1996). Research in knowledge transfer began in the early 1960s (1961-

1963) when merchandise knowledge from United States of America was compiled in card books 'MD Notes' and disseminated to sellers in Japan by researchers at Takashinaya department store (Kenshi, 2006). Since then, there have been several studies on transfers at individual (e.g. between experts and novices), group (e.g. on transfer impediments), and organizational levels (e.g. knowledge acquisitions, speed of knowledge transfer and organizational learning) (Kwan & Cheung, 2006). There are two basic knowledge management models that explain the process of knowledge transfer. These are discussed in the following section.

2.1.3.1 Epistemological Notion

There are two assumptions on which knowledge transfer may be based: the epistemological notion and the ontological notion (Gerbert, Geib, Kolbe & Brenner, 2003). The epistemological notion focuses on the nature of knowledge independent of its context (Gerbert et al., 2003, p.111). Joshi, Sarker and Sarker (2007) identified three epistemological stances: i.e. the cognitivistic, connectionistic and autopoietic stances.

Cognitivistic theorists claim that knowledge is regarded as fixed; it is similar to data; shared easily among entities and stored in archives or computers. The previous knowledge behaviour of the sender and that of the receiver as well as the knowledge itself are not viewed as critical to knowledge transfer. They therefore consider knowledge to be shared easily among entities and that it can be stored in archives or computers. From a connectionistic point of view, knowledge has limited characteristics and is contextual. Connectionists acknowledge that the contextualised nature of knowledge and the characteristics of the connections between the source and recipient tend to hinder its transfer. In opposition, autopoietic theorists believe that knowledge is history dependent, develops in an autonomous manner, and is abstract, not shareable and always created.

The researcher believes that knowledge sharing is problematic, for during knowledge transfer, there could be many impediments as suggested by Szulanski (1996). The connectionist notion is therefore, adopted in the present study. Knowledge is considered to

comprise of diverse characteristics that are not universal and that its context, nature, social interactions, and other factors may influence its transfer in project groups.

2.1.3.2 Ontological Notion

The ontological notion on the other hand, view knowledge as an integrated whole and focuses on the relationship between knowledge and its environment or context, independent of its nature (Gebert et al., 2003, p.111). For instance, ontological knowledge management models use three modelling dimensions i.e. the process dimension, the agent dimension (individual versus group) and the financial dimension (Gebert et al., 2003). Process-oriented models deal with knowledge characteristics during its life cycle. They analyze relationships and environmental variables influencing the development, dissemination, modification and use of knowledge processes. Agent-oriented models explain the characteristics of knowledge during its flow between agents or individuals as well as the variables expediting or hindering knowledge flow in social networks. Lastly, the financial dimension include those studies conducted, for instance in the financial environment, which involve the generation of business intelligence and intellectual capital through studying patterns in data and data mining (Cheng, Lu & Sheu, 2009; Gebert et al., 2003).

According to Moteleb and Woodman (2007), none of the assumptions is viewed as superior than the other. They argue that it is inadequate to adopt either the epistemological or ontological assumptions completely in order to address cultural and technological aspects of knowledge management. They add that focusing on one assumption may not be proper since, epistemological concepts are exclusive of context and fail to represent existing relationships, while ontological models “would be so process-focussed that only a single inflexible world view could be supported” (Moteleb & Woodman, 2007, p.60). This research will therefore adopt concepts from both notions because, it deals with the nature of knowledge (i.e. tacit knowledge and its impediments) and how this knowledge may be transferred or shared by students in a mobile environment.

2.1.4 Knowledge Transfer Processes

In their SECI model, Nonaka and Takeuchi (1995, p.62) postulate that knowledge can be arranged and re-generated through four distinct conversion processes i.e. socialisation, externalization, combination and internalization (as shown in Figure 5).

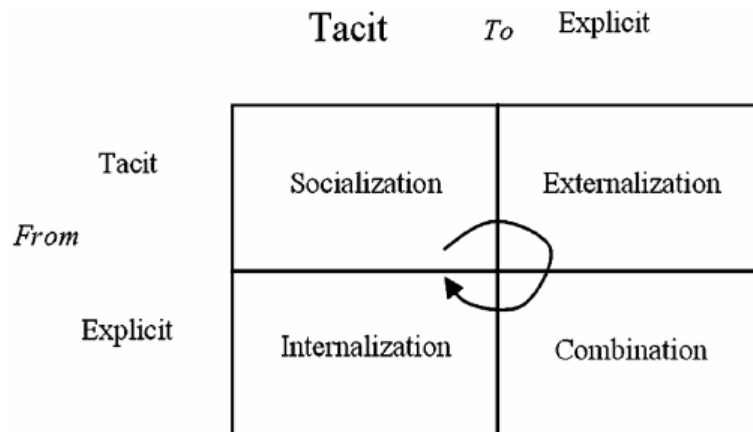


Figure 5: Four Processes of Knowledge Conversion (Nonaka & Takeuchi 1995, p.62)

According to Nonaka and Takeuchi (1995) the processes are explained as follows:

Socialisation converts tacit knowledge into tacit knowledge. It allows individuals to acquire tacit knowledge directly from others without use of language. For example apprentices learn craftsmanship from their masters through observation, imitation or practice. Individuals can also acquire tacit knowledge, create and share mutual trust during face-to-face interactions, sharing the same environment or during informal meetings. Knowledge and skills obtained is stored in tacit form (know-how).

Externalization articulates tacit knowledge into explicit concepts e.g. metaphors, analogies, concepts, hypotheses or models. It prompts sharing of ideas, beliefs, experiences and instant feedback. The explicit form is also derived from drawings, models, words, concepts or metaphors that can be used by experts to articulate tacit knowledge (MacKenzie, 2001). The process results in knowledge crystallisation as it allows knowledge to be disseminated and communicated in a flexible manner.

Combination is a process that systemizes concepts into a knowledge system through combining various bodies of explicit knowledge. It involves the conversion of explicit

knowledge into explicit knowledge. Individuals construct, merge or sort bodies of explicit knowledge into new explicit knowledge e.g. documents, meetings, telephone conversations or computerised communication networks.

Lastly, internalization transforms explicit knowledge into tacit knowledge. Individuals learn by practising certain tasks i.e. learn by doing. They read, blend, and conceptualize their findings to create new insights, concepts and methods (Roberts, 2000). Documentation, therefore, assists people to internalize experiences, develop and broaden their tacit knowledge base.

Nonaka and Takeuchi (1995) however consider externalization and internalisation to be the most critical processes since they require active individual involvement and commitment. After the completion of the internalisation process, the process goes back to socialisation hence, the spiral form and the name SECI.

2.2 Impediments to Knowledge Transfer

Szulanski (1996) claims that knowledge transfer depends upon the characteristics of the source, recipient, context and nature of knowledge. The knowledge transfer characteristics are explained as follows:

The source of knowledge may influence knowledge transfer due to its knowledge level, attitude, perceptions and techniques employed to transfer knowledge. For instance, the fear of losing ownership, privilege and lack of reward for sharing knowledge may impede knowledge transfer (Szulanski, 1996). Szulanski (1996) also maintains that if the source of knowledge is not seen to be reliable, trustworthy or knowledgeable, effective transfer may not take place. A credible and trustworthy source ensures successful knowledge transfer and recipients are more receptive to the message.

Characteristics of the recipient of knowledge e.g. feeling of “not invented here”, lack of absorptive capacity and knowledge retention may influence knowledge transfer (Szulanski, 1996). Organizational theorists see the lack of absorptive capacity and retention as the most significant barriers to knowledge transfer in organizations. Absorptive capacity describes the

ability to recognize the value of new information, assimilate it and apply it to commercial or practical ends (Cohen & Levinthal, 1990). Lack of this capability arises from ignorance, lack of prior knowledge and in most cases lack of a common language between the provider and recipient of knowledge.

Szulanski (1996) also suggests that knowledge transfer may be influenced by organizational context. Szulanski (1996, p.31) describes an organizational context as a “context which influences gestation, evolution and intra-firm exchanges of knowledge”. Additionally, it affects the capability of sub-units to undertake complete transfers of tasks. A fertile context facilitates the development of transfers while, a barren one hinders its gestation and evolution. The author also emphasises the importance of arduous relationships between units to ensure smooth transfer of knowledge. Chung (2001) argues that, a centralised bureaucratic management style stifles the creation of new knowledge. The authors also maintains that more flexible and responsive structures are needed to ensure successful knowledge transfer. Flatter structures for instance have been found to lead to increased levels of knowledge sharing (Hall, 2001b).

The nature of knowledge (e.g. tacit and explicit) (Nonaka & Kono, 1998) may also influence knowledge transfer. Since this research focuses on the nature of knowledge, the following section provides a more detailed discussion on this aspect and how it may impede knowledge transfer.

2.2.1 Nature of Knowledge

Knowledge exists in tacit and explicit forms and is described in different ways. Tacit knowledge has been rather difficult to define. Polanyi (1966a) considers tacit knowledge to be personal and context specific knowledge perceived as difficult to articulate and communicate to others. On the other hand, Howells (1996, p.92) referred to it as “the non-codified, disembodied know-how that is acquired via the informal take-up of learning behaviour and procedures”. Sternberg et al. (1995, p.916) view tacit knowledge as “knowledge that enables individuals to achieve goals they value and is acquired with little assistance from others”. Polanyi’s (1966a) definition captures many aspects of tacit

knowledge and is adopted in the present study, although the research believes that with existing technologies, some of the impediments to its transfer can be resolved today.

In contrast, explicit knowledge is defined by Roberts (2000, p.430), as “codified knowledge that is recorded in symbols like drawings, writings or expressed in tangible form like machinery and tools”. Nonaka and Takeuchi (1995) describe explicit knowledge as formal and systematic knowledge shared through scientific formulas or computer programs. Explicit knowledge is commonly transmitted in formal, methodical language and expressed in words or numbers (Polanyi, 1966a). Most studies consider the following to be significant aspects of explicit knowledge: it can be easily articulated in formal language; duplicated and stored in databases or libraries. However accessing explicit knowledge can also be difficult due to its complex syntax and semantics (Foray & Hargreaves, 2003).

The nature of knowledge influences the rate at which knowledge is gathered, retained and transferred (Szulanski, 1996). Recent studies suggest that of all the above impediments to knowledge transfer, the nature of knowledge causes a major challenge to the transfer of knowledge in groups (Fernie et al., 2003). Since this study is about tacit knowledge transfer, the following two sections examine in more detail the nature of this knowledge and how it is shared in the educational institutions.

2.2.1.1 Tacit Knowledge

The aspect of tacit (non-codified) knowledge was first developed by Michael Polanyi in the 1960s. In a learning environment, students can transfer tacit knowledge in many ways. Polanyi (1966a) observed that tacit knowledge can be gained through various physical and mental activities like playing chess, using tools, making medical diagnoses and conducting chemical experiments. According to Somech and Bogler (1999, p.605) students can transfer tacit knowledge when they review comprehensive notes, learn library and computer rules, appeal to an unfair grade, speak with professors after class or consult senior students. These procedures enable students to share tacit knowledge through reasoning and making judgements. Citing the work of Wagner and Sternberg (1990), Somech and Bogler (1999) argue that a person who possesses tacit knowledge can manage oneself (i.e. has knowledge

about self-motivation and self-organization), manages other people (e.g. manages lower and upper level employees and peers) and can manage tasks (e.g. possesses knowledge about the proper ways of fulfilling managerial duties and assignments). The authors claim further that, individuals can achieve personal goals and make better predictions of their performance if they possess tacit knowledge. Moreover, they maintain that tacit knowledge improves academic achievement and is essential for the success of an individual in different settings since, it enables the application of knowledge throughout learning experiences. Practical intelligence is associated with tacit knowledge (Sternberg, Okagaki & Jackson, 1990). Interestingly, an intelligent person is believed to have acquired formal academic knowledge and has undergone intelligence tests (Somech & Bogler, 1999). The acquisition of tacit knowledge is encountered during the procedure therefore; an intelligent person possesses tacit knowledge.

Organizations rely on the interaction of tacit and explicit knowledge for knowledge creation (Nonaka & Konno, 1998). Stenmark (2001) argue however, that expertise is largely depended upon tacit knowledge. Tacit knowledge is useful in project work and workers often share this knowledge during the interactions (Koskinen, Philanto & Vanharanta, 2003, p.285). It is considered to be critical to building key organizational capabilities (Swap, Leonard, Schields & Abrams, 2001).

While most research on tacit knowledge has been conducted in non-academic settings, Somech and Bogler (1999) argue that, such knowledge matters very much in academia and it is important that students apply such knowledge throughout their learning experiences and processes to improve academic achievement. However, since tacit knowledge is not easily articulated or codified, some researchers think there are limited opportunities for its transfer by way of digital codes and electronic communication (Hildrum, 2009; Howells, 1996; Maskell & Malmberg, 1999; Salter & Gann, 2003). Contrary to this view, Prensky (2004) and Weininger and Shield (2001) have shown that the availability of tools like voice, video, SMS, MMS and others that support knowledge acquisition, codification and absorption make it possible to transfer tacit knowledge in a mobile environment. Additionally, instant messages, electronic-mails, electronic games, online discussions and

connections through social network sites (Facebook or MySpace) can also augment knowledge transfer (Prensky, 2008).

Issues of knowledge acquisition and transfer using mobile devices have not been carefully investigated (Li & Wang, 2007). Prensky (2004, p.7) also observed that there are very few studies investigating learning in a mobile environment. Due to the dearth of research in this area, the effectiveness of mobile tools in facilitating tacit knowledge transfer has not been tested. It is also unclear whether learners leverage these tools to share valuable tacit knowledge for better performance hence, the need to investigate these problems in the present study.

2.2.1.2 Tacit Knowledge Sharing in Educational Institutions

Earlier studies show that in educational institutions, students can exchange tacit knowledge through interaction with administrative staff members, applying practical knowledge in learning experiences, consulting senior students concerning course requirements and expectations, as well as speaking with a professor or teaching assistant after class (Somech & Bogler, 1999; Sternberg, Wagner & Okagaki, 1993). It has also been revealed that students with both academic and tacit knowledge attain higher academic achievement than those possessing both low academic and tacit knowledge (Somech & Bogler, 1999). The transfer of tacit knowledge is usually enabled through the socialisation process (as indicated in Section 2.1.4) and it is important that the participants are motivated to share this knowledge (Hildrum, 2009). The section that follows presents a discussion on knowledge transfer in group projects and the problems involved.

2.3 Transfer of Knowledge in Group Projects

Group learning is essential for enhancing student understanding, sharing of knowledge and critical thinking (Levine, 2002; McCorkle et al., 1999; McGhee & Kozma, 2001; McKenzie, 2001). Critical thinking usually consists of know-how and it improves the ability of students to express tacit knowledge. Many institutions are therefore, adopting group learning as an alternative to traditional methods (Lam, 2008). Group learning evolves when students work in collaboration, share knowledge, ideas and skills to achieve a certain goal (Disterer, 2002).

Gokhale (1995, p.22) defines collaborative learning as “the grouping and pairing of students for the purpose of achieving an academic goal”. Johnson and Johnson (1999, p.73), instead, view group learning as “the instructional use of small groups in which students work together to maximise their own and each other’s learning”. As a result, this research believes group learning to be a group of individuals working together to accomplish specific objective(s).

Groups have several benefits comprising of student motivation, enhanced communication and deep thinking (Hansen, 2006). Effective group learning enables students to improve academic achievements (Johnson & Johnson, 1989; Nicholas & Miller, 1994; Slavin, 1990) and allow each group member to engage actively in taking up authority and learn to be responsible (Lieng, 2009). Student success is depended upon each individual in the group since, they work collaboratively. Assignments done in groups prompt students to share knowledge and solve problems better as they are forced to think and analyse facts critically (Burdett & Hastie, 2009). Students learning in groups encourage one another to ask questions, explain or justify opinions, articulate their reasoning, elaborate and reflect upon the knowledge they possess (Soller, 2001, p.40). Also active and aggressive team members demand explanations and justifications from fellow peers to enhance effective interaction in their respective collaborative learning groups. Groups also offer opportunities to learn new skills and improve satisfaction as well as learning outcomes. Therefore, students can recognize the benefits and need for developing appropriate teamwork skills (McCorkle et al. 1999).

In technology supported and collaborative learning environments, Kreijns et al. (2003) claim that, social interaction pitfalls can be avoided by evaluating educational techniques proposed by instructors and educators with the findings of educational researchers and guidelines.

2.3.1 Problems with Group Projects

Group projects may however comprise of several shortcomings (Burdett, 2006; Burdett & Hastie, 2009; Hansen, 2006; McCorkle et al., 1999). Bandura (1986) mentioned that

individuals in groups may shun difficult tasks that are beyond their capabilities due to efficacy beliefs. In addition, dissatisfaction of other group members can cause poor performance (Freeman, 1996). Other challenges identified include lack of leadership, time and scheduling of workload, free riding, individual and social barriers, lack of team development, lack of motivation, lack of social interaction, inadequate rewards, skills and attitude problems or social loafing (Burdett & Hastie, 2009; Hansen, 2006; Kreijns et al., 2003; McCorkle et al., 1999; Shongwe, 2009).

Workload is believed to be a major cause of dissatisfaction because; the amount of work and responsibilities taken by each individual is associated with questions concerning fairness and justice (Burdett & Hastie, 2009). Thus, uneven sharing of workload results in frustrations and conflicts in group assignments. Lack of participation can result in students not sharing ideas or what they know (McCorkle et al., 1999). Hence students who participate more in group tasks acquire more tacit knowledge. Scheduling conflicts sometimes cause disruption of meetings and students fail to meet face-to-face to share tacit knowledge. Students incur transaction costs during design analysis and report writing which leads to poor access and sub-standard sharing of explicit knowledge (McCorkle et al., 1999).

Lack of social interaction also causes negative effectiveness in collaborative learning since; students may assume that social interaction occurs automatically because the environment allows them, at the same time neglecting the social dimension of the desired interaction (Kreijns et al., 2003). Further students fail to comprehend that social interaction enables relationship building, affiliation, impression formation and healthy learning communities. Lack of social interaction could be caused by the method used to allocate members into groups. For instance, Chapman, Meuter, Toy and Wright (2006, p.566) state that “the method of group member assignment influences group dynamics, attitude and outcome and students in self-selected groups rated their groups higher on team work scope, reported better group attitude and outcome than those in randomly selected groups”. They also mentioned that, random assignment of students into groups result in inferior group dynamics ratings, negative attitudes and lower group outcomes.

These examples clearly show that while group learning plays an essential role in enhancing student understanding, sharing of knowledge and critical thinking, there could be many challenges when learning in groups. Recent studies confirm that the integration of ICT and mobile technologies in group learning can assist in minimising some of these barriers (Kim et al., 2006; Sharples et al., 2005).

2.4 The Impact Of Technology on Organizational Aspects

Technology is essential in the development and coordination of complex procedures experienced in an organization. In the theory of the duality of technology, Orlikowski (1992a, p.403) view technology as material artefacts, for example, physical objects created as an “outcome of coordinated human action”. The duality of technology model explains the creation and transformation of technology through human action as well as how humans use technology to accomplish various tasks. The behaviour and actions of workers in an organization is influenced by technology (Orlikowski, 1992a, p.402). Their actions determine the operation, interpretation, meaningfulness and extent to which technology is manipulated (Orlikowski, 1992a). Furthermore, cognitive and structural elements also influence people’s choices and assessment of the value of technology (Orlikowski, 1992a). Therefore as people interact with technology, they shape its structures and define its rules of usage (Orlikowski, 2000, p.407) but, at the same time the technology impacts on their activities.

2.4.1 Impediments to Effective Adoption and Use of ICT

The effective adoption as well as use of technology is impeded by several factors. Suchman (1987) for instance, examined the interaction between humans and technologies in many areas and identified many of the tensions that arise. For example, the problem of human-machine communication is affected by social constraints on actions. Actions are not determined by rules, but actors who use normative rules of conduct available to produce significant actions. Also, tensions could result during breakdown of computers or their unavailability causing disturbances in technology use. When users (novices) are not familiar with the equipment to be used instructing them on how to use computers could be

problematic. Earlier in Suchman (1983), the author argues that such tensions can only be minimised if the tasks or work is well represented in the design of technologies. Further, human organization and their actions are essential for the design of technologies (Suchman, 1983). Therefore, people constantly modify properties of technology in an effort to understand it and suite their needs (Orlikowski, 1992a, 2000). Social factors also determine how individuals understand and control technology. If they do not understand its features, it faces resistance and difficulty of incorporation in work practices (Orlikowski, 1992a). Thus, technology implementation is greatly affected by human beings.

In Orlikowski (1992a), the author states that organizations gain a lot from technology due to its flexibility however, it is constrained by its material characteristics, institutional context, knowledge and power of individuals who design and use the technology (Orlikowski, 1992a). The author views establishment of technology as a major cause of disconnection between technology and its constructors, i.e. human agents. In addition, technology is viewed as a fixed object and is largely determined by a stage researchers concentrate on.

Adoption of technology is also influenced by the level of technology possessed by educators, their actual use of technology and how they incorporate it in the classroom environment (Fabry & Higgs, 1997). The shift in economic conditions could force managers to reconsider technology operating standards and adjust organizational strategies (Orlikowski, 1992a). Organizations depend much on technology on their daily operations hence, in cases of technology breakdowns; they are prone to delays, disrupted workflow and rising expenses (Orlikowski, 1992a). Other imminent technology inhibitors can be instability and continuous evolvement due to influential factors like, competition, poor maintenance, environment, culture or politics.

2.5 The Role and Limitations of ICT in Education

ICTs are believed to bring a transformation on teaching and learning processes through the facilitation of communication and interaction among teachers and learners (Maiye & McGrath, 2010; Valk, Rashid & Elder, 2010). ICTs comprise of cell phones, laptops, personal digital assistants, personal computers or video cameras (Kozma, 2005; McFarlane &

Sakellariou, 2002). Learning technologies are a key driver to the improvement of quality of education (Concannon, Flynn & Campbell, 2005). They establish, enhance flexibility in learning (Cross & Adam, 2007), and promote a mixture of both content and activity through visuals (Calongne, 2008).

ICTs have been used in support of electronic learning and also facilitate group learning. They facilitate feedback interactions among group members and easy access of course materials. Students may have a hazy understanding of complex content, but, Calongne (2008) claims that virtual worlds offer information in a variety of ways allowing students to use information to create solutions and solve problems. Virtual worlds allow engagement of students in stimulating spaces where they can meet on-line for normal class activities, like discussions, lectures, case studies, exams, labs or projects (Calongne, 2008, p.36). For example, students work and learn using technology (e.g. an undergraduate accounting class used technology to improve learning through using the Internet, online course material and writing online tests (Concannon et al., 2005). In universities, for example, electronic learning promotes interaction between teachers and students by providing them with various knowledge representations (Mahdizadeh, Biemans & Mulder, 2008, p.142). The integration of ICTs facilitates collaboration and knowledge sharing among students who are distributed geographically thereby, breaking the distance barriers to learning (Hattangdi & Gosh, 2008; Kozma, 2005; Reynoldson & Vibert, 2005).

Mobile technology is made up three generations i.e. new technologies clearly depict a massive generation change from the first generation (1G) to a second generation (2G) and the recent phase the third generation (3G) (Liikanen, Stoneman & Toivanen, 2002). The rapid diffusion of technology through mobile phones differs greatly with the price and type of technology being offered as well as the generation of mobile phones differ technologically though they are purchased on lower prices, network size or effects and voice transfer (Liikanen et al., 2002). The authors also state that the diffusion of old generation technology is lowered down when a new generation is introduced.

2.5.1 Limitations of ICT in Education

However, as predicted by Orlikowski (1992a) and Suchman (1987), despite the benefits of ICT, there are also some limitations. In education, there are several barriers affecting its use in this field. These include lack of proper controls and licensing which pose problems towards the accountability, consumer protection or accreditation of ICTs (Hattangdi & Gosh, 2008). Costs associated with implementation of technology facilitated learning are generally high (Oliver, 2002). The inability of students to use technology could cause undesirable outcomes on ICT usage (Gardner et al., 1993). It could be as a result of fear, uncertainty and complexity of ICTs limiting its use by students (Calongne, 2008). Reliable delivery of stimulating virtual content and a stable environment for ICTs is another challenge faced by course designers, instructors, IT professionals, since they have to design virtual worlds that engage students (Calongne, 2008). Although, ICTs promote student centred learning, it often results in tensions among teachers and students (Oliver, 2002). While there are such shortcomings in using ICT in education, there is evidence suggesting that the benefits outweigh limitations (Calongne, 2008; Clark, 1984; Hattangdi & Gosh, 2008; Reynoldson & Vibert, 2005).

The present research investigates the use of one ICT (e.g. mobile phone) in the transfer of tacit knowledge in group projects. Students use mobile phones for group communication concerning deliverables specifically features like, chat, voice, SMS or MMS, electronic mail, geo-positioning, browsers, downloadables, camera or video features (Prensky, 2004). In addition, ICTs facilitate the evaluation and examination of learning processes and provide a link to various levels of information and educational set-up (Mooij, 2007).

The section that follows presents a discussion on the effectiveness of mobile technology in facilitating knowledge transfer and mobile features that can enhance its transfer to achieve better performance. Tacit knowledge is shared through voice-call on mobile phones or videos in group projects while; explicit knowledge is shared through features like SMS, MMS, graphics, geo-positioning, camera, videos, downloadables and browsers (Benta, Cremene & Padurean, 2004; Prensky, 2004).

2.6 Mobile Learning

Mobile learning (MLearning) involves learning without being confined to a fixed place or location while, utilising fully the advantages of mobile technologies (O'Malley, Vavoula, Glew, Taylor, Sharples and Lefrere, 2003). According to Kekwaletswe (2007) MLearning includes knowledge transformation through individual experiences and interactions in different learning contexts. Furthermore, mobile learners who share a similar background may engage in learning activities that vary from formal to informal learning contexts through social interactions, awareness of context and social presence. MLearning is therefore, centred on learner mobility (Kukulska-Hulme & Traxler, 2005).

Attributes of MLearning largely contribute to its definition for example; it is ubiquitous, portable, personal, informal, durable, user-centred and networked (Sharples, Taylor & Vavoula, 2007). MLearning comprise of devices like mobile phones, laptop computers, handheld computers, palmtops, or personal digital assistants (Kukulska-Hulme & Traxler, 2005). Mobile phones for instance, support communication features like voice, text (MMS, SMS), images, e-mail, phone calls, video clips, camera, geo-positioning, downloadable programs, browsers etc. (Amin, Kersten, Kulyk, Pelgrim, Wang & Markopoulosal, 2005; Benta et al., 2004; Prensky, 2004; Seewoonauth, Rukzio, Hardy & Holleis, 2009).

The MLearning process results in convergence of mobile technologies, human learning capabilities and social interaction (Koole, 2009). MLearning makes learning accessible by enabling students to work at their own pace despite physical location and enhances great opportunities for students (Valk et al., 2010). It facilitates the design of authentic learning targeting real world problems which are of interest to learners (Kukulska-Hulme & Traxler, 2007). Wireless networks allow students to access educational information from any location, however, the medium faces problems of low bandwidth, input and output capabilities (Koole, 2009).

Recent studies show that the integration of mobile context and technologies in group learning can assist in minimizing some of these barriers (Kim et al., 2006; Sharples et al., 2005). In a research that research that investigated the impact of mobile technology on

knowledge transfer in student groups, Shongwe (2009) found that mobile technology can minimize social barriers, time constraints and motivate students. The writer however, found that very few (about a tenth of the respondents) managed to transfer tacit knowledge using mobile phones. The following section outlines the mobile phone features that facilitate transfer of tacit and explicit knowledge.

2.6.1 How Technology Facilitates the Transfer of Tacit and Explicit Knowledge

In support of learning and knowledge transfer, mobile phone features play a significant role in aiding the transfer of tacit and explicit knowledge. Tacit knowledge is transmitted through voice in the socialisation procedure (Nonaka & Takeuchi, 1995). Students make phone calls with their mobile phones and chat during face-to-face interactions. In contrast, explicit knowledge is supported by mobile phone features e.g. SMS (short messaging service), MMS (multi-media messaging service), graphics, geo-positioning, camera, video, downloadables and browsers (Benta et al., 2004; Prensky, 2004). Prensky, (2004, pp. 5-6) explains the mobile phone features as follows:

Messaging services consist of SMS and MMS. SMS can be written in a short period of time and is useful for learning, while, MMS comprise of text, images with colour, animations, voice and video clips. Both SMS and MMS are regarded as cheap and quick modes of communication.

Graphic displays consist of high-resolution screens that display words, pictures and animations. Large amounts of text are displayed as paragraphs or words in high resolution screens depending on the speed of the reader.

A global positioning system (GPS) is a navigation system that provides locations and directions to reach a particular destination. The feature is appropriate in assisting students with information relating to a city, countryside campus locations. Students in Science, Engineering, Architecture or Archaeology can use GPS to search for locations and images.

Cameras and video clips enable collection of scientific data, documentation and visual journalism. Cameras enhance the collection and classification of images or photos that can assist in creative writing or story contests.

Cell phones possess memory card slots that enable students to download programs, content, tools and teaching programs. Voice, text and graphic applications can be downloaded for example, spread sheets or word processors.

Lastly, Internet browsers permit students to access research tools like dictionaries, thesauruses, encyclopaedias or Google. Students in Architecture or Art get a chance to search for images on the Internet to gain an understanding of certain properties.

2.7 Summary of the Literature Review

The literature review demonstrated that group learning is increasingly being encouraged in institutions of higher learning. It provided an insight on knowledge transfer and impediments affecting its transfer among students in group projects. Characteristics of the source, recipient, context and nature of knowledge e.g. tacit and explicit were discovered to influence knowledge transfer. Tacit knowledge for instance, is essential to both industry and academia since, it enables individuals to manage themselves, tasks and others. It also allows students to achieve personal goals and improves their academic achievement. However, tacit knowledge is difficult to articulate and codify while, explicit knowledge is problematic due to complex syntax and semantics.

However, these impediments to knowledge transfer can be minimised through the integration of mobile context and ICTs e.g. mobile technology in group learning. ICTs are believed to bring a transformation to teaching and learning processes since, they prompt interactions among students and teachers. Therefore, the literature review revealed that ICTs e.g. mobile phones can address and facilitate the transfer of both tacit and explicit knowledge to achieve better project outcomes. The section that follows presents a conceptual model which summarises the findings and relationships obtained from the literature review.

2.7.1 Conceptual Model

In making sense of relationships, a conceptual framework provides concrete foundation to undertake research and identify the relationships among variables in a given phenomenon (Cavana, Delahaye & Sekaran, 2001, p.78; Sekaran, 2003, p.87). The framework assists in testing relationships among variables to improve and understand the dynamics of a particular situation. The variables that describe a conceptual framework are dependent, independent, moderating and intervening (Cavana et al., 2001; Sekaran, 2003).

The dependent variable influences the research and is a key element for researchers in finding a solution to a problem. In this research, the dependent variable is (success in group projects). The researcher intended to discover if students perform better when they share tacit knowledge in group projects. The independent variable has a positive or negative influence on the dependent variable and in this case, they are (tacit and explicit knowledge). Then, the moderating variable has a dominant impact on the relationship of both the independent and dependent variable. In this research, it is the mobile phone. The intervening variable surfaces between the time independent variables begin to operate influencing the dependent variable and the time period their impact is felt on it. However, in this research, the intervening variable was not further examined because it was not applicable. Hence, much emphasis was given on the other three variables (dependent, independent and moderating).

Chapter 1 specified the objectives of this research as to investigate the extent to which students share tacit knowledge using mobile phones in group projects and examine whether students who share tacit knowledge achieve better performance. Therefore, the conceptual model in Figure 6 offers clarification on how the mobile phone addresses and facilitates the transfer of tacit or explicit knowledge to enable success in group projects. The relationships between the elements deliver output; therefore choosing appropriate relationships enables favourable outcomes (Cousins, 2002). The conceptual model was tested empirically as explained in Chapter 3.

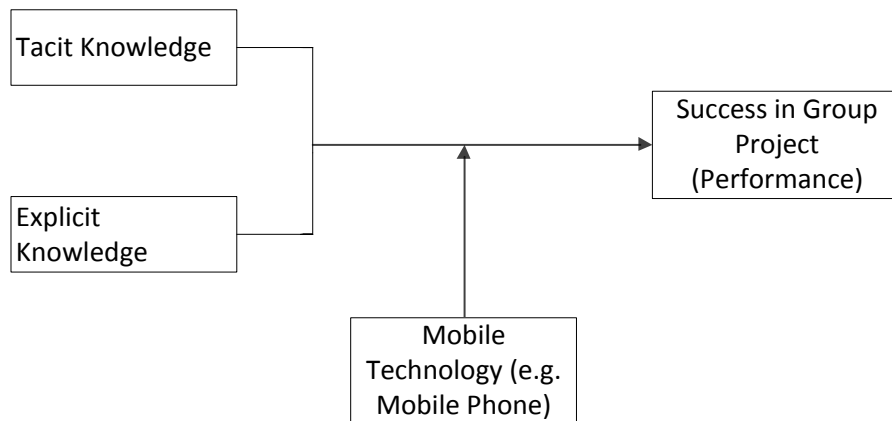


Figure 6: Conceptual Model

2.8 Research Hypotheses

Research hypotheses are developed to test a specific phenomenon and finding a solution to the particular problem (Cooper & Schindler, 2003; Sekaran, 2003, p.103). They determine the validity of a formulated theory and test if the statement would be supported (Sekaran, 2003). According to existing literature, explicit knowledge can be learned easily, since it requires less socialisation (Dhanaraj, Lyles, Steensma & Tihanyi, 2004). Students use mobile phones to share more of explicit than tacit knowledge through features like SMS, MMS, downloadables and browsers etc. (Benta et al., 2004; Prensky, 2004). Hence

Hypothesis 1: In a mobile environment, students will share more explicit than tacit knowledge.

Existing research shows that students who share tacit knowledge acquire better grades (Somech & Bogler, 1999). Citing the work of Wagner and Sternberg (1990), Somech and Bogler (1999) argue that students who possess tacit knowledge can manage oneself (i.e. has knowledge about self-motivation and self-organization), manages other people (e.g. manages lower and upper level employees and peers) and can manage tasks (e.g. possesses knowledge about the proper ways of fulfilling managerial duties and assignments). The authors claim further that, tacit knowledge enables people to accomplish personal objectives and measure or predict job performance. Moreover, they maintain that tacit knowledge improves academic achievement and is essential for the success of an individual in different settings since, it enables the application of knowledge throughout learning

experiences. Students can use mobile phone features e.g. video facilities, cameras, voice etc. to share tacit knowledge. However, this has not been tested extensively in academia. Hence

Hypothesis 2: In a mobile environment, the more tacit knowledge shared by students, the greater their project performance.

University of Cape Town

CHAPTER 3: RESEARCH DESIGN

3.1 Introduction

This chapter provides the design employed in this research. A research design describes a sequence of appropriate choices and decisions conducted during the research process (Cavana et al., 2001; Sekaran, 2003). It gives an overview of the road map, plans, guidelines, procedures to be followed in the research (Myers, 2009). There are two schools that explain how to investigate a phenomenon. In the first school of thought, researchers argue that one should start by proposing a method followed by the epistemology (Crotty, 1998), while the second school of thought recommends that, epistemology should be explained first followed by the method (Gadamar, 1976a). This research adopted the second school by Gadamar (1976a) which explains the epistemology first followed by method.

The chapter is presented as follows: *Section 3.2* discusses the philosophical assumptions adhered to when conducting research. *Section 3.3* outlines the research methodology comprising of the research purpose, paradigm, time frame and instrument, target and sample population, strategy, data collection and analysis techniques. *Section 3.4* describes how ethical and confidentiality issues were resolved by the researcher.

3.2 Philosophical Assumptions

Research philosophies are of key interest in the IS field because they depend on the researcher's thoughts concerning knowledge development and reflection (Orlikowski & Baroudi, 1991; Saunders, Lewis & Thornhill, 2003). It could be argued that the manner in which researchers choose to develop knowledge affects how research is conducted (Saunders et al., 2003). Philosophies applied by a researcher can influence the research questions while research questions shape the assumptions being investigated (Orlikowski & Baroudi, 1991). Further, researchers adopt perspectives to suit their research interests and take into account applicability of the context. Quantitative or qualitative research is centred on fundamental assumptions relating to epistemology, ontology and methodology. The assumptions are explained as follows:

Epistemology is understood to be an assumption of knowledge acquisition (Hirschheim, 1992). The main objective of epistemology is to provide the base of decision making processes that involve legitimacy and adequacy of appropriate forms of knowledge (Crotty, 1998). It is predominantly concerned with the views of knowledge interpretation (Koskinen et al., 2003, p.283), nature, sources and processes, for example the relationship between the inquirer and the known (Baptiste, 2001, p.6; Denzin & Lincoln, 2000, p.157).

From an ontological standpoint, ontology describes the study of nature and its exposure to existence (Crotty, 1998). In this respect, Orlikowski and Baroudi (1991) state that beliefs may exist independently from human interaction or intervention in the existence of human rationality and objective phenomena. There are therefore two views that clarify ontology – i.e. realism and objectivism (Crotty, 1998, p.10). In view of realism, realities exist independent of the mind while objectivism, as the name suggests, derives its name from objects and is unconscious of its surrounding. The two assumptions can be used in combination without separating them. Guba and Lincoln (1994) view them to be interconnected, i.e. when researchers assume reality, they should detach themselves from it to in order to obtain the actual truth of the given state of affairs and its operations.

Crotty (1998) proposes that, methodology specifies the strategy or plan of action linked by a certain choice to achieve a goal. It perceives how a research will be conducted inclusive of the research method, approaches applied, techniques for data collection and analysis (Saunders et al., 2003). Therefore, choosing a philosophical assumption largely depends upon the IS community.

3.3 Research Methodology

Research methodology consists of techniques or procedures applied in the gathering and analysis of the data (Crotty, 1998). The process is done in response to the research question and hypotheses. The subsequent sections consist of an in-depth discussion of the research purpose, paradigm, time frame, strategy, data collection and analysis techniques, instrument, target and sample population.

3.3.1 Research Purpose

An exploratory research survey is conducted when a problem is not clearly defined or when there is no information concerning how a similar problem has been resolved in the past (Cavana et al., 2001; Sekaran, 2003). This type of research gives a clear understanding of a problem (Saunders et al., 2003). The authors also claim that exploratory research is conducted through conversations with experts, focus group interviews or through searching the literature (as portrayed in this research). This research is therefore, exploratory in nature, to examine the extent to which students share tacit knowledge in group projects and determine whether they perform better using mobile phones, because this area is not clearly defined.

3.3.2 Research Paradigms

A paradigm consists of philosophical beliefs concerning certain concepts of the world (Cavana et al., 2001). The aspect also provides rules and guidelines for conducting research, in addition to the results to be obtained. IS research is characterised by three research paradigms i.e. interpretive, critical and positivist (Myers, 1997; Orlikowski & Baroudi, 1991). They assist to understand factors that constitute validity and value of a research. The research paradigms are explained as follows:

Interpretive research involves attempting to understand the meanings participants assign phenomena. Interpretive research produces deep insight to a phenomenon under study and an understanding of reality is gained through language, consciousness, shared meanings, documents or artefacts (Klein & Myers, 1999). Interpretive approach therefore considers people and the artefacts they create. The approach does not assume objectivity in the researchers and the interaction which takes place with the phenomena being investigated. Interpretive studies aim to understand the phenomena through meanings that people assign to them (Walsham, 1993). However, a study conducted by Kaplan and Maxwell (1994) mention that interpretive research does not pre-define dependent and independent variables, but focuses on human sense making in emerging situation. Lee (1991) argues that

the methods proposed by the natural sciences are both inappropriate and inadequate for investigating social phenomenon.

Critical researchers are concerned with human empowerment and to improve the world (Cavana et al., 2001, p.10). Critical research enables the recognition of opportunities for realising human potential (Alvesson & Willmott, 1992; Hirschheim & Klein, 1994). The authors' further claim that social reality is established historically and people produce and reproduce it through changing social and economic conditions. However, Klein and Myers (1999) indicate that the chance to improve their conditions may be constrained by a variety of forms of social, cultural, natural laws, resource limitations and political domination.

Positivist researchers assume that reality is objectively given and is described according to quantifiable properties that do not consider the observer and the research instruments (Myers, 2009). This approach is derived from natural sciences (Lee, 1991; Neuman, 2000). Positivist research is deductive in nature, comprise of formal propositions, quantifiable measures of variables, causal relationships and hypothesis testing (Orlikowski & Baroudi, 1991; Shanks, 2002). The epistemological perspective of positivism assumes that the phenomenon under investigation can be measured empirically while assuming objectivity in the observer (Shanks, 2002). It describes a phenomenon without questioning its existence at the same time focusing on physical realities (Lee, 1991). Researchers are impartial observers who detach themselves from a phenomenon so as to predict certain actions without subjective opinions (Myers, 1997; Orlikowski & Baroudi, 1991).

This dissertation adopted the positivist approach in order to test the theories available. The present research falls in the social science field. Thus, it examined students' behaviour and how they can make use of mobile phones in a social environment e.g. university. In this paper, the researcher proposes that group performance is influenced by the level of knowledge shared. The researcher argues that when the nature of knowledge shared in a mobile environment is tacit, better performance in group projects will be obtained. The research consists of propositions (outlined in Section 2.8) that were tested to understand sharing of tacit knowledge and performance of students in a mobile environment.

3.3.3 Research Timeframe

There are two research time horizons namely cross-sectional and longitudinal time horizons (Chambliss & Schutt, 2010). Cross-sectional designs involve the collection of data at a certain point in time (Saunders et al., 2003). For example, a researcher collects data once, in weeks or months to provide an answer to a research question (Sekaran, 2003). The data collected however, fails to measure the impact of time. Contrastingly, longitudinal studies include the study of a phenomenon more than once to provide a solution to a research question involving the collection of data over a long time period (Sekaran, 2003). This research adopted the cross sectional time horizon since; it was supposed to be completed within a confined time period allowed for the programme under study. The researcher conducted a survey which is appropriate for cross-sectional studies (Sekaran, 2003). A longitudinal study is not suitable for this research since, it requires a longer time scale than the one required for this research.

3.3.4 Research Instrument

The research questionnaire was developed from the work of (Somech & Bogler, 1999; Sternberg & Wagner, 1986, 1989), the literature review in Chapter 2 and existing secondary materials such as course outlines, project description documents and discussions with students. Questions were tailored to capture specific type of data shared by students in each discipline. The questions were based on the conceptual model in Figure 6. The questionnaire consists of a brief introduction of the objectives of the research and six Sections (as outlined in Appendices A to D):

1. Section A consists of general information about students;
2. Section B contains information about project details;
3. Section C provides an overview on tacit knowledge shared by students i.e. Questions 1-3 were common tacit knowledge shared in all disciplines while, Questions 4-8 were specifically for knowledge shared within a particular discipline.
4. Section D outlines explicit knowledge questions;

5. Section E is unique in the sense that, it was used to analyse qualitative data. It consists of general information on the mobile phone; and
6. Section F concludes the questionnaire with an overview of group project outcome i.e. performance. The performance questions were presented as follow:

- Question 1 determined if students had completed group projects or not.
- Question 2 prompted students to indicate the mark obtained for a completed project ranging from less than 50% to 80% and above. While, the outcome was given as a percentage, Table 1 shows that it was converted into a scale as follows:

Table 1: Performance Scale

Mark	Score	Comment
Less than 50%	1	Poor
50-60%	2	Fair
61-70%	3	Good
71-80%	4	Very Good
80% and above	5	Excellent

- Question 3 determined performance rate from poor to excellent for students with completed or incomplete projects.
- Question 4 prompted students to rate the performance of a present and incomplete project ranging from poor to excellent.

Students were asked to indicate their agreement or disagreement with statements about the nature of knowledge they share (i.e. tacit and explicit) using mobile phones. A rating scale was used to obtain opinion data from students (Saunders et al., 2003). There are several rating scales like dichotomous, category consensus, Likert scales, only to mention a few. The researcher adopted a five point Likert scale as illustrated in Table 2 since; it allowed students to select a range of options including the possibility of “uncertainty” (Cavana et al., 2001; Saunders et al., 2003).

Table 2: Five-point Likert Scale (Cavana et al., 2001, p. 205)

Strongly Agree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
1	2	3	4	5

3.3.5 Target and Sample Population

Target population consists of groups of people, events or elements of interest to be investigated (Cavana et al., 2001). The target population was students in group projects at UCT from the faculties of Science, Engineering and the built Environment, Commerce and Humanities. Four departments were chosen instead of one to increase confidence and the representativeness of the sample (Cavana et al., 2001; Saunders et al., 2003). Third and fourth year students were targeted since they were exposed to group projects or were conducting them. Various projects were being undertaken in the departments which enabled the researcher to obtain a wide selection of responses and different types of knowledge shared. For example students in Computer Science (CS) develop algorithms using object orientated program design like Java or Python number systems. In Civil Engineering (CE), they conduct basic survey operations and prepare site plans. Information Systems (IS) students conduct system development projects and analyse how people interact with systems while Psychology (PSY) students analyse how the brain and internal mental processes work.

A sample is defined by Cavana et al. (2001, p.253) as a “subgroup or subset of the population”. Sampling involves the selection of a certain number of elements in a population to study its characteristics for generalization purposes to the population as a whole (Sekaran, 2003, p.266). Generalization involves applying research findings to different organizational settings (Cavana et al., 2001, p.31). In view of that, the sample should be representative of the population so as to generalize the results. To reduce generalization errors, the sample size should be large enough (Saunders et al., 2003, p.155). The sampling frame consists of all elements of the population from which the sample is taken (Saunders et al., 2003).

Sampling is appropriate when it is impractical to collect data from several hundreds of elements since it reduces the time taken collecting data, minimize costs incurred and results can be obtained instantly (Sekaran, 2003). During data collection, sampling techniques offer several methods that assist to reduce data in sub-groups instead of the whole group (Saunders et al., 2003). Thus, there are two types of sampling techniques precisely, probability and non-probability sampling outlined as follows:

In probability sampling, elements have a chance of being selected from the total population (Saunders et al., 2003; Sekaran, 2003). This sampling technique is commonly used in survey research. It allows statistical estimates to be conducted on sample characteristics of the population to fulfil the research question and objectives of the research. There are several kinds of probability sampling techniques - for example, simple random, systematic, cluster, multi-stage and stratified random.

For the purpose of this research, stratified random sampling was used to group the student population into strata or homogeneous teams to allow random selection of subjects from each stratum (Cavana et al., 2001). It facilitated the division of the population of students from four departments and faculties. The division of the population into strata increased representativeness of the sample. It however, depended upon the ability to make a distinction of the important strata in the sampling frame (Saunders et al., 2003).

Stratified random sampling is efficient compared to other probability designs as sampling and comparisons among groups can be conducted more comprehensively. Nevertheless, stratified random sampling has its own weaknesses. It is time consuming, requires a meaningful stratification and each stratum should have a sampling frame (Cavana et al., 2001).

With non-probability sampling, the chance of an element being selected from the total population is not known. Case study research is widely used with non-probability sampling. It however, does not take into account statistical inferences (Saunders et al., 2003). Non-probability sampling is common in convenience, judgement, snowball and quota sampling techniques.

3.3.6 Research Strategy

There are two common kinds of research methods i.e. quantitative and qualitative. The methods are explained as follows:

3.3.6.1 Quantitative Research

Quantitative research is defined by Fitzgerald and Howcroft (1998) as a research method that uses mathematical and statistical tools to identify facts and causal relationships. However, it minimises involvement with respondents (Creswell, 2003). Myers and Avison (2002), describe that quantitative methods enable the study of a natural phenomenon through surveys (questionnaires), laboratory experiments or mathematical modelling. Questionnaires consist of a set of pre-formulated questions that enable people to state their opinions (Cavana et al., 2000) while, survey research requires certain and specific information from the subjects under study (Pinsonneault & Kraemer, 1993). Since questionnaires require large numbers of people however, they require consistency and care during design, since the design affects response rate and reliability (Cavana et al., 2003).

There are several types of questionnaires in existence. For example, self-administered questionnaires (e.g. on-line, postal and delivery and collection) and interviewer administered (e.g. telephone and structured interview) (Saunders et al., 2003). Self-administered questionnaires are completed by respondents via the Internet as online questionnaires or could be posted and returned by post to respondents as postal questionnaires. Delivery and collection questionnaire involves delivering the questionnaire to the respondent by hand and collecting it at a later stage. A telephone questionnaire is administered mostly in market research through the telephone. Lastly, structured interviews involve face-to-face interaction with respondents asking them questions.

A survey research strategy was proper for this research since it is connected with deductive approach (Saunders et al., 2003). It gives the researcher control of the research process, involves the collection of large quantities of data that can be easily compared since it is standardised (Saunders et al., 2003). This research applied personally administered questionnaire approach to obtain immediate responses in a short time period (Sekaran,

2003). It allowed the researcher to motivate the respondents to answer the questionnaire by providing detailed explanations to doubts or questions and collect the questionnaire soon after they were completed. The survey research method enabled the researcher to analyse the research model, patterns of variables, test hypotheses, describe the characteristics and collect information concerning mobile phone usage among students. However, self-administered questionnaires are quite expensive to administer in geographically distributed areas and the procedure is cumbersome (Cavana et al., 2001). Also, quantitative research measures the set variables leaving out variables independent of the study.

3.3.6.2 Questionnaire Design

Most importantly, questionnaires are designed to test hypotheses and provide answers to a research question (Cavana et al., 2001). Additionally, the questionnaire ought to be designed in a manner that flows and reduces bias (Cavana et al., 2001). They require a good appearance (i.e. they should be both positively and negatively worded, short, attractive, neat), an effective principal of measurement (validity and reliability), both open ended and closed questions with the exclusion of double barrelled, ambiguous, leading and loaded questions (Cavana et al., 2001; Saunders et al., 2003; Sekaran, 2003). The questionnaire should have a proper introduction, well-organized questions, strong conclusion and lastly, pre-tests are a pre-requisite to assess its validity (Cavana et al., 2001).

3.3.6.3 Pre-testing of Questionnaires

Pre-tests are a requisite after the design of a questionnaire before they are distributed (Cavana et al., 2001). Pre-tests are conducted through pilot study, face validity, content validity. A pilot study consists of a small portion of the sample of respondents to test if the questionnaire is appropriate (Cavana et al., 2001). It also ensures the validity and reliability of the data to be gathered before it is handed out officially to the targeted population. Pilot studies ensure a thorough refinement of questions that makes it easier for respondents to answer questions and also, for a stress free data capture (Saunders et al., 2003, p. 308). This questionnaire was piloted with 2 senior academics in each department and with 8 students

from the sampled departments. Necessary adjustments were made before the questionnaire was administered.

3.3.6.4 Validity and Reliability Assessment

Validity and reliability tests are used to measure the goodness of data. Validity assesses the ability of an instrument to measure a concept (Sekaran, 2003, p.244). It is tested in the following ways:

Face validity determines the sensibility of a questionnaire (Saunders et al., 2003, p. 309), ensuring that respondents understand the wording and the questionnaire as a whole (Cavana et al., 2001, p.238). Few respondents are appropriate to verify if the questionnaire makes sense.

In contrast, content validity measures the representativeness and adequacy of the questionnaire (Sekaran, 2003, p.206). Saunders et al. (2003) suggests that questionnaires can be verified by a group of experts to assess its representativeness and appropriateness. On the contrary, reliability specifies how the responses are consistent to the questions (Saunders et al., 2003, p.309). Reliability tests are explained by (Cavana et al., 2001) as follows:

1. Tests re-test: measurements of reliability coefficient are conducted twice. A questionnaire could be handed out to respondents to measure a certain concept and is re-handed out later to the same respondents.
2. Internal consistency- ensures uniformity in of concepts to be measured to attach meaning to the concepts.
3. Alternative form is conducted during the questionnaire design.

3.3.6.5 Qualitative Research

From a different approach, qualitative research method is most appropriate to study the environment, situations and procedures that cannot be interpreted clearly with the quantitative approach (Myers, 2009). The author states further that qualitative research method enhances the study of the human phenomena and behaviour in depth through

involvement with respondents to obtain sound results. Qualitative research methods comprise of case studies, action research and grounded theory and are explained as follows:

Case study research studies in-depth information of an entity through a variety of data collection methods (Cavana et al., 2001). Case study research considers use of hypotheses. Most organisations do not use case study research to solve problems since; organizations in the same settings face problems at different times. It however, requires a careful selection of cases for correct interpretation of situations to solve the problems. Case study research supports qualitative data analysis, instead of quantitative.

Action research is mainly concerned with change strategies (Cavana et al., 2001) or change intervention (Saunders et al., 2003). The process involves the identification of a problem, data collection and implementation of the solution. A continuous evaluation, definition and diagnosing of effects is applied up to the period the problem is solved. Action research requires effective problem definition and creative ways of collecting data.

In grounded theory research, inductive and deductive research approaches explain theory development from data collected through observations (Saunders et al., 2003). The initial stage of data collection excludes a theoretical framework. Theory is developed at a later stage from data collected through observations. The data is then tested to confirm predictions.

Strauss and Corbin (1990) mention that, qualitative research does not depend on quantification and use of statistical processes to obtain findings. However, qualitative data can be acquired from interviews, field notes or any other written sources of data (Myers, 1997). Interviews enable the collection of rich information from people in various roles and situations (Myers, 2009). Interviews offer participants the freedom to express themselves (Saunders, et al., 2003). There are three types of interviews namely structured, semi-structured and unstructured.

Structured interviews comprise of pre-determined questions asked in order within a defined time period (Saunders, et al., 2003). It promotes social interaction with the respondents and

there is clarity of questions. However, structure interviews averts the emergence of new ideas since, there is no improvisation while, unstructured interviews are totally the opposite (Myers, 2009).

Semi-structured interviews consist of a list of themes and questions to be asked in the interview (Saunders, et al., 2003). Questions are flexible and offer room for improvisation. That is, some questions can be excluded in an interview depending upon the context and the order of questions is not strictly adhered to according to question flow (Saunders, et al., 2003).

Unstructured interviews in contrast, are not formal (Saunders, et al., 2003) and contain pre-formulated questions if they exist (Myers, 2009). Interviewees have a chance to bring out their opinions and the interviewer should improvise in case of breaks when the interviewee stops talking. Respondents have a chance to talk freely about certain behavioural aspects or beliefs concerning the area of study under discussion (Saunders, et al., 2003). Nevertheless, unstructured interviews depend upon the interviewee's perceptions which can be misleading. Myers (2009) stated that qualitative research is often difficult to generalize to a large population. Researchers argue that qualitative research is not as accurate as statistical results obtained from the quantitative approach (Myers, 1997, 2009).

This research supported the mixed method approach therefore; both quantitative and qualitative data were gathered. The mixed method approaches are appropriate when limited empirical work on the topic exists or when they are of a preliminary nature (Brown & Russell, 2007). Saunders (2003) argues that mixed methods enables the researcher to apply different methods for different purposes and triangulation to obtain the correct meaning of data. Mixed methods provided statistical and text analysis through open and closed-ended questions (Creswell, 2003).

3.3.6.6 Distinctions of Qualitative and Quantitative Data

The differences between the two approaches is that the quantitative approach mainly focuses on hard issues e.g. numerical data analysis while, qualitative approach deals with

soft issues e.g. data collection and analysis in the form of words or pictures (Chan, 2005). There are additional differences between the two types of data as postulated by Neuman (2000). Three features distinguish between the measurement of quantitative and qualitative data as shown in Table 3.

Table 3: Summary of Qualitative and Quantitative Measurement (Neuman, 2000)

Feature	Qualitative Measurement	Quantitative Measurement
Timing	Measurement occurs during data collection process	A priori determination of variables
Data Form	Multi-format-text or pictorial. May include some numerical data	Numerical
Logic	Partial conceptualisation of ideas with full development during actual data collection	Full conceptualisation of ideas and data collection

In quantitative methods, timing involves the time taken by a researcher to define variables and quantify them for measurement whereas; in qualitative methods activities are not given prior consideration (Sekaran, 2003). Differences can be observed through both (data form and presentation). Quantitative data is presented as numbers while, qualitative data is presented through e.g. text (words) and pictorial (visual) (Miles & Huberman, 1994). Therefore, data collection commences after conceptualisation of data through linking data and ideas with the logic. Qualitative measurement requires only partial conceptualisation before data collection starts (Neuman, 2000). Therefore, qualitative measurement is depended upon the method used to collect data from questionnaires or interviews i.e. it can be biased (Cavana et al., 2001). Therefore, the researcher proposes that collection of data from different sources and methods could assist in reducing bias. A survey consisting of open ended and closed questions were applied in this dissertation. The data collection and analysis is explained as follows:

3.3.7 Data Collection

Data collection was conducted after the research questions and research hypotheses were formulated. In this research, the collection of data consisted of both quantitative collection through questionnaires and qualitatively through interviews.

3.3.7.1 Quantitative Data Collection

The survey included both open-ended and closed questions. In exploratory research, open ended questions prompt respondents to answer questions in a way that suites them (Sekaran, 2003). Closed questions in contrast, allow respondents to make choices from options defined by the researcher and are restrictive (Cavana et al., 2001; Sekaran, 2003). Therefore, it was suitable to have some open ended questions to allow students to cover the topic comprehensively. In the present study, the collection of quantitative data was conducted as follows:

The researcher obtained permission from the course conveners and lecturers to hand out questionnaires to students towards the end of lectures. Students filled in the questionnaires in the presence of the researcher and handed them back before leaving the lecture venue. This allowed the researcher an opportunity to address queries or clarify issues during data collection. The survey comprised of 150 students at University of Cape Town (UCT) from the faculties of Science, Engineering and the Built Environment, Commerce and Humanities. Students were selected from the departments of Computer Science (CS), Civil Engineering (CE), Information Systems (IS) and Psychology (PSY). These departments were appropriate because of the differences in group projects and nature of knowledge shared by students. For example, Students in (CS) develop algorithms using object orientated program design like Java or Python number systems. In (CE), they conduct site surveys and prepare site plans. Students in (IS) develop systems using programming languages e.g. Visual Basic. NET, while those in (PSY) conduct projects that analyse humans e.g. the brain or internal mental processes.

Initial, 200 questionnaires were distributed. 165 responses were received in total and 15 of these were excluded due to incomplete information and also because some students indicated that they did not communicate using mobile phones. The total number of respondents were CS (23), CE (69), IS (42) and PSY (16). Only those students that communicated in their projects using mobile technology were involved. Therefore, the usable sample was 150. Table 4 presents the profile of the respondents.

Table 4: Respondents Background (N=150)

Category	Frequency		Group Details	
	No	%	Average Students in a Group	Allocation Done by
Academic Discipline				
Computer Science	23	15	3	Lecturer
Civil Engineering	69	46	5	Students
Information Systems	42	28	4	Students
Psychology	16	11	6	Students
Gender				
Male	99	66		
Female	51	34		

3.3.7.2 Qualitative Data Collection

Structured interviews comprise of pre-formulated questions, asked in a specific order or specified time limit (Myers, 2009). Structured questions enabled the researcher to maintain consistency and capture the required information for this research. Hence, qualitative data was obtained from Section E (mobile phones) of the questionnaire. The section consists of 5 questions about the purpose, functionality, transfer of project information and how the mobile phone enhances performance. Students completed this section and the data was transcribed into Microsoft Excel 2010 prior to data analysis.

3.3.8 Data Analysis

Data analysis was conducted to confirm if research questions and hypotheses were supported (Sekaran, 2003). Both quantitative and qualitative analyses assisted in determining if the research objectives were fulfilled. In this research, the objectives were to establish the extent to which students share tacit knowledge using mobile phones in group projects and also determine whether by sharing such knowledge their performance improves. The analysis is presented in the sections that follow.

3.3.8.1 Quantitative Data Analysis

The analysis of quantitative data involves getting data ready for analysis, testing goodness of data and finally the hypothesis (Cavana et al., 2001). Further, data requires editing and cleaning up, screening for anomalies and effective handling of blank points. The analysis of

the quantitative data was done using a Statistical Analysis Software (Statistica 10) and Microsoft Excel 2010. This involved summarising the data, conducting reliability checks and establishment of variable relationships. Cronbach Alpha was used to measure reliability of variables. For internal consistency measures, a reliability co-efficient of close to 1.0 is acceptable and those close to less than 0.60 are regarded as poor (Cavana et al., 2001). Validity tests include factorial validity (factor analysis), criterion related validity (measure for differentiating individuals) and discriminant validity (concepts not correlated). This research used discriminant validity to assess variables that are not correlated.

Hypotheses testing were also conducted. Hypothesis 1 was tested by comparing the percentages of students who agreed to share tacit knowledge (i.e. TK1-TK5) and explicit knowledge (i.e. EK1-EK5). Students who scored 4 and above on the knowledge items were selected. Hypothesis 2 was tested using a t-test to determine the impact of variations between student scores on tacit knowledge and performance. Students who shared all the six tacit knowledge items were considered in this test (i.e. students who scored 4 and above on TK1-TK6).

Significance tests determined probability tests on relationships between variables that occur by chance and also determine the differences in population from which the sample was obtained (Saunders et al., 2003, p.356). Cavana et al. (2001) define significance level as the possibility of rejecting a true null hypothesis. In testing hypotheses, the common significance level or p-value is 5% which means that the hypothesis is assumed to be true. If it is higher than 0.05, the relationship is not significant (Saunders et al., 2003). A significance level of 0.05 also means that confidence level is 95%, thus, the higher the significance level, the lower the confidence level.

3.3.8.2 Qualitative Data Analysis

Qualitative data analysis assists in understanding a phenomenon under study (Cavana et al., 2001). Content analysis was used as the main technique to analyse qualitative data. It is applicable for qualitative data analysis for the reason that, it focuses on human communication. Content analysis identifies key themes from raw data, coding of the themes

and assigns unique identity to every theme (Cavana et al., 2001). From another standpoint, Mayring (2000) argues that content analysis analyses material content like words or concepts within texts. It consists of recorded communication, for example, transcripts of interviews, discourses, protocols of observations, video tapes and documents. The meanings and relationships of words and concepts is analysed to make inferences about the messages within the texts.

Therefore, this research applied the general inductive approach by (Thomas, 2003) for qualitative data analysis. The approach was appropriate since it allowed the researcher to condense raw data into a summarised format, establish links with objectives and summary findings from the data. The analysis was therefore conducted as follows:

The researcher prepared the raw data file and read through text to obtain the main and sub-categories of data. The main categories obtained were purpose, functions, communication, information transfer and performance. The researcher noted down appropriate textual phrases and quotes that outlined the meaning of the categories and these were presented on a Microsoft Excel 2010 spread sheet. The spread sheet was studied repeatedly, revised and refined to obtain the correct meaning, themes and patterns fitting with the conceptual model. The interpretation and presentation of the results was conducted last.

3.4 Confidentiality and Ethics

Research ethics comprise of appropriateness of behaviour and research conduct expected from researchers (Saunders et al., 2003). Ethical concerns were taken care of by seeking permission from the University to conduct data collection, analysis and reporting. Principles and procedures for conducting research were obtained through the code of ethics. It assisted in adhering to the behavioural norms of the institution (Saunders et al., 2003). Before commencement of this research, an ethics form (as shown in Appendix F), research access form (as shown in Appendix G) and the research proposal were sent to the University's Research Ethics committee for approval. The approval initiated data collection. Participation of the students was voluntary and strict measures were enforced to guarantee the integrity of data collected. Respondents need assurance that responses would be kept

strictly private and confidential (Cavana et al., 2001). Therefore, students were guaranteed that the information they provided would not be divulged but, kept private. The research avoided sensitive and private information to be asked on the questionnaires. Also, data collected was used for the purpose of this research only and for no other reasons and destroyed upon completion of the research.

3.5 Summary of the Chapter

This chapter provided an overview of the philosophies conducted during a research process. Research processes follow epistemological, ontological and methodological philosophies that determine the selection, choice of methods, research approaches and paradigms including the data collection and analysis techniques adopted by a study. The objective of this research was to investigate the extent to which students share tacit knowledge in group projects using mobile phones and the impact on their performance. Therefore, this research adopted a positivist stance, exploratory paradigm and mixed methods (i.e. qualitative and quantitative). Data collection was conducted through open and closed ended questions. The researcher collected 150 questionnaires from students in four disciplines i.e. Computer Science, Civil Engineering, Information Systems and Psychology for data analysis. Table 5 outlines a summary of the research methodology for this research as follows:

Table 5: Research Methodology Summary

METHODOLOGY	APPROACH
Underlying philosophy	Positivist
Research purpose	Exploratory
Reasoning approach	Deductive
Research strategy	Mixed approach (Quantitative & Qualitative), Content Analysis and Survey
Data collection techniques	Quantitative and Qualitative <ul style="list-style-type: none"> • open and closed questions
Data Analysis	Quantitative <ul style="list-style-type: none"> • Statistical analysis software (Statistica 10) and Microsoft Excel 2010. Qualitative <ul style="list-style-type: none"> • General inductive approach and Microsoft Excel 2010
Time-frame	Cross-sectional

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

The objectives of this research were to investigate the extent to which students share tacit knowledge using mobile phones in group projects, and examine whether students who shared this knowledge achieved better performance. The researcher formulated a research proposal, questions and a design which was tailored to gather data from university students on the use of their mobile phones in the sharing of tacit and explicit knowledge.

Qualitative and quantitative analysis techniques were used. In quantitative analysis, statistical techniques were employed to summarise data, test for reliability and validity and establish the relationships among variables of the conceptual model (Saunders et al., 2003). In addition, qualitative analysis involved the general inductive approach on analysis of qualitative data (Thomas, 2003). The researcher identified and categorised the responses from the students, including comments to support their claims.

This chapter presents the results of the reliability and validity tests. This is followed by a presentation of the findings, analysis and discussion of the results. The chapter is presented as follows:

Section 4.2 discusses the results of the reliability and validity tests conducted in this research. *Section 4.3* outlines demographic analysis, i.e. information regarding gender, distribution of students, number of members in a group project and group allocation. *Section 4.4* presents findings, analysis and discussion on sharing of tacit knowledge for the four departments while, *Section 4.5* presents sharing of explicit knowledge and *Section 4.6* outlines responses to open ended questions, using the general inductive approach. *Section 4.7* describes the outcomes of group projects, i.e. performance. *Section 4.8* illustrates how the hypotheses were tested in order to answer the research question.

4.2 Reliability and Validity Testing

4.2.1 Reliability Testing

Cronbach's alpha and composite reliability co-efficient were used to determine the reliability of variables. For internal consistency measures, Cronbach alpha threshold of 0.70 is normally used, although in exploratory research a threshold of 0.60 can also be considered (Fornell & Larcker, 1981; Hair, Black, Babin, Anderson & Tatham, 2006). The results in Table 6 show that the measuring constructs exhibited adequate internal consistency i.e. the test may give the same results if conducted in a different setting. Tacit knowledge (TK) has a Cronbach alpha score of 0.79 and performance scored of 0.83, suggesting that they are reliable. The Cronbach alpha value of Explicit Knowledge (EK) was however lower than the threshold (0.70). This could be explained by the fact that fewer questions were asked about this construct.

However, the composite reliability co-efficient which measures the internal consistency of the measurement instrument suggests that all constructs (including Explicit Knowledge-EK) have higher composite reliability compared to the benchmark of 0.60 (Fornell & Larcker, 1981). The researcher therefore, decided to retain the Explicit Knowledge variable in further analysis.

Table 6: Reliability Scores

Variable	Reliability	
	Cronbach's α	Composite Reliability Co-efficient
TK	0.79	0.85
EK	0.50	0.70
Performance	0.83	0.92

4.2.2 Discriminant Validity

Discriminant validity measures the quality of a measurement instrument and is regarded good when respondents understand the meaning of research questions associated with a variable without confusing the questions (Fornell & Larcker, 1981). Discriminant validity means that two different variables and their scores are not correlated (Cavana et al., 2001; Sekaran, 2003). With regards to each separate latent variable, the values along the diagonal

in bold should be higher than the values (correlations) below them (Fornell & Larcker, 1981). The results in Table 7 show that tacit knowledge (TK), explicit knowledge (EK) and performance (P) have high correlations demonstrating that students surveyed understood the questions in the way they were intended.

Table 7: Discriminant Validity Scores

Variables	TK	EK	P
TK	0.640		
EK	0.357	0.556	
P	0.124	0.147	0.925

4.2.3 Reliability of Qualitative Analysis

To ensure reliability of qualitative data, the questionnaire was piloted with a small number of people namely, 2 senior academics and 8 students from the sampled departments. This enabled the researcher to modify the questionnaire before it was handed out.

For credibility purposes, questions were answered in the presence of the researcher, thereby allowing the researcher to answer questions or queries that arose from students.

The qualitative data obtained from the students i.e. textual phrases, were organised into categories and sub-categories on a Microsoft Excel 2010 spread sheet to ensure dependability. Furthermore, charts were used to compare values across categories in order to obtain a broader view of interpretations and findings from the data. All questionnaires were cross-checked to ensure that they were properly filled in.

4.3 Demographic Analysis

Students completed general questions to specify their faculty, department and project details e.g. name of the project they were currently doing or done before. Demographic data also yielded information on gender and distribution of participants, number of members in a group and method of allocation.

4.3.1 Gender

A total of 98 males and 52 female students participated in the survey. 16 males and 7 females were from CS (Computer Science), 48 males and 21 females from CE (Civil Engineering), 29 males and 13 females from IS (Information Systems) and 5 males and 11 females from PSY (Psychology).

4.3.2 Participants

Figure 7 shows that from the 150 students who participated in the survey, 23 were from CS, 69 from CE, 42 from IS and 16 from PSY. There were more students from Engineering than in other disciplines.

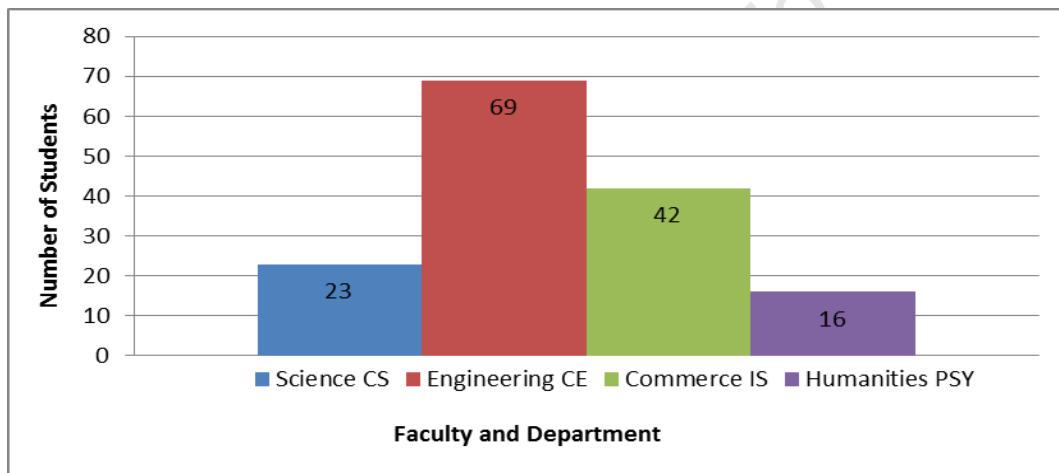


Figure 7: Distribution of Students in the Four Disciplines

4.3.3 Group Members

Figure 8 confirms that all the students surveyed were involved in a group project and most groups (68%) had between 4 and 6 members.

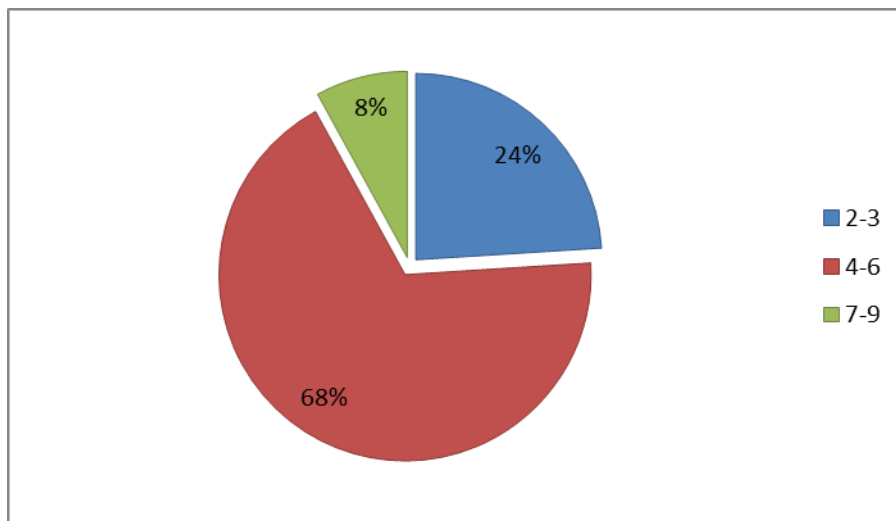


Figure 8: Number of Members in a Group Project

The variations in Figure 9 suggests possible relationships between group size and the nature of projects conducted. For example, CS students usually work in smaller groups (e.g. 2-3 members) or individually on software development projects.

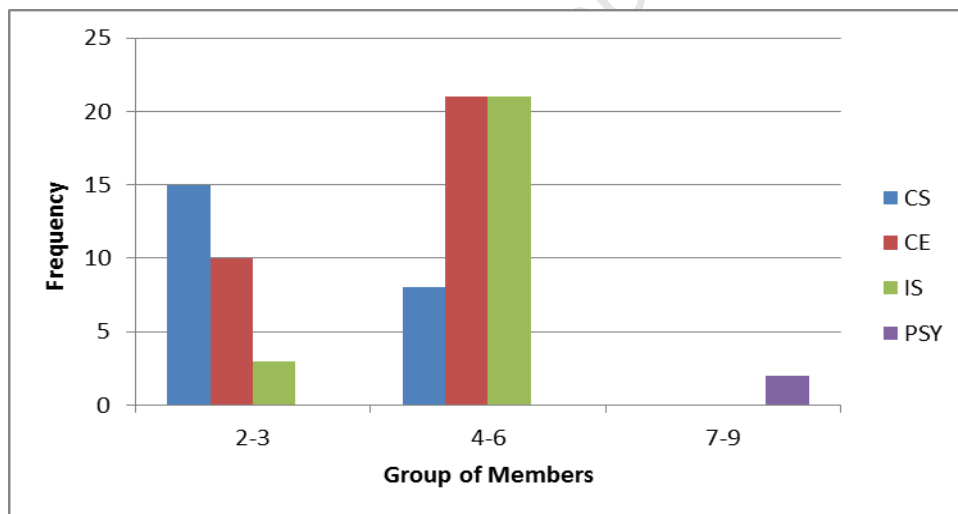


Figure 9: Number of Groups Found in each Discipline

On the other hand, projects in CE (e.g. construction projects) and IS (e.g. system development) may also require distribution of tasks to many members in order to achieve better project outcomes (Ragunath, Velmourougan, Davachelvan, Kayalvizhi & Ravimohan, 2010).

Groups in PSY appear to consist of more members (e.g. 7-9). Learning in PSY is usually student-centred (Hammond & Bennett, 2002), and this often involves discussions and

development of critical analysis skills. The Cognitive Psychology or Eyewitness Projects may require more team members to reflect on the findings and justify opinions (Soller, 2001).

4.3.4 Group Allocation

Figure 10 shows how the groups were allocated (e.g. by students, lecturers or random assignment). 56% of the students surveyed allocated themselves into group projects, 39% were allocated by the supervisors and only 5% by random selection.

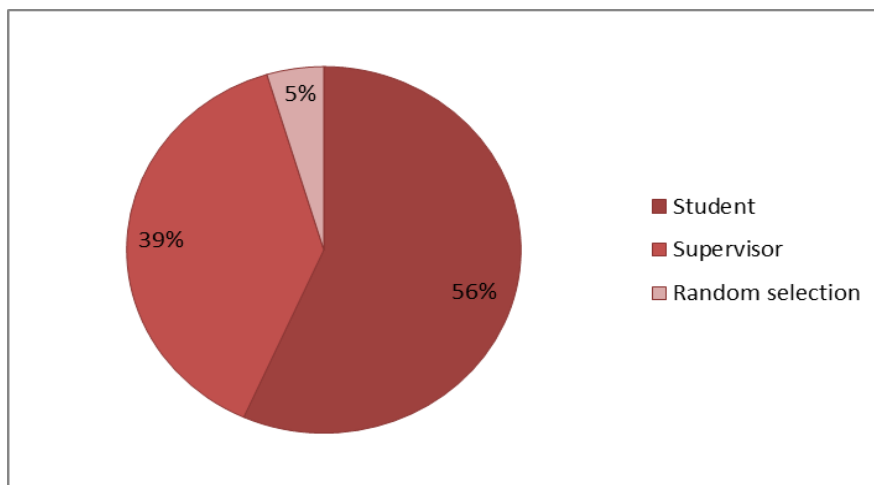


Figure 10: Group Allocation

4.4 Sharing of Tacit Knowledge

The responses to each item that measured tacit knowledge are presented in Tables 8-11. Questions 1-3 relate to categories of tacit knowledge one would expect to find across the departments (e.g. ability to discuss and assign project tasks and responsibilities, ability to share theoretical concepts, and ability to seek clarification from Professors). Questions 4-8 measured knowledge specific to a discipline. Table 8, to begin with, summarizes the results from the Computer Science (CS) groups.

Table 8: Knowledge Shared Using Mobile Phones by Computer Science Students

Type	Items that Measured Tacit Knowledge	No of Responses	Mean score	Std
CS1	Discuss project tasks and allocation of responsibilities	23	4.13	1.21
CS2	Share knowledge on the theoretical principles of algorithm development (using e.g. Java, C++ or Python number systems).	23	4.13	1.19
CS3	We seek clarification from professors/lecturers about project issues	23	3.62	1.27
CS4	We share knowledge on the application of artificial intelligence, 3D graphics and game programming	23	3.26	1.17
CS5	We share knowledge on application of intelligent systems, digital libraries and extensible mark-up languages (XML)	23	2.95	1.18
CS6	We share knowledge of data structures, computer networks and compilers	23	4.04	1.14
CS7	Peers discuss aspects of human computer interaction, computer architecture and database systems	23	3.86	0.91
CS8	We share knowledge on how to measure the sense of presence, immersion and flow in virtual environments (VEs)	23	3.26	1.17

Students agreed that they discussed project tasks (CS1) and shared knowledge on algorithm development (CS2) using mobile phones. They also agreed that they used the mobile phones to seek clarification from professors (CS3). However, they did not provide a firm response to whether they shared knowledge on application of artificial intelligence (CS4) and concepts of intelligence systems design (CS5). It is possible that at the time of the research study, these areas had not been covered by the curriculum.

Hammond and Bennett (2002) examined how ICT is used to facilitate learning in different disciplines. They claim that skills acquired in Sciences consist of a set of defined guidelines and solution paths for solving problems, i.e. they are procedural in nature. While their study focused on Physical Science, Computer Science may fall in the category of sciences. Hammond and Bennett (2002) state that in Physical Science, ICT is used to facilitate task based activities e.g. simulations, use of practical analytical tools, use of on-line work sheets, etc.

CS students agreed that they shared knowledge of data structures, computer networks and compilers (CS6). CS students are often involved in task-based activities involving the use of data structures, computer networks and compilers from undergraduate years of study. It would therefore be possible for them to share such knowledge. This knowledge is also needed in many of the projects conducted at Honours level. For example, CS Honours students were involved in a project that used mobile phone features, e.g. voice, SMS, photo and video to report crime activities anonymously (Kayem, 2011). This project involved data-handling and mining and use of machine languages, i.e. algorithm development which requires knowledge of data structures and compilers. Figure 13 also shows that CS students send SMS (short messaging service) more than they make phone calls probably due to the high call rates in South Africa which clearly impedes the sharing of knowledge (Foray & Hargreaves, 2003; Prensky, 2004). CS students confirmed that:

"We communicate more through SMS"

"...We hardly call because it's expensive; I don't have a smartphone with free applications"

Further, CS students agreed that they discuss aspects of human computer interaction, architecture and database systems (CS7). They however do not appear to use this technology to share knowledge on how to measure sense of presence, immersion and flow in virtual environments (VEs), (CS8).

Sense of presence, immersion and flow in virtual environments (VEs) consist of visual experiences with technology that enhance motivation in learning and training processes (Popovici & Marhan, 2008). These writers however indicate that sharing such knowledge may be impeded by the differences in knowledge levels attained by students and their interests during their studies. While this could explain the above results, this study however did not investigate this further.

Table 9 below presents the responses of the students in the CE (Civil Engineering) discipline.

Table 9: Knowledge Shared Using Mobile Phones by Civil Engineering Students

Type	Items that Measured Tacit Knowledge	No of Responses	Mean score	Std
CE1	Discuss project tasks and allocation of responsibilities	69	3.10	1.31
CE2	Discuss theoretical principles of mathematics, physics and drawings	69	3.26	1.12
CE3	We seek clarification from professors/lecturers on project issues	69	3.88	0.97
CE4	Discuss and analyze properties of various construction materials e.g. nature of soil, foundation design and waste treatment	69	2.94	1.17
CE5	Share knowledge of basic survey operations and preparation of site plans	69	3.42	1.04
CE6	Analyze pictures and compare populations	69	3.30	1.04
CE7	Discuss calculations to determine optimal dimensions of facilities	69	3.44	1.10
CE8	Evaluate detailed drawings and specifications to ensure projects are constructed to standards	69	3.51	1.04

In the case of CE, students did not give a firm response to the question that determined whether they discuss project tasks (CE1) and theoretical principles (CE2) using mobile technology. Foster, Masoso, Sebusang and Uys (2002) reported that Engineering students mainly learnt through face-to-face communication in their groups. This is particularly possible where students are required to have an understanding of the context perspectives, task costs and construction plans which may require face-to-face discussion (Hendrickson & Au, 1989).

CE students however agreed that they used mobile technology to seek clarification from professors (CE3) on project issues. They also used SMS (short messaging service) and phone calls predominantly (as shown in Figure 13). Students supported their use of text messages and phone calls as follows:

“SMS allows us to communicate with group members quickly”

“We call to get immediate feedback regarding project progress”

With regard to sharing knowledge relating to various properties of construction (CE4), students indicated that they do not. It is possible that students who took the survey had not done practical sessions in the field or labs to examine properties of construction materials (e.g. soil, foundation design and waste management), since the survey was conducted at the beginning of the semester. Students usually conduct site projects and work at the design office during vacations. CE students revealed that:

“Group members do not share such type of project information...it requires a laboratory”

“I have a simple phone, can't do much with it really”

“We do not use mobile phones for that”

In the case of knowledge relating to basic survey operations (CE5), analysis of pictures and populations (CE6) and discussion of calculation of optimal dimensions (CE7, CE8), their responses were firm enough. CE students confirmed that they use mobile phones to share knowledge through exchanging and analysing pictures.

“...Can take and send pictures to team members”

“We send and store pictures and announce meetings with the mobile phone”

Table 10 summarises the results of tacit knowledge shared in Information Systems (IS).

Table 10: Knowledge shared using Mobile Phones by Information Systems Students

Type	Items that Measured Tacit Knowledge	No of Responses	Mean score	Std
IS1	Discuss project tasks and allocation of responsibilities	42	4.02	0.94
IS2	Share knowledge of underpinning theories of Information Systems	42	3.88	0.91
IS3	We seek clarification from professors/lecturers about project issues	42	4.02	1.11
IS4	Share knowledge of the basic components of Information Systems	42	4.23	0.87
IS5	Share practical experience on using presentation tools, project planning tools, web-design applications or Microsoft Office	42	4.26	0.85
IS6	Discuss the application of Information Systems in practical settings	42	3.88	0.91
IS7	Share knowledge on how to use common tools of system analysis e.g. scoping, risk and feasibility assessment and prototyping	42	3.85	0.89
IS8	We share practical knowledge and experience in design, development and management of Information Systems	42	3.85	1.00

IS students shared most of the tacit knowledge measured, i.e. they discuss project tasks (IS1), share theoretical knowledge (IS2), seek clarification from professors (IS3), share knowledge of basic components of IS (IS4) and practical experience on presentation tools (IS5). Furthermore, they agreed to the application of IS in practical settings (IS6), use of tools of system analysis (IS7) and sharing of practical knowledge in management of IS (IS8).

Figure 13 shows that IS students used all the functionalities of the mobile phone examined in this study. This is possible due to the nature of their projects and perhaps due to the educational belief in Information Systems which emphasises “systems thinking” (Hammond & Bennett, 2002). In systems thinking, one is expected to understand that a system consists of subsystems, operating in an environment, with different goals and expected to interact with each other to operate effectively. Therefore it may be possible that in an effort to develop systems that address issues more holistically, they find it necessary to use many functionalities available on their mobile phones. For instance, the Internet, to search, download open software and share knowledge on how to use it; SMS for sharing text

knowledge; MMS for sending images and video clips; etc. as predicted earlier by (Benta et al., 2004; Prensky, 2004).

Table 11 provides a summary of the results of tacit knowledge shared in Psychology (PSY).

Table 11: Knowledge Shared Using Mobile Phones by Psychology Students

Type	Items that Measured Tacit Knowledge	No of Responses	Mean score	Std
PSY1	Discuss project tasks and allocation of responsibilities	16	3.87	1.36
PSY2	Discuss how the brain, mind and computer works (theoretical principles)	16	2.68	1.13
PSY3	We seek clarification from professors/lecturers about project issues	16	4.18	0.98
PSY4	Discuss how people think, remember, speak and solve problems	16	3.25	1.34
PSY5	Share answers to understand requirements of projects	16	3.87	1.02
PSY6	Discuss how people acquire, process and store information	16	3.00	1.31
PSY7	We analyze practical applications for cognitive research	16	3.12	1.54
PSY8	Discuss practical applications of cognitive science	16	3.43	1.36

PSY students use mobile phones to discuss group tasks (PSY1), seek clarification from professors (PSY3) and share answers to understand project requirements (PSY5) but not for discussions on theoretical principles about how the brain, mind and computer work (PSY2). These students did not give a firm response to the questions that determined whether they discuss how people think or remember (PSY4) and acquire information (PSY6). They also do not appear to use the technology for analysis of practical applications of cognitive research and science (PSY7) and (PSY8) respectively.

Students agreed sharing knowledge (PSY1, PSY3 and PSY5) which shows that they use mobile phones to discuss project requirements. However, they do not appear to be using the technology to share knowledge (PSY2, PSY6, PSY7 and PSY8).

According to Hammond and Bennett (2002), learning in humanities is student-centred in the sense that students develop solutions to problems through critical analysis and reflection on issues. Psychology is described as the study of the mind and intelligence and how individuals acquire certain kinds of thinking or knowledge (Thagard, 2005). Such knowledge is shared

through discussions and most likely face-to-face discussions, hence the impact of the educational belief (as predicted by Hammond & Bennett, 2002). Figure 13 indicates that students mainly use SMS (short messaging service) and do not make phone calls. Phone calls would definitely be expensive for students and discussions may not be conducted effectively using SMS. This therefore explains why there was limited sharing of tacit knowledge in PSY and a higher preference for face-to-face communication. Students supported face-to-face communication as follows:

“We send SMS to get hold of group members and discuss detailed project tasks during meetings”

“Face-to-face meetings are more productive...I can ask questions and get answers instantly”

4.5 Sharing of Explicit Knowledge

While the main focus of this study was on the transfer of tacit knowledge in groups, the researcher also wanted to determine if students share more explicit than tacit knowledge in a mobile environment. Students were asked to indicate the extent to which they use mobile phone features/applications to transcribe and communicate knowledge in their areas of study. The responses are presented in Table 12 below.

Table 12 summarizes the results of explicit knowledge shared in CS (Computer Science), CE (Civil Engineering), IS (Information Systems) and PSY (Psychology) project groups.

Table 12: Explicit Knowledge Shared Using Mobile Phones by Students

Type	Items that measured Explicit knowledge	Mean Scores by discipline			
		CS (N=23) Mean (SD)	CE (N=69) Mean (SD)	IS (N=42) Mean (SD)	PSY (N=16) Mean (SD)
EK1	Knowledge expressed in form of SMS, MMS	3.13 (1.32)	3.37 (1.38)	3.40 (1.21)	2.87 (1.31)
EK2	Knowledge expressed in form of Instant Messaging	3.34 (1.30)	2.65 (1.32)	3.71 (1.23)	3.12 (1.02)
EK3	Knowledge expressed in form of Email	4.17 (1.11)	3.76 (1.04)	4.14 (1.00)	4.12 (1.31)
EK4	Knowledge expressed in form of pictures, graphs, charts, codes, plans	2.13 (1.28)	3.76 (1.16)	3.76 (0.98)	1.87 (1.40)
EK5	Knowledge in form of video clips	1.65 (1.22)	1.92 (1.01)	2.14 (1.18)	1.75 (1.18)

Students in all disciplines share explicit knowledge expressed in form of electronic mails (EK3). IS students also express their knowledge using instant messaging (EK2) and in form of pictures, graphs, charts and codes (EK4). Specifically, they exchange software (codes) with their peers. Civil Engineering students indicated that they share knowledge expressed in pictures, graphs or charts using mobile phones (EK4). However, students in general do not appear to express their explicit knowledge in the form of SMS, MMS, Instant messaging and in Video clips (EK5).

Tazari, Windlinger and Hoffmann (2005) argue that impediments to knowledge sharing in a mobile environment consist of technical and infrastructural limitation of the devices; organisational limitations; and individual limitations such as work load, time constraints and other distractive factors. Sending SMS (short messaging service) may indeed be appropriate for short messages such as reminders but not for distributing large amount of data or detailed descriptions. Retrieval of lengthy messages may also be problematic for users with mobile phones having limited storage and display capabilities. The message may also require proper organisation or formatting to be intuitive. Therefore the conceptualization of knowledge, its organisation and representation on the mobile phone may be a major challenge for students working in groups.

In their study that examined the use of mobile phone for Project Based Learning in Nigerian Universities, Utulu, Alonge and Emmanuel (2010) obtained almost similar findings except for SMS. Of the 532 undergraduate respondents, over 70% used SMS; 25% used MMS; 18.4% used voice mail and 37.8% video recording. However, Utulu's et al. (2010) study did not specifically address the explicit knowledge transfer issue, rather general usage of the mobile phone facilities.

4.6 Responses to Open Ended Questions

The open-ended questions in Section E of the survey were analysed qualitatively using the general inductive approach (Thomas, 2003, as explained in the research design section above. The results are presented below:

4.6.1 Purpose of using Mobile Phones in Group Projects

Students were asked to indicate the purposes of using mobile phones in group projects. The following sub-categories of purposes emerged from the analysis i.e. communication, scheduling of meetings, urgency and convenience (see Figure 11).

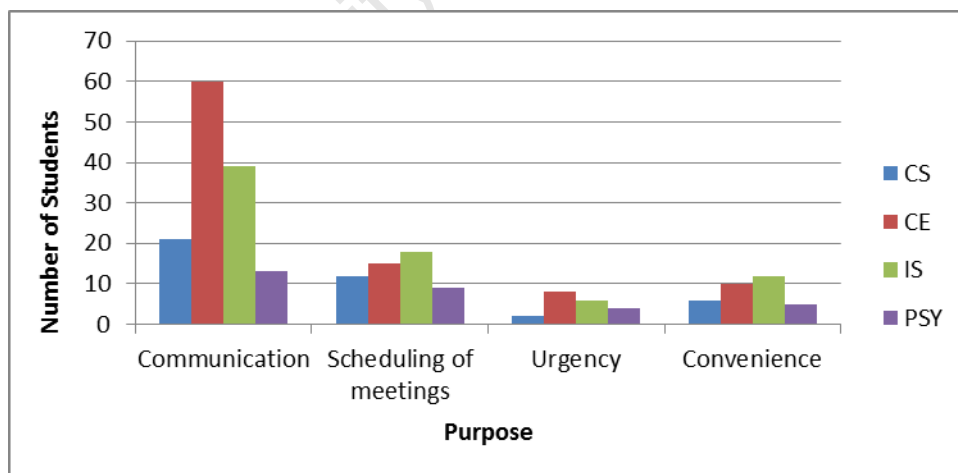


Figure 11: Purposes for Using the Mobile Phones in Group Projects

Communication was conceptualised as the interaction of students in group projects. It emerged that students from CE (Civil Engineering) used mobile phones extensively for communication than other disciplines. IS (Information Systems) had the second largest number while PSY (Psychology) the least. Students perceived that mobile phones allow

communication among group projects, hence a social communication tool as indicated in these responses:

"I feel that it helps to communicate with family, friends and social networking..." [CE]

"It is more of a work or business device than social...used as a personal organiser for checking e-mails and browsing the Internet" [CE]

"It is essential for communication, data transfer, accessing the internet, camera, media player, mobile documents, mobile bible, calendars and time" [CE]

"I notify people about various events and chat with males with my cell-phone" [CE]

"...Calling other group members asking for progress or clarity on areas I could not understand" [IS]

"A mobile phone serves as a communication medium among team members for clarification of what each group member should do" [IS]

"Communication is key to efficiency and without mobile phones we cannot communicate properly" [IS]

Scheduling of meetings involved scheduling of time and venue for group project meetings. The results show that IS students used the mobile phone mostly for scheduling meetings with group members compared to their counterparts. CE had the second largest number of students using the mobile phone for scheduling of meetings. PSY again had the least. Students viewed the mobile phone as a meeting scheduler:

"I use it to communicate with my team on matters concerning project progress and to arrange meetings for the team" [IS]

"I can send a 'please call me', SMS or phone to remind my group members of a meeting" [IS]

"I call to arrange a meeting, confirm time, venue or when late" [IS]

"It allows me to phone my group members when I need clarity on a subject or confirm meetings with them" [CE]

“Mobile phones are essential for planning of group meetings, reminders of tasks and task deadlines” [PSY]

“We use mobile phones when organising where people meet... the phone is not used to send the actual information to each other” [PSY]

“I use it to meet up with group members and communicate where I am” [PSY]

Urgency related to group immediate attention to critical matters using the mobile phone. The results show that CE students appear to have more critical issues to deal with, followed by IS, PSY, and CS with the least need for urgency. Students acknowledged that a mobile phone assists in handling urgent issues concerning the project as indicated below:

“I use it to communicate urgent issues that need immediate attention because, it is quick and you can get in touch with all the group members instantly” [IS]

Convenience was viewed as ease with which one could use of the mobile phone to get hold of group members. It appears that IS students found it most convenient, followed by CE and PSY last. The following comments were made:

“I use the mobile phone for quick and easy access of communication and surfing the internet” [CE]

“I use the mobile phone to get instant updates or contact members on issues that need clarification” [CE]

4.6.2 Functions on Student Mobile Phones

Students were asked to indicate the functions on their phones that supported knowledge sharing. These are summarised in Figure 12:

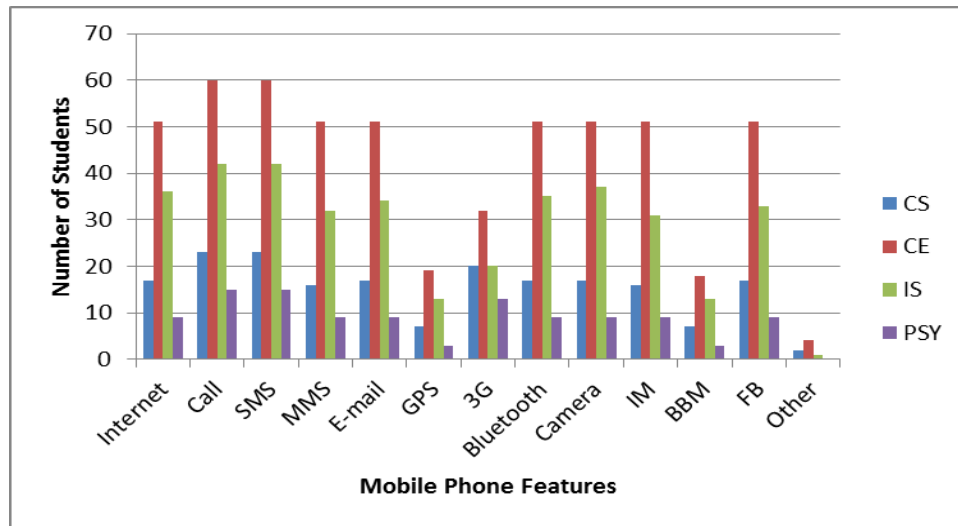


Figure 12: Mobile Phone Functions

The use of functions varied among students due to the differences in the mobile phone models possessed by students. Most phones had the following capabilities: Internet access, voice on the mobile (phone call), SMS (short messaging service), MMS (multi-media messaging service), E-mail (electronic mail), GPS (global positioning system), 3G (third generation), Bluetooth and camera, IM (instant messaging), BBM (black-berry messenger) and FB (Facebook). It appears that CE students possessed mobile phones with most of the features mentioned followed by IS, CS and PSY.

4.6.3 Mobile Functions Used Regularly by Students

Students were asked to indicate the functions they use regularly to share knowledge. These are summarised in Figure 13:

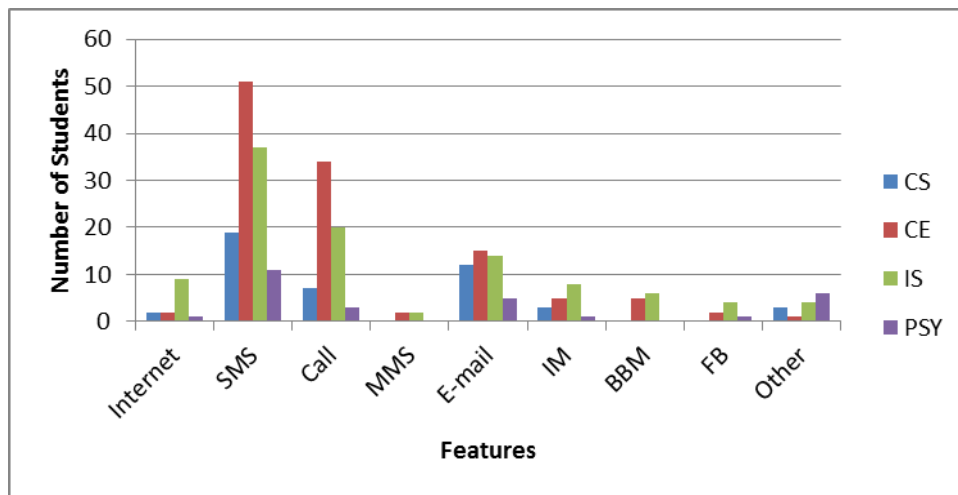


Figure 13: Mobile Functions Used

It was noted that IS students have the highest number of Internet users in group projects while those in the other departments (CS, CE and PSY) were not regular users. Figure 13 shows that most of IS students accessed the Internet to communicate with group members than in other departments. Students made the following comments:

“We use the Internet to search for group project information and check e-mails” [IS]

“We use the Internet rarely but when we do, it will be to connect to Vula and search for information on the web” [PSY]

Consistent with Figure 13, CE students do not appear to use the Internet that much. One of the students mentioned that:

“Internet is too slow to send large files or pictures”

CE students however used the SMS (short messaging service) function more often followed by IS and lastly by PSY students (see Figure 13). The following comments were made:

“SMS gives the certainty that the person received and read it right away” [CE]

“We rarely send SMS but, we meet face-to-face” [PSY]

“We SMS or call to get clarity about the project and look at the e-mail for full details”
[PSY]

With regards to making phone calls, CE students use this function the most, followed by IS, while PSY students call the least.

"We call to explain sections of project work which are unclear to perform better" [IS]

"My mobile phone is useful for voice communication, sharing photos or videos if there is a need" [IS]

Calling was however considered to be expensive as indicated below:

"I work on a student budget and the mobile phone is the most expensive means of communication, so I do not use it that much" [IS]

4.6.4 Perceived Usefulness of the Mobile Phone in Group Projects

The researcher also determined the perceived usefulness of the mobile phone as an information communication/transfer tool. The responses were categorised as: fast, convenience and other (e.g. Vula, MXit and Google documents) as indicated in Figure 14 below:

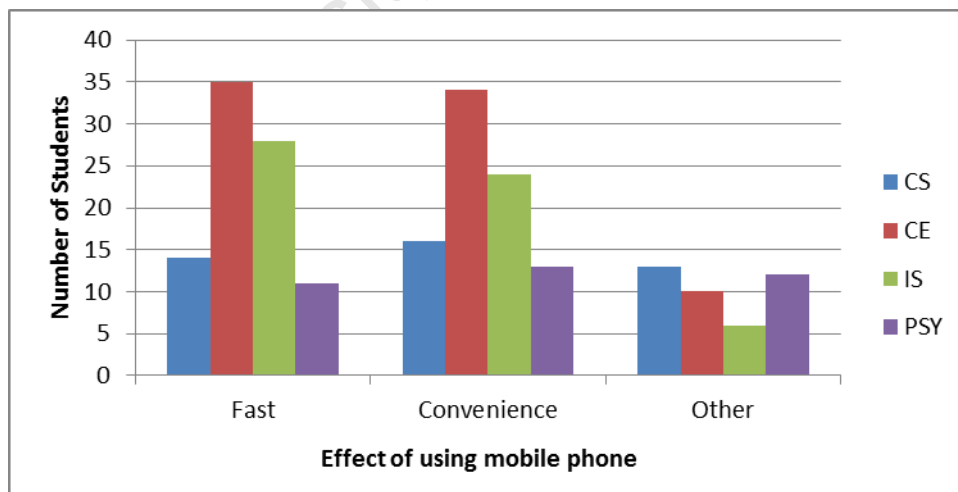


Figure 14: Perceived Usefulness in Group Projects

These tools were mainly considered to be most useful in facilitated fast transfer of project information among group members, and also in ensuring convenient student operations. Student comments included:

“... Can disseminate information faster and discuss issues and ideas without delay”
[IS]

“It is very useful in sorting our projects issues, improves the rate of information transfer and can handle a variety of media” [CE]

“It only helps in transfer of written or spoken information but, not graphs and tables”
[CE]

“We can take and re-send pictures and communicate with team members” [CE]

Some students however found them to be restrictive in transferring detailed project information:

“It is very important when communicating information although, you cannot transfer detailed ArcGIS data, Auto Cad and other software” [CE]

“We only discuss or rather ‘chat’ about meetings not, the project itself” [PSY]

4.7 Outcome of Group Projects (Performance)

Performance is described as the outcome of a project group deliverables. Performance was measured in Section F of the survey and the results are presented below:

4.7.1 Results of Student Self-Assessment

Performance results were obtained through student self-assessment. It appears that CS (Computer Science), CE (Civil Engineering) and IS (Information Systems) students obtained between 71-80% in their projects while the results of those in PSY (Psychology) were between 61-70% as illustrated in Figure 15.

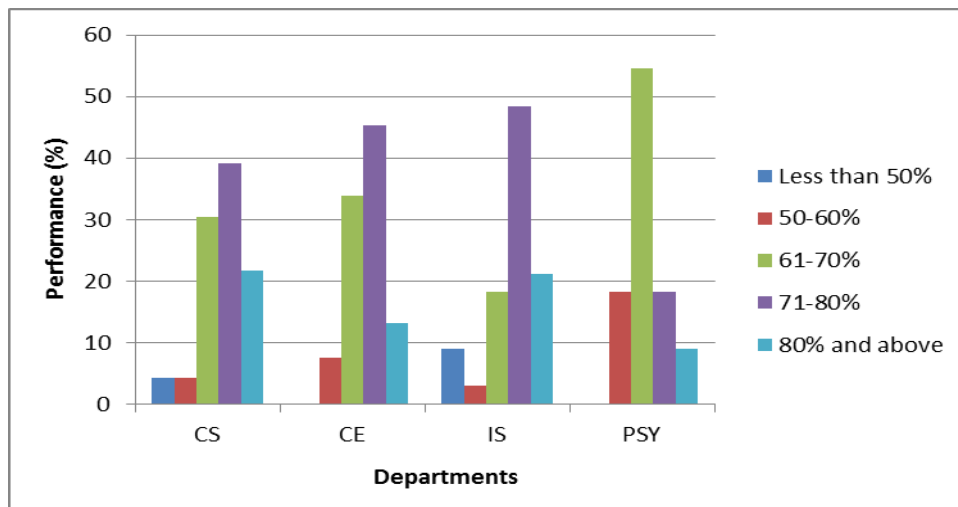


Figure 15: Student Self-Assessment

Most students considered their performance to be good. This may be attributed to the fact that they managed to use a number of the functionalities and applications on their phones (e.g. to send SMS, electronic mail and make phone calls). The number of students in a group (see Figure 9) may have also enabled students in IS and CE to obtain good project results since tasks were distributed to different people (Ragunath et al., 2010). Again the size of the group in PSY may have enabled better reflection on issues, justification of opinions and provision of better answers thereby improving group project performance (Soller, 2001).

Group member allocation is another factor that might have contributed to good performance in some departments. Research shows that it influences group dynamics, attitude and outcome (Chapman et al., 2006). These authors state that students in self-selected groups report high rates of team work scope, better group attitude and outcome than students in randomly selected groups. Students in self-allocated groups may share what they know (i.e. tacit knowledge) freely than in randomly selected groups or those allocated by the supervisor. Therefore, performance may be attributed to the ability of students to manage themselves, others and tasks (Sternberg et al., 1990). Student application of practical knowledge in learning experiences may also contribute to better performance (Somech & Bogler, 1999). Reflecting on this point, one student from IS confirmed that:

“The mobile phone enables us to communicate, share, discuss project issues and improve performance of the group”

4.7.2 Sharing of Tacit Knowledge and Performance

Figure 16 illustrates the results of tacit knowledge shared (TK1-TK8) and the performance of students in each discipline.

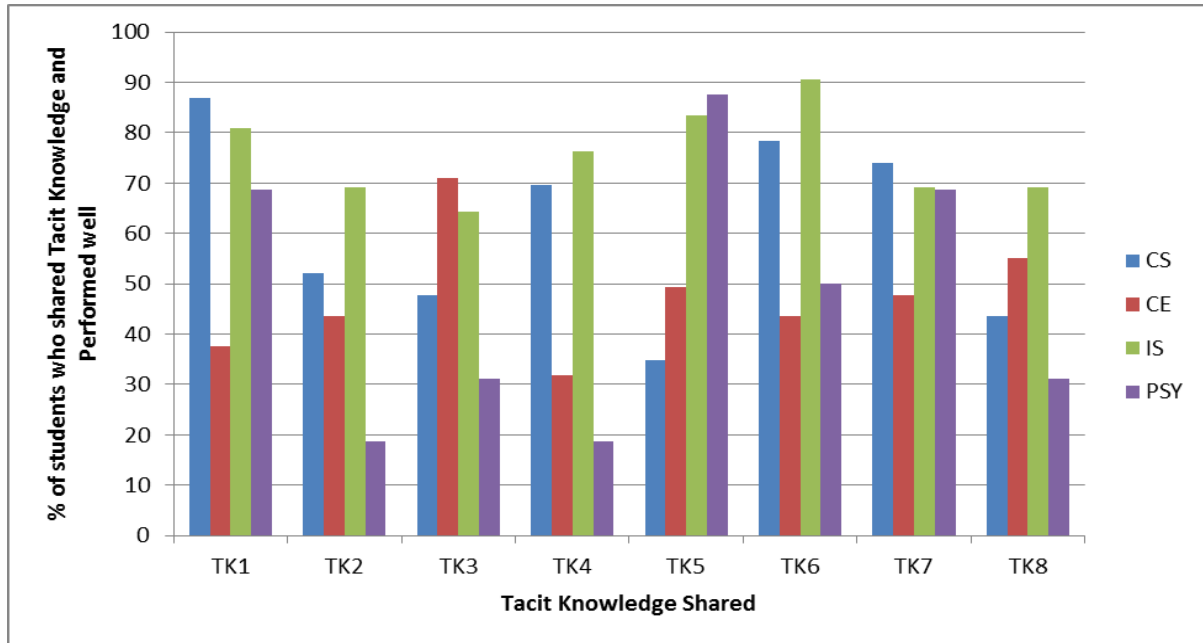


Figure 16: Students who Shared Tacit Knowledge and Performed Well: Analysis by Discipline

There were many IS students who shared all the types of knowledge measured in this study (i.e. TK1-TK8). Most CS students mainly shared TK1, TK2, TK4, TK6 and TK7. PSY students shared mainly TK1, TK5 and TK7. CE students mainly shared TK3 and TK8. The results therefore suggests that of all those who performed well, IS students shared most knowledge items.

4.7.3 Influence of Discipline on Tacit Knowledge Shared

Figure 16 above indicates that IS students shared most of the tacit knowledge examined and also performed well. The researcher wanted to know whether a discipline had any influence on tacit knowledge sharing. This was achieved by conducting univariate analysis of variance (ANOVA) using three knowledge types. These were: Com TK1 which represented all the first items in Table 8-11 (i.e. CS1, CE1, IS1 and PSY1); Com TK2 which represented the second items in Tables 8-11 (i.e. CS2, CE2, IS2 and PSY2) and Com TK3 which represented the third items in Table 8-11 (i.e. CS3, CE3, IS3 and PSY3). The ANOVA results are presented in Table 13 below.

Table 13: Results of Analysis of Variance (ANOVA)

Variable	Mean Square	Df	F	p
Com TK1	10.79	3	7.30	0.0001
Com TK2	5.46	3	4.79	0.0032
Com TK3	2.93	3	2.65	0.0504

The results indicate that discipline (i.e. educational beliefs, methods of teaching etc.) has a significant effect on sharing of tacit knowledge represented by Com TK1 and Com TK2 (as depicted by the significant p value of <0.05). The p value for Com TK3 is slightly above 0.05 suggesting that sharing of knowledge represented by Com TK3 (e.g. seeking clarification from Professors) is not influenced by discipline.

This finding is also supported by the results in Table 9 and 11 and Figure 16. In Figure 16, students whose discipline emphasises procedural learning (i.e. CS and IS) scored highly on TK1 and TK2 than those who normally share knowledge through discussions e.g. CE (3.26) (see Table 9) and PSY (2.68), (see Table 11).

Overall, the mean score in Table 14 shows that students share tacit knowledge (3.60) more than explicit knowledge (2.90). In particular, students in (CS) and (IS) shared more tacit knowledge than those in other departments.

Table 14: Mean Comparisons

Department	Mean Score (TK)	Mean Score (EK)
Computer Science	3.65	2.73
Civil Engineering	3.35	2.28
Information Systems	3.99	3.21
Psychology	3.42	2.63
Overall Mean Score	3.60	2.90

4.8 Hypothesis Testing

Two hypotheses were stated in Chapter 2 as follows:

- Hypothesis 1: In a mobile environment, students will share more explicit than tacit knowledge.
- Hypothesis 2: In a mobile environment, the more tacit knowledge shared by students, the greater their project performance.

Hypothesis 1 was tested by comparing the percentages of students who agreed to share tacit and explicit knowledge, while Hypothesis 2 was tested by running a t-test for each department. The results of the tests are presented as follows:

4.8.1 Hypothesis 1

In a mobile environment, students will share more explicit than tacit knowledge.

The hypothesis was tested by comparing the percentages of items of both tacit (TK) knowledge and explicit (EK) knowledge shared by students (e.g. a score greater or equal to 4 on the scale showed that they agreed that they shared that type of knowledge). Only knowledge items TK1-TK5 and EK1-EK5 were considered in these tests to ensure the same number of items compared. The results are presented in Figure 17-20, commencing with Computer Science (CS), followed by Civil Engineering (CE), Information Systems (IS) and lastly, Psychology (PSY).

Figure 17 shows that there were more students who shared tacit knowledge as opposed to explicit knowledge in CS. For instance, there were three cases whereby more tacit than explicit knowledge was shared (e.g. TK1 is greater than EK1, TK4 is greater than EK4 and TK5 is greater than EK5). Hence, it can be concluded that, in the case of CS, Hypothesis 1 is not supported.

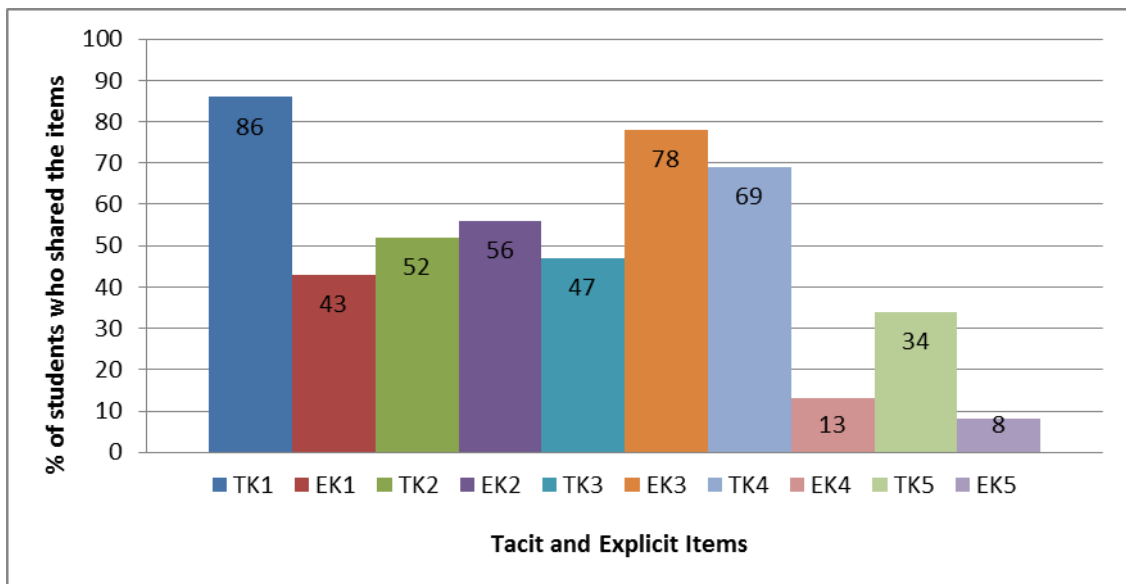


Figure 17: Tacit and Explicit Knowledge Measures in Computer Science

In the case of CE, there were more students sharing tacit than explicit knowledge. For example, there were three cases whereby more tacit than explicit knowledge was shared (i.e. TK2 is greater than EK2, TK3 is greater than EK3 and TK5 is greater than EK5) as shown in Figure 18. Thus, it can be concluded that, in the case of CE, Hypothesis 1 is also not supported.

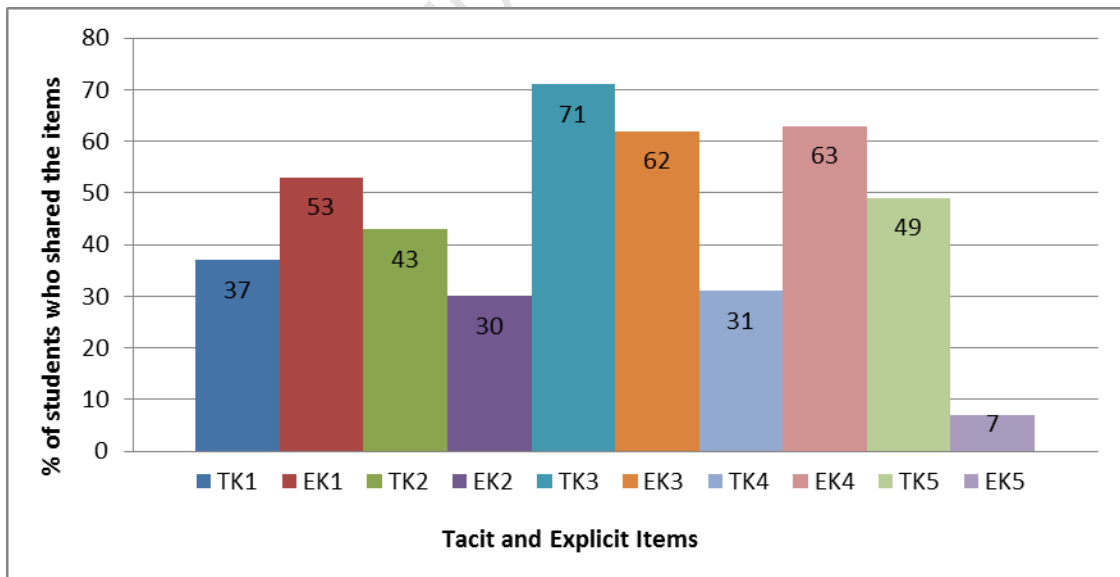


Figure 18: Tacit and Explicit Knowledge Measures in Civil Engineering

In the case of IS, there were four cases whereby more tacit than explicit knowledge was shared (e.g. TK1 is greater than EK1, TK2 is greater than EK2, TK4 is greater than EK4 and

TK5 is greater than EK5) as shown in Figure 19. Hence Hypothesis 1 is again not supported in this case.

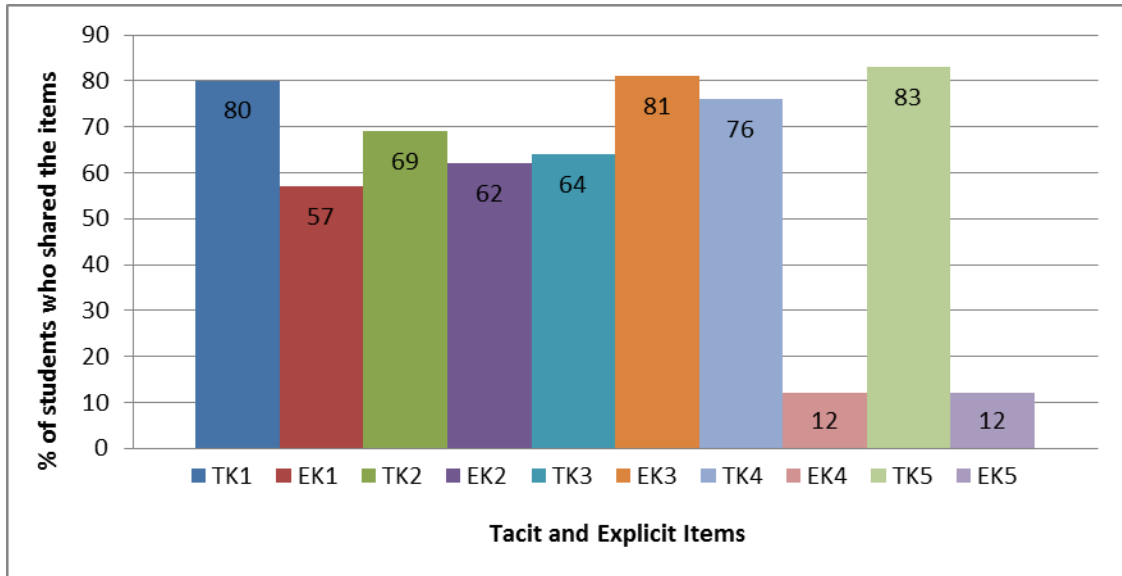


Figure 19: Tacit and Explicit Knowledge Measures in Information Systems

Figure 20 illustrates that there were more students who shared tacit knowledge as opposed to explicit knowledge. For instance, there were three cases whereby more tacit than explicit knowledge was shared (e.g. TK1 is greater than EK1, TK4 is greater than EK4 and TK5 is greater than EK5). Therefore Hypothesis 1 is not supported in the case of PSY.

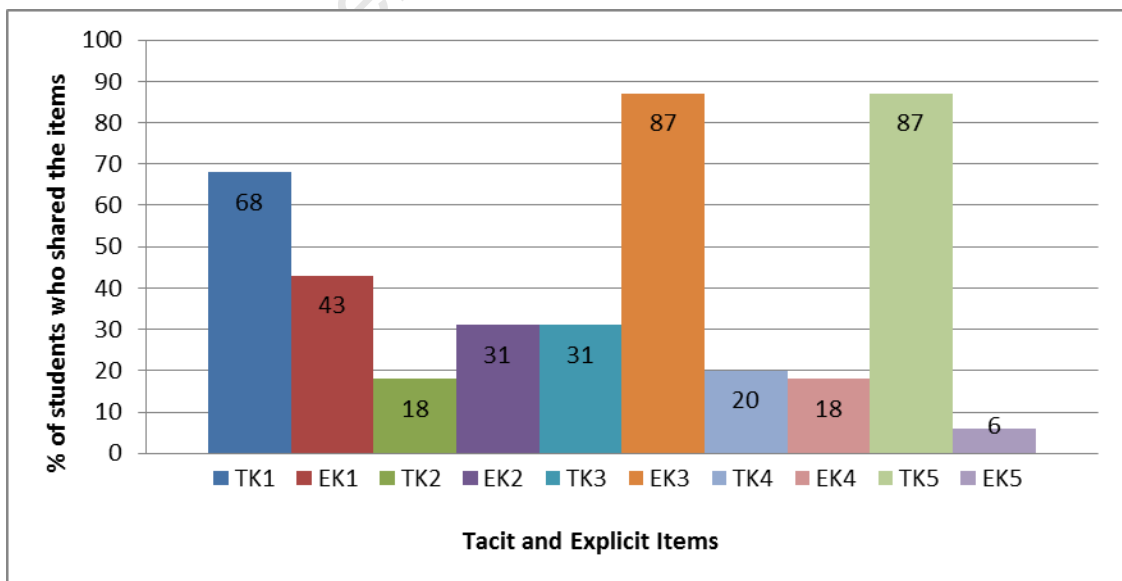


Figure 20: Tacit and Explicit Knowledge Measures in Psychology

Overall, students shared more tacit than explicit knowledge using their mobile phones and therefore the researcher can safely reject Hypothesis 1.

4.8.2 Hypothesis 2

In a mobile environment, the more tacit knowledge shared by students, the greater their project performance.

This was tested by determining the significance of the differences between student scores on tacit knowledge and performance. It was expected that students who shared more of the tacit knowledge items measured, would also obtain better performance results. Only those students who shared all the six tacit knowledge items were considered in this test (i.e. students who scored 4 and above on TK1-TK6).

The researcher conducted t-tests to compare the mean scores on tacit knowledge (TK) and performance. The results in Tables 15 indicate that the differences are significant in the different departments except for Psychology.

Table 15: T-test Results Comparing Tacit Knowledge and Performance Mean Scores

Department	Group 1 vs. Group 2	Mean Group 1	Mean Group 2	t-value	df	p
Computer Science	TK vs. Performance	4.60	3.60	2.98	8	0.0174
Civil Engineering	TK vs. Performance	4.60	3.60	2.98	8	0.0174
Information Systems	TK vs. Performance	4.63	3.85	3.08	26	0.0047
Psychology	TK vs. Performance	3.28	3.28	0.02	30	0.9827
All Departments	TK vs. Performance	4.61	3.82	4.06	38	0.0002

The combined result (i.e. for all departments) was also significant ($p = 0.0002$). This confirms that sharing of tacit knowledge ensures better performance. Hence Hypothesis 2 is supported as predicted by (Somech & Bogler, 1999; Wagner & Sternberg, 1990).

In summary:

Table 16: Summary of Research Findings

Hypothesis	Results	Outcome
H1	In a mobile environment, students will share more explicit than tacit knowledge	<i>Not Supported</i>
H2	In a mobile environment, the more tacit knowledge shared by students, the greater their project performance	<i>Supported</i>

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study investigated the extent to which students participating in group projects, shared tacit knowledge using mobile phones and whether they achieved better performance or results. The results revealed that students who used mobile phones to share tacit knowledge achieved better project performance. However, most students do not share tacit knowledge using mobile phones. IS (Information Systems) students shared tacit knowledge more than students in CS (Computer Science), CE (Civil Engineering) and PSY (Psychology). They also performed better as indicated above thereby supporting the observation by Somech and Bogler (1999) that students with high tacit knowledge achieved significantly higher grades than those with low tacit knowledge. The study revealed that CE students shared the least of the tacit knowledge measured in the present study.

The researcher further looked at the relationship between discipline and tacit knowledge sharing in a mobile environment. The outcome indicated that while a discipline may influence sharing of tacit knowledge of type TK1 (discuss project tasks and allocation of responsibilities) and TK2 (theoretical knowledge), it does not influence the sharing of knowledge through seeking clarification or advice from professors (TK3). Therefore, the lack of tacit knowledge sharing observed in non-(IS) disciplines could be attributed to factors other than the nature of these disciplines.

The mobile phone was discovered to be a fast and convenient communication tool among students in group projects. From all the disciplines surveyed, the most used feature was SMS (short messaging service) although sometimes students called and also used electronic mail. This research confirms that mobile phones can be leveraged to share tacit knowledge and play a crucial role in enhancing learning and group project performance in academic disciplines. The second hypothesis which tested this relationship was supported.

5.2 Limitations of the Research

This research has however some limitations. The researcher could not obtain actual student grades from all the departments and as such caution should be exercised when interpreting the results. In addition, the findings of this research should have been compared to that of a control group consisting of students who do not use mobile technology to share tacit knowledge. This would have assisted in establishing exactly whether the improvement in performance of the students was as a result of the use of mobile phones or not.

Lack of functionality on mobile phones possessed by students might have influenced knowledge sharing. Some phones had limited storage and display capabilities which made it difficult to retrieve lengthy messages. Therefore, knowledge conceptualization, organisation and representation on the mobile phone might have been difficult for some students than for others which could also affect the results of this study.

5.3 Recommendations

5.3.1 Policy and Practice

This research highlights the dangers of relegating tacit knowledge to the background. Despite its importance, most students do not share it, suggesting limited understanding of its significance. The fact that there has not been much emphasis or a commonly agreed framework to address m-learning issues at this institution, may have impacted on the development of m-learning methods. Since there is much to benefit from the use of mobile technology in sharing tacit knowledge, educators are encouraged to embark on such projects. This will enable learners to improve their ability to make judgments and manage themselves, other people and their tasks effectively.

The present study did not examine how learning in groups in a mobile environment may be assessed. Assessment of learning should not only be conducted at the end of the learning period (e.g. by measuring students' final performance). It would be appropriate to keep track of the learning process as it takes place. Singh (2003) argues that learning models need to transform into context-driven, task-sensitive and performance support models. M-

learning takes place anywhere and at any time which makes it difficult to follow-up on students' achievement. Therefore if m-learning is the way to go, research into how this may be evaluated on a continuous basis would be useful.

The limitations of the mobile device also impact on the effectiveness of learning and sharing of knowledge. Mobile phone service providers should work on ensuring a reduction in call rates. Students in PSY, for instance, mainly share knowledge through discussions and these cannot be sustained at the existing high call rates. There are also limitations relating to the size of the screen, low resolution which could damage users' sight and mobile input constraints (size of the keyboard, time taken to switch from number input mode to letters, difficulties in browsing materials, etc.). All these prevent users from transcribing knowledge or accessing it. While it is understandable that the size of the instrument cannot be too large, improvements in some of these areas can make a difference. These limitations must be seriously considered by the mobile and service providers as they do not limit m-learning only but general acceptance of the mobile technology.

5.3.2 Future Research

This study should be repeated using actual student grades instead of students' self-assessment of performance. It would also be interesting to know if the improvements in performance were really as a result of leveraging mobile phones or other factors not studied. A control group consisting of students not using mobile phones should be used to test this assumption.

Furthermore, a longitudinal research could also yield better results since this would ensure collection of data over a longer time period. This is important since in some disciplines students conduct their projects in the second semester and some post-graduate projects could also last longer than the duration of a semester.

This research has been useful in shading more light on sharing of tacit knowledge using mobile technology in academia. The researcher believes that learners, academics and the industry have much to learn from its findings.

REFERENCES

- Alavi, M., & Leidner, D. E. (1999). Knowledge management systems: Issues, challenges and benefits. *Communications of the Association for Information Systems Journal*, 1(7), 1-37.
- Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107-136.
- Alvesson, M., & Willmott, H. C. (1992). *Critical management studies*. London: Sage
- Amin, A. K., Kersten, B., Kulyk, O. A., Pelgrim, E., Wang, J., & Markopoulos, P. (2005). The SenseMS: Enriching the SMS experience for teens by non-verbal means. *Proceedings of the 7th International Conference on Human Computer Interaction with Mobile Devices & Services, 19-22 September 2005* (pp. 161-166). Salzburg: ACM.
- Argote, L. (1999). *Organizational learning: Creating, retaining and transferring knowledge*. Boston, MA: Kluwer Academic.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.
- Baptiste, I. (2001). *Qualitative data analysis: Common phases, strategic differences*. Retrieved September 18, 2010, from <http://www.qualitative-research.net/fqs/fqs-eng.htm>
- Benta, K. L., Cremene, M., & Padurean, R. (2004). Multimedia m-learning using mobile phones. In J. Attewell, & C. Smith-Savill (Eds.), *Mobile learning anytime everywhere: A book of papers from MLEARN* (pp. 27-28). London: Learning and Skills Development. Retrieved April 23, 2010, from http://elearning.typepad.com/thelearnedman/mobile_learning/reports/mLearn04_papers.pdf
- Bierly, P. E., Kessler, E. H., & Christensen, E. W. (2000). Organizational learning, knowledge and wisdom. *Organizational Change Management*, 13(6), 595-618.
- Braganza, A. (2004). Rethinking the data-information-knowledge hierarchy: Towards a case-based model. *Information Management*, 24(4), 347-356.
- Brown, I., & Russell, J. (2007). Radio frequency identification technology: An exploratory study on adoption in the South African retail sector. *Information Systems Journal*, 27(4), 25-265.
- Burdett, J. (2006). Degrees of separation-Balancing intervention and independence in group work. *Australian Educational Researcher*, 34(1), 55-71.

- Burdett, J., & Hastie, B. (2009). Predicting satisfaction with group work assignments. *University Teaching and Learning Practice Journal*, 6(1), 62-71.
- Calongne, C. M. (2008). Educational frontiers: Learning in a virtual world. *Educause Review Magazine*, 43(5), 36-48.
- Cavana, R. Y., Delahaye, B. R., & Sekaran, U. (2001). *Applied business research: Qualitative and quantitative methods* (3rd ed.). Australia: John Wiley.
- Chambliss, D. F., & Schutt, R. K. (2010). *Making sense of the social world. Methods of investigation*. USA: Sage.
- Chan, M. F., Day, M. C., & Chan, S. K. (2005). Perinatal bereavement: A quantitative study. *British Journal of Midwifery*, 13(8), 516-521.
- Chapman, K. J., Meuter, M., Toy, D., & Wright, L. (2006). Can't we pick our own groups? The influence of group selection method on group dynamics and outcomes. *Management Education*, 30(4), 557-569.
- Cheng, H., Lu, Y-C., & Sheu, C. (2009). An ontology-based business intelligence application in a financial knowledge management system. *Expert Systems with Applications*, 36(2), 3614-3622.
- Chung, F. L. (2001). An analysis of Taiwan's distribution system. *Retail and Distribution Management*, 29(2), 87-98.
- Clark, B. R. (1984). The organizational conception. In B. R. Clark (Eds.). *Perspectives on higher education* (pp. 106-131). Berkeley: University of California Press.
- Cohen, W., & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly Journal*, 35(1), 128-152.
- Concannon, F., Flynn, A., & Campbell, M. (2005). What campus-based students think about the quality and benefits of e-learning. *Educational Technology*, 36(3), 501-512.
- Cooper, D. R., & Schindler, P. S. (2003). *Business research methods*. MA: McGraw-Hill/Irwin.
- Cousins, P. D. (2002). A conceptual model for managing long-term inter-organisational relationships. *Purchasing & Supply Management*, 8(2), 71-82.
- Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.
- Cross, M., & Adam, F. (2007). ICT policies and strategies in higher education in South Africa: National and institutional pathways. *Higher Education Policy Journal*, 20(1), 73-95.

- Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage.
- Davenport, T. H. (1997). *Information ecology*. New York, NY: Oxford University Press.
- Davenport, T. H., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Cambridge, MA: Harvard Business School Press.
- Denning, P. J., Comer, D. E., Gries, D., Mulder, M. C., Tucker, A., Turner, A. J., & Young, P. R. (1989). Computing as a discipline. *Communications of the ACM*, 32(1), 9-23.
- Denzin, N. K., & Lincoln, Y. S. (2000). Introduction: The discipline and practice of qualitative research. In N. K. Denzin, & Y. S. Lincoln (Eds.). *Handbook of qualitative research* (pp. 21-29). Thousand Oaks, CA: Sage.
- Dhanaraj, C., Lyles, M. A., Steensma, H. K., & Tihanyi, L. (2004). Managing tacit and explicit knowledge transfer in IJVs: The role of relational embeddedness and the impact on performance. *International Business Studies*, 35(5), 428-42.
- Disterer, G. (2002). Management of project knowledge and experiences. *Knowledge Management*, 6(5), 512-520.
- Dourish, P. (2001). Seeking a foundation for context-aware computing. *Human-Computer Interaction*, 16(2), 229-241.
- Dretske, F. (1981). *Knowledge and the flow of information*. Cambridge MA: MIT Press.
- Fabry, D. L., & Higgs, J. R. (1997). Barriers to the effective use of technology in education: Current status. *Educational Computing Research Journal*, 17(4), 385-395.
- Faucher, J., Everett, A., & Lawson, R. (2008). Reconstituting knowledge management. *Knowledge Management*, 12(3), 3-16.
- Fernie, S., Green, S. D., Weller, S. J., & Newcomb, R. (2003). Knowledge sharing: Content, confusion and controversy. *Project Management*, 21(3), 177-187.
- Fischer, G., & Ostwald, J. (2001). Knowledge management: Problems, promises, realities, and challenges. *IEEE Intelligent Systems Journal*, 16(1), 60-72.
- Fitzgerald, B., & Howcroft, D. (1998). Towards dissolution of the IS research debate: 351 from polarisation to polarity. *Information Technology Journal*, 13(4), 313-326.
- Foray, D., & Hargreaves, D. H. (2003). The production of knowledge in different sectors: A model and some hypothesis. *London Review of Education Journal*, 1(1), 7-19.

- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Marketing Research Journal*, 18(1), 39-50.
- Foster, J. D. G., Masoso, O. T., Sebusang, S. E. M., & Uys, P. M. (2002). *A Study of how engineering students share learning*. Retrieved March 19, 2011, from <http://www.globe-online.com/philip.uys/200209uysengineeringstudentssharelearning.htm>
- Freeman, K. A. (1996). Attitudes towards work in project groups as predictors of academic and performance. *Small Group Research*, 27(2), 265-282.
- Gadamer, H. G. (1976a). *Philosophical hermeneutics*. California: University of California Press.
- Gardner, D. G., Dukes, R. L., & Discenza, R. (1993). Computer use, self-confidence and attitudes: A causal analysis. *Computers in Human Behaviour*, 9(4), 427-440.
- Gebert, H., Geib, M., Kolbe, L., & Brenner, W. (2003). Knowledge-enabled customer relationship management: Integrating customer relationship management and knowledge management concepts. *Knowledge Management*, 7(5), 107-123.
- Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Technology Education*, 7(1), 22-30.
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin, & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). Thousand Oaks, CA: Sage.
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis*. New Jersey: Pearson Prentice Hall.
- Hall, H. (2001b). Social exchange for knowledge exchange: Managing knowledge conversions and critiques. *Proceedings of the International Conference on Managing Knowledge: Conversations and Critiques, 10-11 April 2001* (pp. 1-23). Edinburgh, University of Leicester Management Centre. Retrieved September 15, 2010, from http://www.bim.napier.ac.uk/esis/about_us/hazel_publications.html
- Hammond, N., & Bennett, C. (2002). Discipline differences in role and use of ICT to support group based learning. *Computer Assisted Learning Journal*, 18(1), 55-63.
- Hansen, R. S. (2006). Benefits and problems with student teams: Suggestions for improving team projects. *Education for Business*, 82(1), 11-19.
- Hattangdi, A., & Gosh, A. (2008). *Enhancing the quality and accessibility of higher education through the use of information and communication technologies*. Retrieved February

9, 2011, from <http://phs-ict-as.wikidot.com/the-benefits-and-drawbacks-of-ict-in-education>

- Hejazinia, M. & Razzazi, M. R. (2010). Providing data grid capability using society network on mobile phones. *Journal of Applied Collaborative Systems*, 2(1), 5-15.
- Hendrickson, C., & Au, T. (1989). *Project management for construction: Fundamental concepts for owners, engineers, architects, and builders*. Pittsburgh, Prentice Hall.
- Hildrum, J. M. (2009). Sharing tacit knowledge online: A case study of e-learning in Cisco's network of system integrator partner firms. *Industry and Innovation*, 16(2), 197-218.
- Hirschheim, R. A. (1992). Information systems epistemology: An historical perspective. In R. Galliers (Eds.), *Information systems research: Issues, methods and practical guidelines* (pp. 28-60). London: Blackwell Scientific.
- Hirschheim, R., & Klein, H. K. (1994). Realizing emancipatory principles in information systems development: The case for ethics. *MIS Quarterly*, 18(1), 83-109.
- Hlupic, V., Pouloudi, A., & Rzevski, G. (2002). Towards an integrated approach to knowledge management: Hard, soft and abstract issues. *Knowledge and Process Management*, 9(2), 90-102.
- Howells, J. (1996). Tacit knowledge, innovation and technology transfer. *Technology Analysis and Strategic Management*, 8(2), 91-106.
- Jacobson, D. (2009). *Unlocking tacit knowledge with social networking*. *Technology Trends in Business and Society*. Retrieved March 16, 2011, from <http://www.pwc.com/ca/en/emerging-company/tacit-knowledge-social-networking.ihtml>
- Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Co.
- Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory in Practice Journal*, 38(2), 66-73.
- Jones, A., & Issroff, K. (2007). Motivation and mobile devices: Exploring the role of appropriation and coping strategies. *Association for Learning Technology Journal*, 15(3), 247-258
- Joshi, K. D., Sarker, S., & Sarker, S. (2007). Knowledge transfer within information systems development teams: Examining the role of knowledge source attributes. *Decision Support Systems*, 43(2), 322-335.

- Kekwaletswe, R. M. (2007). *Knowledge transformation in a mobile learning environment. An interpretive inquiry of ubiquitous context and social presence awareness*. Doctoral dissertation, South Africa, University of Cape Town.
- Kaplan, B., & Maxwell, J. A. (1994). *Qualitative research methods for evaluating computer information systems, in evaluating health care information systems: Methods and applications*. Thousand Oaks, CA: Sage.
- Kayem, A. (2011). *Using mobile phone capabilities: Voice, sms, photo and video to report crime activities or law infringements anonymously*. Retrieved July 19, 2011, from http://www.cs.uct.ac.za/teaching/honours/Honours%20Projects%20Offered%202011.html#_Toc287335620
- Kenshi, M. (2006). *Knowledge Transfer in management of department stores: Centering on transfer of "buyers manual" and "MD notes"*. Retrieved November 17, 2010, from http://merc.e.u-tokyo.ac.jp/mmrc/dp/pdf/MMRC102_2006.pdf
- Kim, S. H., Mims, C., & Holmes, K. P. (2006). An Introduction to current trends and benefits of mobile wireless technology use in higher education. *Association for the Advancement of Computing in Education (AACE)*, 14(1), 77-100.
- Kindberg, T., Spasojevic, M., Fleck, R., & Sellen, A. (2005). The ubiquitous camera: An in-depth study on camera phone use. *Pervasive Computing*, 4(2), 42-50.
- Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23(1), 67-94.
- Koole, M. L. (2009). A model for framing mobile learning. In M. Ally (Eds.), *Mobile learning: Transforming the delivery of education and training* (pp. 25-47). Athabasca, AB: Athabasca University Press.
- Koskinen, K. U., Philanto, P., & Vanharanta, H. (2003). Tacit knowledge acquisition and sharing in a project work context. *Project Management*, 21(4), 281-290.
- Kozma, R. (2005). National policies that connect ICT-based education reform to economic and social development. *Human Technology*, 1(2), 117-156.
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behaviour*, 19(3), 335-353.
- Kukulska-Hulme, A., & Traxler, J. (2005). *Mobile learning: A handbook for educators and trainers*. New York: Routledge.

- Kukulka-Hulme, A., & Traxler, J. (2007). Designing for mobile and wireless learning. In H. Beetham, & R. Sharpe (Eds.), *Rethinking pedagogy for a digital age: Designing and delivering e-learning* (pp. 180-192). London: Routledge.
- Kwan, M. M., & Cheung P. K. (2006). The knowledge transfer process: From field studies to technology development. *Database Management Journal*, 17(1), 16-32.
- Lam, M. (2008). *Learn while doing: Applying team based learning in a finance course*. MA: Salem State College Press.
- Lee, A. S. (1991). Integrating positivist and interpretive approaches to organizational research. *Organization Science*, 2(4), 342-365.
- Levine, L. M. (2002). Campus-wide mobile wireless: Mobility and convergence. *Syllabus*, 16(3), 14-18.
- Li, X., & Wang, T. (2007). Knowledge management in mobile environment. *Networking and Virtual Organisations Journal*, 4(3), 229-244.
- Lieng, F. H. H., Hii, L., & Lee, G. C. (2009). *Collaborative learning: A way to engage student learning*. *Teaching & learning open forum*. Retrieved October 16, 2010, from www.curtin.edu.my/TLForum2009/fullpaper.html
- Liikanen, J., Stoneman, P., & Toivanen, O. (2002). Intergenerational effects in the diffusion of new technology: Case of mobile phones. *Industrial Organization*, 22(8-9), 1137-1154.
- Liss, K. (1999). Do we know how to do that? Understanding knowledge management. *Harvard Management Update*, February, 1-4.
- Mahdizadeh, H., Biemans, H., & Mulder, M. (2008). Determining factors of the use of e-learning environments by university teachers. *Computers & Education*, 51(1), 142-154.
- Maiye, A., & McGrath, K. (2010). ICTs and sustainable development: a capability perspective. *Proceedings of the 16th Americas Conference on Information Systems, 12-15 August 2010* (pp.1-15). Lima, Peru. Retrieved April 29, 2011, from <http://aisel.aisnet.org/amcis2010/541>
- Majchzak, A., Rice, R., King, N., Malhotra, A., & Ba, S. (2000). Computer-mediated inter-organizational knowledge-sharing: Insights from a virtual team innovating using a collaborative tool. *Information Resources Management*, 13(1), 44-53.
- Maskell P., & Malmberg A. (1999). Localized learning and industrial competitiveness. *Cambridge Journal of Economics*, 23(2), 167-18.

- Mayring, P. (2000). Qualitative content analysis. *Qualitative Social Research*, 1(2), 1-28. Retrieved August 25, 2010, from <http://217.160.35.246/fgs-texte/2-00/2-00mayring-e.pdf>.
- McCorkle, D. E., Reardon, J., Alexander, J. F., Kling, N. D., Harris, R. C., & Vishwanathan, I. (1999). Undergraduate marketing students, group projects and teamwork: The good, the bad and the ugly. *Marketing Education*, 21(2), 106-117.
- McFarlane, A., & Sakellariou, S. (2002). The role of ICT in science education. *Cambridge Journal of Education*, 32(2), 219-232.
- McGhee, R., & Kozma, R. (2003). *New teacher and student roles in the technology-supported classroom*. Retrieved November 23, 2010, from <http://edtechcases.info/papers/teacherstudentroles.pdf>
- McKenzie, J. S. (2001). The unwired classroom: Wireless computers come of age. *Educational Technology*, 10(4). Retrieved August 21, 2010, from <http://www.fno.org/jan01/wireless.html>
- Miles, M., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage Publications.
- Mooij, T. (2007). Design of educational and ICT conditions to integrate differences in learning: Contextual learning theory and a first transformation step in early education. *Computers in Human Behaviour*, 23(3), 1499-1530.
- Moteleb, A., & Woodman, M. (2007). Notions of knowledge management systems: A gap analysis. *Electronic Journal of Knowledge Management (eJKM)*, 5(1), 55-62.
- Myers, M.D (1997). Qualitative research in information systems. *MIS Quarterly*, 21(2), 241-242.
- Myers, M. (2009). *Qualitative research in business and management*. SAGE Publications.
- Myers, M. D., & Avison, D. E. (2002). *Qualitative research in information systems: A reader*. London: Sage.
- Neuman, W. (2000). *Social research methods: Qualitative and quantitative approaches*. Needham Heights: Allyn & Bacon.
- Nicholas, J., & Miller, R. (1994). Cooperative learning and student motivation. *Contemporary Educational Psychology Journal*, 19(2), 167-178.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organizational Science*, 5(1), 14-37.

- Nonaka, I., & Konno, N. (1998). The concept of “Ba”: Building a foundation for knowledge creation. *California Management Review Journal*, 40(3), 116-132.
- Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford: Oxford University Press.
- Norris, D., Mason, J., Robson, R., Lefrere, P., & Collier, G. (2003). A revolution in knowledge sharing. *EduCause Review* 38(5), 14-26. Retrieved April 28, 2011, from www.educause.edu/ir/library/pdf/erm0350.pdf
- Oliver, R. (2002). *The role of ICT in higher education for the 21st century: ICT as a change agent for education*. Retrieved January 22, 2011, from <http://elrond.scam.ecu.edu.au/oliver/2002/he21.pdf>
- O'Malley, C. O., Vavoula, G., Glew, J. P., Taylor, J., Sharples, M., & Lefrere, P. (2003). *Guidelines for Learning in a Mobile Environment. Mobilelearn Project*. Retrieved May 10, 2010, from http://www.mobilelearn.org/download/results/public_deliverables/MOBilelearn_D41_Final.pdf
- Orlikowski, W. J. (1992a). The duality of technology: Rethinking the concept of technology in organizations. *Organization Science*, 3(3), 398-427.
- Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science*, 11(4), 404-428.
- Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: research approaches and assumptions. *Information Systems Research Journal*, 2(1), 1-28.
- Pinsonneault, A., & K. L. Kraemer (1993). The survey research strategy in studies of information systems: Review and critique. *Management Information Systems Journal*, 10(2), 75-106.
- Polanyi, M. (1966a). *The tacit dimensions*. Garden City, NY: Doubleday.
- Popovici, D. M., & Marhan, A. M. (2008). Virtual reality-based environments for learning and training. In D. Talaba, & A. Amditis (Eds.). *Virtual reality: Applications and tools for intelligent manufacturing systems* (pp.123-140). Springer Verlag.
- Prensky, M. (2004). *What can you learn from a cell phone? Almost anything*. Retrieved January 1, 2011, from [http://innovateonline.info/pdf/vol1_issue5/What Can You Learn from a Cell Phone Almost Anything!.pdf](http://innovateonline.info/pdf/vol1_issue5/What_Can_You_Learn_from_a_Cell_Phone_Almost_Anything!.pdf)
- Prensky, M. (2008). Turning on the lights. *Educational Leadership*, 65(6), 40-45.

- Puikkonen, A. M., Hakkila, J., Ballagas, R., & Mantyjarvi, J. (2009). Practices in creating videos with mobile phones. *Proceedings of the 11th International Conference on Human Computer Interaction with Mobile Devices and Services, 15-18 September 2009* (pp. 1-10). Bonn, Germany, ACM.
- Ragunath, P., K., Velmourougan, S., Davachelvan, P., Kayalvizhi, S., & Ravimohan, R. (2010). Evolving a new model (SDLC model-2010) for software development life cycle (SDLC). *Computer Science and Network Security, 10*(1), 112-119.
- Reynoldson, C., & Vibert, C. (2005). Technology enabled business education- breaking down the boundaries between the academy and business. *Proceedings of the 5th Frontiers of E-Business Research Conference* (pp. 232-250). Tampere, Finland. Retrieved March 17, 2011, from www.ebrc.fi/kuvat/232-250_05.pdf
- Roberts, J. (2000). From know-how to show-how: questioning the role of information and communication technologies in knowledge transfer. *Technology Analysis and Strategic Management, 12*(4), 429-443.
- Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Information Science, 33*(2), 163-180.
- Salter, A. J., & Gann, D. M. (2003). Source of ideas for innovation in engineering design. *Research Policy Journal, 32*(8), 1309-1324.
- Saunders, M., Lewis, P., & Thornhill, A. (2003). *Research methods for business students*. England: Pearson Education Ltd.
- Seewoonauth, K., Rukzio, E., Hardy, R., & Holleis, P. (2009). Touch & connect and touch & select: Interacting with a computer by touching it with a mobile phone. *Proceedings of the Mobile Human Computer Interaction Conference, 15-18 September 2009* (pp.1-4). Bonn, Germany: ACM.
- Sekaran, U. (2003). *Research methods for business: A skill building approach* (4th ed.). New York: John Wiley.
- Shanks, G. (2002). Guidelines for conducting positivist case study research in information systems. *Information Systems, 10*(1), 76-85.
- Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. In H. van der Merwe, & T. BrownT. *Mobile Technology: The Future of Learning in Your Hands, mLearn 2005 Book of Abstracts. Proceedings of the 4th World Conference on mLearning, 25-28 October 2005* (p. 58). Cape Town, South Africa. Retrieved November 17, 2010, from <http://www.mlearn.org.za/CD/papers/Sharples-%20Theory%20of%20Mobile.pdf>

- Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornthwaite (Eds.), *The Sage handbook of e-learning research* (pp. 221-247). London: Sage.
- Shen, J. (2003). Utilizing mobile devices to capture case stories for knowledge management. In *CHI '03: CHI'03 Extended Abstracts on Human Factors in Computing Systems*, (pp. 688–689). New York, USA. ACM Press.
- Shongwe, M. M. (2009). *Investigating the extent to which mobile phones minimize knowledge transfer barriers in student project teams*. Unpublished master's thesis, University of Cape Town, Cape Town, South Africa.
- Silver, D. L., & Shakshuki, E. (2002). Knowledge management: Integrating perspectives. *Proceedings of I-KNOW'02 the 2nd International Conference on Knowledge Management, 11-12 July 2002* (pp. 254-259). Graz, Austria: In K. Tochtremann, & H. Mauer (Eds.). Special Issue of J.UCS.
- Singh H. (2003). *Leveraging mobile and wireless internet*. Retrieved July 16, 2011, from <http://www.learningcircuits.com/2003/sep2003/singh.htm>
- Skyrme, D. (1998) *Knowledge management solutions: The IT contribution*. Retrieved June 17, 2011, from <http://www.skyrme.com/pubs/acm0398.doc>
- Slavin, R. (1990). *Cooperative learning: Theory, research and practice*. Hillsdale, NJ: Prentice-Hall.
- Somech, A., & Bogler, R. (1999). Tacit knowledge in academia: Its effects on student learning and achievement. *Psychology Journal*, 133(6), 605-616.
- Soller, A. L. (2001). Supporting social interaction in an intelligent collaborative learning system. *Artificial Intelligence in Education*, 12(1), 40-62.
- Stenmark, D. (2001). Leveraging tacit organisational knowledge. *Management Information Systems*, 17(3), 9-24.
- Stenmark, D. (2002). Information vs. knowledge: The role of intranets in knowledge management. *Proceedings of the 35th Hawaii International Conference on System Sciences (HICSS-02), 7-10 January 2002* (pp. 1-10). Hawaii, USA: IEEE Press.
- Sternberg, R. J. & Wagner, R. K. (1986). *Practical intelligence: Nature and origins of competence in the everyday world*. New York: Academic Press.
- Sternberg, R. J., & Wagner, R. K. (1989). Individual differences in practical knowledge and its acquisition. In P. Ackerman, R. J. Sternberg, & R. Glaser (Eds.), *Learning and individual differences* (pp. 255–278). New York: Freeman.

- Sternberg, R. J., Okagaki, L., & Jackson, A. S. (1990). Practical intelligence for success in school. *Educational Leadership*, 48(1), 35-39.
- Sternberg, R. J., Wagner, R. K., & Okagaki, L. (1993). Practical intelligence: The nature and role of tacit knowledge in work and at school. In H. Reese, & J. Puckett (Eds.), *Advances in lifespan development* (pp. 205-227). Hillsdale, NJ: Erlbaum.
- Sternberg, R. J., Wagner, R. K., Williams, W. M., & Horvath, J. A. (1995). Testing common sense. *American Psychologist*, 50(11), 912-927.
- Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage
- Suchman, L. (1983). Office procedure as practical action: Models of work and system design. *ACM Transactions on Office Information Systems*, 1(4), 320-328.
- Suchman, L. (1987). *Plans and situated action: The problem of human machine communication*. Cambridge: Cambridge University Press.
- Swap, W., Leonard, D., Schields, M., & Abrams, L. (2001). Using mentoring and storytelling to transfer knowledge on the workplace. *Management Information Systems*, 18(1), 95-114.
- Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management*, 17(Winter special), 27-43.
- Taylor, A. S., & Harper, R. (2003). The gift of the gab: A design oriented sociology of young people's use of mobiles. *Journal of Computer Supported Cooperative Work*, 12(3), 267-296.
- Tazari, M., Windlinger, L., & Hoffmann, T. (2005). Knowledge management requirements of mobile work on information technology. In *Mobile Work Employs IT (MOWeIT'05) Prague*.
- Thagard, P. (2005). *Mind: Introduction to cognitive science*. MIT Press, Cambridge, MA.
- Thomas, D. R. (2003). *A general inductive approach for qualitative data analysis*. Auckland, New Zealand: University of Auckland.
- Thornton, R. (2009). The transmission of knowledge in South African traditional healing. *International African Institute*, 79(1), 17-34.
- Tuomi, I. (2000). Data is more than knowledge: Implications of the reversed knowledge hierarchy for knowledge management. *Management Information Systems*, 16(3), 103-117.

- Utulu, S. A., Alonge, A., & Emmanuel, O. (2010). Use of mobile phones for project based learning by undergraduate students of Nigerian private universities. *Proceedings of Informing Science & IT Education Conference (InSITE)*.
- Valk, J., Rashid, A. T., & Elder, L. (2010). Using mobile phones to improve educational outcomes: An analysis of evidence from Asia. *Open and Distance Learning, 11(1)*, 117-140.
- Wagner, R. K., & Sternberg, R. J. (1990). Street smarts. In K. E. Clark, & M. B. Clark (Eds.), *Measures of leadership* (pp. 493-504). West Orange, NJ: Leadership Library of America.
- Walsham, G. (1993). *Interpreting information systems in organizations*. Chichester: Wiley.
- Weininger, M. J., & Shield, L. (2001). Orality in MOO: Rehearsing speech in text. A preliminary study. In K. Cameron (Eds.), *The challenge of change* (pp. 89-96). Exeter: Elm Bank.

University of Cape Town

APPENDIX A: COMPUTER SCIENCE QUESTIONNAIRE

Introduction

The objective of this study is to investigate the extent to which students share tacit knowledge¹ using mobile phones in group projects. The researcher would like to know whether students who share tacit knowledge achieve higher performance in project tasks than those who are low in tacit knowledge. The questionnaire also contains questions about explicit knowledge².

Section A: General Questions

This section comprises of general questions about the respondent. The questions are specifically about you and the project you are currently undertaking.

1. Which faculty are you in? _____
2. Which department are you in? _____
3. Gender (**Put an X on the most appropriate answer**)

Female	<input type="checkbox"/>	Male	<input type="checkbox"/>
--------	--------------------------	------	--------------------------

Section B: Project Details

This section consists of questions about the project.

1. Which project are you doing/ have you done before? _____
2. How many members does your group possess? _____
3. Who allocates individuals into project teams? _____

Section C: Tacit Knowledge

This section consists of tacit knowledge shared by students in Computer Science.

	The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.	1	2	3	4	5
CS1	Discuss project tasks and allocation of responsibilities					
CS2	Share knowledge on the theoretical principles of algorithm development (using e.g. Java, C++ or Python number systems)					
CS3	We seek clarification from professors/lecturers about project issues					
CS4	We share knowledge on the application of artificial intelligence, 3D graphics and game programming					
CS5	We share knowledge on application of intelligent systems, digital libraries and extensible mark-up languages (XML)					
CS6	We share knowledge of data structures, computer networks and compilers					
CS7	Peers discuss aspects of human computer interaction, computer architecture and database systems					
CS8	We share knowledge on how to measure the sense of presence, immersion and flow in virtual environments (VEs)					

¹ Tacit knowledge is knowledge possessed by an individual and derived from experiences while embedded in beliefs and morals.

² Explicit knowledge is recorded in form of symbols drawings, writings, scientific formulas or calculations.

Section D: Explicit Knowledge

This section consists of explicit knowledge questions.

The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.		1	2	3	4	5
CS1	Ideas and suggestions are expressed in SMS and MMS and shared with group members					
CS2	We share knowledge expressed in form of instant messaging					
CS3	We share knowledge expressed in e-mail					
CS4	We share knowledge expressed in pictures, graphs, charts or codes					
CS5	Group members exchange knowledge recorded in video clips					

Section E: Mobile Phone

This section consists of questions concerning the mobile phone. **(Please answer all questions).**

1. What purpose does your mobile phone serve in group projects?

2. Which functions does your mobile phone have?

3. Which functions do you use regularly to communicate with team members?

4. How does the mobile phone assist in the transfer of project information?

5. Does the mobile phone enhance your project performance? Explain.

Section F: Outcome of Group Projects

The questions in this section give an overview of the performance and outcome of the group.

Put an X on the most appropriate answer					Yes	No
1	Have you completed your group project?					
If yes answer question 2 and 3, If no answer question 3 and 4.						
2	Which mark did you get for the completed project?	Less than 50%	50-60%	61-70%	71-80%	80% and above
3	How do you rate your group project performance?	Poor	Fair	Good	Very Good	Excellent
4	How do you rate the performance of your project at the present moment?	Poor	Fair	Good	Very Good	Excellent

APPENDIX B: CIVIL ENGINEERING QUESTIONNAIRE

Introduction

The objective of this study is to investigate the extent to which students share tacit knowledge³ using mobile phones in group projects. The researcher would like to know whether students who share tacit knowledge achieve higher performance in project tasks than those who are low in tacit knowledge. The questionnaire also contains questions about explicit knowledge⁴.

Section A: General Questions

This section comprises of general questions about the respondent. The questions are specifically about you and the project you are currently undertaking.

1. Which faculty are you in? _____
2. Which department are you in? _____
3. Gender (**Put an X on the most appropriate answer**)

Female		Male	
--------	--	------	--

Section B: Project Details

This section consists of questions about the project.

1. Which project are you doing? _____
2. How many members does your group possess? _____
3. Who allocates individuals into project teams? _____

Section C: Tacit Knowledge

This section consists of tacit knowledge shared by students in Civil Engineering.

The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.		1	2	3	4	5
CE1	Discuss project tasks and allocation of responsibilities					
CE2	Discuss theoretical principles of mathematics, physics and drawings					
CE3	We seek clarification from professors/lecturers on project issues					
CE4	Discuss and analyze properties of various construction materials e.g. nature of soil, foundation design and waste treatment					
CE5	Share knowledge of basic survey operations and preparation of site plans					
CE6	Analyze pictures and compare populations					
CE7	Discuss calculations to determine optimal dimensions of facilities					
CE8	Evaluate detailed drawings and specifications to ensure projects are constructed to standards					

³ Tacit knowledge is knowledge possessed by an individual and derived from experiences while embedded in beliefs and morals.

⁴ Explicit knowledge is recorded in form of symbols drawings, writings, scientific formulas or calculations.

Section D: Explicit Knowledge

This section consists of explicit knowledge questions.

The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.		1	2	3	4	5
CE1	Ideas and suggestions are expressed in SMS and MMS and shared with group members					
CE2	We share knowledge expressed in form of instant messaging					
CE3	We share knowledge expressed in e-mail					
CE4	We share knowledge expressed in pictures, graphs, charts or codes					
CE5	Group members exchange knowledge recorded in video clips					

Section E: Mobile Phone

This section consists of questions concerning the mobile phone. **(Please answer all questions).**

1. What purpose does your mobile phone serve?

2. Which functions does your mobile phone have?

3. Which functions do you use regularly to communicate with team members?

4. How does the mobile phone assist in the transfer of project information?

5. Does the mobile phone enhance your project performance? Explain.

Section F: Outcome of Group Projects

The questions in this section give an overview of the performance and outcome of the group.

Put X on the most appropriate answer					Yes	No
1	Have you completed your group project?					
If yes answer question 2 and 3, If no answer question 3 and 4.						
2	Which mark did you get for the completed project?	Less than 50%	50-60%	61-70%	71-80%	80% and above
3	How do you rate your group project performance?	Poor	Fair	Good	Very Good	Excellent
4	How do you rate the performance of your project at the present moment?	Poor	Fair	Good	Very Good	Excellent

APPENDIX C: INFORMATION SYSTEMS QUESTIONNAIRE

Introduction

The objective of this study is to investigate the extent to which students share tacit knowledge⁵ using mobile phones in group projects. The researcher would like to know whether students who share tacit knowledge achieve higher performance in project tasks than those who are low in tacit knowledge. The questionnaire also contains questions about explicit knowledge⁶.

Section A: General Questions

This section comprises of general questions about the respondent. The questions are specifically about you and the project you are currently undertaking.

1. Which faculty are you in? _____
2. Which department are you in? _____
3. Gender (**Put an X on the most appropriate answer**)

Female		Male	
--------	--	------	--

Section B: Project Details

This section consists of questions about the project.

1. Which project are you doing/ have you done before? _____
2. How many members does your group possess? _____
3. Who allocates individuals into project teams? _____

Section C: Tacit Knowledge

This section consists of tacit knowledge shared by students in Information Systems.

	The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.	1	2	3	4	5
IS1	Discuss project tasks and allocation of responsibilities					
IS2	Share knowledge of underpinning theories of Information Systems					
IS3	We seek clarification from professors/lecturers about project issues					
IS4	Share knowledge of the basic components of Information Systems					
IS5	Share practical experience on using presentation tools, project planning tools, web-design applications or Microsoft Office					
IS6	Discuss the application of Information Systems in practical settings					
IS7	Share knowledge on how to use common tools of system analysis e.g. scoping, risk and feasibility assessment and prototyping					
IS8	We share practical knowledge and experience in design, development and management of Information Systems					

⁵ Tacit knowledge is knowledge possessed by an individual and derived from experiences while embedded in beliefs and morals.

⁶ Explicit knowledge is recorded in form of symbols drawings, writings, scientific formulas or calculations.

Section D: Explicit Knowledge

This section consists of explicit knowledge questions.

	The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.	1	2	3	4	5
IS1	Ideas and suggestions are expressed in SMS and MMS and shared with group members					
IS2	We share knowledge expressed in form of instant messaging					
IS3	We share knowledge expressed in e-mail					
IS4	We share knowledge expressed in pictures, graphs, charts or codes					
IS5	Group members exchange knowledge recorded in video clips					

Section E: Mobile Phone

This section consists of questions concerning the mobile phone. **(Please answer all questions).**

1. What purpose does your mobile phone serve in group projects?

2. Which functions does your mobile phone have?

3. Which functions do you use regularly to communicate with team members?

4. How does the mobile phone assist in the transfer of project information?

5. Does the mobile phone enhance your project performance? Explain.

Section F: Outcome of Group Projects

The questions in this section give an overview of the performance and outcome of the group.

	Put an X on the most appropriate answer	Yes	No
1	Have you completed your group project?		
	If yes answer question 2 and 3, If no answer question 3 and 4.		
2	Which mark did you get for the completed project?	Less than 50%	50-60%
3	How do you rate your group project performance?	Poor	Fair
4	How do you rate the performance of your project at the present moment?	Poor	Fair

APPENDIX D: PSYCHOLOGY QUESTIONNAIRE

Introduction

The objective of this study is to investigate the extent to which students share tacit knowledge⁷ using mobile phones in group projects. The researcher would like to know whether students who share tacit knowledge achieve higher performance in project tasks than those who are low in tacit knowledge. The questionnaire also contains questions about explicit knowledge⁸.

Section A: General Questions

This section comprises of general questions about the respondent. The questions are specifically about you and the project you are currently undertaking.

1. Which faculty are you in? _____
2. Which department are you in? _____
3. Gender (**Put an X on the most appropriate answer**)

Female	<input type="checkbox"/>	Male	<input type="checkbox"/>
--------	--------------------------	------	--------------------------

Section B: Project Details

This section consists of questions about the project.

1. Which project are you doing/ have you done before? _____
2. How many members does your group possess? _____
3. Who allocates individuals into project teams? _____
4. How do you communicate with group members? (**Put an X on the most appropriate answer**)

Email	<input type="checkbox"/>	Face-to-Face	<input type="checkbox"/>	Mobile	<input type="checkbox"/>	Telephone	<input type="checkbox"/>	Facebook	<input type="checkbox"/>	SMS	<input type="checkbox"/>
-------	--------------------------	--------------	--------------------------	--------	--------------------------	-----------	--------------------------	----------	--------------------------	-----	--------------------------

If other (**State**) _____

Section C: Tacit Knowledge

This section consists of tacit knowledge shared by students in Psychology.

	The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.	1	2	3	4	5
PSY1	Discuss project tasks and allocation of responsibilities					
PSY2	Discuss how the brain, mind and computer works (theoretical principles)					
PSY3	We seek clarification from professors/lecturers about project issues					
PSY4	Discuss how people think, remember, speak and solve problems					
PSY5	Share answers to understand requirements of projects					
PSY6	Discuss how people acquire, process and store information					
PSY7	We analyze practical applications for cognitive research					
PSY8	Discuss practical applications of cognitive science					

⁷ Tacit knowledge is knowledge possessed by an individual and derived from experiences while embedded in beliefs and morals.

⁸ Explicit knowledge is recorded in form of symbols drawings, writings, scientific formulas or calculations.

Section D: Explicit Knowledge

This section consists of explicit knowledge questions.

	The ratings and scores are as follows: Strongly disagree = 1, Disagree = 2, Neither disagree nor agree = 3, Agree = 4, Strongly agree = 5. Put an X on the most appropriate answer.	1	2	3	4	5
PSY1	Ideas and suggestions are expressed in SMS and MMS and shared with group members					
PSY2	We share knowledge expressed in form of instant messaging					
PSY3	We share knowledge expressed in e-mail					
PSY4	We share knowledge expressed in pictures, graphs, charts or codes					
PSY5	Group members exchange knowledge recorded in video clips					

Section E: Mobile Phone

This section consists of questions concerning the mobile phone. **(Please answer all questions).**

1. What purpose does your mobile phone serve in group projects?

2. Which functions does your mobile phone have?

3. Which functions do you use regularly to communicate with team members?

4. How does the mobile phone assist in the transfer of project information?

5. Does the mobile phone enhance your project performance? Explain.

Section F: Outcome of Group Projects

The questions in this section give an overview of the performance and outcome of the group.

	Put X on the most appropriate answer	Yes	No			
1	Have you completed your group project?					
	If yes answer question 2 and 3, If no answer question 3 and 4.					
2	Which mark did you get for the completed project?	Less than 50%	50-60%	61-70%	71-80%	80% and above
3	How do you rate your group project performance?	Poor	Fair	Good	Very Good	Excellent
4	How do you rate the performance of your project at the present moment?	Poor	Fair	Good	Very Good	Excellent

APPENDIX E: TACIT AND EXPLICIT KNOWLEDGE CASES

Table 17: Tacit and Explicit Knowledge Measures in Computer Science

Department	Item	TK (%)	EK (%)
CS	1	86	43
CS	2	52	56
CS	3	47	78
CS	4	69	13
CS	5	34	8
CS	6	78	17

Table 18: Tacit and Explicit Knowledge Measures in Civil Engineering

Department	Item	TK (%)	EK (%)
CE	1	37	53
CE	2	43	30
CE	3	71	62
CE	4	31	63
CE	5	49	7
CE	6	43	15

Table 19: Tacit and Explicit Knowledge Measures in Information Systems

Department	Item	TK (%)	EK (%)
IS	1	80	57
IS	2	69	62
IS	3	64	81
IS	4	76	12
IS	5	83	12
IS	6	90	69

Table 20: Tacit and Explicit Knowledge Measures in Psychology

Department	Item	TK (%)	EK (%)
PSY	1	68	43
PSY	2	18	31
PSY	3	31	87
PSY	4	18	18
PSY	5	87	6
PSY	6	50	12

APPENDIX F: ETHICS FORM

1. PROJECT DETAILS	
Project Title: Investigating the Extent to which Students Share Tacit Knowledge Using Mobile Phones in Group Projects	
Principal Researcher: Chiedza Khumbula	Research Supervisor / Co-researchers: Professor Michael Kyobe
E-Mail Address: ckhumbula@gmail.com	
<p>Brief description of the project: Recently, due to the problems being faced in traditional learning, the introduction of Information Communication Technologies (ICTs) e.g. mobile technology in group learning is becoming an area of interest in institutions of higher learning since; it promotes and transforms learning and teaching processes among students and lecturers. Tacit knowledge is believed to play an essential part in collaborative learning i.e. it enables each group member to be actively involved in taking up authority, learn to be responsible, make judgements and engage in some of reasoning in project work. The extent to which student students leverage mobile phone features to share tacit knowledge and overcome impediments associated with its transfer to attain better performance in group projects is not known. Therefore, the objectives of this study is to investigate the extent to which students share tacit knowledge using mobile phones in group projects and determine if they perform better.</p>	
<p>Research methods and procedure: <input type="checkbox"/> Interviews <input type="checkbox"/> Survey questionnaire <input type="checkbox"/> Experiment <input type="checkbox"/> Secondary data <input type="checkbox"/> Observation <input type="checkbox"/> Other A survey questionnaire will be conducted in four departments at the University of Cape Town (Civil Engineering, Information Systems, Psychology and Computer Science). Questionnaires will be designed separately for each department.</p>	
2. PARTICIPANTS	
Characteristics of participants:	
Gender: Female and Male Race: All Age range: 18-30 Location: University of Cape Town, South Africa Other	
Affiliations of participants:	
<input type="checkbox"/> Company employees <input type="checkbox"/> Hospital employees <input type="checkbox"/> General public <input type="checkbox"/> Military staff <input type="checkbox"/> Farm workers <input type="checkbox"/> Students <input type="checkbox"/> Other Students involved in group projects or those who have done projects before	
3. ORGANISATIONAL PERMISSION	

If your research is being conducted within a specific organization, please state how organizational permission will be obtained:

4. INFORMED CONSENT

What type of consent will be obtained from study participants?

- Oral consent
- Written consent (e-mail)
- Anonymous survey questionnaire (covering letter required, no consent form needed)
- Other (specify): _____

How and where will consent/permission be recorded?

The students will be asked if they are willing to participate in the survey

5. CONFIDENTIALITY OF DATA

What precautions will be taken to safeguard identifiable records of individuals? Please describe specific procedures to be used to provide confidentiality of data by you and others, in both the short and long run. This question also applies if you are using secondary sources of data.

The questionnaire will be kept anonymous. No names will be noted from the participants. The questionnaires will be discarded after completion of the research.

6. RISK TO PARTICIPANTS

Does the proposed research pose any physical, psychological, social, legal, economic, or other risks to study participants you can foresee, both immediate and long range?

Yes No

7. INTENDED DISSEMINATION OF RESEARCH FINDINGS

Have you discussed authorship issues with your co-researchers or supervisor?

Yes No

DOCUMENTS ATTACHED

1. APPROVAL FROM IDUSOFTWARE TO INTERVIEW CLIENTS
2. COVER LETTER
3. INTERVIEW PROTOCOL
4. QUANTITATIVE DATA AVAILABLE
5. CONFIDENTIALITY AGREEMENT BETWEEN IDUSOFTWARE AND RESEARCHER
6. NON DISCLOSURE AGREEMENT BETWEEN IDUSOFTWARE AND CLIENTS

I certify that that the material contained herein is truthful and that all co-researchers and supervisors are aware of the contents thereof:

Applicant signature: Chiedza Khumbula

Date: 25/03/11

FOR ETHICS COMMITTEE REPRESENTATIVE ONLY:

RECOMMENDATION

FOR ETHICS COMMITTEE CHAIRPERSON ONLY:

APPENDIX G: RESEARCH ACCESS FORM

	RESEARCH ACCESS TO STUDENTS	DSA 100 (c)
---	--	--------------------

NOTES

1. This form must be completed by applicants that want to access students for the purpose of research. Attach your research proposal.
2. Return Completed application forms to: Moonira.Khan@uct.ac.za; or deliver to: Attention: Executive Director, Department of Student Affairs, North Lane, Steve Biko Students' Union, Room 7.22, Upper Campus, UCT.
3. The turnaround time for a reply is approximately 10 working days.
4. NB: It the responsibility of the researcher/s to apply for ethical clearance to the relevant (a) Faculty's 'Research in Ethics Committee' (RIEC), and (b) to the Executive Director, HR to access staff for research purposes.
5. For noting, a requirement of UCT is that items (1) and (4) apply even if prior clearance has been obtained by the researcher/s from any other institution.

SECTION A: PERSONAL DETAILS

Position	Staff / Student Reference No	Title and Name		Contact Details
Student Number	KHMCHI001	MISS CHIEDZA KHUMBULA		0739799672
Academic / PASS Staff No.				
Visiting Researcher – ID No.				
Contact details of faculty officer for inquiries	PROF. IRWIN BROWN (Course Convenor) UNIVERSITY OF CAPE TOWN +27 21 650 4260 Irwin.brown@uct.ac.za			
University / Institution at which employed / or a registered student	UNIVERSITY OF CAPE TOWN	Address if not UCT:		
Faculty and Department	COMMERCE: DEPARTMENT OF INFORMATION SYSTEMS			
Division / School / Unit				
APPLICANTS DETAILS	Title and Name	Tel.	Email	
	MISS CHIEDZA KHUMBULA	0739799672	ckhumbula@gmail.com	

SECTION B: SUPERVISOR DETAILS

Position	Title and Name	Tel.	Email
Supervisor	PROF MICHAEL KYOBE	+27 21 650 2597	Michael.kyobe@uct.ac.za
Co-Supervisor			
Co-Supervisor			

SECTION C: APPLICANTS STUDY FIELD (If applicable) / TITLE OF RESEARCH PROJECT / STUDY

Degree	MSC INFORMATION SYSTEMS
Research Project / Title	Investigating the extent to which students share tacit knowledge using mobile phones in group projects
Research Proposal attached	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Target population	STUDENTS
Lead Researcher details	
Research Methodology and Informed consent:	Quantitative and qualitative, positivist, exploratory
Ethical clearance status	

SECTION D: APPROVAL STATUS - FOR ACCESS TO STUDENTS FOR RESEARCH PURPOSE
(To be completed by the ED, DSA or Nominee)

APPROVAL GRANTED	Ref. No.:	Yes <input type="checkbox"/>	No <input type="checkbox"/>	Comments
APPROVED BY	Title and Name	Designation		Signature
		Executive Director Department of Student Affairs		Date