

**Investigating Methods of Capturing and Sharing
Learning Experience during Field Trip to Support
Students Activity**

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BSc, MSc

Thesis Submitted to the University of Nottingham for the
Degree of Philosophy

September 2015

Abstract

Field trips provide memorable experiences that help students to understand different aspects of natural sciences. They are considered as essential and effective teaching methods to use in environmental sciences such as geography, biology, and architecture (Rieger and Gay, 1997). Traditional methods for capturing experiences during field trips include documentation in the form of student note-taking and photographs. Whilst these are easy to use in the field, effort is required to convert this information into a format that can be easily shared with others and used to write up reports after the field trip event. Recent developments in digital and mobile technologies provide students with a range of software applications that could be used to facilitate capture and sharing of the field trip experience. These technologies offer additional advantages such as social interactivity, connectivity, individuality, portability and context sensitivity (Klopfer et al., 2002).

The focus of this PhD research was to understand the role of smart mobile technology in supporting note taking activities during field trips. In addition, this research aimed to investigate the impact of using these devices to enhance field experiences in different contexts. A series of case studies were conducted with undergraduate students from different disciplines who conduct field studies as part of their coursework (geography and architecture). Consideration was also given to the clinical practice context for nursing students. Previous studies had examined the use of mobile devices in educational field trips but none had assessed the use of generic mobile technologies such as the new generation of smart mobile devices. In recognition of the increasing availability and use of these smart mobile devices, this

research identified user requirements for information capture and sharing in field studies as well as the development of generic guidelines for design and implementation of mobile applications and tools in forthcoming years. The research provided an understanding of generic requirements (and context-specific requirements) in order to inform recommendations for use of mobile technologies in field study activities. This required understanding specific goals of the users to perform specified task in specific environments in the context of usability, effectiveness, efficiency and satisfaction toward (Bevan, 1995).

In the initial stages of the research, three contexts of use for development of knowledge and practical skills in undergraduate students were considered. Four main studies were conducted, utilising a qualitative approach and applying a variety of methods. The characteristics of the target users, the understanding and meaning of their field experience, the kind of support that the mobile technology could usefully provide in the fieldwork were identified. The later stages of the research focused on the field trip excursions made by geography students and architecture students and considered the applicability of the research outcomes to the nursing students context in order to examine generalisability of the recommendations.

The overall outcomes of this research show that current generation of mobile devices such as smart phones and tablets play a positive role in enhancing the capturing and sharing learning experience in undergraduate field trips. However, the enhancement is appeared when the participants are provided with training to familiarise them with use of the mobile devices before going into the field. The contribution of this thesis is the identification of user needs and requirements, and an

understanding of what makes mobile technology good to use in the field. Recommendations are provided that could influence the education sector to consider the smart mobile devices as field equipment and to find ways to encourage students to use them in the field.

Author Keywords: Mobile Technology; Experience; Field Trip; Note Taking; Geography; Architecture

Conference papers published from this Thesis:

- Allwihan, R., Brailsford, T., Cobb, S., (2012) "Guidelines for Developing Mobile Technology to Support Note Taking in Undergraduate Field Trips". EDULEARN12, Barcelona: Spain
- Allwihan, R., Brailsford, T., Cobb, S., (2013) "Capturing Experience in the Field Trip: A Comparison Study of Using Mobile Devices Between Geography and Architecture Students". Inted13, Valencia: Spain.

In the Name of Allah, the Most Gracious, the Most Merciful

I dedicate this work to my beloved Mother (Dr. Modi Alasqah) and My Father's soul (Brigadier. Mohammad Allwihan) who shown me complete kindness and love and have guided and supported me throughout my life

I wish to express my deepest gratitude to my sister Mrs. Wid and my brother Arch. Fahad for their unending support and encouragement

I would also expand my thanks to my love and husband, Mr. AbdulRahman Bin Saad ALSulaimi, who stands by me with support and patience despite we were apart most of the journey

I would thank Dr. Tim Brailsford and Dr. Sue Cobb for their supervision, insight, guidance and continuous support

I also wish to offer special thanks to the following:

- Colleagues and Staff in Horizon DTC and Human Factors Research Group for showing their support and help from day one for the good time that we spent together for whole the four years
- My friends: Richard Donker and Amal AlDabbagh for providing their help and how real friendship
- My university in Saudi Arabia (King Saud Bin AbdulAziz University for Health Science) for giving me this opportunity to achieve my goal
- And finally to all my relatives and friends in Saudi Arabia and the UK for their caring and encouragement.

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1. Introduction

1.1 Introduction

Field trips provide popular and memorable experiences that help students to understand different aspects of natural sciences and are therefore considered to be essential and effective teaching methods used in environmental sciences such as geography, biology, architecture, etc. (Rieger and Gay, 1997). Traditional methods for capturing experiences during field trips include documentation in the form of student note-taking and photographs. Whilst these are easy to use in the field, effort is required to convert this information into a format that can be easily shared with others and used to write up reports after the field trip event. Developments in digital and mobile technologies provide students with a range of software applications that could be used to facilitate capture and sharing of the field trip experience. The research work in this thesis investigates the impact of applying mobile technology in field trips for capturing and sharing the learning experiences. The pages that follow explain the use of mobile technology during field trips to capture and share the learning experiences in the context of technology design, implementation and evaluation.

1.2 Background

Outdoor learning applies in a wide range of educational activities in many different settings such as: adventure education, nature studies, field studies, heritage education, outdoor play, experiential education, agricultural education, and environmental education (Rickinson et al, 2004). Within and between these different types of activities, the field trip is one of many different conceptions of outdoor learning. Field trips can be considered as a

major contribution to achieve the educational objectives for a wide variety of subjects. It is defined as “A trip which made by students, or research workers, to study something at first hand” (OED, 2010). Field trips in education can be used to provide students with a learning experience beyond what can be attained in the classroom. The main objectives of the field trip are to provide students with a learning experience that can only be achieved through observation and interaction with the real environment. Knowledge learning takes place through use of different equipment to record, measure, test and analysis information in the field. This new perspective may then be used by the student to evaluate and reflect knowledge and skill developments (Clark, 1996).

The connection between field trips and the classroom is the field experiential learning (Lei, 2010). The Association for Experiential Education (2011) defines experiential learning as “A philosophy that informs many methodologies, in which educators purposefully engage with learners in direct experience and focused reflection in order to increase knowledge, develop skills, clarify values, and develop people's capacity to contribute to their communities”. Kolb (1984) suggests that learning comes from understanding the experience through the experiential activities that focus on exploration and observation things, in order to transfer it into an application or result.

Therefore, as an experiential learning activity in the field, students are required to capture data whilst on the field trip to help them to remember and extend their learning experience to use for further activity in the classroom (Weng et al, 2012). Students use different methods for data gathering and carry a variety of tools for their field experience. One of the traditional methods is the

use of notebooks for taking and recording information in the field. This is used to record information to aid knowledge reflection and may include a combination of raw data collection and the documentation of ideas (Boch and Piolat, 2005). The benefit of using paper notebooks is the ability to record freeform typing, spatial layout, and even sketches (Wilcox et al, 1997). However, a limitation of the paper-based notebook is that it cannot support gathering and combining different types of notes together such as audio-recorded notes.

Computer technology is a major contributor to modern history, not simply because computing plays an essential role in human life, but since the second half of the twentieth century by the fact that computing has also contributed dramatically to human activities (Sebe, 2010). The fast growth of computer technology opens the door for the electronic note taking tools to be introduced in the educational sector to support students in collecting notes and capturing their knowledge in many contexts. Since 2000, several studies have been conducted to study the role of handheld devices to support capturing and managing data gathering in educational field trips.

Naismith et al (2004), define Mobile technology as “...with respect to technologies, ‘mobile’ generally means portable and personal, like a mobile phone” (p. 2). Therefore, Mobile Technology has become a hybrid tool that integrates with other new technologies for instance, with a digital camera, portable digital assistants and location technologies, such as the new generation of smart mobile phones and can be considered as being a bridge between information and communication (Goggin, 2006).

Research analysis of mobile phone subscriptions shows an increase to approximately five billion in 2010; more than double

the subscriptions in 2005 (Wilken and Goggin, 2012). The dramatic growth in the smart mobile devices industry increases the percentage of mobile users around the world. Figure 1.1 illustrates the number of smart phones which have been sold to end users worldwide from the fourth quarter of 2007 to the fourth quarter of 2013 (Gartner, 2014).

Generally, mobile technology offers the benefits of computers in a portable form. In addition, the ability to take these devices anywhere offers additional advantages. Klopfer et al. (2002) identified five different properties of mobile devices that offer unique educational benefits which are listed below:

1. Social Interactivity: through interacting and collaborating with other people data can be exchanged without the need for face-to-face connection.
2. Connectivity: as a result of the network support, mobile devices can exchange and share data by connecting to other mobile devices or communication networks.
3. Individuality: different activities can be designed for individual users.
4. Portability: mobile devices can be taken to different sites due to the light weight and size of the devices. They have also been designed to be more practical and usable during the mobility of the device.
5. Context Sensitivity: mobile technology can gather and respond to simulated or real data at the current location and time.

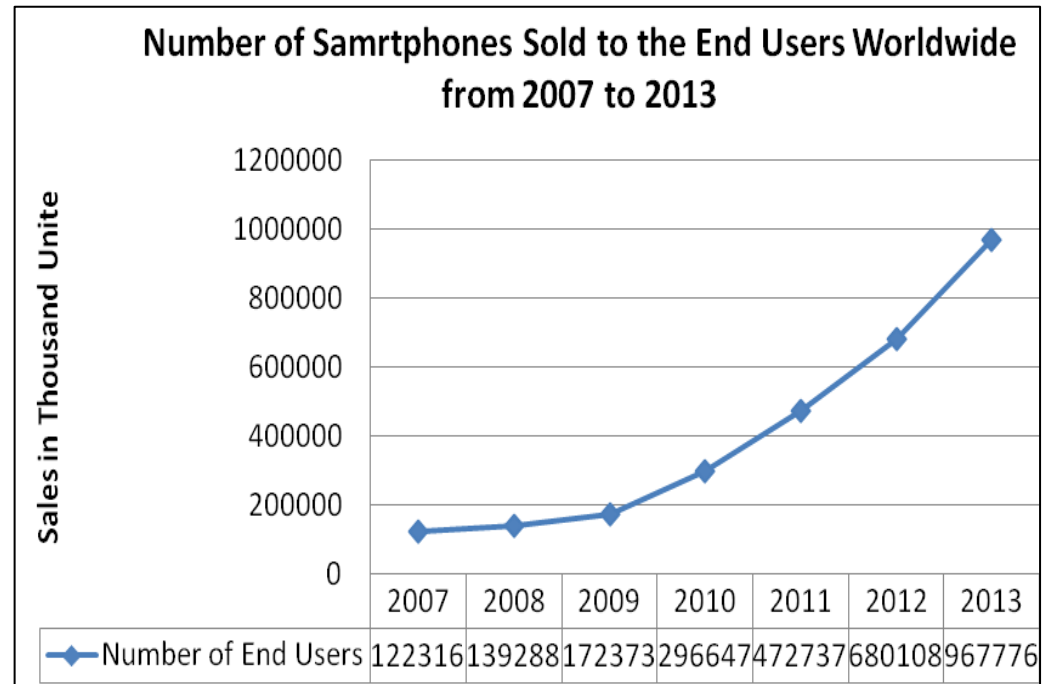


Figure 1.1: Number of Smart Phones Sold to the End Users
(Thousands of Units) Worldwide from 2007 to 2013 (Source:
Gartner Inc., 2014)

As new network generations are deployed, and as the third generation (3G) and the fourth generation (4G) networks have developed, providers have been able to increase the features of mobile communication and this allows for the release of new inventions into the mobile market. The arrival of the iPhone during the middle of 2007, and then the iPad in early 2010 has provided many new openings for the integration of technology between smart phones and tablets to assist developing data sharing and information. In addition, with the development of new mobile devices, they attract a keen interest from many people to apply mobile technology to enhance human activities (Richmond, 2012).

Nowadays, there are many different varieties of mobile applications available for different mobile operating system platforms, such as the Apple Store and the Android Market. Mobile applications can be defined as follows: “Apps are software applications often designed for a specific task and targeted at a particular set of smart devices such as smart phones, tablet computers and internet connected televisions. They organise information in a way suitable for the specific characteristics of the device and they often closely interact with the hardware and operating system features present on the devices” (Kohnstamm, 2013, p.4).

Applications provide a wide range of functions to the end users, such as communication (calls, text messages, emails, internet messages), entertainment (games and music), web browsing, social networking, banking and location based services and so on. In 2012, there were 1600 new and different applications uploaded to the application stores on a daily basis (Harris, 2013), and the number of mobile applications downloaded was 36 billion (ABI research, 2012).

1.2.1 The Call for Research in the Field

Several previous studies inspired and shaped the current research concepts. Lozzi (1989a; 1989b) reported that students get benefits from the outdoor environmental education experiences in many ways including the development of environmental attitudes and values, and so he suggested that environmental education should be included into all levels of the educated curriculum. Emmons (1997) investigated the contribution of non-formal learning experience on the formation of environmental sensitivity,

attitudes and concerns. Over a five-day field course, two small groups of high school students were able to experience positive aspects about nature through direct experience and through sharing opinion with others. Rieger and Gay (1997) identified field trips as an effective teaching method that provides popular and memorable experiences for students; often in understanding various aspects of natural sciences. More recently, Maskall and Stokes (2008) examined the idea of using mobile devices to support data collection and analysis in field study. They suggested that using these devices added benefits during the learning process as the mobile devices provide quick feedback between the students and the tutors which could directly influence the students learning process.

However, Wentzel et al (2005) expressed concern that there is a difference between applying the technology in fieldwork for the sake of technology, and applying technology to enhance the fieldwork. For instance, Ruchter et al (2010) aimed to compare the effect of using traditional approaches and mobile computing in environmental education. They designed a field experiment to examine the participants using different media in a guided tour. The study demonstrated that the mobile computing approach might offer new opportunities in particular to the field of environmental education. The results of the study shows that the mobile guide systems achieved similar effectiveness to the traditional guide approaches with regards to the impact on environmental literacy. However, the study also recommended the need for further studies to focus on improvements of the usability of applying this approach in the field.

Based on these findings, the focus of this PhD research was to understand the role of smart mobile technology in supporting note taking activities as a main method to capture and share the learning experience during field trips. In addition, this research aims to investigate the impact of using these devices to enhance the field experiences in different contexts such as environmental field study (as conducted by geography and architecture students) and the clinical practice context for nursing students. As has been already mentioned, whilst previous studies have examined the use of mobile devices in educational field trips, the majority of these were designed to evaluate bespoke mobile systems designed specifically for the learning context examined. None of these studies tested use of generic mobile technologies such as the new generation of smart mobile devices (e.g. smart phones or tablets) which have made rapid growth even during the period of this research.

In recognition of increasing availability and use of such technologies, this research focused on identification of user requirements for information capture and sharing in field study contexts in order to develop generic guidelines for design and implementation of mobile applications and tools in forthcoming years. Moreover, limited previous research has considered the quality of use of mobile devices in field study. Since the quality of use is measured by usability, effectiveness, efficiency and satisfaction toward specific goals which can be achieved by specific users perform specified task in specific environments (Bevan, 1995), this research aims to fill the gap by studying the impact of the quality of using mobile technology on capturing and sharing experience in the field.

1.3 Research Definitions

As the research conducted draws upon literature and previous research across several scientific disciplines, including education and computing science, some of the terminology used may convey different meanings depending upon the perspective of the reader. Prior to describing the research conducted, it is useful to provide a definition of concepts and definitions of key terms used in this thesis. In addition, constraints of the research included limited access to user groups and availability of technologies. The research context and resources are also described in the following sections.

1.3.1 Definition of 'Field Trip' and Context of Use

Defining the context of use clearly is an essential starting point of general computing system development research. In this research, the main context of use was a higher education field trip. The dictionary definition of a field trip is: "A trip which is made by students, or research workers, to study something at first hand" (OED, 2010). The important aspect of this definition for the focus of this research is the 'study at first hand' in order to develop knowledge and practical skills that could be used by professionals in the discipline of interest. The research was not intended to focus on a specific discipline or learning objective but instead to provide an understanding of generic requirements (and context-specific requirements) in order to inform recommendations for use of mobile technologies in field study activities. To achieve this, it was important to conduct case studies with different student groups in different contexts. In the initial stages of the research, three contexts of use for development of knowledge and practical skills in undergraduate students were considered:

- The clinical practice environment for nursing students,
- Short field trip excursions for geography students,
- Field trip excursions for architecture students.

The later stages of the research focused on the field trip excursions made by geography students and architecture students and consideration of applicability of the research outcomes to the nursing student context is made in the discussion chapter in order to examine generalisability of the recommendations.

1.3.2 Definition of Experience

A notable feature of definitions of field trips in education is the importance of the student 'experience' and two interpretations may be drawn from the scientific literature:

- I. The experience of being on the field trip itself. This includes the activities conducted such as collecting and sharing information.
- II. The experience gained from the field trip. This refers to the contribution of the learning gained from the field trip to knowledge and understanding of the subject of study.

In order to distinguish between these different types of experience different prefixes will be used in this thesis as follows:

- (FX) for field experience
- (LX) for learning experience

In addition, the concept of the 'user experience' in computing science and human-computer interaction (HCI) research conveys a different meaning related to the user's experience of interacting

with technology. Therefore a third definition of experience is used in this thesis:-

- (UX) for user experience

In the context of field trips, understanding the behaviours of students when capturing and sharing their knowledge leads to identify the specific meaning of experience. In the early stages of the research, the researcher attended field trips to observe the students' activities in the field. It was found that the main activity the students performed was taking notes about their experience in the field by using different tools and techniques in order to record, collect and share. Therefore, it was decided to focus on studying the field notes taking activity including understanding the nature of notes and collective data by using mobile devices.

1.3.3 Mobile Technology in this Research

This research has focused on the use of smart phones and tablet devices as the media to collect and share information during field trips. At the beginning of this research in 2009, the competitive markets of smart devices had introduced the iPhone device, Google Mobile and Windows Phone. However, the rapid development of these smart phones, makes following and keeping up with the trends very difficult. The author decided to choose one market in which to develop the major elements of the devices being used in this research, these were the products developed and sold by Trade markets. The mobile devices used by the students in the case studies were: the iPhone 4S and the iPad 2. In addition to Apple application stores, it is worth noting that the reason behind choosing an iOS platform was due to the availability of iOS devices as tools for this research. Therefore, the

availability to these devices during this research influenced the decision to choose this trade market.

1.4 Research Aims and Objectives

The overall aim of the research was to investigate the potential for mobile technology, such as smart phones and tablets to improve and facilitate the capture and sharing the learning experience in undergraduate field trips.

The specific objectives of this research are to identify clearly the characteristics of the target users, besides understand the meaning of the experience that the students are interested to collect from the field. In addition, to study and clarify the kind of support that the mobile technology could usefully provide in fieldwork.

1.5 Research Questions

In order to achieve the aim of this research, the main research question is:

How do mobile technologies enhance the activities of capturing and sharing the learning experience in field trips?

This was further divided into the following three sub-questions:

RQ 1: How do students capture and share their learning experience during the field trip?

- What is the meaning of learning and field experience during the field trip?
- What kinds of tools are suitable to capture and share the learning experience in the field?
- What are the user requirements of mobile technology to support capturing and sharing learning experiences during the field trip?

The first group of questions aim to identify the target users, their characteristics, and requirements. This is to understand the meaning of 'learning experience' they obtain from the field. The outcomes of this would help to detect the usage implications of mobile technology in the context of use for students in different disciplines (e.g. nursing, geography, and architecture). This information was used to provide guidelines to enable researchers and designers to integrate the implications within a user centred study.

RQ 2: How does Mobile Technology Impact upon the capturing of learning experience during the Field Trip?

- What kind of learning experience do students capture in the field by using mobile devices?
- What are the usage implications of mobile technology to enhance the field experience in the field?
- What are the key contextual factors that affect the use of mobile technology during the field trip to capture and share learning experience?

The second group of questions investigates the impact of applying mobile technology for capturing and sharing learning experiences during field trips. The aim was to understand the contextual influences on field experience when using mobile devices during the field trip. Moreover, the questions investigate the potential barriers that users can face when using mobile devices during the field activities.

RQ 3: What is the potential for mobile technology to contribute to the aspects of capturing and sharing the learning experience during the field trip?

The third question aims to investigate and evaluate the potential contribution of mobile technology in capturing and sharing the learning experience context during the field trip. This can answer the overall research question of how mobile technologies enhance the capturing and sharing of experience during the field trips.

1.6 Research Scope and Outcomes

The thesis was undertaken from the perspective of HCI (Human Computer Interaction), rather than technological development. It embraces the user centred design principles for studying the impact of mobile technology on the user experience during the field trip. Figure 1.2 illustrates the research focus. The figure shows there are three main components of this research: the task (collecting the learning experience); the technology (mobile); and the context (field trip). As the diagram illustrates, the task in this research is informal note taking, while the technology is smart mobile devices, such as smart phones and tablets. Finally, the

context is the field trip, and specifically undergraduate field trips. These three components provide the context for study of the use of mobile technology in a number of combinations: mobile in the field, mobile note taking, and taking notes in the field. Therefore, the focus of this research is to examine the impact of mobile technology on note taking activities in field trips.

The outcomes of this thesis will be related to the product design, as well as to educational contributions. The product design element explores the implementations for a new generation of mobile devices, such as smart phones and tablets at the field trips to enhance capturing and sharing the students' experience there. It describes how innovative the products need to be to take the user experience into account.

Moreover, the educational contributions demonstrate how, with the use of mobile technology, note taking would improve the students' field experience during the field trip and work context. Suggestions will be proposed to help the students to study, design and evaluate methods to embed the use of mobile devices during the field trip activities.

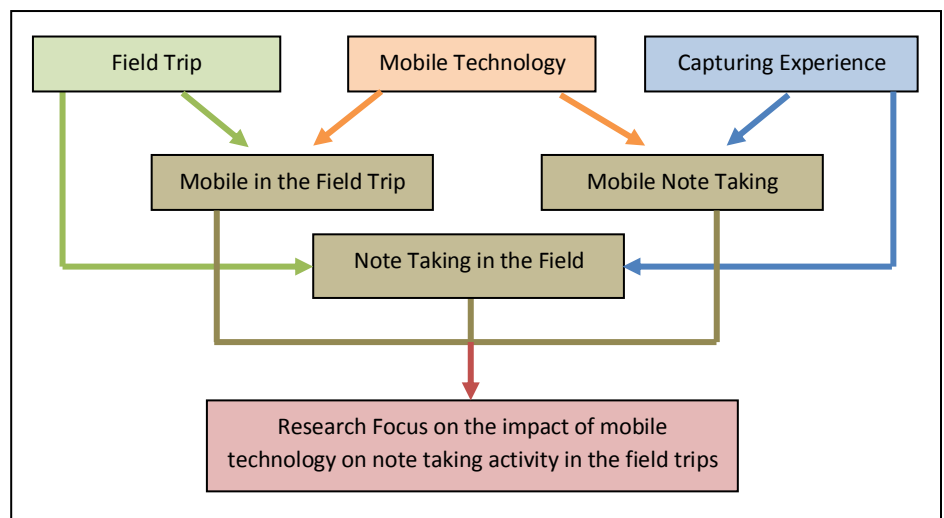


Figure 1.2 Research Focus

1.7 Overview of Thesis

The structure of this thesis uses a traditional research format. It begins with a literature review, followed by a methods chapter reviewing all the research activities. Next, there are four chapters, which describe the main research activities respectively. The discussion and conclusion chapter make up the remainder of the thesis. A more detailed overview of each of the thesis chapters is provided below.

Chapter 2 – Literature review:

This chapter deals with three key concepts: mobile technology, experience and field context. The literature was initially examined to help define the concepts, including, the nature of field trips in education, interpretation of the experience, and methods for information capturing and sharing. Then following that, this chapter discusses the literature of related works which shape this research.

Chapter 3 – Research Methods:

The methodology chapter begins with an overview of the HCI research framework followed by an introduction of the methodology used during this research and concludes with a discussion of the validity and reliability of the methods used.

Chapter 4 – Understanding User Requirements in Context:

This chapter describes three case studies that include on-site observation and interview of students during field study activities in an aim to understand their field experience. Each study was conducted with the aim of understanding the users and their requirements for capturing their current learning experiences in the field trips. It also described difference methods and

techniques the students used to capture and share data in the field.

Chapter 5 – Conceptual design: developing the initial conceptual model:

This chapter describes the application of the requirements identified in chapter 4 to develop a conceptual model that is fundamental to interaction design. In addition, the chapters aim to evaluate the functional requirements for developing mobile technology to support capturing and sharing experiences during a field trip.

Chapter 6 – Understanding the use of mobile technology in the field:

This chapter presents the mobile context research, which is presented through two field studies that were undertaken at field trips within the UK. The purpose and aim of this is to demonstrate to the reader an understanding of the use of mobile devices to capture and share the undergraduate experience during the field trips. These field studies have been described separately to reflect which aspects of context are relevant to improve the user experience within the confines of field trips.

Chapter 7 – Investigating the effects of using mobile technology during the field trip:

This chapter investigates the usability issues, which are related to the capture and sharing of experiences during the field trips. This chapter covers the outcomes of a comparative study between three sets of students from geography and architecture were the groups combined. The purpose is to investigate the usability issues of three different methods used for capturing and sharing experiences in the field. These three methods are: paper based

method such as paper, pen and digital camera; the iPad without specifying a particular application to use; the iPad with a specific application to use, in addition to a previous training session to learn how to use this device.

Chapter 8 – Discussion and Conclusion:

This chapter discusses the main findings of the thesis. These findings primarily pertain to the design of the mobile system requirements in the field, the impact of applying the mobile system on capturing and sharing experience in the field and the effectiveness of using a mobile system in the field. Moreover, this chapter draws together the conclusions regarding the research questions and states a range of potential avenues for further research that can be derived from this thesis. The overall structure of this thesis is illustrated in figure 1.3.

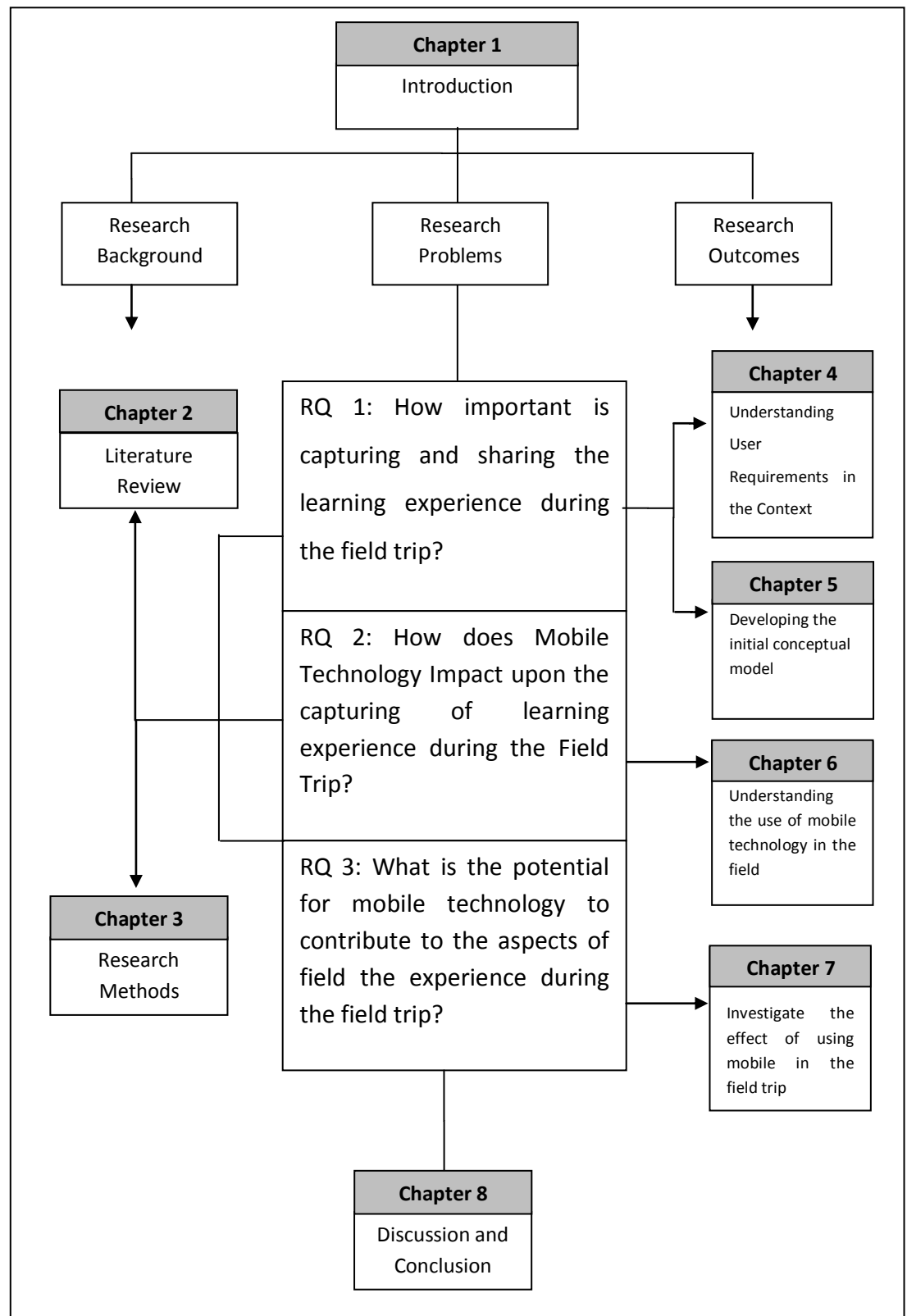


Figure 1.3: Thesis Structure

2. Literature Review: Multidisciplinary Perspectives

2.1 Introduction and Aim

The purpose of this research is to investigate whether, and how, the use of mobile technology in educational field trips can facilitate capturing and sharing of the learning experience (LX) more effectively than traditional methods. This chapter provides the basis for understanding the context of use (i.e. the nature of field trips and their benefits to the students learning), traditional methods for capture of information in field trips (i.e. student note taking) and the role of digital media and potential for mobile technologies, to support this process. The structure of the literature review is illustrated in Figure 2.1.

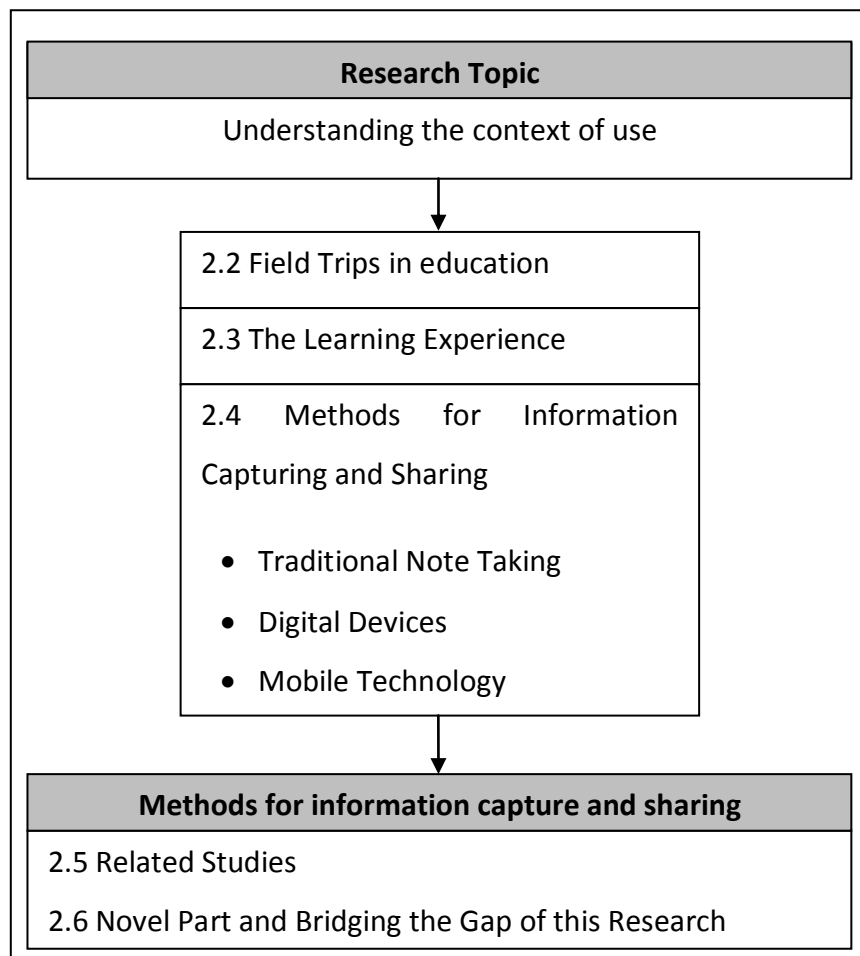


Figure 2.1: Literature Overview.

This section contains a review of previous research work to examine the purpose and method of data capture in educational field trips, the nature of the field experience and explores how developments in mobile technology may facilitate this process and enhance the student experience. The first sections of the literature review (sections 2.2, 2.3 and 2.4 as shown in Figure 2.1) establish the rationale for the relation between the development of digital technology and the need to capture and share information in field trips. Subsequent sections will present similar research on the topic (Section 2.5) and gaps the author has found in the research that suggest the need for this work (Section 2.6).

The chapter concludes with a discussion of the convergence between mobile technology development and the emergent need of field trips to enhance the process for capturing and sharing of information among different groups. This chapter lays the groundwork for the theoretical construct upon which this research is based. The specific objectives of this chapter are to:

1. Understand the theory behind field trip learning designs.
2. Understand the importance of information capture and sharing to achieving field trip learning objectives.
3. Investigate the utility of digital devices over traditional methods of field trip information capture and sharing.
4. Identify the potential for digital devices in designing future field trip.

2.2 Context of Use: Practical Context

In general computing system development, identifying the particular context of use is the starting point for understanding the behaviour of use for mobile technology devices in a human

centred design process. In the HCI (Human Computer Interaction) literature, there is no default definition of context of use. For instance, Schilit et al (1994) defined the context of use as: “Location of use, the collection of nearby people and objects, as well as changes to those objects over time” (p.85). Dey et al (2001) defined the context of use as any information that can be used to characterise the situation of an entity. In their definition, the entity could be a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves. Defining the context of use clearly is an essential starting point of general computing system development research. Dey (2001) established two main benefits. First, due to the difficulty in detecting the user objectives directly, the purpose of the context of use is to recognize what the users are trying to achieve in order to know how to best support them. Secondly, Dey and Abowd (2000) point out that developers are more likely to produce more useful computational services by understanding the context of use. That is because a clearly defined context can increase the abundance of communication and interaction between human and computer. It can also lead to improved usability (Dey, 2001b). A study by Bradley and Dunlop (2002) investigated the required contextual interaction for route navigation, with the aim to illustrate the heterogeneous nature of humans in interaction with their environmental context. Besides their main finding, the study results pointed to the need to understand contextual interactions in order to maximise usability.

This section outlines the rationale for the relation between the development of digital technology and the need to capture and share information in practical context such as field trips.

The following sections are structured to:

- Define and detect the context of use;
- Describe the field trip context;
- Discuss the benefits of field trips in education, including the field experience.

2.2.1 Field Trip Context

The Oxford English Dictionary defines a field trip as “a trip made by students, or research workers, to study something at first hand” (OED. 2010). The literature provides specialised definitions which convey more detail about the purpose of field trips, encompassing to learning objectives and nature of field trips, and the individual learning experience. Dando and Wiedel (1971) defined field trips as an extension to fieldwork, field teaching, field camps and field research. Fieldwork has also been defined as “any arena or zone within a subject where, outside the constraints of the four walls classroom setting, supervised learning can take place through first-hand experience” (Lonergan and Andreson, 1988). More recently, Maskall and Stokes (2008) reported that the social activity and interaction experienced in fieldtrips can help to build the students’ knowledge due to shared experiences with others in the field, which are able to enhance behaviour and inherent beliefs.

Gold et al (1991) categorised five different types of field trip:

1. Cook’s Tour: A rapid tour with limited activity in travel.
2. Short Field Excursion: A limited travel in a limited time.
3. Study Tour: A multi-location activity.
4. Residential Course: An extended travel in an extended time.
5. Project Work: A learner practitioner and participant observation.

Field trips provide a variety of learning experiences that vary with the subject and context of the learning objectives. Subjects that are studied include: biology, geology, practical medical studies, history, archaeology, and educational science of all types.

The learning objectives for field trips can be summarised as the following (Lederman and Abell, 2007):

- Motivation to learn the subject matter. A significant amount of literature suggests that informal science field trips create a positive impact (Michie, 1998). For example, two studies by Falk and Balling (1982) and Bitgood (1989) demonstrated that the students who participated in field trips showed a more positive attitude toward the subject matter following the field experience.
- Engage students in the learning process using a different methodology outside the classroom. For instance, the field trip provides an enriched experience to observe things that cannot be seen at the classroom.
- Develop skills that are best acquired outside the classroom such as their technical skills in using specific equipment in the field (Clark, 1996).

2.2.2 The Benefit of Field Trip in Education

Given the great variety of contexts in which field trips occur, one might expect that the effect on students would differ for a multitude of reasons. According to one study, the field trip experience has been considered as one of the main factors which led 300 full time science and engineering professors to choose their career (Nazier, 1993). Other researchers have also noted

that the purpose of field trips in education is to provide students with a learning experience beyond what can be attained in the classroom. Fuller et al (2003) argue that the field trip student experience or “geographical reality” is enhanced through understanding the subject knowledge, obtaining technical abilities, sharing skills, interacting socially with colleagues and transferring their experiences. In addition, the students benefit from an increase in academic confidence, after completing the field trip, since the field trip allows the students and teachers -to work in closer proximity, as well as challenge both to redefine the social relationships between them. Hence, field trips can bring many positive experiences to the student (Fuller et al, 2006).

Dillon et al (2006), suggest that, “Fieldwork, properly conceived, adequately planned, well taught and effectively followed up, offers learners opportunities to develop their knowledge and skills in ways that add value to their everyday experiences in the classroom” (p.107). More recently, Meek et al (2013) commented that the purpose of field trips is to take the students away from everyday classrooms to put them in the environment that enables them to have an experience which the classrooms cannot provide. For instance, on one hand the students can gain their knowledge through observation the environment surrounded them; in addition develop their technical skills by using specific equipment through collecting, measuring and analysing their data collection.

On the other hand, field trips provide a wealth of learning opportunities for students, especially if they are involved in the planning process. They learn by being actively involved in as many aspects of the experience as possible. Learning outcomes vary with the student, group and context but they can learn critical thinking skills, if they are responsible for solving logistical

problems or learning to work in teams. To obtain these personal outcomes the students are required to apply the observational and analytical skills to achieve the educational objectives of the field trip. Researchers have shown that the intended or expected results of field trips are not automatic, but they require the deliberate action of enlightened teachers to influence the outcome (Gennaro, 1981). For example, Griffin and Symington (1997) found that the amount of learning that takes place will be a direct reflection of the attitude of the teacher and the purpose for which the field trip was conducted. Their research showed that 50 percent of teachers were unable to explain the purpose of their field trip, and still fewer teachers had linked the field trip to their curriculum. Similar research by Tal et al (2005) found that most teachers could not define the purpose of the visit, and some provided only vague, generic purposes such as “enrichment.”

Optimal effectiveness depends on the links between the field trip and the overall course curriculum and objectives. Gennaro (1981) found that there are two approaches to exposing students to material prior to the experience - an “overview” approach versus an “advance organizer” approach. The overview approach is one in which students are presented with the key concepts, terms, and principles that they are likely to encounter on their field trip. In an “advance organizer” approach, students are provided with more complex details specific to the upcoming field trip. He reported that the two approaches showed that the group that received the trip-specific orientation performed better on the post-test than the group receiving the unrelated pre-visit orientation. In other words, learning outcomes are affected by how the field trip is positioned in the overall educational experience. A study by Davidson et al (2009) showed that if the field trip is introduced using an overview approach, students found it to be the least

enjoyable part of the experience and likened it listening to someone go on and on about topics that were not interesting. As Gennaro (1981) found, this type of orientation has a direct effect on the learning that occurs. One of these can be explained as the possibility that detailed orientations may use technical terminology that is poorly explained (Tal and Morag, 2007). Moreover, the emphasis on teacher-prescribed concepts that are important for students to know takes away some of the responsibility students have for their own learning.

From the above, it can be deduced that field trips can be a major addition to achieving educational objectives for a wide variety of subjects, concepts and methods. Furthermore, “In the last few years, the word interactivity has tended to be applied more frequently to the facilities afforded through computer mediated communication and the increased promotion of online learning and web based training. Regardless of the computer based medium, any interaction between ‘learners and learners’ or ‘learners and content’ cannot be assumed to be an automatic facility of the computer based medium. Rather, considerable design effort must continue to be placed on the ways in which learners will both adopt and adapt to the exchange of ideas and engagement with content through computer mediated resources” (Sims ,2000, p.53). This is a particularly relevant perspective since this work will address certain aspects of the interactivity of learning processes and the use of digital technology that enhances learning and collaboration.

2.3 Experience in the Field

A notable feature of the definition of field trips in education is the importance of the field ‘experience’. This section provides a

description of what is meant by 'experience' and then presents a review of literature concerning how this is important for student learning.

2.3.1 Definition of Experience

John Dewey (1938) in his landmark book, 'Education and Experience', defines experience as the interaction between two principles; continuity and interaction. The interaction relates to the objective and internal conditions of an experience. Continuity comprises all experiences, past and present, continue forwards into the influence future experiences and decisions. The educational experience engages both continuity and interaction between the learner and what they learn (Dewey, 1938). Hektner et al. (2007), defines experience as naturally occurring contexts of everyday life and, in their view, experience is about how people feel about their lives. The Oxford English Dictionary (1989) defines experience as "the fact of being consciously the subject of a state or condition, or of being consciously affected by an event." In other words, experience is subjective and contemporaneous. This definition is particularly relevant to the purpose of field trips.

However in a different context of field trip such as in nursing clinical practice, the experience could also be defined differently. Work by Dornan et al (2005, p.3) defined the experience as "Authentic (real as opposed to simulated) human contact in a social or clinical context that enhances learning of health, illness and / or disease, and the role of the health professional". They also define early clinical experience as "what would traditionally have been regarded as the preclinical phase, usually the first two years".

2.3.2 Learning through Experience

This research investigates the informal experience and knowledge, which the students capture and share during field trips. There are a number of theories that back this line. One of the earliest proponents of the importance of experience is Dewey's (1938) theory, which noted the necessity for integrating the processes of actual experience and education in learning.

Dewey argued that "Every experience is a moving force. Its value can be judged only on the ground of what it moves toward and into. The greater maturity of experience which should belong to the adult as educator puts him in a position to evaluate each experience of the young in a way in which the one having the less mature experience cannot do" (Dewey, 1938, p. 31). He makes the case that educators have the responsibility to shape the experiences of their students in ways that lead to personal growth. Later theorists build on the concept of experience (past and present) as a context for future learning.

Another theorist (Kolb, 1984), stated that, learning is best achieved in an environment that considers both concrete experiences and conceptual models. Kolb's theory was used as a framework to interpret and diagnose individual learners, as well as designing learning environments. It contains four learning environment: affectively oriented (feeling), symbolically oriented (thinking), perceptually oriented (watching) and behaviourally oriented (doing) as figure 2.2 shows below.

Kolb's learning cycle has been adapted by others to illustrate the continuity of experience through various stages of learning. Experience in this cycle has been shown to have a past, present and future aspect to it, ((Dewey, 1938), (Kolb, 1984), (Wierzbicka,

2010)). This is an important understanding for designing field trips and enriching the education outcomes. Lozzi (1989a; 1989b) reported that students get benefits from the outdoor environmental education experiences in many ways, including the development of environmental attitudes and values. He suggested the inclusion of the environmental education into all levels of the educated curriculum. In addition, Emmons (1997) reported that the students who participated in field trips were able to experience positive aspects through direct experience and through sharing opinion with others.

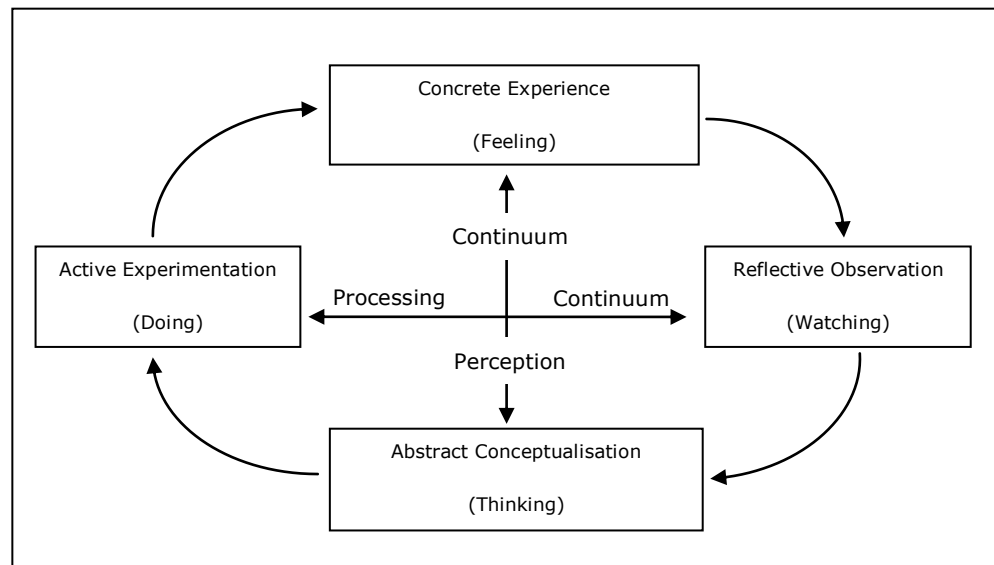


Figure 2.2: Kolb's Learning Cycle

A number of other theorists have shown that being able to learn through human experience enlightens perspectives, creates new ideas and more effective methods and allows the description of results emotionally, logically and physically (Fenwick, 2001). For example, Mittelstaedt et al (1999) analysed a 5-day programme of biodiversity activities at a summer science camp. The camp provided a variety of activities and experience such as introducing the campers to the skills and the tools of the professional

naturalist. Mittelstaedt et al (1999) found that “even though the children arrived with a positive attitude toward the environment, they left with an even stronger positive attitude.” (p. 147). Another outcome was the fact that over half (25) of the campers returned the following year and, when asked about the impact of previous summer’s programme on their environmental behaviour, they identified a significant number of activities they had done which they attributed to the camp experience (Field Studies Council, 2004).

Although research studies on the effects of field trips on student learning appear to be quite limited and lacking in academic sectors, there is evidence to suggest that learning from field trips can be profound on the lives of some individuals. According to the Field Studies Council (2004), most research evaluations from the early 1990s were dominated by a focus on quantitative studies which sought to evaluate the impacts of adventure programmes and field trips through pre-test/post-test designs. However, more recent studies are investigating qualitative outcomes as well as affective changes. The Field Studies Council (2004) concluded its report by acknowledging that research needs to take a more integrated view of learning in different kinds of settings both within and beyond the classroom, such as suggesting new questions to be asked at the learning context or explaining blind spots in taught subjects that would keep understanding and observing phenomena clearly.

Dornan et al (2005) stated that the early clinical practice motivated and satisfied students and helped them acclimatise to clinical environments, develop professionally, foster their self-reflection and interact with patients with more confidence and less stress, develop self-reflection and appraisal skills and develop

a professional identity. This early clinical experience helps to strengthen the learning of healthcare students and make it more real and relevant to clinical practice. For instance, it teaches them about the structure and function of the healthcare system and about preventive care and the role of health professionals. In addition, it supports the learning of biomedical and behavioural/ social sciences and helps students acquire and communicate basic clinical skills.

A report on a meta-study of 150 research projects on outdoor learning was published between 1993 and 2003 (Rickinson et al (2004) and Dillon et al (2006)). The literature of these projects included three main types of outdoor learning which were the school grounds and community projects, the outdoor adventure education, and the fieldwork and outdoor visits. The outdoor learning projects were with primary school pupils, secondary school students, and with undergraduate learners. The report concluded that, trips carefully planned, thoughtfully implemented and followed up back at school (Dillon, 2006) offers participants opportunities to develop their knowledge and skills in ways that also positively affect their everyday classroom experiences.

In summary, the values of experiential learning in field trips have been established. The benefits of experiential learning also can be summarised in three major categories. First, experiential learning methods and procedures can provide a bridge connecting a learner's existing level of understanding with a new set of knowledge and abilities. Second, the learner adopts a more self-confident role in assuming responsibility for their own learning. Last, the experiential learning supports transferring the learning from an academic mode to one that would engage well in practical content (Swanwick, 2010).

One can see that learning theory and the importance of experiential learning has evolved over time from Dewey (1938) until recent time. In today's digital age, there appears to be another quantum leap forward that is developing in learning methodology. Today's students are familiar with information and communications technology (ICT). ICT has become a part of their social life. Learning today occurs from a variety of sources, both *in situ* and from others; it is social as well as cognitive (Brown and Duguid, 2000). There is also a transition occurring from an authority-based lecture model to a discovery-based learning model that is enhanced by digital technology (Brown, 2001).

2.4 Note Taking in the Field

As a learning activity, students are required to capture data and important information whilst on the field trip to help them remember the experience and use the knowledge for further activity in the classroom. Students also carry with them tools for data gathering and experience capturing, (Weng et al, 2012). One of the most traditional methods for doing this activity is the use of notebooks.

2.4.1 Definition of Note Taking

Note taking, as an activity, is the practice of writing down pieces of information to fulfil two major functions: to record information and/or to aid reflection (Boch and Piolat, 2005). The activity of note taking appears to initially interfere with the appreciation and understanding of the surroundings. However, it is a common activity throughout all daily life, as well as that of the academic activity. Note taking has many uses: to avoid forgetting information, to help aid and support the memory, resolve issues,

make judgments, and make decisions. It focuses the note taker's attention on identifying salient information, which then should be recorded and coded (Boch and Piolat, 2005).

However, one of the difficulties in taking effective notes in the field is that it may take time to record extensive notes and may divert attention from listening to teacher instruction or observation of data. To overcome these, students adopt techniques to reduce the burden of note-taking. Some of these techniques include a variety of different formats, such as short texts, sketches, symbols, figures, numbers, etc. Information is also classified into different types, for example, temporary, long term, confidential, private or public (Brandl et al, 2010).

2.4.2 Field Notes

The benefit of note taking, in general, is not in taking the notes themselves, but more to making them available for later review and processing (Carter and Van Matre, 1975). Sanjek (1990) investigated the definition of field notes in his work. He found that field notes are considered, to a great extent, differently, as people define the field notes depending on how they feel about them. For examples, the field note has been defined as field diaries, or as a running log which is written at the end of each day. In addition the field notes also have been considered as the activity that represents the process of transferring the observed interaction into written. The observed interaction includes public communication, raw data, or ideas.

Emerson et al (2011) classified the field notes into three types:

- Methodological Notes: describing techniques for collecting data.

- Descriptive Notes: most of the descriptive notes are based on two sources: watching (observation) and listening (interview).
- Analytical Notes: these notes are produced over a period of time by understanding the work in a descriptive and methodological way.

In each case the notes are coded according to the purpose of the notation at the time it was made. As Emerson et al (2011) note, during the post note-taking analytical process: “The researcher’s stance toward the notes changes: the notes, and the persons and events they recount, become textual objects” (p. 143). Therefore, a medium that facilitates note taking and note capturing would lead to facilitating the act of recording as well as make later analysis and interpretation easier and accurate. The benefit of using paper notebooks is the ability to provide a freeform typing, spatial layout, and even sketches (Wilcox et al, 1997). However, the paper based notebook cannot support gathering and combining different types of notes together such as in case of audio recording notes. Hence, the development of electronic note taking tools, such as mobile device applications. The electronic note taking tools have led to the facility to include multimedia sources, such as photos and videos.

2.4.3 Digital Note Taking

Electronic note taking tools have been used in the educational sector to support students in collecting their notes and capturing their knowledge in many contexts in recent times. Since 2000, some studies have been done to develop and design mobile technology, such as smart phones to study the role of handheld devices in supporting and capturing informal, personal

information management. There are three examples of related studies which explain the activities that have similarities with the type of note taking activities that are required in the field studies.

The first example is the work by Dai et al (2005). The aim of this study was to examine the routine behaviours of users using PDA (Personal Digital Assistant) and Informal note users to identify clear areas for improvement. The main features of informal notes were: *easy to create and destroy, mobility, transferable, viewable, temporary, short, and portable*. Dai et al. (2005) also examined how PDA users use the handheld devices to record informal personal information such as memos, emails, and lists etc. Each participant was provided with a mobile device with four universal PIM (Personal Information Management) functions to use. These four applications were: the calendar (Date Book) which shows the daily schedules based on particular time. The participants reported that they used this application to record appointment and the tasks with specific deadlines. The second application was the to-do list (Task), which manages tasks by offering a checklist. The participants reported that they used to create tasks list such as shopping list, in addition to record all their tasks individually. The third application was the address book (Contacts) which provided a list of contact information. The participants entered their important contacts only. The last application was the memo, which does not support specific tasks like the previous applications. It offered a free form space to record any kind of notes which do not belong to any form of the three previous applications. It was found that the participants preferred to use an unstructured application because it facilitates data entries without the need to decompose the informal notes into an organised field.. Despite the disadvantages and limitations of digital support for informal notes, this study revealed the success stories of digital

support by expert PDA users. Moreover, as a suggested solution to bridge a gap between structured and unstructured applications, a design for a universal link and persistent categories across all personal information management applications was indicated as needed to provide a free and fast style to record informal data. Dai et al. (2005) concluded that, this solution could offer a potential digital support to all stages of the informal note lifecycle. The study by Dai et al (2005) helped to inform this research in understanding the different user behaviours in recording their notes by mobile device. The outcomes of the study also helped this research in building the initial perception about the construction and design of the mobile technology and application which would be used for the purpose of note taking.

Lee and Klemmer (2005) described the iDeas system which provides electronic capture system that allows the designers to capture and share their activities. This project contained three components: the iDeas notebook, the iDeas blog and the iDeas wall. The iDeas notebook allowed the designer to use digital ink to draw sketches on notes and then use a digital pen to transfer that entry to the digital wall to share the ideas with others. The iDeas wall provided an interactive surface for other collaborators to exchange and create ideas and other content. The third component was the iDeas blog which provided the ability to upload the creative work and functioned as an electronic store to collect the content. A study reported by Lee and Klemmer demonstrated that there is a significant possibility for embedding technology into design activity and education, from sharing ideas among classmates and teachers to improve learning. The study of Lee and Klemmer (2005) helped this research in understanding the mechanism of notes sharing technically through different types of technologies. In addition, the outcomes of that study

encouraged this PhD research to formulate the idea of mobile technology to be included into different learning context, such as field trips in order to share experiences among students.

Buttfield-Addison et al (2012) discussed the findings of research that aimed to fit the tablet devices into the process of collecting and managing information and to evolve the role of these devices in personal information management. In this research, “tablet” was referred to as the portable computing device with a diagonal screen size of greater than 7” that is larger than a smart phone and the primary method of interaction is touch screen. The tablet was fitted with the micro note lifecycle, which is an invaluable lens through which to understand the role of tablet devices in Personal Information Management. The micro note enabled brief messages to be recorded by people to themselves. It worked like an appointment reminder, to do list, mobile address and telephone numbers (Lin et al., 2004). Figure 2.3 shows that the five stages of a micro note lifecycle are to: record, transfer, refer, complete and archive or dispose; these stages were designed based on the work by Lin et al. (2004).

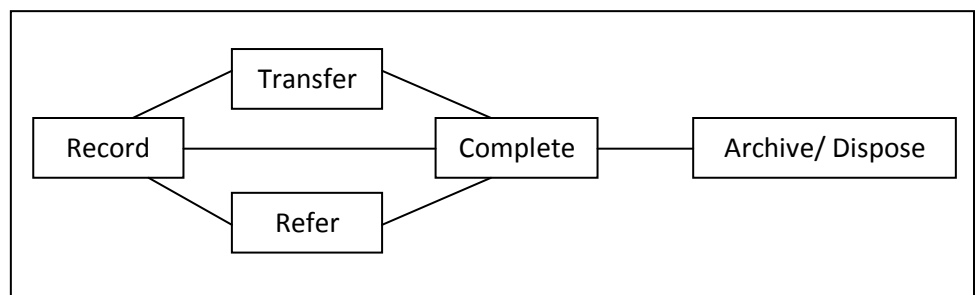


Figure 2.3: The Stage of the micronote lifecycle used as a lens for (Buttfield-Addison et al, 2012) work which has been designed based on Lin et al (2004).

The participants in the study of Buttfield-Addison (2012) were divided into two groups based on their experience of using the device; the heavy use users and the occasional use users. The heavy users were those users who use or attempt to use their tablet for almost all of their everyday personal information management activities. Whereas, the occasional users are those who use their tablet on a daily basis, but do not integrate it in everyday personal information management activities. The study found and emphasized the change in individual treatment for the micro notes when compared with the behaviour observed in past studies. It was found that the users took more notes to keep for a longer period of time, and share them with friends and colleagues. The tangible benefits the users experienced in their daily tasks, the tablet devices were related to use of that, and some ways meet the goal of the micro notes system stages. It also enhanced the users experience in their daily personal information management activities. The study concluded that, due to the increasing development of technology, and therefore the use of tablets, the ideas in the study need to be re-evaluated in terms of their impact on personal note taking with respect to the complexity of paper usage. This complexity comes about because the use of papers in recording micro notes is required to archive or dispose the old information, in addition to the time consuming of transferring information to digital means or emails.

The research of Buttfield-Addison (2012) provided a significant input in the research work reported in this thesis. Firstly, it assisted in understanding the nature of using this type of smart mobile devices (tablet) which would be addressed in this research as well. Recognising the advantages and disadvantages of using this tool in the context of note taking helped in discover the technique of informal note taking by using tablet device.

Moreover, as the study illustrated the life cycle of micro notes in general in addition to the different behaviours in treating these notes. It helped this research in identifying and studying the students behaviours in dealing with their field notes including recording, sharing, and documenting these notes.

2.4.4 Use of Mobile Devices in Educational Field Trips

The rapid development in mobile technology, over the last decade, has had a measureable impact on the natural field of Science. Mobile technology offers massive opportunities, such as increasing the portability and processing power of different field tools and devices. For example, the different services that are provided over the wireless Internet connection such as GPS (Global Positioning System) and GIS (Geographic Information Systems), allow the use of mobile technology in the field to be applied at three different stages. For instance, mobile technology can be used before the field trip to prepare materials such electronic handouts and instructions, or during the field trip when data is collected, or after the field trip for data analysis and presenting the work (Beddall-Hill, 2012).

Several studies have applied mobile technology for use in educational field trips. Kravcik et al. (2004) developed a mobile system called RAFT (Remote Accessible Field Trips) that enabled virtual field trips to support students in active, collaborative and sustainable learning. The RAFT applied a real time interaction link between the activity that takes place during field trips and classrooms. In another words, the RAFT philosophy creates a means for web-based tools between the classroom students and the students in the field trip, in terms of allowing real time interaction between them. The mobile collector is another

example of a portable tablet PC that has been equipped with a camera, microphone and wireless communication. The mobile collector application allows images to be captured, and allows the observer to preview the images as a thumbnail view of collected data for easy navigation. The synchronisation channel can be provided over a video conferencing system such as Flash Meeting, which was been applied in their project. The Mobile Collector has been regarded as a useful tool, because it is easy to understand and easy to use in the field. However, there is a learning experience when applied the PC and mobile apps. Kravick et al. (2004) mentioned the importance of applying an introduction course for the students, so that they could become familiar with all of the features of the system. Like mobile collector, Kravick et al. (2004) also agreed that the mobile technologies being used could enhance the learning opportunities during the real time interaction field trips.

Rost and Holmquist (2008) presented a study where a mobile capturing tool and data browser was used to support students in capturing data and collaborating in the field trip. The study took place in a university course which taught ethnography and design. In this course, the students worked in groups studying a workplace of their choice. They started their work by taking two weeks out in the field to collect data, take notes and photos, record audio and videos.

The system sets up a wiki to upload field notes and materials where university students are required to participate in a field trip to observe and collect data. The study deployed three different tools to embed in the field. The first is a mobile tool which has been designed to collect data and automatically upload to a previously established wiki. The students could download the

program on their mobile phone so they can capture photos, record videos and audio notes, in addition to writing simple text notes. The second tool, the awareness tool, allows the students to browse the wiki to see what other students have uploaded. The third one is a novel browser tool, which relates the collected objects by both time and location.

The result of the study showed that the students used the mobile application for taking photos and for recording videos only. The wiki browser was used to review and discuss photos and the video that they needed for their analysis. In general, the students found the system to be a powerful and useful tool in the field, especially because of the usability in uploading all of the materials into the wiki was no effort. In the future, the authors of this study believe that there will be an extensive application of mobile devices for capturing and sharing digital media. Therefore, applying mobile technology in the study of Rost and Holmquist (2008) as a tool for collecting data in the field trip supported designing the concepts of this research.

The last example of mobile devices in the field comes from research developed by Ryokai et al. (2011). The study presents the GreenHat system, which is a combination of two different tools.

1. GreenHat Mobile: a mobile application that can be run on GPS- enabled smart devices such as Android phones or the iPhone.
2. GreenHat Web View: a website, which collects data from multiple users.

The aim of this study was to help students learn about sustainability from their surroundings from an expert's point of

view, by simulating how experts go about making observations in the field in order to enhance the students' observation ability in their environment. The system was designed using the three core features of mobile learning: capture, access and connect to enable students capture their observations in the field through text, photos and audio. In addition, the system automatically generated time and location metadata. The system also allowed the students to access more information. For instance, a request can be made by the student to the system to alert the student as to when they are close to an interesting opportunity to learn that is based on a previously tagged location. The GreenHat system supported the collaboration between the students through the GreenHat Web view website. The students could view a common map marked with students' observations and the locations being used. It also helped to develop collaborative conversation between students around each other's fieldwork. Findings suggested that access to the experts' perspective regarding the field trip activities through the GreenHat Mobile application and Web View, encouraged the students to actively observe the physical environment around them and support them in providing more contextual evidence for their responses to the fieldwork. These are examples of how mobile technology may enhancing student learning experiences in field trips and predicts what the future might be for the technology.

2.5 Related Studies

There has been an increase in the growth of electronic note taking tools. Most of these include photos and video apps used in the educational sector to support students in collecting their notes and capturing knowledge in the field. There have been several

investigations into the impact of using electronic note-taking technology to enhance the field trip experience. Most of these were conducted between 2006 and 2012. For instance, ButterflyNet project (Yeh et al., 2006). The ButterflyNet project is a designed mobile system that contributed techniques that simplify the capture, structure, access and transformation of heterogeneous information. It integrated paper notes with digital photographs captured during field research and then it facilitates the transfer of capturing content to spreadsheets to enable the biologists to share their work. The ButterflyNet study inspired this research by replacing the combined equipment with smart devices, which have all of these features embedded into one single device.

In 2006, a project called Mobile Clinical E-portfolio for Nursing and Medical Students, Using Wireless Personal Digital Assistants (PDAs) took place at the School of Nursing at the University of British Columbia. They ran this project with the aim of providing students' with immediate remote access to clinical experiences and resources and for them to record their clinical experience in a variety of media. In addition, the study aimed to support and improve clinical learning and reflective learning in practice. The main research question was: what are the students' perceptions of PDA-based reference tools and a clinical portfolio in supporting their clinical learning? Moreover, this project was based on John's (1995) model of experiential learning theory. In addition to these studies, the Microsoft Pocket PC/Windows mobile platform was used as the handheld device during the *mobile clinical e-portfolio* research. The software was a mobile application that provided: access to clinical placement information; the ability to record experiences from their clinical practice (such as photos, text, voice and video); and secure wireless synchronisation with the user's personal web-based portfolio from any remote location. One of

the advantages of this application was that it allowed teachers to access their students' portfolios and adds comments. Furthermore, this project considered the ethical issues that could face the healthcare students during the capturing of their experiences; it prevented the capture of any personal identifiable patient information. Also, any pictures of patients required written consent of the patient without showing the identity of the person in the image. The project was run with ten final year nursing practice and medical students as participants; they used the handheld devices for three days per week over three months.

The project highlighted several interesting findings about embedding PDAs into the clinical field. The students mainly used the PDAs as a reference tool rather than data recording and communication devices. The major reason behind this was because they had their own mobile devices that they preferred to use rather than the temporary PDAs, especially for communications and recording data. Furthermore, the e-portfolio was not used as frequently either. Several students felt that documenting clinical reflection was not feasible during the job as they were too busy; however, they did complete the reflection element once a week to record all their clinical reflections in a single action. In addition, they liked the electronic format and the ability for teachers to comment (Garrett and Jackson, 2006).

In addition, a study by Priestnall et al. (2009) compared a number of different mobile technologies with regard to how well they could be used to complement and enhance the personal experience of geography students in field visits. These different techniques were: pre-prepared acetate overlay of the visual scene; the mScape location-based software running on GPS-enable mobile phone; a head-mounted virtual reality display; a custom-

designed visitor guide running on a PDA; and Google earth on a tablet PC.

Whilst the students found using the mobile techniques interesting, they identified a number of issues relating to the usability of design of the media and information used through these technologies; such as the ease of user interaction, the size and visibility of the screen, the simplicity of design, and the ease of associating information with the landscape. These usability issues help in designing the mobile device requirements in the field. In addition, Priestnall et al's study also found evidence concerning the student's appreciation of using handheld devices in the field and how these handheld devices allow the students to keep with them the data they find that is relevant to their field experiences.

The mobile learning application known as the Lilly Pad project was used by a team of environmental scientists and students to make sense of their on-going observations when measuring the effects of different planting methods for environmental restoration (Rogers et al., 2010). The Lilly Pad project aimed to develop mobile collaborative tools that can facilitate the fluid movement between observing what is in the physical world, whilst collecting and recording real data in databases. The Lilly Pad project compared one database with previously stored data, analysing it, using visualisations, and using this to generate hypotheses and draw conclusions that can be tested in the field.

The follow-up study conducted in 2009 aimed at implementing a wireless handheld learning environment, taking advantage of the mobility and wireless connectivity of handhelds, to support students' learning in the clinical setting and to facilitate increased

interaction among students and teachers. Moreover, this particular study aimed to help students to make links between theory and practice during their final stage of professional training. This study involved the design of a mobile application containing a number of fundamental functions intended to help nursing students during their practice sessions. For example, the application contained general-purpose tools, such as a message board and discussion forum, as well as psychiatric nursing practice-like symptom assessment scales and a nursing dictionary. It also provided online tools to support students, such as a patient ABC. Students could also use reflective journals that encouraged them to reflect upon what had occurred during daily practice in addition to capturing their behaviour and emotions during the practical task. Moreover, this application located helpful documents and links so the nursing students could refer to: online discussions with peers; a portfolio to organise homework and individual learning materials; a concept mind-mapping application; and an interview feature that allowed the nurses to record audio conversations with patients (Wu and Lai, 2009).

Moreover, Weng et al. (2012) introduced a project called GeoTools. This was an android application to be used in geologic field trips. It supported the field scientists in collecting and managing the data. The application enabled multitasks such as coordinating GPS signals, taking notes and photos, recording voice notes and video clips, measuring “strike and dip” and organising the data in a simple archive.

The GeoTool demonstrated that the benefits of using smart phones with the right software save the field scientists the trouble of carrying a range of tools to the field. They also assist in recording the data digitally and managing them effectively.

And lastly, a work by Li et al. (2012) uses the SketchComm tool. It enables designers to capture and share contextual information, in addition to sharing sketches with the audience asynchronously. The work has proved that the tool enhances the effectiveness of communication and capturing rich and flexible creative experiences in early design ideas.

The ButterflyNet project, the Lilly Pad project, and SketchComm are all illustrations of innovative ideas that are evolving to enhance data capture and sharing in field locations and enrich the learning experience for all.

2.6 Discussion of Literature

2.6.1 Novel Part and Bridging the Gap of this research

This chapter aimed to discuss the relevant theoretical perspectives that can be used to guide the research process. It focuses on the role of mobile technology in supporting capturing and sharing experiences during education field trip activities.

Several studies have inspired and shaped the research concepts outlined in this thesis. According to a study of a five-day field course that was conducted by Emmons (1997) the direct and shared experience of the field investigation can result in an effective strategy to facilitate students' learning. Moreover, Rieger and Gay's (1997) research found field trips to be a very effective mode to teach and provide popular and memorable experiences for the students as well as understanding aspects of natural sciences. Maskall and Stokes (2008) support the concept of using mobile devices to support data collection and analysis. They believe that using these devices add benefits during the learning

process by providing quick feedback from peers and tutors which can be used to directly make changes.

However, there is existing research to suggest that there is a difference between applying the technology into a fieldwork for the sake of technology and applying a mobile technology to enhance the fieldwork (Wentzel et al, 2005). Based on these findings, this research aims to fill-in the highlighted gaps in the literature as outlined below:

- To understand the role of mobile technology in supporting note taking activities, as a primary method to capture and share the experience in the field. Also, the focus will be to evaluate the impact of using these devices to enhance the field experiences for geography and architecture students.
- As mentioned previously, numerous studies have focused on using mobile devices to support field trips. However, the majority of them were designed with a specific mobile system in mind, which then allowed for an evaluation and testing of the implementation of this system on the specific students' learning in the field. None of these studies tested the smart mobile devices, such as smart phones, or tablet PCs, which have experienced rapid growth during the years this research has been under way.
- Also, previous research has focused on the educational outcomes rather than usability and usefulness of using mobile devices. Few of these address concerns about the efficiency and usability issues in using these devices. This research attempts to fill the gap by studying the impact of using mobile

technology and how it could, in effect, replace the traditional methods of capturing and sharing experiences in the field.

- Finally, this study aims to fill the gap by examining the number of students who prefer to use electronic devices over paper-based tools in the field trip context.

3. Methodology

3.1 Introduction and Aims

This chapter describes the methodological perspective applied in this research. A general introduction to qualitative research methodology is first described before detailing methods applicable to user-centred research in HCI and the specific methods used to address the research questions for each stage of the research.

3.2 Research Approach

There is a strong dependence on quantitative and experimental approaches in the scientific research. However, the need for studying socially-based phenomena in HCI research requires use of different approaches. The qualitative approach provides methods to understand the complex based phenomena which cannot be easily quantified (Adams et al, 2008), such as understanding how people contribute to different phenomena in their life, or describing the experience that people have in their world (Merriam, 2009). The qualitative research approach is defined as “research that involves analysing and interpreting texts and interviews in order to discover meaningful patterns descriptive of a particular phenomenon” (Auerbach and Silverstein, 2003, p. 3). Denzin and Lincoln (2005) defined the qualitative approach in terms of the process and context of data collection as follows: “Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes,

interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them” (p. 3).

The strength of this approach lies in the ability to present the complexity of user experience, motivation, and expectation and so on, in regards to the research issues, in addition to the ability in describing the human side in the research such as the user beliefs, attitudes, behaviours and relationships of individuals (Mack et al, 2005). Mack et al (2005) argue that qualitative methods are considered more flexible and effective than quantitative methods. Moreover, the use of mostly open-ended questions in qualitative research makes this more effective for identifying user identities and social norms. Besides, as open-ended questions do not require the same type of responses from each participant, these methods are more flexible because the participants are free to answer in their own words (Fraser, 2004; Guest et al, 2012).

Consequently, the interaction between the researcher and the participants is more fluid and adaptable than in quantitative methods (Mack et al, 2005).

Moreover, Razavim and Iverson (2006) point out that, within HCI, designing and implementing an effective system requires more than focusing on the tasks; it needs an understanding of how usability issues are personally and communally experienced by users. Therefore, there is an increasing need for HCI researchers to use a qualitative approach in order to study human interaction with technology, in order to understanding the users’ behaviours,

attitudes, perspectives and emotions rather than measuring the users' performance (Adams et al, 2008).

Based on the nature of this research, it was decided to apply the qualitative research approach in order to investigate and explore the research topics and provide a complete detailed description of them. Several qualitative methods e.g. observation, interview, questionnaire, case studies, and card sorting, will be applied through different stages in the research. It is envisaged that integrating a variety of qualitative methods rather than selecting one method would provide the opportunity for triangulation of data analysis and thus facilitate verification of conclusions that would not possible from use of single methods.

3.2.1 The Research Design

The use of qualitative methods provides a number of advantages for design of studies to be conducted in a social context. For example, Flick (2009) mentioned the benefit of collecting data from various social and cultural background which otherwise would be difficult. Guest et al (2012) suggested that the major advantage of a qualitative approach is the ability to investigate responses to gain further detailed explanations and descriptions. Anticipated answers of "how" and "why" questions provide rich and in-depth clarifications of human experiences, behaviours, and beliefs.

Several HCI research projects have used qualitative methodology design. For instance, Millen (2000) conducted a case study approach in the "Thinking Spaces" project which aimed to study how the use of the internet could change the way people work and conduct their business in the future. This study applied a

qualitative rapid ethnography approach in order to discover the natural context of use and develop an understanding of the changes that may occur. The qualitative rapid ethnography approach is “A collection of field methods intended to provide a reasonable understanding of users and their activities given significant time pressures and limited time in the field” (Millen, 2000, p.280). The significant aspects of this approach include applying time-efficient techniques by using multiple observers, observation techniques, and collaborative qualitative data analysis in order to constrain the research scope. Millen (2000) suggested that the use of the qualitative rapid ethnography approach can provide a better understanding of the users, the environments, and the interaction between both of them.

3.3 User Centred Design and Related Methods

3.3.1 User Centred Design Approach

User Centred Design is a broad term which was firstly used in the 1980s by Norman and Draper (1986). It focuses on involving real users and their experiences throughout the technology design research process in order to develop more efficient, effective and suitable products (Abrams et al, 2004). Having direct contact with real users and understanding their experiences helps the researchers to manage the risks of technology development and increase the chance of system success (Nielson, 2001). The main aim of the user centred design approach is to enhance the usability aspects of the designed product instead of forcing the users to change the way that they interact with the product (Kahraman, 2010). Therefore, the benefits of the user centred research methodology in technology development research are: to reduce the potential for poorly designed or misused technology

and to provide an insight into the complex relationships between people and technology. The user centred research methodology is also a powerful method of research development for the designers as it helps to gain a full understanding of the actual practice, habits and needs of the users, for whom they are designing, rather than having to rely on their own perceptions (Lofthous and Lilley, 2006).

However, the concept of user-centred systems design is sometimes seen as lacking specific definitions. On the negative side, the ambiguity makes it difficult to develop a cumulative body of knowledge that lends itself to developing a unique technology. On the positive side, Karat (1997) makes the case that UCD is an “adequate label under which to continue to gather our knowledge of how to develop usable systems. It captures a commitment the usability community supports—that you must involve users in system design—while leaving fairly open how this is accomplished.”

To demonstrate the viability of this process, Gulliksen et al. (2003) conducted a study that utilised these principles. The pilot project was an in-house development project within the Swedish National Tax Board whose goal was to develop a computerised case handling system to work with national registration. The project aim was to introduce changes in the development process to address user involvement and usability issues, and to observe and record the outcomes of these changes. At the end of the project, the researchers concluded that, even with a commitment to apply UCD principles with a usability focus, usability can get lost in the software development process. There were trade-offs between model-driven approaches that relied on skilful designers and developers using abstract models and user-centred design

principles that reduced user involvement to being mere informants rather than co-designers. Summing up their experience, they concluded that user-centred systems design must be defined at the onset of the process where the work and involvement of users can be tightly integrated with the development process whereby a new paradigm evolves that brings about a profound shift of attitudes a truly user-centred approach towards systems development and user involvement.

Therefore, to gain the benefits of applying a User-centred design approach in this research it was decided to involve the users in the different research stages such as during defining the system requirements, system development, and evaluation.

3.3.2 Research Framework

The user centred approach involves four main interactive activities as shown in Figure 3.1. These four basic activities present the simple interaction design life cycle model described by Preece et al (2011).

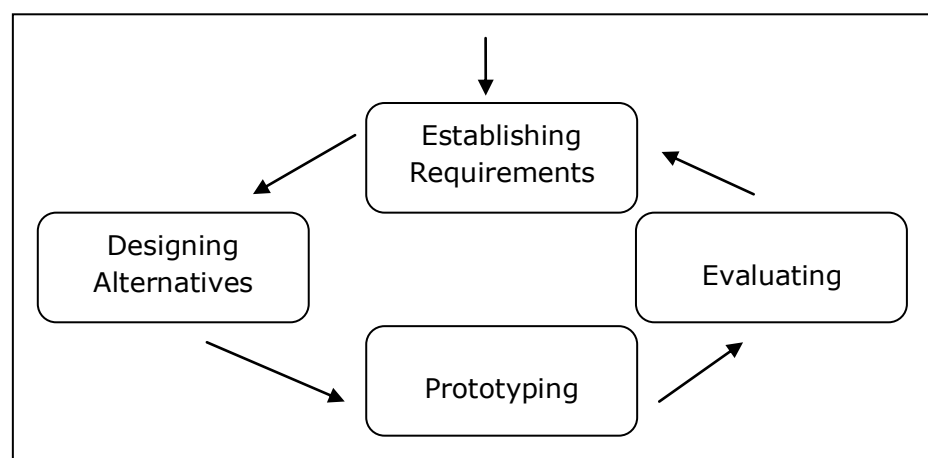


Figure 3.1: A Simple Interaction Design Life cycle Model

In the user centred design approach these four basic activities are intended to identify information about users and goals and not about technology itself. The process starts with establishing requirements which aims to provide a full understanding of the user's needs and their interaction with the environments. This step is described in chapter 4 in this thesis.

The next stage of the process is designing alternatives. This may include designing a conceptual model for the product and requirements that are needed to understand what users can do, and how they would interact with the design product, in addition to outlining what the users can achieve by using the product. This activity is described in chapter 5.

Prototyping is the next stage which aims to design an initial or redesign an existing product using prototyping techniques. The goal of this step is to identify the interaction problems in the early stages of design. This step is described in chapter 6.

Finally, the evaluation stage aims to evaluate the usability and acceptability of technology adoption in the real research context. This step is presented in chapter 7 in order to determine how well adapting the mobile technology would match the user requirements.

There are number of HCI studies which have applied this framework model in their work (e.g. Millen, 2000; Yeh et al, 2006; Rogers et al, 2010). These studies have been described in detail in the literature review chapter.

3.3.3 Research Methods

Kjeldskov and Graham (2003) reported that the use of mobile technology is difficult to emulate in a laboratory setting. However, field study offers the ideal opportunity to identify the user needs and translate that into new or existing design. It provides the ability for integrating detailed data from the research context in a short time. The following methods were applied in this research in order to answer the research questions. These are observation, interview, questionnaire, case study and card sorting.

These methods have been applied in several studies relevant to the nature of this research. For example, Yeh et al. (2006), Priestnall et al. (2009) and Rogers et al. (2010) applied observation methods to understand the user interaction and behaviours with specific technologies in the context of use. In addition, interview methods were applied in the work of Rogers et al (2010). Yeh et al. (2006) applied a questionnaire to gather the details of users' behaviours and actions after a laboratory study. The following sections present an analysis of user centred research methods relating to this research.

- **Observation**

In general, observation is a technique where researchers watch participants at a place of work. In this domain researchers are then able to develop an understanding of the users' perceptions in relation to the research, which allows researchers to then explore in detail the user's physical view of the domain being addressed, against alternative evaluation product designs (Kothari, 2011). Observation can also provide specific information about aspects such as workload and interdependencies (Wilson and Corlett, 1990). There are a variety of observation types but, in

general, direct observation is the most suitable method for this research. This method involves the collection of information on subject performance, which is directly observed by the researchers themselves, or from objective recording of subject behaviour (Newman, 1998). Using this method yields a large amount of information that helps in understanding user opinion and behaviours in the context of use. In addition, this method allows gathering different types of data such as the user interaction, action and behaviour; as well as the nature of the work environment (Wilson and Corlett, 2005).

- **Interview**

The interview is a technique that aims to develop a conversation with users to explore in detail a given domain of interest or/and opinion about the proposed product development. Thus, it offers a flexible approach to data collection (Wilson and Corlett, 1990).

In general, interviews may be structured or semi-structured. Maiden and Rugg (1996) and Stanton et al (2005) report that a semi-structured interview allows the interviewer to ask the interviewee about a topic with a prepared list of questions, but without a resolute order. This allows the interview to be an informal discussion and facilitates collection of a wide variety of data, such as the participant's knowledge, views, understanding, interpretation, experience and interaction (Wilson and Corlett, 2005). Therefore, this technique can be useful to help provide more in-depth explanation of data which has been collected from other methods.

- **Questionnaire**

This method gives the researcher more subjective information from respondents (Brace, 2013). In addition, the questionnaire

method is considered to be a low cost method for data collection and processing and can be useful to provide opinions from users about specific questions which may help to explain the information which has been collected from different method such as observation (Oppenheim, 2000).

- **Card Sorting**

Card sorting is a method used in which the researcher tries to understand how users organise their information and ideas and this is achieved by asking users to sort through a set of cards; each card contains a function or a piece of information related to the system and as the user sorts through the cards this demonstrates how the user then organises their ideas and information (Cooper, 2007). According to Faiks and Hyland (2000), this technique has been shown to be a highly effective and valuable method for gathering user input on organised grouping prior to total system design. Moreover, this particular method is an effective means of discovering the optimal organisation of information for potential users' viewpoints as argued by Wood and Wood (2008).

- **Case Study**

The case study method is one of several methods that is applied in social science research and used to understand a situation, group, or organisation of interest (Robson, 2011). It requires extensive involvement into the real life of people to manage potential technical distinctive situation (Yin, 2009). In case studies, it is common to study more than a single case. Yin (2009) considers that studying more than a single case study is akin to multiple studies. Multiple case examples are analysed in order to generalise the findings to extended population (Robson, 2011).

3.4 Participants

In this research, there were three different case studies from different backgrounds: An initial study to establish the research methods was conducted with a convenience sample of undergraduate nursing students from Saudi Arabia. Then, the research focused on undergraduate geography and architecture students attending field study trips in the UK. The main similarity between these case studies was that they all depend on practical learning in the field. However, the nature of field trips in each of these case studies was different. For example, the nature of field trip in the nursing learning refers to the clinical practice in the hospital. Whereas, the geography field trip takes place in a harsh rural area with a low access to electricity connections, whilst the architects usually go to visit construction sites and urban areas. It was therefore anticipated that studying different these three field trip contexts would enrich the outcomes of this research.

3.5 Analysis Approach

In social sciences, various methodologies are used to analysis the collective data from qualitative approach and these methods have been used in HCI research (Suchman, 1987; Fafchamps, 1991). For example, a thematic based content analysis method (TBCA) can be applied to analyse the qualitative data which has been collected through different methods. Theme Based Content Analysis is a qualitative method which focuses on identifying and describing both implicit and explicit ideas within themes (Guest and MacQueen, 2012). In this method, the data would first be divided into meaningful codes (Neale and Nichols, 2001). Then through analysing the data, the codes are used to identify themes and link them to the research questions. There are different methods for

presenting the identified themes. For instance: by identifying code co-occurrence, or by comparing the code frequencies, in addition to presenting the codes relationships graphically (Guest and MacQueen, 2012).

Neale and Nichols (2001) argue that the thematic based content analysis method is compatible with different data forms which are collected through different data collection methods such as: open-ended questionnaire, observation, and interview.

Adams et al (2008) found that this approach frequently supports analysis of many HCI interaction projects because it can be related to patterns of experience. Guest and MacQueen (2012) pointed out that this approach is still the most useful approach to capture the complexity of meaning in qualitative research. For example, a study by Stanton et al (2001) aimed to design a tangible interface to the KidPad collaborative drawing tool in order to support interactive storytelling activity within classroom environments. In this study, theme based content analysis was applied to analyse the researcher's journal entries.

The benefits of applying this approach are providing a flexible procedure to integrate useful and detailed information about user opinions and behaviours. In addition, the process of data analysis is less- time consuming than other approaches such as grounded theory method which is started by break the data down, then put it back in a new conceptualised way (Strauss and Corbin, 1990), and the analysed results can be presented in a simple format which allows clear feedback of user explanations (Neale and Nichols, 2001). Therefore, this analysis approach is applied to analysis the qualitative finding from observation and interview methods at particular stages from this research.

The scenario method is a storytelling method which aims to illustrate the user context in a descriptive way in order to understand the user situations and therefore aid in usability decisions (Guljónsdóttir and Lindquist, 2008). Carroll (2000) describes the scenario method as a sequence of actions which include characteristics such as an actor (user), a goal (task), and a setting (context of use) without including any details about the design decisions. The effectiveness of this tool makes it popular in interactive system design research because it provides a method to facilitate rapid communication between the usage possibilities and the user concerns, i.e. by using storyboard researchers can clearly illustrate the essential interaction design elements (Rosson and Carroll, 2009).

3.6 User Centred Research Methods applied in this Research

3.6.1 Multiplicity of User Centred Research Methods

As has been suggested, the qualitative approach includes a variety of methods that provide different ways of examining and interpreting the same phenomena. Whilst each method can be used alone, there is no one single purpose method because each has different strengths and weaknesses (some of these are discussed in the following section). It is therefore recommended that researchers should not focus on a single technique, but use several different methods in combination to help to balance and complement each other, and to avoid biases which are inherent in any one approach (Preece et al, 2011).

Each stage of the research activities conducted in this PhD research employed a multiplicity of user centred methods as described in the sections below.

However, it is worth mentioning that there are a number of methods that could be chosen to be applied in different stages in this research but, for the reasons listed below, these methods may be substituted. For instance, the participant observation method could be applied instead of observing the students in the field trip, but it has limitations which could negatively affect the study. Also, the participant observation method is difficult for documenting data because the researcher has to actively participate in the event as well as observing the participants. This makes documenting the experience difficult because the researcher has to rely on his memory to record what was observed (Mack et al., 2005). Moreover, the focus group method could be used instead of interviewing the participants after the field trip. However, in this research case, it was difficult to obtain well organised and lively group interaction after the field trip and it was considered that there may be a risk of introducing personal biases into the study. In addition, the focus group has been argued as an expensive method for data collection (Schmidt, 2001; Knodel, 1995).

Each of these methods has advantages and disadvantages. In the end, the methods selected were those considered to provide the information to address the research questions of interest. These are described below according to the stage of research in which they were implemented.

3.6.2 Methods Applied in Chapter 4 (Understanding User Requirements in Context) and Chapter 5 (Conceptual Design: Developing the initial conceptual model)

The first stage of this research aimed to provide an understanding of the user, user requirements and their current experiences and activities in the context of use.

Research Questions Addressed in this Chapter

RQ 1: How do students capture and share their learning experiences in the field trip

- **What is the meaning of learning and field experience during the field trip?**
- **What kinds of tools are suitable to capture and share the learning experience in the field?**
- **What are the user requirements of mobile technology to support capturing and sharing learning experiences during the field trip?**

To investigate the possibility of applying mobile technology for capturing and sharing learning experience in the field, direct and indirect observation methods were applied during initial field trip visits for the researcher to gain an initial understanding of the user's behaviour during the field trip. These methods were used to allow for an understanding of the user's activities in capturing and sharing experience in the field, in addition to identifying the meaning of experiences in the field context.

A semi-structured interview was conducted to understand how the user captures the experience in the field. This provided the researcher with more detailed information to gain a deeper

understanding of the users' needs and information about the users' activities, their portfolios, notes and tools that they use to capture their knowledge and experiences in the field.

During this stage an open card sorting technique was applied in order to gather the user's input on organising the prior of the system requirements. The use of both of these methods allowed the researcher to gain a detailed understanding of user's needs and requirements for information capture and sharing which could then be used to identify system requirements of mobile technology to be used in field trips.

3.6.3 Methods Applied in Chapter 6 (Understanding the Use of Mobile Technology in the Field)

The second research activity dealt with the second research question of understanding the contextual influences on the user experience in using mobile devices in the field trip.

Research Questions Addressed in this Chapter

RQ 2: How does the Mobile Technology Impact Upon the capturing of learning experience during the Field Trip?

- **What kind of learning experience do the students capture in the field by using mobile devices?**
 - **What are the usage implications of mobile technology to enhance field experience in the field?**
 - **What are the key contextual factors that affect the use of mobile technology during the field trip to capture and share learning experience?**
-

Based on the need to understand action in the situation, two studies have been used which combined the methods of observation and interview, there were undertaken during the field trips with Geography and Architecture students. Using mobile devices helped to identify the kind of learning experiences the students could capture and share during the field trip.

Moreover, the use of semi-structured interviews which were carried out with participants after they had finished the field trip, helped to validate the direct observations.

3.6.4 Methods applied in Chapter 7 (Investigate the effect of using mobile devices to capture and share experience in the field)

Research Questions Addressed in this Chapter

RQ 3: What is the potential for mobile technology to contribute to the aspects of capturing the learning experience during the field trip?

To investigate the potential usability of mobile technology in enhancing the field experience during the field trip, the researcher conducted a comparative study to evaluate the usability issues of mobile technology in capturing and sharing learning experience.

The methods applied in this study were observation followed by a questionnaire. The observation was used to identify differences in use of three different tools for capturing and sharing experiences in the field. Therefore, this method was used to identify positive

and negative, contributions of mobile technology in the field. The questionnaire was used after the observation to clarify the participant's responses. This also contributes to a deeper understanding of the data collection from the observation.

3.7 Reliability and Validation

The substantial philosophy of the research described in this thesis is user centred research, which entails a variety of standard methods, including observation, interview, and card sorting. Whilst conducting this research, the author tried to maximize the reliability and validity of the information gained. Reliability of a particular research method refers to its ability to give the same results if applied repeatedly to the same study conditions and this can be affected by different sources from participants and the observer, such as observer error, observer bias, participant bias and participant error (Babbie, 1998; Robson, 2011).

In contrast, validity refers to whether or not a particular indicator measures what it is intended to measure, rather than some other phenomenon (Robson, 2011; Carmines and Zeller, 1979). There are various aspects that could affect the validity of research such as: not considering explanations, or a lack of understanding of the study phenomena, generating inaccurate or incomplete data and incorrect interpretation. In fact, validating the information is what makes it appropriate, useful and meaningful (Gregory, 1992).

As Jick (1979) argues, triangulation is a powerful technique, in that it uses a combination of sources or methods to study the same phenomena in order to enhance its validity. The triangulation technique has been used during the course of this research to

study the impact of mobile technology on capturing and sharing the experience during field trips. For instance, using the methods of observation and interview in studies that took place at different times, in different places with different participants, enable comparison of finding from multiple resources. Triangulation enhances the reliability of the information gathered once the results are consistent, because it shows that the same data collection methods produce the same results even from different information resources. Triangulation has also been applied to improve the validity of these research findings. Using, collecting and measuring different data types, which have been produced from different methods, enhances the validity of the information. In addition, the researcher can better understand the problem domain by allowing interpretation to emerge without preconceptions about cause and effect. The focus is on the research within the real usage context and thereby improves the validity of the research undertaken.

3.8 Conclusion

This chapter has outlined a range of user centred research methods which have been applied in this research, with a focus on qualitative methods. Multiple methods were applied in a triangulation technique, in a flexible way by combining and balancing each method. This technique provides rich information to address the answering the research questions, as well as improving the reliability and validity of this research. Figure 3.2 illustrates a summary map of the interactive model of the research design which has been designed based on a model for qualitative research by Maxwell (2012).

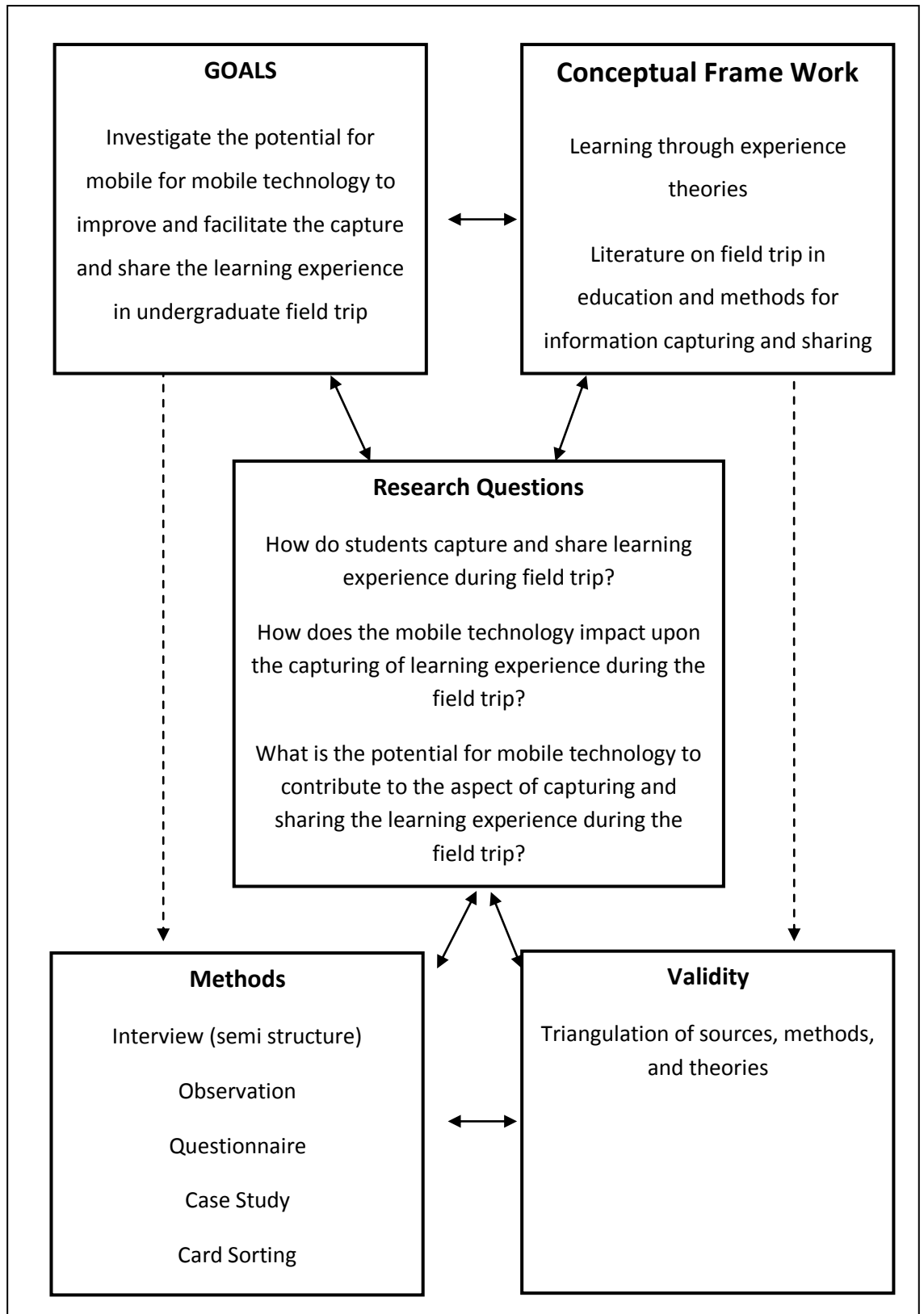


Figure 3.2: A Design Map of the Interactive Model of the Research Design

4. Understanding User Requirements in Context

4.1 Introduction and Aims

This chapter presents the research conducted for the first stage in the interaction design lifecycle which aims to understand the user requirements for use of technology, during field trips.

In order to do this, three case studies were conducted to understand the nature of information capture and sharing used by undergraduate students for development of knowledge and practical skills in three disciplines: nursing, geography and architecture. The outcomes were used to develop guidelines for designing a mobile device, which can be used by students during field trips to capture and share their learning experiences with each other.

In this chapter, the following questions are addressed:

Research Questions Addressed in this Chapter

RQ 1: How do students capture and share their learning experiences in the field trip

- **What is the meaning of learning and field experience during the field trip?**
 - **What kinds of tools are suitable to capture and share the learning experience in the field?**
 - **What are the user requirements of mobile technology to support capturing and sharing learning experiences during the field trip?**
-

4.2 Case Study 1: Nursing Clinical context

The purpose of this study was to explore how mobile technology could help in capturing and sharing experiences in the early stages of clinical practice. The reason for selection of this case study was

partly opportunistic as an opportunity was presented to the author to observe nursing students at her previous workplace in Saudi Arabia. This offered two advantages to the research: an opportunity to test and develop the use of qualitative research methods to record and analyse data, and to provide an understanding of a different higher education learning context to give the author a wider perspective on the requirements and potential for use of mobile technology to support students in information capture and sharing.

Research conducted by Dornan et al. (2005) indicates the importance of early experience in medical education to support student learning outcomes that are not just beneficial for students themselves, but also for teachers, patients, populations, organisations and specialties. Several studies have considered embedding mobile technology to support clinical practice in the final stages of healthcare degrees. However, research indicates that the use of mobile technology, in the early stages of clinical practice, is not evident. Consequently, this particular part of the study attempts to study the potential for use of mobile technology at the early stages of the nursing clinical practice.

Thus, the objective of this case study was to understand the kind of data that students capture during their work in a field setting.

4.2.1 Participants

The study sample consisted of 20 female undergraduate nursing students from King Saud Bin Abdul Aziz University for Health Science in Jeddah, Saudi Arabia. Two different groups participated in the study. The first group were nursing students in their final

year of their bachelor degree. They spend most of their time working at the hospital in clinical practice work. The second group of participants were nursing students in their second year of their bachelor degree. These students study clinical practice sessions at the nursing labs in the nursing college, but do not yet participate in hospital work.

4.2.2 Methods

To gain a preliminary understanding of users in this study, two types of methods were applied: interviews and observations.

There were two kinds of observation method used during this study. The first was the direct observation method, which was used to primarily observe the students in the clinical context to understand how they captured their learning experiences (LX) and knowledge. In addition, it helped to explain how mobile technology would be used in the field. The second observation method in this study was the indirect observation method which examined the material collected by the students in the field. This included observing the students' notebooks and their practical portfolios in order to understand the kind of collected data and how they use it after the clinical practice. Following the observations, a semi-structured interview was used in this study to add explanations about the observation findings. Questions used in the semi-structured interview are given in appendix A.

4.2.3 Study Description

The observation study was conducted with the second year nursing students from the nursing college at King Saud bin Abdul Aziz University for Health Sciences in Jeddah. The purpose was to

study the nursing students in their working environment in order to understand what techniques they use to capture their knowledge and learning experiences (LX) in the field. The study began with monitoring 10 students in the anatomy lab for one hour. It was observed that, when the lab began, the lab assistant taught the nurses about what they are going to learn in this session then left them to work individually. Usually, the students are provided with a hand-out of what they are going to learn during the lab session.

4.2.4 Analysis

After the data collection, the data was transcribed from the observations and individual interviews. From this, categories were identified using the theme based content analysis method. Firstly, the data was divided into meaningful codes. Then, these codes were developed through analysing the collected data to identify themes which would be later linked to the research questions. For the interview responses, the data was then organised into separate questions (for the interview) to illustrate the key theme in each question.

4.2.5 Findings

This section presents the findings of this study. It describes the clinical practices activities observed and users' behaviours, in addition to the context of use.

As already mentioned, the observation took place in the anatomy lab at the hospital. The nursing students were given hand outs at the beginning of the lab session and it was observed that they used their hand outs to write their notes about their work in the

lab. The students did that in order to memorise the work instructions. They recorded their notes in different forms, such as short sentences or as a list of bullet points. In addition, it was also observed that the students preferred to talk to each other during the lab session so as to discuss and learn from each other about particular subjects. Moreover, during the observation, it was noticed that two nursing students used their mobile phones to take pictures of how a specific device works. They commented that they thought these photos would help them to remember the information, and sometimes they preferred to extend that to record a video as well.

After the interviews were analysed, the codes were developed to emerge new themes. Themes were combined, split, or moved according to their similarity relation to each other and to the main interview questions, to produce five main themes as shown in table 4.1.

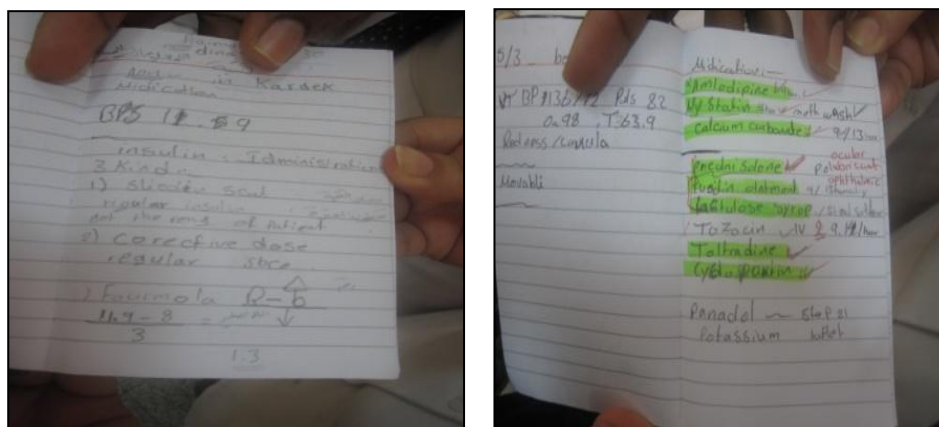
Table 4.1: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
Data Types	D01. Qualitative data D02. Digital format
Objective	O01. Awareness O02. Learning
Tools	T01. Technology T02. Paper based tools
Documentation	Doc01. Original Format
Data Sharing	S01. Formal S02. Informal

- **Theme: Data Types**

It was observed that nursing students collected different types of data in the clinical lab class. The most commonly mentioned type was qualitative data such as text information. This includes recoding notes about names of diagnoses and medicine and general patient information such as the patient file numbers for a quick access. In addition notes were made about new medical terminologies and specific clinical techniques. Examples of the layout of student's notes are presented in Figure 4.1 and show a combination of text and numbers. Some of these were written in a list and some students also used colour coding in their notes. For example, Figure 4.1 shows that some of the important information has been highlighted in a different colour. In addition, the nursing students used codes such as stars and arrows to help them to link different information to each other.

Moreover, students used a variety of multimedia formats to collect data, such as; audio recording about patients diagnoses, photos of body anatomy and clinical techniques, in addition to video clips of medical equipment and their methods of use as shown in figure 4.2.



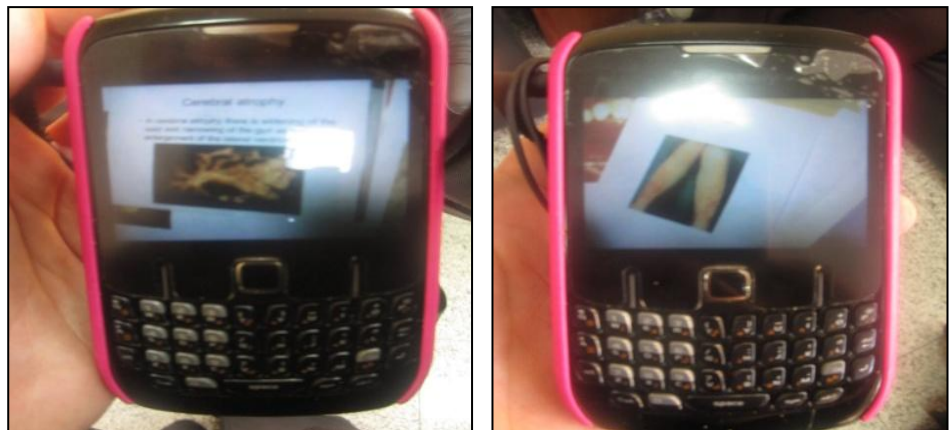
4.1: Samples of the students notes which they take during the clinical practice.

- **Theme: Learning Objective**

In the interview, the participants were asked why they collect their learning experience and two main objectives were identified:

1. Gaining knowledge from the learning experience which they collected from the field trip, and learn from that to help them in exam preparations.

2. The nursing participants who were in their final year also mentioned that the information they collected about the clinical field experience would help them in their hospital work such as completing forms about patients diagnosis, etc.



4.2: Samples of using mobile devices to record data in the clinical practice context.

- **Theme: Tools**

There were two types of tools the participants used to collect their learning experience from the clinical field. The most commonly used was paper based and it was noticed that the participants have small notebooks for note taking. In addition, the participants used their own technology such as their personal mobile phones to collect digital data.

- **Theme: Documentation**

When the participants were asked about how they transfer, save, and organise their notes after the clinical field works, the majority mentioned that they would keep it in the original format. One participant described how she would classify her notes into different documents based on the nature of data. For example, she would create a separate document to list all the new medical terms that she learns during her clinical work.

- **Theme: Data Sharing**

Finally, it was noticed that the nature of sharing learning experience activity was different between the two groups of nursing students. The nursing students who were in their final year preferred to share new medical cases they deal with, without mentioning the patient's personal information. They shared that in a formal way as they usually discussed what they observed at the clinical round with their group and their tutors. In addition, they also shared their observation and clinical experience informally with their colleagues during the break time at the hospital or on the bus when they travelled back to the school. On the other hand, the nursing students who were in their second year shared their learning experiences with their colleagues by copying each other's notes either by scanning or copying by hand. Moreover, they also shared the photos they collected by emails. They usually shared new information and knowledge they learned in the clinical practice lab whether it was in text or digital formats such as photos, or videos.

Unfortunately, due to restrictions regarding access to the nursing students, it was not possible to continue to work with this student

group for the remainder of the research. Instead, further work was conducted with higher education students from other disciplines who use field trips as part of their learning as detailed below. These provided the author with different case study contexts that could be used to study the impact of using mobile technology for students to capture and share their activities during field trips.

The nursing study provided a good basis that influenced the following studies. Learning from this study enabled the researcher to improve the design of the studies that followed.

The new case studies conducted in this research involved undergraduate geography and architecture students from universities in the UK. For both of these disciplines, field trips are an important part of student learning. Of interest to this research, it was expected that the nature of the field trips (both in terms of the context of the field trip and learning objectives) may be different for each of these groups: Usually the geography field trip takes place in a harsh rural area with intermittent access to internet connections, whilst the architects usually go to visit construction sites and urban areas. It was therefore anticipated that studying different these two field trip contexts would enrich the outcomes of this research. The following section describes the second case study conducted with the geography student groups.

4.3 Case Study 2: Geography Field Trip

The purpose of this study was to identify the student experience during their respective field trips to understand the kind of experiences and knowledge that the students would like to capture and share. Specifically, the aim of this study was to

identify the methods and tools used by the students to capture and share their experiences during the field trip.

The study was conducted in three phases, following the same procedure as had been developed in the study of nursing students:

Phase 1: direct observation of the note taking activity in the field.

Phase 2: indirect observation of the notes taken by the students during the field trip.

Phase 3: a semi structured interview with the students after the field trip.

To facilitate this case study, the author was invited to accompany undergraduate students from the University of Nottingham to observe their field trips. The geography field trip took place in the village of Malham in the Craven district of North Yorkshire in England during September 2011. In order to facilitate the analysis of the outcomes from this case study, the details of participants, study design, analysis and finding are presented in the following sections.

4.3.1 Participants

The participants in this study were 60 undergraduate students from the second year from the School of Geography at the University of Nottingham attended the geography field trip. All participants signed a consent form agreeing that the researcher could observe them and their notes during the field trip. Of these, 10 students (eight male and two female) randomly selected from the group agreed to participate in post-field trip interviews. Ethical approval for the study was awarded by the Faculty of Engineering Ethics Committee prior to the study.

4.3.2 Methods

To gain preliminary understanding of user requirements in this field study context, the same methods used in the previous nursing study were applied in this study. Two types of methods were applied; observation and interview, as described in section 4.2.2.

4.3.3 Study Description

During September 2011, the study took place during a one day field trip to Malham (North of Yorkshire, England) with 60 undergraduate geography students from the School of Geography at the University of Nottingham. The students were observed for two hours while they worked in separated groups in the field.

Each group included five students working together on a practical exercise, which the tutor explained before they climbed to the mountains. The observation was conducted with the author joining each group for 10 minutes and recording videos and taking photos of the student's activities (figure 4.3).

Once the students had returned to their residence they worked on writing a report about their work in the field and prepared a presentation to give the next day to their colleagues.

Two weeks after the field trips, a random sample of students who attended the field trip was invited to participate in a follow-up interview. The one to one interviews were conducted with 10 Geography students and a semi-structured interview method was used to obtain more detailed information about how they take notes and what techniques they used to capture and share their

experience in the field trips. During the interview session, the students were asked to show their field notes. The majority of students presented their camera devices which were used to collect photos from the field, in addition to their notebooks. A number of them presented smart phones which they used to capture multimedia elements and writing notes.



Figure 4.3 Geography students collect their experience in the field trip in Malham Sept 2011

4.3.4 Analysis

After the data was collected from the observations and individual interview, the data was first divided into meaningful codes (Neale and Nichols, 2001). Then through analysing the data, the codes were used to identify themes and link them to the research questions. There are different methods for presenting the identified themes. For instance: by identifying code co-occurrence, or by comparing the code frequencies, in addition to presenting the codes relationships graphically (Guest and MacQueen, 2012). The full description of thematic based content analysis and how

this was applied has been described in the previous chapter, (See section 3.5)

In addition, the scenario technique has been applied to present the qualitative data in this study.

4.3.5 Findings

This section illustrates the findings of this study using the scenario method to describe the context and activities conducted in the field trip and to identify user needs for data capture and sharing. A number of problems faced the students. For instance, one of the main problems was the poor phone signal and this was due to the fact that the students were working in a rural area. This prevented them from sharing their data over the internet in the field. Moreover, because the weather was rainy and windy, a number of the students used a waterproof cover to protect their notes and it was difficult to take notes in the windy weather (Figure 4.5). Instead, a number of students used their phones to take notes.

Observation during the geography field trip found that the students first divided themselves into groups of five and began by measuring the area and making notes. The work task was split amongst the group (for example, each group/person within the group, was expected to make notes, measure the areas, draw sketches and collect samples from the field). Also, the equipment used were meters, calculators, compass, GPS, special Geo equipment, pens and paper, highlighter pens, smart phones, paper maps, plants references, and the instruction sheet, which the students had to follow. During the fieldwork, the students preferred to sit and discuss their work and results together. There were field assistants to help the students and answer their questions (see Figure 4.4). A number of problems faced the

students. For instance, one of the main problems was the poor phone signal and this was due to the fact that the students were working in a rural area. This prevented them from sharing their data over the internet in the field. Moreover, because the weather was rainy and windy, a number of the students used a waterproof cover to protect their notes and it was difficult to take notes in the windy weather (Figure 4.5). Instead, a number of students used their phones to take notes.

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Figure 4.4: The geography students collect samples from the field to examine them at the lab when they return from the field (left).

The student uses a paper map during the field trip (right)

In the evening, the students had to spend their evening in a class to work on their group report, and to prepare a presentation for the following day. The students transferred their notes to the

computer and they saved their statistical tables in Microsoft Excel. They used Microsoft Word for writing the documents and, because of poor Internet signals in the area, the students used a USB flash memory to share data between them. Moreover, a number of overseas students had an electronic dictionary to help them to develop their work in English.



Figure 4.5: The Difficulty to use paper notes in the windy weather

After the interviews were analysed, codes were developed to identify new themes for this case study. Themes were combined, split, or moved, so then the final version of the codes presents five main themes as table 4.2 shows below. An example of coding development and sorting is given in Appendix B.

Table 4.2: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
Data Types	D01. Qualitative data D02. Quantitative Data D03. Multimedia Data
Objective	O01. Awareness O02. Learning O.03 Reflection
Tools	T01. Technology T02. Paper based tools
Documentation	Doc01. Transferring Doc02. Saving Doc03. Organising
Data Sharing	S01. Selective Data S02. Unselective Data S03. Peer-to Peer S04. Online

- **Theme: Data Types**

It has been recognised that there are three main types of data the students were interest to collect in the field. During the geography field trips, students were observed to collected qualitative data such as texts which describe the surrounding area. For examples, the geography students were interested in collecting notes to describe the field weather, techniques, and instructions for using the field equipment.

The following is a sample of geography student's responses about what they captured in the field.

“Notes describe the area, that hard to remember like directions, and weather” – The participant described what data he collected in the field
“I was drawing for group works” – This participant was in a group that split the field work between them.

Besides that, the geography students also did some drawing on their notes of maps, and quick sketches of the area (Figure 4.6).

However, only the geography students collected quantitative data in their notes. These were presented in a set of columns containing measured numbers that they had calculated in the field (see figure 4.7).

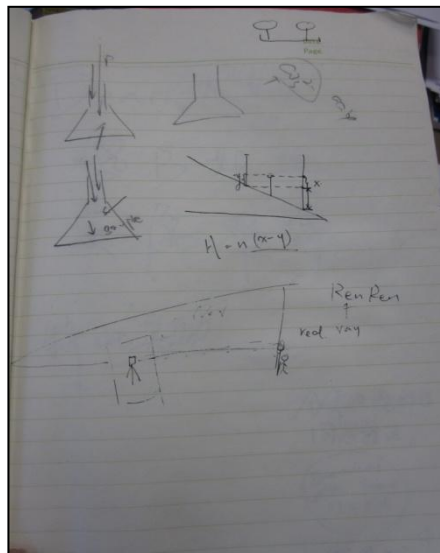


Figure 4.6: Geography student notebook includes qualitative data and graphics

Moreover, the geography students collected their learning experience using multimedia formats such as taking photos and recording videos of what they observed in the field.

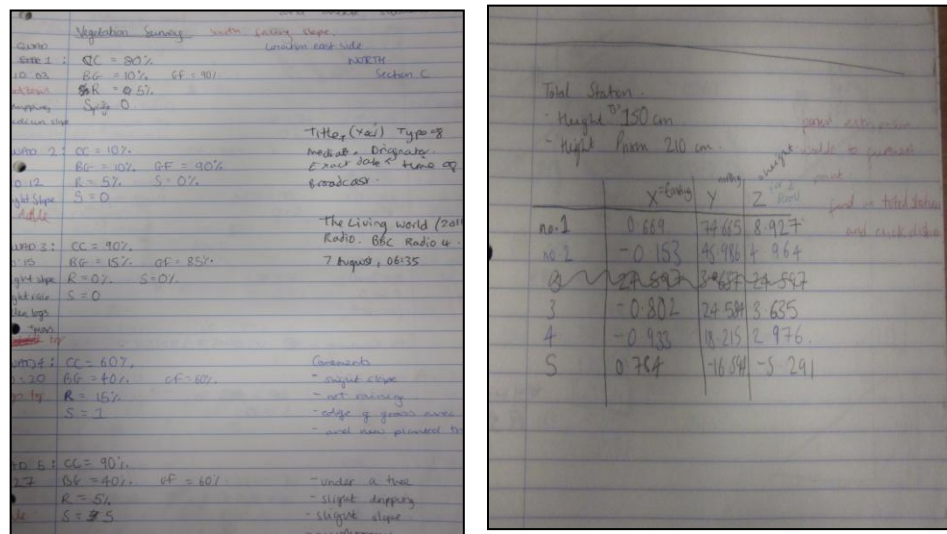


Figure 4.7: The geography student's notes include quantitative data

- **Theme: Objectives**

All of the participants said that the purpose of collecting their experience was to memorise the information to reflect later on their works to follow the field and technique procedures. These notes were used by the geography students to write up their field reports. Recording photos and videos supports the students to gain knowledge after the field work.

These are some answers the students made about the purpose of capturing their experience in the field:

"To build up my experience, to use in courses, I record data I can't find in websites".

"To learn and for late experience".

- **Theme: Tools**

Regarding the tools used to collect the learning experience in the field trips, all the participants mentioned similar tools. These were: using notebooks for note taking, digital camera

and mobile phones for capturing photos and recording videos (Figure 4.8).

"I use pen and paper note pack, it is quicker and all the notes in one place, it is easy"

"I don't like using technology, because I love to use pen and paper as a hobby"

"Depends on the weather, it is rain I use my phone. If it is dry and not windy, I use pen and paper, and smartphone. No specific apps, I use Evernote, Dropbox, and mindmap" – the weather is an essential factor that affects the students choices about which tools they would to use in the field to collect and share their information.

The previous comments are explanations given by the geography students about their tools in the field and why they preferred them. In addition, the geography students mentioned use of other tools such as a compass, calculator, and GPS, whereas the architecture mentioned use of sketch books.

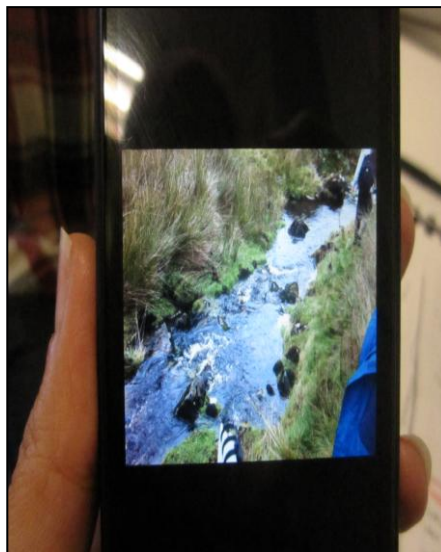


Figure 4.8: A mobile phone has been used by a geography student in the field trip

- **Documentation**

Three main activities were identified in order to document the experience after the field trips.

The first activity is transferring the data:

The geography participants transferred their multimedia data to digital storage media such as hard disks. They also used Microsoft Offices to transfer the data such as Microsoft Excel for calculation, and Microsoft Word for Note taking and reports.

“All my works I transfer to the computer”, “I keep it as it is, or transfer data to Excel or writing on words” – Two geographers described how they transfer their experience after the field trip.

The second activity is saving the data:

As the geography students reported, they preferred to print out their data after they had been organised in the form of field reports, or they save it into digital folders on their computers or on cloud storages.

“I had a Nottingham university laptop, all the group save their work in one folder, and then I take one softcopy on my USB” – A geography student described how he saved the field group work, as they shared one folder on one computer, he then took a soft copy by using the USB storage device.

The third activity is organising the data:

In order to organising the learning experiences, the geography students prefer to organise their experience in a digital format to print them out for course works or field reports.

"I prepare my tables before I start" – A geography student described that she organises her measurements in tables that she prepared on her notes before she go to the field.

"Messy style for taking notes (boys style), but I don't mind to stick in format" – A geographer described his behaviour in organising his data. He mentioned that his organising style is messy but he does not mind if he got a template to fill his data in.

"I tried to make tables, but it end ups like free hand sections. I prefer free writing on the sheets" – The geography student mentioned that he likes to organise his notes in free hand writing style on the sheets instead of organising them in specific format such as tables.

- **Data Sharing**

It was noticed that the geography students did not mind sharing their raw data with others. The raw data is the data that they collect in the field before they analyse it, such as the measurements which have been collected in the field. Furthermore, the geography participants preferred face-to-face communications to share their experience in the field. The lack of internet signals could be one of the causes that made the geography use only portable USB storages to share their data in the field. However, when the geography students returned from the field trips, they were able to use emails to share their data but they did not. Finally, the geography students use social networks only as a communication means to organise the group meeting.

"I used USB because the internet was rubbish" - The poor internet signals made the students use alternative methods to share their experience with other colleagues, such as using USB.

“If it is going to affect my work, I will leave it secret” – The geography students were also concerned about their own ideas and experience. They would not share their experience if it will affect their work negatively.

“I didn’t use social networks because the internet was shot, and we are all in one place, when we go back I just text my group or email them” – This comment shows that the students communicated face to face while they were in the field. Another alternative way to share is by using the email to exchange their experiences when they back from the field site.

Table 4.3 provides a summary of theme codes that were derived from all analysed data from the observations and interviews with each of the student groups.

Table 4.3: Summary of codes emerging from responses from the geography students

Subjects	The Codes from Geography Students
The Kinds of Capturing Data	Qualitative data: describing the surrounding area. Quantitative data: measuring and calculation. Drawing: Maps and quick sketches. Notes include: Directions (using arrows), Weather Description. Techniques. Instruction of using equipment. Tables, diagrams, mind maps. Records: Photos and videos
The Purpose of Capturing Data in the Field	Notes: For easy remembering. For writing the annual reports. For the group working. For reflection. Help in following field and technique procedures. Photos / Video: Supporting gained knowledge after the Field work

Subjects	The Codes from Geography Students
Tools Used to Capture Data	Notebooks, Camera, Compass, Calculator, GPS, Mobile Phone.
Places to Capture the Data	In the field: Collecting the data from the site In the residence: Transferring the data to their personal devices. Also, sharing it with colleagues.
Transferring Data: T a	Using Microsoft Offices to transfer the data. Microsoft Excel for calculation and measuring. Microsoft Word for Note taking and reports. Multimedia Data: transfer them to digital storages
Saving Data: I	Printing the data and save it in digital folders. Using Cloud Sourcing for saving multimedia data Notebook: Using columns for measuring and numerical data.
Organising Data:	Organising the data in a digital edition to print them out for course works or reports.
Sharing Data:	Sharing raw data not the data analysis. Prefer face to face informally discussion in the field or at the residence. Using: USB – Emails
The Usage of Social Networks:	The lack of internet signal prevents using social networks in the field. Use them as communication tools to set appointments and meetings

4.4 Case Study 3: Architecture Field Trip

This case study has the same purpose of the previous one in section 4.3. The study was conducted in three phrases, and

following the same procedure as had been developed in the previous two case studies.

To facilitate this case study, the author was invited to accompany undergraduate students from the University of Nottingham to observe their field trips. The architectural field trip took place in Derbyshire during November 2011. In order to facilitate the analysis of the outcomes from this case study, the details of participants, study design, analysis are presented in the following sections.

4.4.1 Participants

The participants in this study were 22 second and third undergraduate students from the School of the Built Environment at the University of Nottingham attended the architecture field trip. Of these, 10 students (six male and four female) agreed to participate in the post-field trip interviews. As before, all participants signed a consent form and the Faculty of Engineering Ethics Committee awarded ethical approval before they partook in this study.

4.4.2 Methods

To gain preliminary understanding of user requirements in this field study context, the same methods used in the previous case studies in sections 4.2.2 and 4.3.2 were applied in this study.

4.4.3 Study Description

In November 2011, the study began with a one-day field trip to Derbyshire, in England, with 22 undergraduate Architectural students from the School of the Built Environment at the University of Nottingham. The students visited three sites during this trip; Caudwell's Mill and Craft Centre; Masson Textile

Museum and Heritage Centre; and the Magna Science Adventure Centre. The field visit was optional and aimed at allowing the students to gain knowledge and get an experience to enrich their work portfolio. The students were observed whilst they were in the field gathering data. The students were walking in a group, but each student captured their own experience and interests. Alongside this, there were tutors walking with the students to answer their questions (figure 4.9).



Figure 4.9 Architecture students collect their experience in the field trip in Derbyshire Nov 2011

Two weeks after the field trips, a random sample of students who attended the field trip was invited to participate in a follow-up interview. The one to one interviews were conducted with 10 architecture students and a semi-structured interview method was used to obtain more detailed information about how they take notes and what techniques they used to capture and share their experience in the field trips. During the interview session, the students were asked to show their field notes. The majority of students presented their camera devices which were used to

collect photos from the field, in addition to their notebooks. A number of them presented smart phones which they used to capture multimedia elements and writing notes.

4.4.4 Analysis

After the data was collected from the observations and individual interview, the same analysis method from the previous case study has been applied in the study. The full description of the analysis method has been described in section 4.3.4 in this chapter.

4.4.5 Findings

This section illustrates the findings of this study using the scenario method to describe the context and activities conducted in this field trip and to identify user needs for data capture and sharing.

During the architectural field trip, the students visited two sites in the same trip. The first site was an outdoor site, while the second was an indoor museum site.

The author observed that the students were roaming in small groups around the fields. They worked individually but discussed the interesting findings together. They carried different tools to capture their experience. The majority of students preferred to capture their experiences by digital camera. In addition, the students had note books for note taking and sketch drawing. They used a variety of sizes, the large size notebooks were the most common.

Despite the fact that many of the students carried smart phones, the students preferred to capture photos using a digital camera

because of the higher resolution. They captured photos for the landscapes, the museum sections; and the tools and the equipment at the visit site. They preferred this method to save time instead of drawing a quick sketch and missing the details.

However, a number of students also drew quick sketches of their results. They used their sketch notebooks and colour pens. They also collected information leaflets and maps to record information. (See Figure 4.10)

After the interviews were analysed, codes were developed to identify new themes. Themes were combined, split, or moved, so then the final version of the codes presents five main themes as table 4.4 shows below. An example of coding development and sorting is given in Appendix C.

The themes that emerged from the analysis are shown in Table 4.2 and 4.3 to some extent, the emergence of similar themes is not surprising, as geography and architecture groups were asked similar questions in the post-field trip interviews. However, the responses from students also identified some specific themes that were unique to either student group. Differences between the two groups are particularly interesting and these are discussed in detail in the following sections.



Figure 4.10: The architecture students collect samples from the field. The student collects an information brochure of the site (left). The student carries several pieces of equipments in the field such as notes, pen, and camera to collect different types of experience (right)

Table 4.4: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
Data Types	D01. Qualitative data D02. Multimedia Data
Objective	O01. Awareness O02. Learning O.03 Reflection
Tools	T01. Technology T02. Paper based tools
Documentation	Doc01. Transferring Doc02. Saving Doc03. Organising
Data Sharing	S01. Selective Data S02. Unselective Data S03. Online

- **Theme: Data Types**

During the architecture field trips, students were observed to collect qualitative data such as texts which describe the surrounding area. The architecture student's notes included describing techniques and instructions for using architecture equipment which are used in the field. As shown in Figure 4.8 and Figure 4.9, the notes were a combination of text and sketches, in addition to collected leaflets from the visited sites.

Furthermore, it was noticed that the architecture students relied more on the multimedia to capture their learning experience (LX). They took photos and voice notes, videos to the surrounded area including the building they visited, machines and techniques, and different building materials

The following is a sample of architecture student's responses about what they captured in the field.

"Photos for small details in the building, such as windows and plan"

– The participant took photos to capture the small details in the building he visited

"I was recording video as much as I can, 5 minutes approximately. And I drew after the field" – This participant used to record videos for the area that he observed. In order to save his time in the site, he would postpone drawing his sketches until after the field trip.

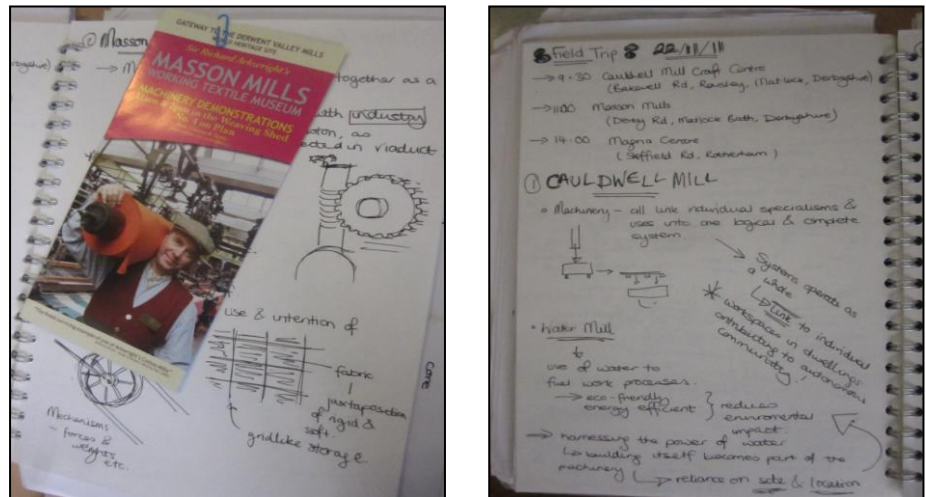


Figure 4.11 Samples of experiences that the architecture students collect in the field trip in Derbyshire

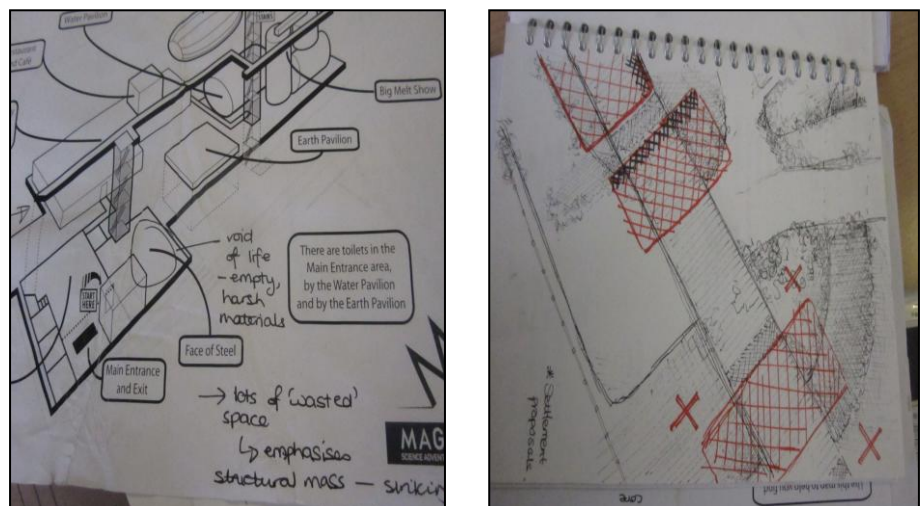


Figure 4.12: Sample of Architects Notebook. The student uses the museum map to write down notes (left) the student uses different colours to draw the sketches in the field (right)

• Objectives

The participants reported that the purpose of collecting their experience was to memorise the information to reflect later on their works to follow the field and technique procedures. The

architecture students used these notes to fill in their critical diary and portfolios. Recording photos and videos supports the students to gain knowledge after the field work.

These are some answers the students made about the purpose of capturing their experience in the field:

"Too much information is not easy to remember".

"I capture photos to relate back and understand what I miss or can't remember, this helps in the report".

"I am a visual learner, I learn from photos".

- **Theme: Tools**

Same as the previous case study, the participants used notebooks for note taking, digital camera and mobile phones for capturing photos and recording videos (Figure 4.13).

The comments from the architecture students were:

"I use black pen, special pen called Charcoal pen for drawing, pencil, sketchbook" – Number of tools the architect carries to collect his experience in the field

"Professional camera, it is more professional than phone" – The architects prefer the digital camera over the mobile phones, because of the high resolution in the professional camera.

"Sketch notes, camera, different colourful pens. I use my iPhone, and apps such as Panorama" – This participant mentioned that he uses mobile application to capture pictures by panorama technique.



Figure 4.13: The student takes photos for the sites while carrying a number of items in her hand (left). Notebook size varied; a number of students carry small size notebook and a number of them preferred the large one (right)

- **Theme: Documentation**

Three main activities were identified in order to document the experience after the field trips.

The first activity is transferring the data:

The architecture participants transferred their multimedia data to digital and cloud storages media such as hard disks, and cloud storage services.

“I keep my photos on the phone, or on Dropbox for long saving”

Architecture student described his way in transferring his learning experience.

The second activity is saving the data:

The architecture students behaved differently in saving their data as they keep their notes and sketches in their books. Besides, the multimedia data is saved in cloud sourcing services such as Dropbox.

“I keep my sketch book, but the photos I save it on my laptop” –A technique to save the field collection data by architecture student.

The third activity is organising the data:

Regarding to organising the data, the architecture students preferred to organise their field experience in a critical diary or portfolio.

“I print the photos that I need for the portfolio” – The architecture students are required to present their learning experience in critical diary or portfolio at the end of the academic year.

- **Theme: Data Sharing**

It was noticed that the architecture students preferred to share selective data with their group if they were working on a group projects. That was done by using social networks such as Facebook to create a private group. They use it as a communication tools to discuss, announce, and meeting setting. Moreover, they also use USB storages, emails and cloud services to share their data.

“I love to see others portfolios, and never mind to share mine but after the tutor checked up and gave me the marks. I am ok till it is not affecting my work” – The architecture student showed her concern about sharing her works with others. As the architecture experiences are more about ideas and concepts about designing, the student cares to protect her ideas until they are marked by her tutor, then she would share her experience with others.

“I just share the site photos to my group work because we divide the job between us. I use Dropbox and emails and Facebook for

sharing. I set a secret group on Facebook for privacy”- This comment presents how Architects share their experiences with their colleagues in a group project.

Table 4.5 provides a summary of theme codes that were derived from all analysed data from the observations and interviews with the architecture student groups.

Table 4.5: Summary of codes emerging from responses from the Architecture students

Subjects	The Codes from Architecture Students
The Kinds of Capturing Data	Qualitative data: describing the surrounding area. Drawing: quick sketches. Notes include: Techniques. Instruction of using equipment. Site Description Records: Photos and videos for Buildings, Sites, Machines, Materials, Techniques.
The Purpose of Capturing Data in the Field	Notes: For easy remembering. For Critical Diary and Portfolios. For reflection. Help in following field and technique procedures. Photos / Video: Supporting gained knowledge after the Field work
Tools Used to Capture Data	Notebooks, Sketch Books, Digital Camera, Mobile Phone.
Places to Capture the Data	At the visiting sites such as at the gallery and the museum

Subjects	The Codes from Architecture Students
Transferring Data:	Transferring multimedia data to digital storages such as hard disks
Saving Data:	Notes and sketches are saved in notebooks. Using Cloud Sourcing for saving multimedia data.
Organising Data:	Organise data in a critical diary and portfolio
Sharing Data:	Sharing selective data only in case of group projects. Online sharing for group projects only. Using: USB – Emails- Cloud file sharing
The Usage of Social Networks:	Using Facebook to create a private group for group projects Use them as communication tools to informal discussion, and setting meetings.

4.5 Discussion of Cases Studies

Comparison can be made between the nursing, geography and architecture students and geography students shows that there is a large amount of similarity, but also some contrasts, between the geography and architectural students when capturing and sharing their knowledge and experiences in the field setting. These are illustrated in the diagram in Figure 4.14, and discussed in the following sections.

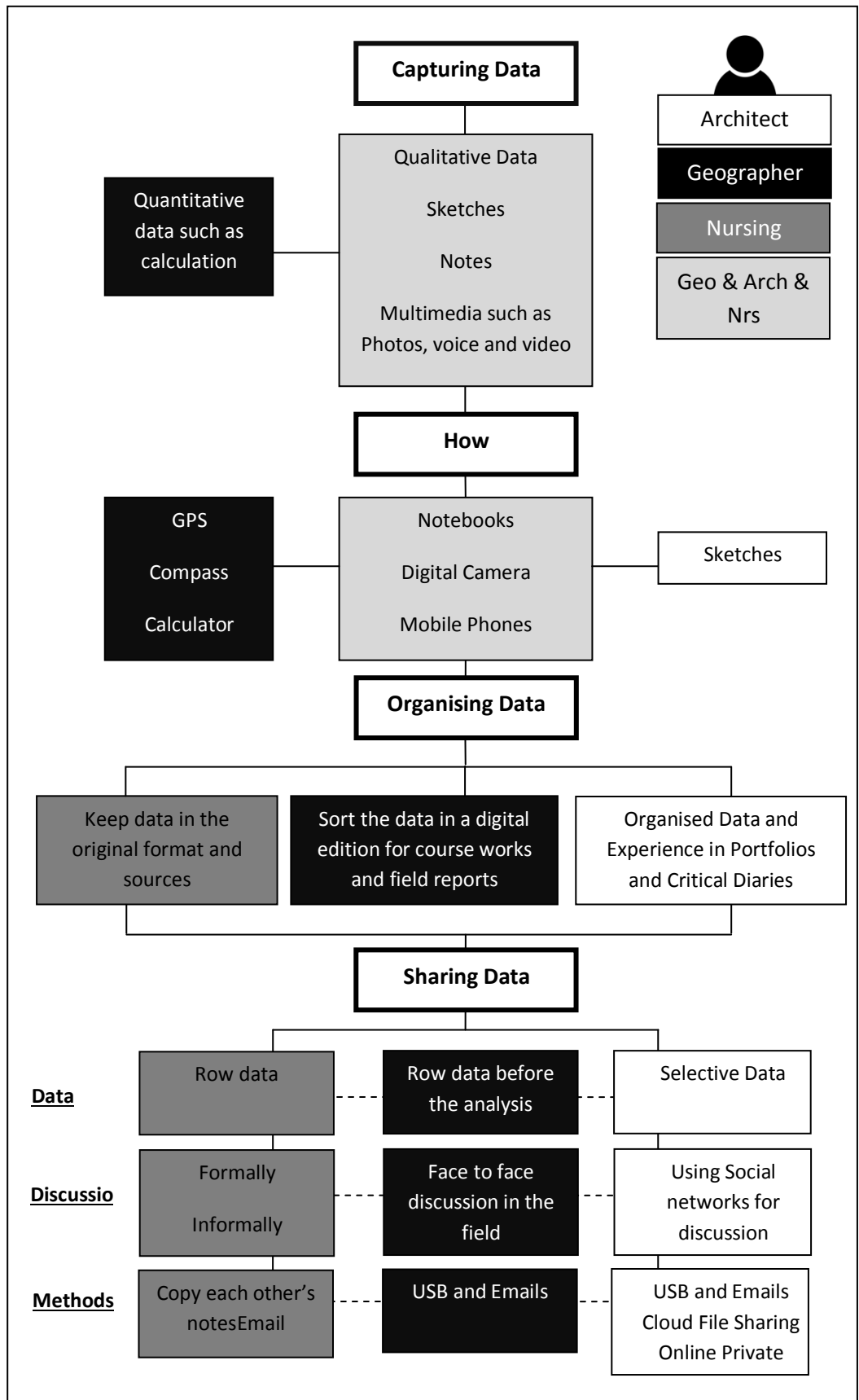


Figure 4.14: A comparison between Nursing, Geographers and Architects

Figure 4.14 illustrates four main areas of comparison between the results from the nursing, geography and architecture students. The first is the type of data captured in the field; both student groups collect the same kind of data, while the geographers also collect numerical data.

The second aspect to compare is the methods the students use to collect these data. All of them use notebooks, digital camera, and mobile phones. However in addition to these, the geography students use different tools such as GPS, compass and calculators, whereas, the architecture students use sketches.

The third aspect to compare is how the students organise their data. As can be seen, the difference here is that the geography students put their notes and multimedia in a digital edition such as for designing a field report or course works. Whereas, the nursing students would like to their data in the original format. Where, the architects prefer to organise their data and experience in portfolios and critical diaries.

The last comparison aspect is sharing data. The type of data that the geography and nursing students share is the raw data was collected from the field. They don't like to share the analysed data. In contrast, the architects prefer to share selective data under conditions. Moreover, the nursing and geographers favour face-to-face discussion whereas the architects like using social networks for group discussion. Finally, all the three groups use USB and emails for sharing their data. However, the architecture students in addition to that use cloud file sharing services and the online private groups such as Facebook private groups.

In summary, the similarities between the three student groups fall into three main areas. First, all students need to collect data during the field trip to develop their work: course work and portfolio.

Secondly, all sets of students share their notes and experience, but have control over the conditions in which they share their information. Finally, all sets of students during the three case studies show their need to have technological support so as to capture their information and share their experiences during field trips.

On the other hand, the contrast between the case studies can also be summarised through three main points. First, privacy issues were the obvious difference between the case studies. In terms of privacy, the geography students did not show any concern about avoiding note sharing. Indeed, the results of the geography case study reveal that the students actually preferred to see each other's notes in order to show support for their data collection. Whilst the architects, on the other hand, were concerned about their own ideas and more protective of their individual results and they generally avoided sharing their experiences except with those colleagues who shared their information, such as close friends who were also on the field trip. In terms of privacy, the nursing students were concerned that they must avoid sharing the patients' records and information. Other than that, they were happy to share their information and knowledge with others.

The next issue concerns the type of data collected during the field trips. The majority of geography data collections are diverse between qualitative (for example: notes and sketches); and quantitative data (for example: measuring). Whereas, the nature of nursing and architecture data collections is a qualitative data only, such as, note taking and sketch drawing.

The final contrast between the three case studies relates to the environment. The geography students work in rural areas in which it could be considered as a harsh environment to use the mobile technology. For example, the low internet connections require the students to adapt themselves to using basic techniques in order to share the data such as using USB cables. In addition, the weather plays an essential part in the geography field trips. As it has been observed in the previous field trip to Malham, the students protected their equipment and notes with water proof covers during wind and rain storms. However, the nature of architectural field trips is that they can take place in outdoor and indoor environments. Working in urban areas prevents the previous difficulties which were not faced by the architectural students. For instance, since the architects work in urban areas, the potential of losing the internet connections is so low that it is not considered as a serious problem. Similarly, for the weather, where predominantly there are indoor places to go to. Conversely, the nature of practical clinic where the nursing students work is an indoor environment, where the using of mobile technology would be convenient than the two previous environments.

These results lead to the next step which aims to develop suitable requirements for a mobile system to be used by the students in the field.

4.6 Guidelines for Developing Mobile Technology to Support the Capturing and Sharing of Undergraduate Experience in Field Trips

This section illustrates the system requirements for the mobile technology that could be used by Nursing, Geography and Architecture students to capture and share their experience during field trips. A requirement is a statement about an intended

product that specifies what it should do or how it should perform (Preece et al, 2011). These requirements have been derived from two sources of information. The first one by reading literature from previous studies about mobile devices that can be used during the field trips. In addition, the second source is derived from analysing the data collections of the previous study with the undergraduate students. The draft of developing these requirements is shown in Appendix D.

4.6.1 Methods of Analysing the System Requirements

The expression of requirements analysis, as Preece et al (2011) explain, is to describe the activity of investigating and analysing an initial set of requirements that have been gathered, elicited, or captured.

The tables below present the requirements for developing a mobile note taking system to be used in the field trip. The requirements are classified based on the “establishing requirements” technique by Preece et al (2002). According to Preece there are five main areas within which the requirements can be classified:

- Functional Requirements: a statement of what the product should be able to do.
- Data Requirements: a statement about the data within the product.
- Environmental Requirements: specifically the circumstances within which the product will operate; this will include the physical environment, the social environment, the organisational environment and the technical environment.

- User Requirements: used to capture the characteristics of the user group; their skills, whether they are novices or experts, whether they will be casual or frequent users.
- Usability Requirements: will be concerned with effectiveness and efficiency, accessibility and learner ability.

Moreover, there are different ways to prioritise the requirements, some of methods are very complex and require involvement of many stakeholders, while others are simple (Ralyté et al, 2011). In this research, the requirements have also been ordered based on the MoSCoW rules for priorities (Clegg and Barker, 1994).

The concept of the MoSCoW approach is to group all requirements into four main priority groups as follows:

- Must to have: the system would be useless and un-usable without the requirement
- Should to have: essential if resources permit
- Could to have : could be left out, but important to include at some stage
- Want to have : can be left for future development

MoSCoW is a simple method to define the requirements priorities in a time-limited project. A case study by Hatton (2007) compared four prioritisation methods, one of them is MoSCoW. The study examined the methods by three criteria: ease of use, the time to complete the prioritising process and the user's confidence which means how deeply the user believes the prioritisations result actually reflects his real priority. As a result, MoSCoW achieved the highest degree of confidence and the lowest difficulty rating,

suggesting that the MoSCoW method is the easiest method to use and it takes less time to perform and provides high user confidence even with the large numbers of requirements. However, the method cannot present detailed differentiations as ordinal scale or ratio scale methods because it prioritises the requirements into diverse priorities categories. But the requirements which are in the same group appear equal in priority. (Ma, 2009).

4.6.2 System Requirements for Developing Mobile Technology to Support Capturing and Sharing Learning Experience in Field trips

One of the aims of requirements analysis is to make the requirements as specific, clear and unambiguous as possible. The lists below present the requirements for developing and designing a mobile system, which will enhance the capture of information and the subsequent sharing of experience during the undergraduate Nursing, Geography and Architecture field trips. The requirements have been classified based on the Establishing Requirements Technique by Preece et al (2002)

I. Functional Requirements for the Mobile System

- The system must have a writing text function
- The system must have a built-in digital camera for capturing photos
- The system must provide a drawing function to draw sketches
- The system could provide a drawing function to draw charts
- The system must support group discussion

- The system must be lockable by username and password
- The system must support data sharing
- The system must contain a USB port
- The system must provide a free-hand writing style for note taking
- The system must provide a voice recording function † #
- The system must split sections between public and private notes
- The system must be able to measure the volume of the voice and the degree of noise †
- The system must have a built-in clock
- The system must provide a colour drawing function for drawing sketches †
- The system must support group work
- The system must offer photo filters (black and white filter)†
- The system must sort the data into folders
- The system should allow a downloading files function from the computer
- The system should allow an uploading file function to the computer
- The system should provide expanded storage memory
- The system should offer social networks access
- The system should provide a video recording function
- The system should offer an email access function
- The system should contain a built-in compass *
- The system should contain a built-in calculator *
- The system should provide a high resolution camera †
- The system should support the visual content with zoom and pan options †
- The system should contain a built-in GPS

- The system should offer internet connection
- The system should provide different camera lenses †
- The system could allow for designing spider diagrams
- The system could offer designing mind maps
- The system could offer a map retrieving function
- The system could link programs and applications together
- The system could offer linking with cloud storage service
- The system could provide a link function to link notes with maps
- The system could work with a stylist pen

(#) special requirement for Nursing students; (*) Special requirement for Geography students; (†) Special requirement for Architecture students

II. Data Requirements for the Mobile System

- The system must provide a bullet point layout function in the note taking content
- The system must allow recording of qualitative data such as text and quantitative data such as time stamping
- The system should offer a spreadsheet layout function to sort the data in * #
- The system should register time and date automatically
- The system should number the notes pages automatically
- The system should offer various styles of labelling and tagging data
- The system could offer creating a unique marker function to allow the user to create their own marker to mark the data
- The system should allow the data to be embedded into electronic portfolio and critical diary † #

(#) special requirement for Nursing students; (*) Special requirement for Geography students; (†) Special requirement for Architecture students

III. Environment Requirements for the Mobile System

- The system must have a fast time performance and should be weather resistant
- The system functions must be functional in the field setting and environment. That is the system must work under different conditions of lighting and weather.
- The system must be suitable for use in the field
- The system should offer a night vision function to allow night access
- The system should be indoor and outdoor accessible
- The system should be protected by a waterproof protection

IV. User Requirements for the Mobile System

- The system must be usable by beginners and experts in the field work
- The system must provide safe navigation at the environment during the user interaction
- The system must be able versatile for use by students in the field

V. Usability Requirements for the Mobile System

- The system must provide a simple and clear menu structure
- The system must use simple functional sentences

- The system must provide clear error messages with an understandable solution guide
- The system must be user friendly
- The system must be a portable lightweight device
- The system must permit use with gloves on
- The system must not obstruct the work in the field
- The system must support the students ability to learn in the field
- The system must have a long life battery
- The system should offer a consistent layout to avoid unexpected changes from one screen to another
- The system should provide a fast and usable user interface
- The system could offer a stand to help in note taking and drawing

4.7 Conclusion

This chapter has presented case studies with undergraduate nursing, geography and architecture students to provide an overall understanding of the nature of capturing and sharing the learning experiences in student field work. This understanding leads to identification of the user requirements for use of a mobile technology system intended to assist students in capturing and sharing their learning experiences (LX). Therefore the contribution of this work can be summarised as follows:

- Understanding the task requirements is useful to inform the next stage of research which aims to study embedding mobile technology in the field trips

- The system design guidelines are a suitable basis for developing and designing new technologies for field trips.

The following chapter presents the research conducted for the next step in the interaction design lifecycle: the development of conceptual design alternatives to meet the user requirements.

5. Conceptual Design: Developing the Initial Conceptual Model

5.1 Introduction and Aims

This chapter presents the work that aims to design and develop a mobile system to support capturing and sharing experience by evaluating the functional requirements which have been identified in the previous chapter. Transferring the system requirements into a conceptual model is a fundamental step to the interaction design. Preece et al (2011) state that the conceptual model is the outline of concepts that are needed to understand what users can do, and how they would interact with the product design. Understanding this concept depends on a number of issues relating to the user characters, the nature of interaction with the product, and the type of the interface, and so on. These issues derive from the functional requirements which were collected in the previous step to produce the conceptual model. It possibly becomes a subset of the functional requirements, or even an extended edition of them. Because the interactive system requirements cannot be specified completely at the beginning of the interaction design life cycle (Dix et al, 2004), designing alternative is a method to generate and implement the primary conceptions that have been gathered from the established requirements in order to characterise a product or a system (Kroll et al, 2001).

Furthermore, there are different methods that may be used to accomplish the conceptual design. Beyer and Holtzblatt (1997) recommend that reviewing different user perspectives on the data collected and established requirements helps the conceptual design ideas to emerge. Therefore, the objective of this stage of

the research was to evaluate the functional requirements for developing mobile technology to support capturing and sharing experiences in the field trips. In this study, the card sorting method was applied in order to increase the system functionality. The benefit of applying this technique is that it is an effective means of discovering the optimal organisation of information from the potential users' viewpoint (Wood and Wood, 2008).

5.2 Case Study 4: Requirements Evaluation with Geography and Architecture Students

5.2.1 Study Description

The open card-sorting task was applied in this study. Open card sorting is defined as “[a methodology] in which subjects can determine their own groupings by first sorting the cards and then labelling the resulting piles” [(Deaton, 2002, p.4) in Hannah (2005)]

In this study 32 labelled cards were used. Each label states a single functional requirement from the requirements list defined in the previous step (see chapter 4).

Each participant was required to do the following activities:

- 1- The participants were required to choose cards that describe requirements they need. Table 5.1 shows the labels of the 32 cards used in this study.
- 2- Then, the participants were asked to write the important features they think are missing or must be available in the system.
- 3- Next, the participants were asked to categorise the chosen cards into categories. Sorting the cards into categories assists the participants to navigate through their labels to identify their needs clearly. For instance, the participants may categorise the

functional requirements which are related to photo capturing and editing together (see Figure 5.1).

Table 5.1: List of Card Sorting Labels

Capture Photos	Record Video	Record Voice	Write Texts
Draw Sketches	Connect to Internet	Lockable by username and Password	Measure volume of noises
Built in Compass	Built in Digital Camera	Built in Calculator	Built in GPS
Split sections into public and private	Connect to USB Port	Link with applications such as Microsoft Offices	Link notes with maps
Retrieve maps	Support group works	Access to social networks	Access to emails
Support Data Sharing	Provide Camera Lenses	Connect to cloud storage service	Provide Photo Filters
Provide Long Life Battery	Expand storage memory	Design Diagrams and mind mapping	Upload and Download from and to Computer
Sort Data into Folders	Provide Colour Change for drawing	Free Handwriting Style for Note Taking	Provide Zoom and Pan Options

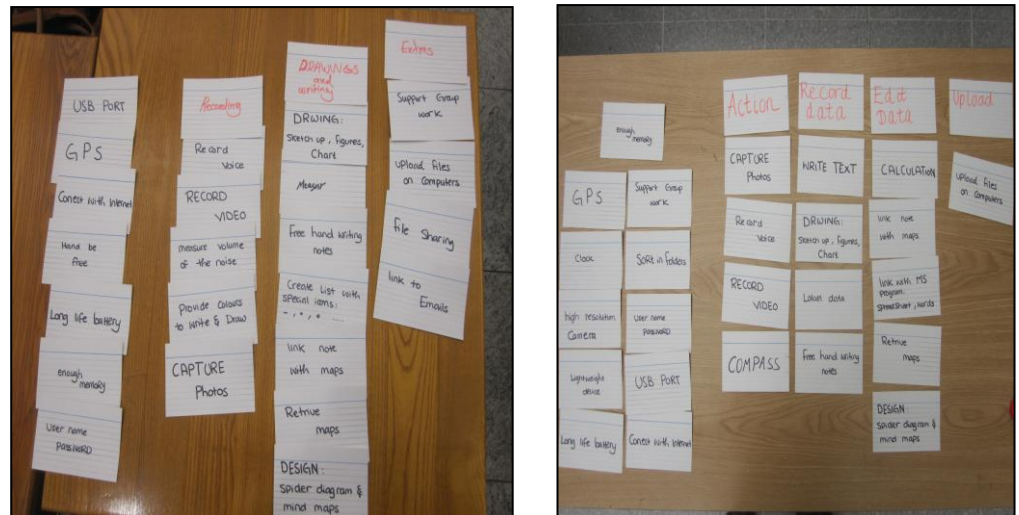


Figure 5.1: An Example of Card Sorting by Architecture and Geography Students

5.2.2 Participants

The participants in this study were undergraduate students from the geography school, and architecture and built environment school at the University of Nottingham, UK. A requirement for participation in this study was that that the participant must have previously attended an educational field trip to ensure that they were familiar with the field work and activities. An invitation was sent to all participants who took part in the field trip case studies described in chapter 4. Twenty participants were recruited for the study; ten from each school. All participants signed a consent form and the Faculty of Engineering Ethics Committee awarded ethical approval of this research prior to it being undertaken.

Table 5.2 describes the number and the gender of the participant sample recruited to this study.

Table 5.2: The Sample Description

Number of Participants	Male	Female	Total
Geography	7	3	10
Architecture	4	6	10

5.2.3 Analysis Method

Card sorting analysis can be done in two ways: by looking for broad patterns in the data, or by using Cluster Analysis software. In this study, the eyeballing technique was applied. The eyeballing technique is defined as the ability to analyse card-sorting data through a qualitative mechanism (Courage and Baxter, 2005). A study by Nielson and Sano (1994) found that the qualitative analysis of card sorting data, using quantitative cluster analysis, supports a smaller number of participative studies. They showed that their design was based on 'data eyeballing' and not on formal statistics. Moreover, Fuccella and Pizzolato (1998) argue that it is better to apply a qualitative analysis to card sorting when there is allow number of participants (five to ten participants). In addition Faiks and Hyland (2000) recommended using the eyeballing technique analysis that produces narrow and uncomplicated results. According to Wood and Wood (2008), eyeballing the data is very tedious, time consuming, and idiosyncratic, which results in a procedure that is not reliable. However, they argue that it works well when there are only five participants and a small set of items, but not so well with 30 or more participants and a hundred items. As this study was conducted with a relatively small sample (20 participants) and a small number of cards (32 cards), therefore the eyeballing technique was recommended (Paul and Whitley, 2013).

5.2.4 Findings

Applying the analysis method in card sorting includes four stages as shown in Figure 5.2.

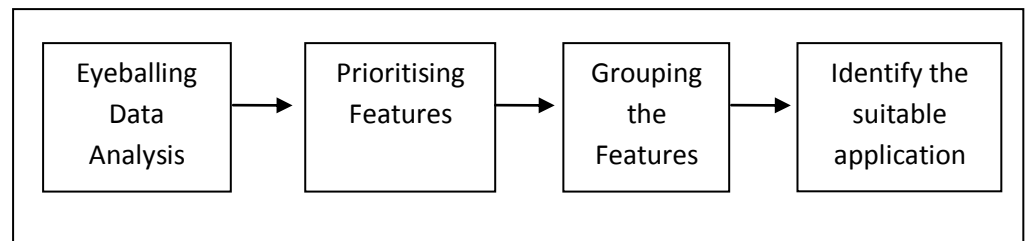


Figure 5.2: The Four Stages for Analysing Card Sorting

I. Eyeballing Data Analysis:

The procedure began with applying the eyeballing technique on card sort groupings. This starts with investigating the card grouping which has been sorted by each participant. Then, a list is made of cards names and how many times these cards have been selected by the participants as shown in Figure 5.3. Subsequently, based on the selection repetition, the cards (features) are sorted and prioritised.

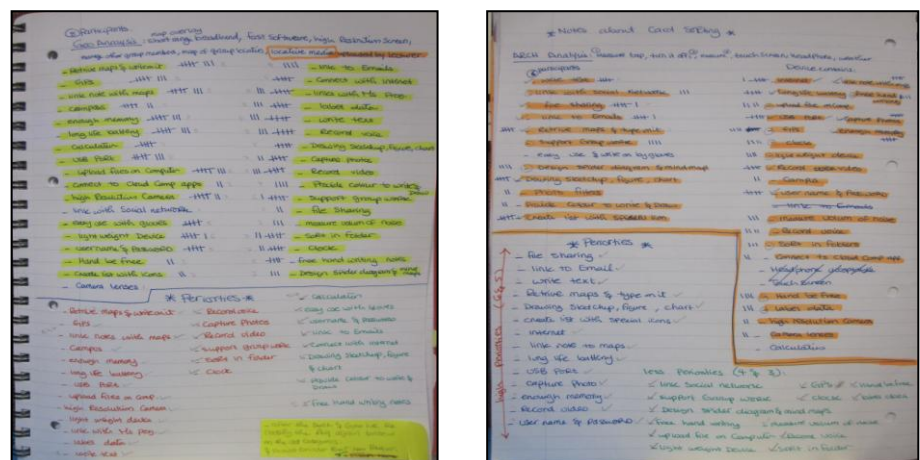


Figure 5.3: Eyeballing analysis outcomes

II. Prioritising Features:

After the eyeballing technique, the prioritised features were divided into three categories: high priority, medium priority and low priority based on how many times these cards have been selected by the participants. Table 5.3 shows these categories.

Table 5.3: Prioritising of the requirements into three categories

High Priority	Medium Priority	Low Priority
Retrieve maps	Built in GPS	Access to social networks
Link notes with maps	Built in Compass	Design Diagrams and mind mapping
Expand storage memory	Upload and download from and to computer	Free handwriting style for note taking
Provide Long life battery	Built in digital Camera	Measure volume of noise
Connect to USB port	Split sections into private and public	Provide camera lenses
Write text	Link with Application such Microsoft office	Built in Calculator
Capture photos	Connect to cloud storage service	Provide photo filters
Record videos	Record voice	Provide colours change for drawing
	Support group works	Measure tap
	Sort Data in folders	Headphone
	Clock	Weather Reader
	Support Data Sharing	Map overlay
	Access to emails	Short broadband
	Drawing sketches	Map of groups location
	Connect to Internet	Provide zoom and pan option

High Priority	Medium Priority	Low Priority
	Lockable by username and password	

III. Grouping the Features:

At this stage, the aim is to select the essential features of relevance to the research focus. In this study, these are: capturing the learning experience during the field trip, sharing the learning experience with others, and organising the learning experience after the field trip, in addition to select the required hardware features of the mobile devices.

Table 5.4 shows the features of the three categories in priority order.

Table 5.4: The Features of Capture, Share and Organise the Field

Trip Experiences

Capturing Features	Sharing Features	Organising Features
Retrieve maps	Support Group Works	Connect to Cloud Storage service
Link notes to maps	Access to Email	Upload and Download from and to computer
Write text	Support Data Sharing	Split Sections into Private and Public
Capture Photos	Access to social network	Link with Other Applications
Record Videos	Maps of group member locations	Sort Data into Folders
Record Voice		Lockable by username and password
Draw Sketches		
Design Diagrams		
Free handwriting style for note taking		
Provide Colours change for drawing		
Map overly		
Provide Photo Filters		
Measure Volume of noise		
Measure Tap		

Moreover, the following list presents features of the hardware devices in priority order:

- Extended Storage Memory
- Provide Long Life battery
- Connect to USB Port
- Built in GPS
- Built in Compass
- Built in Digital Camera
- Built in Clock
- Connect to Internet

- Provide Camera Lenses
- Built in Calculator
- Headphone
- Weather Reader
- Short Broadband
- Provide Zoom and Pan Option

IV. Identify the Suitable Application:

In regards to the physical design activity, it has been found that as a result of the massive increase in market for mobile technology applications, this study has attempted to find a sensible reason that could be used as a base upon which to build up, or develop, an application, which can then be used in specific studies.

However, the idea of having one application to do everything that is required does not provide an ideal answer for the research questions. Especially, the research focuses on mobile technology as a device that might be useful during a field trip for capturing and sharing learning experience. The research here does not test the use of a single application, but tests the use of mobile devices, and of course that includes how the user switches from one application to another and how using multiple applications affects the participants' activities. This mimics a number of actions the student could do during the field trip, such as when the student flips the note pages, changes the pen colours and carries different tools for example, the notes book and camera.

There has been massive increase in the applications market for smart mobile devices, in addition to the availability of professional notes taking applications in the markets. So, a search has been completed to identify the top note taking applications that could work on an iOS system, which students prefer to use. This survey was conducted during the spring of 2012. Nine trade applications were selected and a comparison was made between them to

identify which one of these would meet the highest number of requirements listed in Table 5.4. These applications were selected as a result of ongoing website research and it is noteworthy that the top ranking applications are also available in Apple store.

The reason behind choosing an iOS platform is the availability of iOS devices as research tools, which made it easier to access these devices during the study.

The nine applications selected are listed in Table 5.5. Full details of the applications are given in Appendix E

Table 5.5: List of Applications

	Applications
App 1	Note Taker HD: By Software Garden
App 2	Paper Desk: By WebSpinner, LLC
App 3	Evernote: By Evernote
App 4	Paper by fifty-three: By FiftyThree, Inc.
App 5	Notes Plus: By Viet Tran
App 6	GoodNotes: By Time Base Technology Limited
App 7	UPAD: By PockeySoft:
App 8	Noteshelf: By Ramki
App 9	SketchBook Pro: By Autodesk Inc.

After selecting these nine applications, the following step aimed to examine how well these applications meet the functional requirements identified for this study. Features of each of the applications were compared for each of the functional requirements in turn: first capturing; then sharing; then with organisation. The result of this comparison is discussed in the next section.

5.2.5 Results

After categorising the functional requirements into groups, taking into account the prioritisation of features, the number of requirements that each application could support were counted. The data tables are given in Appendix F and graphical summary diagrams are shown in the figures below.

As previously shown in Table 5.4, 14 features were identified as priority requirements for capturing experience activities during a field trip. For this activity, 14 features were listed as follows:

1. Retrieve maps
2. Link notes to maps
3. Write text - Capture Photos
4. Record Videos
5. Record Voice
6. Draw Sketches
7. Design Diagrams
8. Free handwriting style for note taking
9. Provide Colours change for drawing
10. Map overly
11. Provide Photo Filters
12. Measure Volume of noise
13. Measure Tap

The nine applications were then compared to see how many of the functional requirements they could meet. The results are shown in Figure 5.4.

It can be seen that applications numbered 5, 8, and 9 achieved the highest number of functional requirements for capturing experience activities in the field trips. These three applications

meet 9/14 functional requirements for the capturing features. Three more applications (numbered 1, 6, and 7) met 7/14 features. There is no massive difference between them and the previous three applications that allows to exclusion out of the comparison.

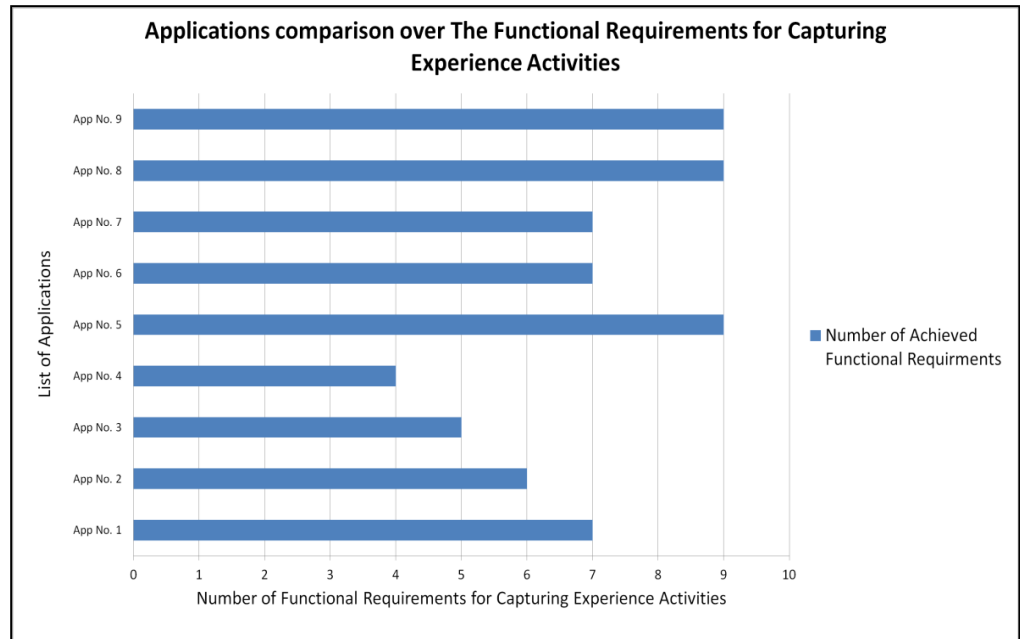


Figure 5.4: The comparison between capturing features with the nine applications

Next the comparison was repeated for the requirements of sharing experience. As shown in Table 5.4, five features were listed as follows:

1. Support Group Works
2. Access to Email
3. Support Data Sharing
4. Access to social network
5. Maps of group member locations

The nine applications were compared to see how many of the functional requirements for sharing experience they could meet. The results are illustrated in Figure 5.5.

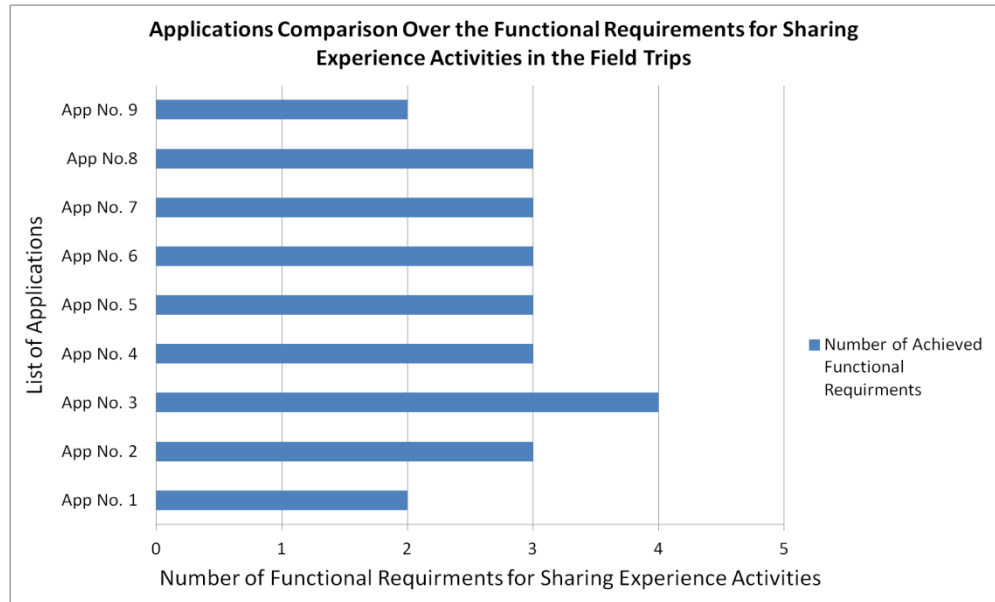


Figure 5.5: The comparison between the sharing features with the nine applications

It can be seen that application number 3 achieved the highest number of functional requirements for sharing experience activities in field trips. This application meets 4/5 of the functional requirements for the sharing features. However, another six applications (2, 4, 5, 6, 7 and 8) met 3/5 features. As there was little difference between these 7 applications, they were not excluded from the comparison.

The final comparison was made with the requirements of organising experience. As shown in Table 5.4, six features were listed as follows:

1. Connect to Cloud Storage service

2. Upload and Download from and to computer
3. Split Sections into Private and Public
4. Link with Other Applications
5. Sort Data into Folders
6. Lockable by username and password

The nine applications were compared to show which these meet the functional requirement for organising experience. The results are illustrated in Figure 5.6.

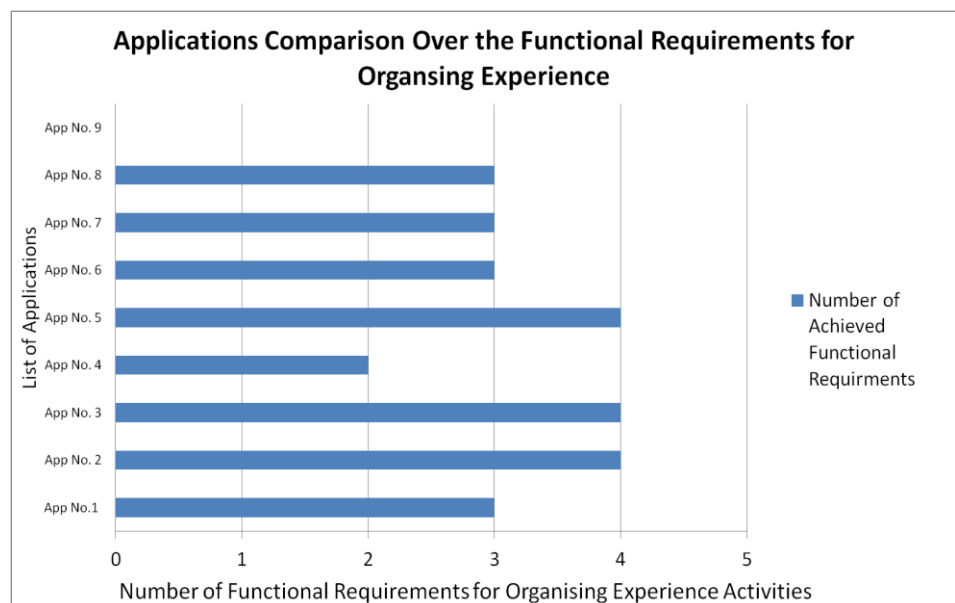


Figure 5.6: The comparing between organising features with the nine applications

It can be seen that applications numbered 2, 3, and 5 achieved the highest number of functional requirements for capturing experience activities in the field trips. These three applications met 4/6 functional requirements for the organising features. Another four applications 1, 6, 7 and 8 met 3/6 features. There is little difference between these and the previous three applications that allows their exclusion from the comparison.

After all comparisons were completed, the applications that met the least number of requirements were excluded. The study identified that there are four applications which have a high rank in meeting the functional requirements needed. These are Applications 5, 6, 7 and 8, which are: Note Plus, Good Notes, UPAD and Note Shelf.

However, there were some missing features that none of the applications above had. Table 5.6 shows the missing features and the additional applications that could be used to meet these requirements.

Table 5.6: additional applications

	Features	Suggestion Applications
1	Link with Other Applications such as Linking with Microsoft office	Quickoffice® Pro, iWork. In addition, there is news about launching Microsoft office on iPad next November.
2	Maps of group member locations	Find My Friends, Google Latitude
3	Link notes with maps	BatchGeo
4	Measure volume of noise	dB Volume Meter
5	Measure tape	Tape Measure, My Measures & Dimensions, Map Ruler Touch
6	Map overlay	Map Overlay Tracer
9	USB Port	Two ways to connect USB with device: by USB adaptor, and by iPad Camera Connection Kit

Other hardware features are built in features on Apple mobile devices. For examples: clock, compass, GPS and camera features are all included in these devices.

5.3 Conclusion

The main aim of this chapter was to design the conceptual model for developing mobile technology to support capturing and sharing experiences during a field trip by modifying and evaluating the functional requirements.

Firstly, the card sorting method was applied with geography and architecture students to evaluate the functional requirements which were established in the previous study. The analysis of card sorting data in this study, illustrates a unique model for a mobile system which aims to meet the needs of both user groups.

The second step in the interaction design was completed using a process for designing an alternative. This is necessary because the interactive system cannot be characterised completely from the beginning (Dix et al, 2004). The activity for designing an alternative can be divided into two sub-tasks; conceptual design and physical design (Preece et al, 2011).

In regards to the physical design activity, as a result of the increase in the market for mobile technology applications, this study attempted to develop requirements that could be used as a base upon which to build, or develop, an application, which could then be used in specific studies.

However, the idea of having one application to do everything that is required does not provide an ideal answer for the research questions. In particular, the research focuses on mobile technology as a device that might be useful during a field trip for capturing and sharing experience. The research here does not test the use of a single application, but tests the use of mobile devices in general, and of course that includes how the user switches from one application to another and how using multiple applications

affects the participants' activities. This mimics a number of actions the students could do during field trips, such as when the student flips the note pages, changes the pen colours and carries different tools for example, the notes book and camera, etc.

However, there are already a range of individual applications that might be suitable to be used in field trip activities. Therefore, the results of this study identified a need to evaluate iOS mobile devices (iPad and iPhone) with the four applications that were compared with the system requirements. These four applications are: Note Plus, Good Notes, UPAD and Note Shelf, besides to the additional applications to be used when designing the following studies.

The next stage in the research is to build a prototype to be tested with real users. This is described in the following chapter.

6. Understanding the use of Mobile Technology in the Field

6.1 Introduction and Aim

The previous study determined the conceptual model for developing a mobile system for capturing and sharing experiences in the field. This chapter presents the findings from a case study conducted to understand how mobile technology may impact capture and sharing of experience in a field trip. The mobile devices used in this study were prototyped based on the interactive system requirements identified in the previous chapters.

The study presents the results of a qualitative comparative analysis between geography and architecture students with regard to how they use the mobile devices to capture and share their experience during the field trip.

The questions addressed in this chapter are listed below:

Research Questions Addressed in this chapter

How does the Mobile Technology Impact upon the Capturing of Learning Experience during the Field Trip?

- What kind of learning experience do the students capture in the field by using mobile devices?
 - What are the usage implications of mobile technology to enhance the field experience in the field?
 - What are the key contextual factors that affect the use of mobile technology in the field trip to capture and share learning experience?
-

6.2 Case Study 1: Geography Field Trip

After the interactive requirements have been established through an iterative design cycle, the ideas should then be prototyped for

user evaluation. In interactive computer design, the prototypes are considered to be a core means for exploring and expressing ideas at the early stage of product development (Houde and Hill, 1997). The prototype is a manifestation process that allows the users to interact with the design to explore its usability and limitations (Preece et al, 2011). Brown (2008) comments that the aim of the prototype is to identify the strengths and weaknesses of the design idea which helps to drive the design in an improved direction.

There are two main characters of prototypes: the functional prototype is concerned with how the design works, and the form prototype is concerned with how the design looks (Buchenau and Suri, 2000). Thus, the nature of the study problem influences the nature of the prototype. Therefore, this study focused on the functional prototype because, the concern here revolves around designing the functions of the smart mobile devices to facilitate students in their information capture and sharing, working in a similar way to the equipment which the students need in the field. The study was conducted with geography undergraduate students in the field trip settings.

6.2.1 Participants

The first case study involved six first year undergraduate students from the School of Geography, at the University of Nottingham. The cohort consisted of five males and one female, who were selected in response to a call for participants asking for students who have smart devices, such as smart phones, and who know how to use them. All participants signed a consent form and the Faculty of Engineering Ethics Committee awarded ethical approval before anyone participated in this study.

6.2.2 Methods

To gain an understanding of use of the technology in this study, two types of methods were applied; observation and interview.

As in the previous case study approach, two kinds of observation method were used during this study: direct observation was used to primarily observe the students in the field to understand how they use the mobile devices to capture their learning experiences (LX) and knowledge; an indirect observation method was used to examine the collected data that the students gathered using the mobile devices in the field. After the field trip, a semi structured interview was used to ask students questions that could add clear explanations about the observation findings. The list of questions asked in the semi-structured interview is given in Appendix G.

6.2.3 Study Description

During November 2012, a study took place in a one-day field trip. The trip was in the Peak District National Park in Derbyshire with the geography students. The study began when the author accompanied the students on the field trip. Then, the following steps were followed:

1. Each student was then loaned an iPad or iPhone, where each device has been allocated to the participants randomly. The devices on loan to the students had been prepared earlier, with specific applications. Two different mobile devices were used during the study; the iPhone 4s and an iPad 2. In addition, the iPad device was combined with a stylus to help with note making.

These devices were prepared earlier with specific applications that could help with the capture and sharing of experiences. The list below shows the name of applications:

- iPad Applications:

In addition to the original embedded applications, the following applications were added to the device: Note Plus; UPAD; Good Notes; Note Shelf; Evernote; PaperDesk LT; Dropbox; Map Ruler; Tape Measure; Map Overlay Tracer; and dB Volume Meter (see figure 6.1)

- iPhone Applications:

In addition to the original embedded applications, the following applications were added to the device: Documents; Evernote; Notes; Dropbox; Map Ruler; Tape Measure; Map Overlay Tracer; and dB Volume Meter (See figure 6.1).

2. When the student began the experiment, a specific application was run to record the device screen.



Figure 6.1: The Devices Interface. The iPad interface (left), and the iPhone interface (right)

3. Student used the device for 15 minutes to capture and share their experience in the field.
4. At the end of the field trip there were three students that had used the iPad and three students that had used the iPhone.

After finishing the field trips, the students were then involved in an individual 10 minutes semi-structured interview. This method was used to understand further the participants' experience in using mobile devices to capture and share their experience in the field. The participants' answers illustrated the difficulties that they found when using these devices in the field.



Figure 6.2: Geography student takes a photo using an iPad

6.2.4 Analysis

After the data collection, the data was transcribed from the observations and individual interview. Then, it was generated into categories to reflect in the relation to the research issue and concern. In addition, the data was separated question by question (for the interview) to illustrate the key theme in each question.

The approach used to analyse the findings of this study was a thematic based content analysis. Firstly, the data was split down into meaningful codes. Then, these codes were developed through analysing the collected data to identify themes which would be later linked to the research questions. The full description of thematic based content analysis and how this was applied has been described in the previous chapter (see section 3.5 in chapter 3). Besides, in this study the scenario method has been used to present the qualitative data.

6.2.5 Findings

This section illustrates the findings of this study. It starts with describing the field activities using a scenario to explore the contexts and discuss the needs of the user. The field trip was with the geography students at the Peak District National Park in Derbyshire. Before the trip started, the trip instructors gave instruction sheets to all students. These sheets were a part of the coursework to be submitted after the field trip. They included a number of questions and exercises that the students were required to answer individually relating to their observations and experiences in the field.

When the students arrived at the field, they put themselves into groups and walked together around the field so as to get a feel for the area. The instructors were also available so that students could to ask questions about the site, and the students took notes and photos. The students, who were supplied with smart mobile devices, were allowed to roam with their classmates. Despite having smart mobile devices, the students preferred to communicate face-to-face within their group.

Moreover, it was observed that, when the participants wanted to write a note using the smart device, they stopped where they were until they finished writing and then moved on. That caused them to lag behind their groups. Thus, they preferred to use the devices to capture photos so that they would not get left behind. So, the activity of capturing photos was more frequent than writing notes on the smart mobile devices. As an example, one of participant captured a photo of the instructions sheet, so then she did not need to refer to the sheet whilst carrying the iPad device (see Figure 6.3).

Another action observed during the trip was that the students used their notebook as a stand to put the iPhone on while they writing, and used the stylus pen with the iPad only.



Figure 6.3: The Students Field Experience with Using Mobile Devices. On the left, a geography student captures her instruction sheet using iPad. On the right, two students used their smart device; iPhone, and iPad with stylus.

Moreover, part of the field trip involved entering a wet cave. Two students used the smart mobile devices there. It was observed that, despite the darkness inside the cave, it was possible to take notes due to the brightness of mobile screens. However, the

majority of students took photos instead of typing. The main problem was the need for a waterproof cover to protect the smart devices from the damp atmosphere as Figure 6.4 shows below.

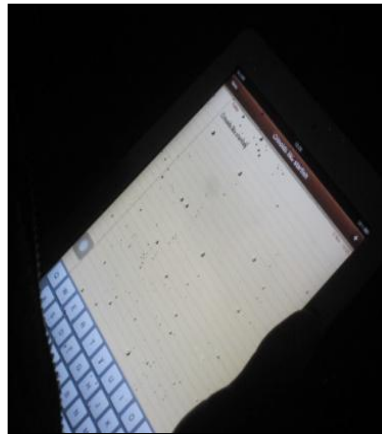


Figure 6.4: The need for a waterproof cover to protect the iPad inside the cave is noted

After the field trip finished, the researcher observed the notes that had been taken in the field using the mobile device. Four out of six participants had taken notes. Three of them used the Note Application and one used the PaperDesk Application to take notes. As figure 6.5 shows, the notes which the participants took by Note Application were quite short and contained brief sentences. The notes written using stylus looked untidy and cluttered. The students used the built in keyboard as an input function to write about their observations in the field.

After the interviews were analysed, codes were developed to identify new themes geography students. Themes were combined, split, or moved, so then the final version of the codes presents five main themes as table 6.1 shows below. An example of coding development and sorting is given in Appendix H.

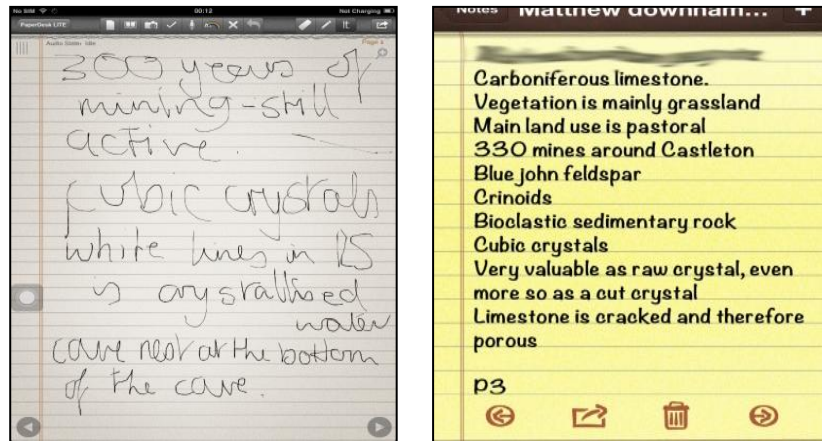


Figure 6.5: Examples of the Students Note by Using mobile Devices. In the left, an example of hand written notes using an iPad and stylus. In the right, an example of word-processed notes using the Notes application.

Table 6.1: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
1. Data Types	D01. Qualitative data D02. Multimedia Data
2. Applications	A01. Built in Applications A02. Substitute Applications
3. Data Organisation	O01. Notes Organisation O02. Multimedia Organisation
4. Data Sharing	S01. Peer-to Peer S02. Online S03. Social Networks.66

- **Theme: Data Type**

Generally, it was observed that there are two main types of data the students collected using mobile devices in the field. These were qualitative data such as taking notes that described

the surrounding area and what they observed in the field. However, there were also a short number of notes the students took in the field. They were dependent strongly on capturing multimedia data such as capturing photos.

“If I have time, I will make notes” –A geography student commented about his reason for not taking notes by iPad device. He found that typing the notes would consume his time in the field. Therefore, he chose to take photos.

“Pictures are most useful” – An opinion from geography student who used iPad device, found that collecting photos is more useful than taking notes to reflect his experience in the field.

“I took photos by phone, but still I want to write by my hand” – Another comment from geographer who used the iPhone for taking notes only, as he still preferred writing his note by hand.

Moreover, it also has been noticed that there was a change of data collected by the geography students compared to the first case study reported in chapter 4, as they did not collect any quantitative data in their notes. The reason for this was because the objective of this field trip was different to the one observed in the previous case study. The objective of this study was to introduce the first year geography students to the field trip environment, in addition to teaching them how to collect field trip data using specialist equipment.

- **Theme: Applications**

During the interview, the participants were asked to list the names of mobile applications they used to capture and share their learning experience. The list of mobile applications was divided into two sub themes, those that were provided with the device and the substitute applications added by the

researcher: applications and substitute applications. The built in applications are those which are designed by the mobile company provider, such as camera application and note application in iPhone and iPad devices. The substitute applications are the applications which were installed into the devices for the study purpose, for example, Notes; Dropbox; Map Ruler; and Map Overlay Tracer. It is worth mentioning that the participants chose which application to use based on their needs and what they thought it would help them in the field.

It was noticed that geography students used the built in applications camera and Notes. However, the other note taking applications were used differently by geography participants, for example, Paper Desk application, and Notes Plus application.

- **Theme: Organisation**

Since the mobile devices did not belong to the participants, it was observed that they did not all organise their data in specific format. They all kept their notes in the notes applications that they used and the multimedia data such as the photos were saved at the default directions in the iPhone and the iPad.

However, two students mentioned their preference to organise their data on paper instead of using technology.

“My notes could be organised but I couldn’t! I prefer to organise it on papers, it is easy, just changing the order of the sheets” – It appears that the participants could not organised his notes on the mobile device because he did not know how to do that.

- **Theme: Data Sharing:**

Finally, the data sharing activity using mobile devices in the geography field trips were affected by the lack of internet signal. As noted in the previous study in chapter 4, poor internet signals prevented the students from sharing their data online. Instead, they shared their data face to face. Otherwise, they mentioned that they would share it after they back from the field trip.

"I'll will share it from my computer; I will upload it from the iPhone to the computer"

"iPad is useful to share, just copy photos to the emails, but sharing in the field is so slowly"

"Upload it first to the computer then to emails"

Table 6.2 summarises the observations made about how geography students used the mobile devices to capture and share their learning experiences (LX) in the field.

Table 6.2: Summary of Geography Findings

Subject	The Answering Codes
	Geography
The Kind of Capturing Data	Qualitative data: Notes describe the surrounding area. Records: Photos
Applications used to capture data	Built in Camera, and Notes. Paper Desk app, Notes Plus app.
Data Organisation	• Organising notes in Notes applications • Photos in camera roll application
Sharing Data	• They did not share data in the field. • They Preferred face to face discussion • The majority would use emails to share data with colleagues if they have an internet service in the field
The Usage of Social Networks	They did not use the social network due to lack of internet in the field

6.3 Case Study 2: Architecture Field Trip

Similar to the previous section 6.2, the same study has been applied with undergraduate participants from the Built environment school in different field trip setting. As there are two case studies from diverse disciplines, the results would identify similarities and differences between the students groups on a number of aspects of use of the mobile technology students such as; organisation, transformation, privacy, and data sharing.

6.3.1 Participants

This case study involved six undergraduate third year architecture students from the School of Built Environment, at Salford University. This group consisted of four males and two females, again who were selected after a call for participants was made asking for students who have smart devices, such as smart phones, and who know how to use them. All participants signed a consent form and the Faculty of Engineering Ethics Committee awarded ethical approval before anyone participated in this study.

6.3.2 Methods

The methods which have been applied in this study are the same as these that described in section 6.2.2.

6.3.3 Study Description

During November 2012, a study took place in a one-day field trip. The trip was to Poynton in Cheshire, with the architecture students. The study began when the author accompanied the students on the field trip. Then, it followed the same steps that have been described in section 6.2.3



Figure 6.6: An Architecture student takes a photo using an iPhone

6.3.4 Analysis

Same as the previous case study in section 6.2, the data analysis has been followed the same approach that is described in section 6.2.4

6.3.5 Findings

This section illustrates the findings of this study. It starts with describing the field activities using a scenario to explore the contexts and discuss the needs of the user.

The field trip with the architecture students took place at Poynton in Cheshire. The students were required to travel individually by train to meet the field instructor at Poynton train station. The students used their smart devices to plan their trip. They accessed the internet to search for the train schedule. Once all the participants had arrived at Poynton, the field trip instructor collected them in a group to roam around the city. They were walking while the field instructor explained the site facilities and characteristics around the area. It was observed that the students

walked together, however they each collected their own experience and interests individually.

One of the differences observed between this case study and the geography case study was that the architecture students had their own devices with them. This allowed the researcher to observe usage behaviours using the prepared study devices and the students own devices. After distributing the devices between the participants, it was observed that the majority of the students used the smart devices to capture photos and video. Two students preferred to record the tutor description by using the voice record application in the smart device.

However, only few participants were seen drawing sketches for the sites on the iPad devices by using the stylus pen (Figure 6.7). In addition, only one participant wrote a note in the site by using the Notes application. The reason behind the reduced amount of note taking is because the nature of touch keyboard in these devices makes the typing function difficult.

Furthermore, the availability of the internet access in the visiting site offered a chance to the participants to use social networks applications such as Facebook and Instagram. Using these applications would keep them in contact with family and friends where they were in the field. In addition, it allowed them to share their experience and interest online in various ways such as sending emails or upload their collective data on cloud storage.



Figure 6.7: Students capture their learning Experience in the Field by using mobile Devices. In the left, two students take photos using an iPad and iPhone for the field site. In the right, An Architecture student drew a sketch on the iPad

After the interviews were analysed, codes were developed to identify themes for the architecture students. Themes were combined, split, or moved, so then the final version of the codes presents five main themes as table 6.3 shows below. An example of coding development and sorting is given in Appendix H. The themes that emerged from the analysis included a common set of themes that emerged from both case studies. These are shown in Table 6.1 and 6.3. To some extent, the emergence of similar themes is not surprising, as both groups were asked similar questions in the post-field trip interviews. However, the responses from students also identified some specific themes that were unique to either student group. Differences between the two groups are particularly interesting and these are discussed in detail in the following sections.

Table 6.3: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
1. Data Types	D01. Qualitative data D02. Multimedia Data
2. Applications	A01. Built in Applications A02. Substitute Applications
3. Data Organisation	O01. Notes Organisation O02. Multimedia Organisation
4. Data Sharing	S01. Peer-to Peer S02. Online S03. Social Networks.66

- **Theme: Data Type**

Generally, it was observed that the collective data was qualitative data such as descriptive notes about the surrounding area. In addition, there were also a short number of notes the students took in the field. They were dependent strongly on capturing multimedia data such as capturing photos and recording videos and voice notes (for architects only).

Regarding to the architecture students, there are three comments on their behaviours in using mobile devices in the field.

“I preferred voice notes than writing” – An architect who used the iPhone, favoured recording an audio note than type it. That was because the effort of recording audio notes was faster than typing notes on the iPhone.

“I captured photos, but I wrote keynotes related to the pictures in my notebook” – This comment also reflects the preference of using the

paper based method to collect notes in the field rather than using the mobile device.

“Photos make me remember better than notes, also capturing the location is important” – the participant mentioned why he found capturing photos is better than taking notes in the field, in addition capturing the location is essential as an architect student.

- **Theme: Applications**

Same as the previous case study, the participants were asked to list the names of mobile applications they used to capture and share their learning experience. Besides the provided applications in the study devices, the students used the following substitute applications: Notes; Dropbox; Tape Measure; and dB Volume Meter. It is worth mentioning that the participants chose which application to use based on their needs and what they thought it would help them in the field.

It was noticed that the architecture participants used the built in applications camera and Notes. In addition, the architecture students chose to use Note Shelf application. Moreover, it was recognised that only the architecture students used the internet and the web applications in the field such as web browser, and Dropbox. They also extended their access to use further applications which were not installed before. For instance, the architects used the internet to get access to Google translate to translate words they found in the field. In addition, they used the train schedule application to arrange their travel back from the field.

- **Theme: Organisation**

Since the mobile devices did not belong to the participants, it was observed that they did not all organise their data in specific format. They all kept their notes in the notes applications that they used and the multimedia data such as the photos were saved at the default directions in the iPhone and the iPad.

However, two students mentioned their preference to organise their data on paper instead of using technology.

"iPhone is more organised for photos, but I still prefer paper and pen"

- **Theme: Data Sharing**

The architecture students shared their learning experiences and got access to the internet and social networks. They shared their learning experiences through emails, and cloud storages. Moreover, the social networks were also used to stay connected with family and friends such as using the chatting applications, and to share their photos on social applications such as Facebook and Instagram.

"I shared interesting information and photos on facebook, and sharing my location with my family" – The participant used the social network to keep connected to her family and friends while she was in the field.

"I email my notes to my friend"

"We have a Dropbox account for our project, so I uploaded my photos there" – The participant mentioned that they have a cloud storage account which has been set up before the field trip. So then, the entire project member can use it to share their finding there.

"I will share what I collect at the class, because I will use these in the presentation" – The participant would use what he found in his

presentation; therefore he would not share that before presenting to the class.

Table 6.4 summarises the observations made about how architecture students used the mobile devices to capture and share their learning experiences (LX) in the field.

Table 6.4: Summary of Architecture Findings

Subject	The Answering Codes
	Architectures
The Kind of Capturing Data	Qualitative data: Notes describe the surrounding area. Records: Photos, Videos, Voices
Applications used to capture data	Built in Camera, and Notes. Notes Shelf, Dropbox, Google Translate, Web browser, Train Schedule
Data Organisation	• Organising notes in Notes applications • Photos in camera roll application
Sharing Data	• Sharing notes by emails • Sharing multimedia data by cloud storage applications such as Dropobox
The Usage of Social Networks	They used them: • To contact with family and friends • To share their locations, photos, and what they found interesting to share

6.4 Discussion and Result

As there were two case studies from diverse disciplines, the results will identify similarities and differences between the geography and architectural students regarding how they use mobile technology to capture and share their experiences in the field trip. These are illustrated in Figure 6.8. The figure shows five

comparison aspects between the architecture and geography students in using mobile devices during a field trip.

The first one is that all the participants capture the same type of experience in the field. Both groups collected notes and photos to describe the surrounding areas. The architecture students extended that to record voice and video data.

The second aspect was that both groups used quite similar applications to capture the experience, in spite of the devices being prepared with a number of different applications for different purposes. For instance, both groups used the built in application (Notes) to capture their experience. The Notes application is a simple application that allows note taking to be typed on the embedded keyboard. However, it does not provide some design combinations, such as, drawing, sketching and linking notes with photos.

In addition to the built in notes application, the geography students used two other applications for note taking; Paper Desk Application and Notes Plus application. On the other hand, the Architecture students expanded their usage to diverse applications such as the web browser to access the Internet and the train schedule to plan their trip back to University.

The third aspect covers the organisation activity for the collected data. In this case, both groups behaved the same in organising the data. For instance, the notes were sorted in the notes applications. The multimedia data such as photos and videos were organised in

the camera roll application, which is the official application to save the multimedia in the smart mobile devices.

The next aspect concerns sharing the collective data and using social networks. In this case, the geography students preferred face-to-face discussion over the digital communication. Besides, due to the lack of the internet, the participants in the geography field trip could not share their data in addition to access social networks. They mentioned that they would like to use emails which are considered as a quick and simple way to share their collective experience with their colleagues. However, as a “quick fix” the geography participants would send their data through emails after they returned from field trips.

On the other hand, the architectural participants were the only group who shared and got access to the social networks when they were in the field trip. They shared their notes through emails, and the collective multimedia through cloud storage applications such as Dropox. Furthermore, they accessed disparate social network applications such as Facebook and Instagram to communicate with their family and friends. They also use them to share their interesting experience, collected photos, and their locations over these applications.

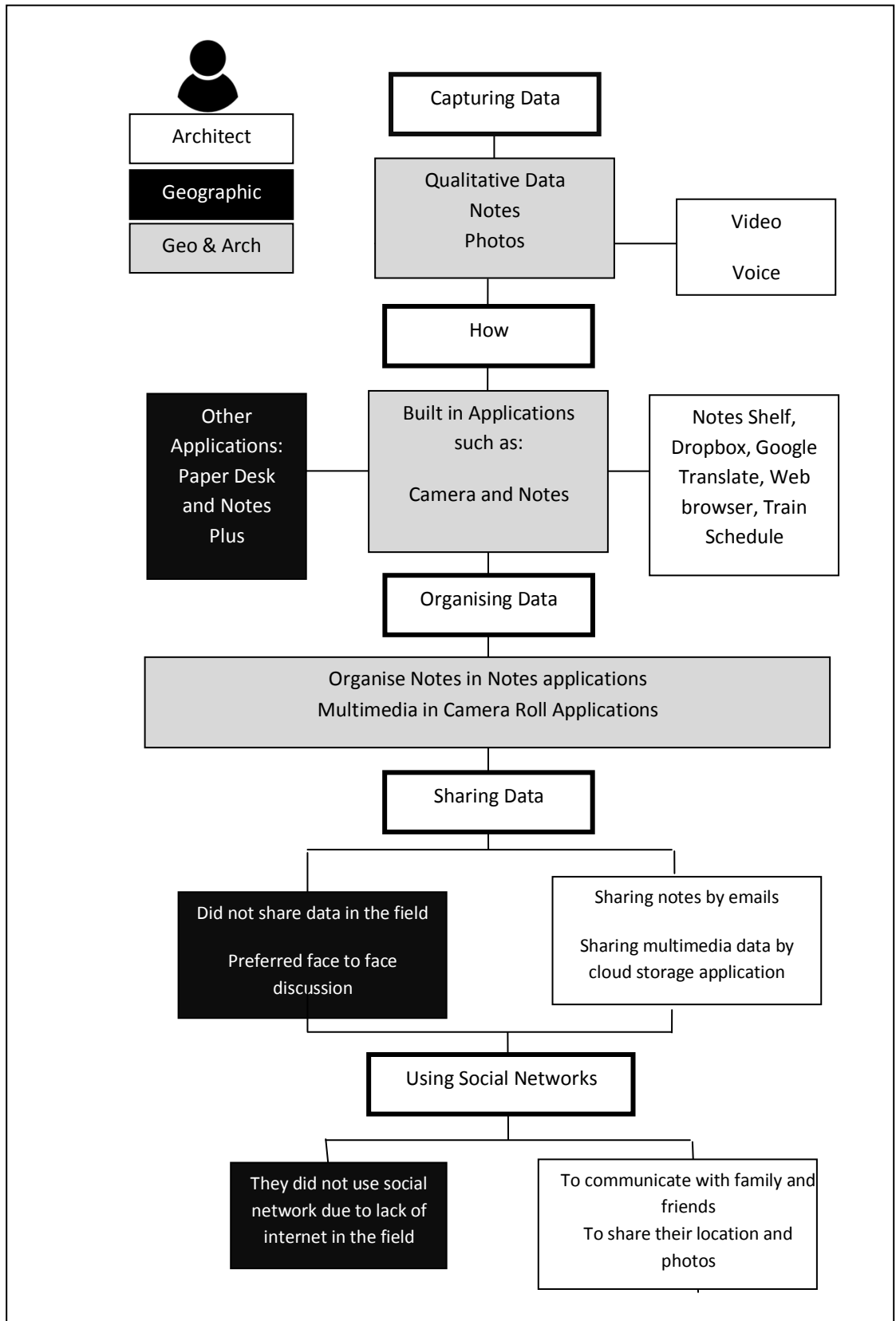


Figure 6.8: A comparison between Geographers and Architects

During the post-field trip interview, participants were asked whether they would use these mobile devices in the field if they owned the device themselves. Different answers were given in response to this question. For the participants who said yes, their explanations include that the mobile devices are more suitable for taking photos than notes. In addition, the mobile devices provide the accessibility to the internet in the field trips. Besides, carrying a single device such as mobile devices is more convenient than having multiple equipment in the field.

There are some examples of the student's comments about that:

"iPad NO ! But iPhone yes for taking pictures not for notes"

"Yes, it is easy to carry around rather than carrying different things but not to take notes"

"Yes it is comfortable and easier than carrying notebook"

On the other hand, there were also participants who had different view regards using mobile devices in the field. Their explanations include that the size of mobile devices especially the iPad device are too large to hold in the field. In addition, the limited time of the field trip leads them to choose a quick way to collect their experience, for which they considered the traditional tools to be more suitable than using mobile devices. As well, the high resolution in the professional digital camera leads the participants to prefer it over the mobile camera to use in the field to capture their photos.

However, an issue raised during the interview conversation was that the participants suffered from being isolated from the physical environment when they were using the smart mobile devices. They explained that using these devices kept them behind the groups especially when they were taking notes. That

was because the touchable keyboard in these devices makes the typing function difficult and required concentration to type correctly. In addition, they mentioned that using the mobile devices to switch between applications required concentration which distracted them from the physical environment around them. In addition, when carrying these devices around a harsh environment such as the field trip it was considered not convenient or safe to use.

Therefore, there are some examples of the student's comments about that:

"Using iPad made me behind my group, because it is not easy to carry around the field safely"

"It seems hard to take notes with these devices because changing between apps need more concentration"

"Yes it is comfortable and easier than carrying notebook"

"Yes, but I prefer a built in keyboard phone such as Blackberry for typing"

"I prefer a built in keyboard phone such as Blackberry for typing, when you type you feel isolated because of the touch keyboard. If it is like the blackberry it is going to be easy"

"iPad is not convenient in the move, but the iPhone size more convenient or maybe the mini iPad"

Consequently, this study concludes that there are three main causes that could affect the usage of mobile device in capturing and sharing experience in the field trips. These are:

- Lack of knowledge

One of the reasons is the lack of knowledge when using the capturing features in the device. As previously mentioned, the students were familiar with using mobile devices as a connecting device. However, they were not familiar with using the mobile devices to capture the experience in the field. More training on using these devices in the field is needed to be introduced to the participants before giving them the devices in the field. Fig 6.9 illustrates the need for more practice in using a stylus with the iPad device so as to take notes more quickly and easily.

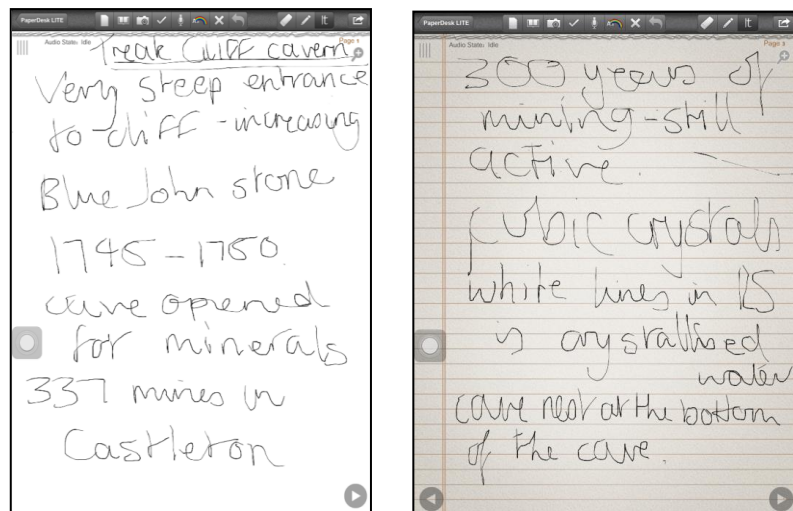


Figure 6.9: Example of a note sheets has been written by using stylist pen

- Time

The second reason is time. A high percentage of the participants of the study mentioned that since there is a time limit to visit the field, they have to be fast so as to capture as much of the experience as they can. Thus, they focused on photos because that helps them to remember the details more clearly than taking notes.

- Isolation

A large number of geography and architecture participants commented on the spatial isolation that they faced when they used their mobile devices in the field. They found themselves lagging behind the group, especially when they typed their notes. However, the isolation disappears slightly if they use the devices for capturing pictures.

6.5 Conclusion

This chapter presented two case studies with undergraduate geography and architecture students to develop an overall understanding of using mobile devices for capturing and sharing the experiences in the field trips. This led to identification of three main reasons that cause a negative effect on using the mobile device in capturing and sharing learning experience (LX) in the field trips. These were that the students have a lack of knowledge about how to use these devices to support their activities in the field. The second cause is the limited time in the field, so the students were looking for a faster method to collect their experiences. In addition, the third cause is that the students suffered from spatial isolation when they used the mobile devices especially when they were taking notes.

The next stage of this research was to design a study that aims to reduce the negative effects of the previous causes to evaluate the usability of using mobile devices in capturing and sharing learning experiences (LX) during the field trip.

7. Investigating the Effects of Using Mobile Technology

During the Field Trips

7.1 Introduction and Aim

This chapter presents a qualitative study conducted to evaluate the usability issues related to use of mobile technology for capture and sharing of experience during student field trips, by comparing use of three different methods used for capturing and sharing experiences in the field.

The previous prototype study had identified three main issues which could cause a negative effect on using the mobile device in field trips: lack of knowledge about using these devices; time limitation in the field trips which forces the students to choose quick methods to capture their observations; and spatial isolation which the students suffered from when they used the mobile devices in the field due to the need to concentrate on using the device.

Therefore, this study aimed to explore whether training users on how to use the features of the mobile device before conducting the field study activity, and therefore reducing the problem of lack of familiarity, would impact on usability of experience capture and sharing in the context of the field trip.

This chapter begins by presenting the concept of usability assessment applied in this study. Then the study description, findings and the results of this study are presented.

This chapter aims to address the following research question:

Research Questions Addressed in this chapter

RQ 3: What is the potential for mobile technology to contribute to the aspects of capturing and sharing the learning experience during the field trip?

7.2 Identifying the Research Problem

As the previous study in chapter six shows, there are three main causes that could affect the usage of mobile devices in capturing and sharing experience in the field trips. These are:

1. A lack of knowledge and awareness about using the mobile devices and applications in the field activities.
2. The limited time of field trips
3. The spatial isolation that affects the students when they used the mobile devices in the field.

After developing a deep understanding of the findings from the previous study in chapter six, it seems there may be a relationship between these three causes. Therefore, reducing the effect of one of these causes could lead to a reduction in the other two causes. In another words, this study aims to investigate the effect of training on the lack of technology, to study if this would help the students to use mobile technology effectively in the field.

In addition, this study aims to compare the efficiency of capturing and sharing learning experience in the field by using the paper-based method and the mobile technology method under the same conditions. The comparative study could illustrate the different impact of these methods on enhancing the activity of capturing and sharing data in the field.

So the specific research question of interest in the study was:
What effect does training have on using mobile devices to enhance capturing and sharing experience?

7.3 Usability Assessment of Different Capturing and Sharing Tools

7.3.1 Definition of Usability Evaluation

Despite the growing interest in, and use of, digital and mobile technology in education, Kulkulka-Hulme et al (2007) reported that there are large numbers of mobile activities in education use devices which are not designed for educational purpose, and that give rise to reported usability issues.

As a general definition, usability in human computer interaction is concerned with measuring ease of use (Miller, 1971). More recent definitions take a wider interpretation of mobile usability to include “Creating user experiences that enhance and extend the way people work, communicate, and interact.”(Preece et al., 2002, p. 6) and recognise that providing the mobile system with good usability will enhance the system operation and people usage (Kulkulka-Hulme, 2007).

Consequently, the benefit of mobile usability and efficiency is to improve the quality of work, in addition to enhancing productivity. It also increases user satisfaction toward the mobile system and reduces the cost of training and support (Yee and Seong, 2009). Furthermore, according to Berns (2004), considering the human factors issues would improve the usability of mobile interactive systems. To achieve that, the user centred design approach leads to better mobile usability.

Usability is a multidimensional structure, which is determined by the user, the task, the tool and the environment. Thus, it has been defined from various perspectives.

According to Shackel et al (1991), usability is defined as:

“The capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios.”

Moreover, the International Standards Organisation (ISO DIS 924-11) (1994) also defines usability as:

“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.”

Furthermore, usability can be defined as:

“Usability is the broad discipline of applying sound scientific observation, measurement, and design principles to the creation and maintenance of Websites in order to bring about the greatest ease of use, ease of learnability, amount of usefulness, and least amount of discomfort for the humans who have to use the system.”
(Pearrow, 2000)

From these three different definitions, it appears that there are a variety of usability attributes. In this research, the ISO (1994) which points to three attributes “Effectiveness, efficiency, and satisfaction” would be considered as describing the usability attributes to be examined. Because the nature of this study aims to compare the usability issues between three different methods, the previous selected attributes would cover the required comparison elements.

7.3.2 Usability Framework in this Research

In terms of a usability framework in this research, Shackel et al's (1991) framework has been applied because it allows for usability to be structured by four dynamic components: user, task, method, and environment. The relation between these components is shown in Figure 7.1.

Based on the previous figure, the four components can be defined as the following in this study: the user is the undergraduate geography/architecture student; the task refers to capturing and sharing of experiences; the methods here are the paper based method and the mobile device which is the iPad; and finally, the environment is the field trip and work.

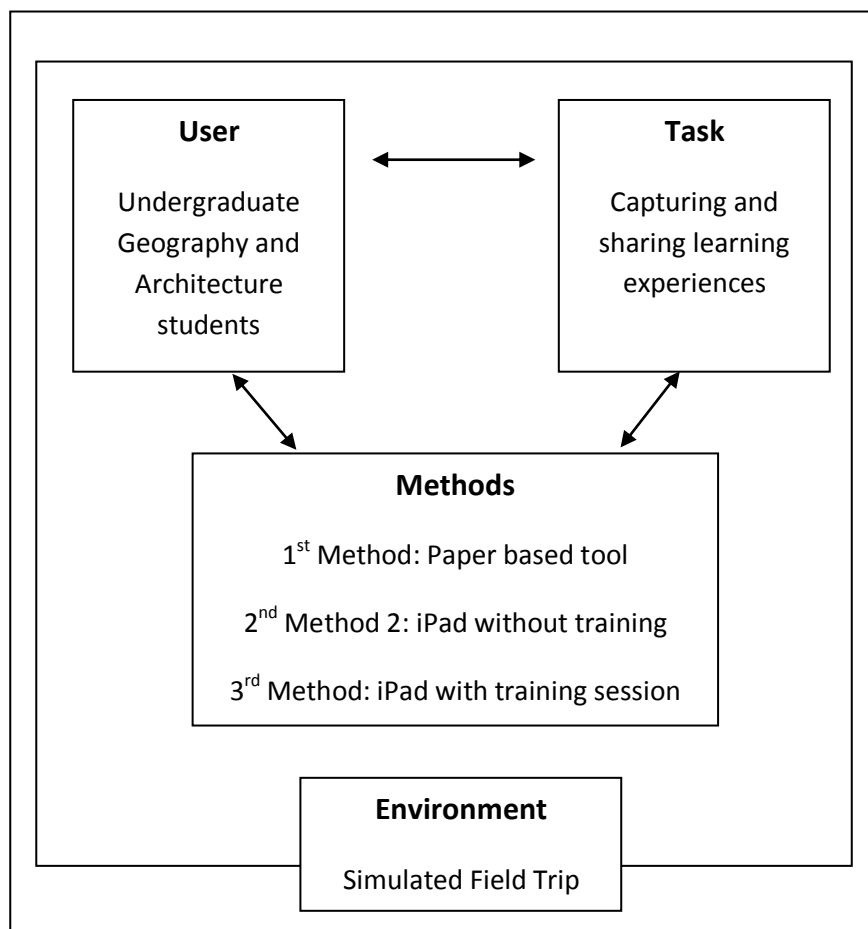


Figure 7.1: The four principle components in a human machine system

7.3.3 Usability Evaluation Approach

The evaluation approach applied in this study is the empirical approach. According to Eberts (1985), this approach involves the target users as a sample, to study their performance and attitude toward the system under specific conditions. This approach is generally applied when examining and comparing multiple conceptual system designs. Therefore, it would be a suitable approach to use for evaluating the usability in this study. The study presents a sample of undergraduate geography and architecture students, with the aim of examining their performance, using different tools to capture and share experience under field trip conditions.

7.3.4 Usability Evaluation Methods

According to Jeng (2005), there are a variety of evaluation methods that can be used to assess usability. These include formal usability tests, card sorting, paper prototyping, and focus group methods; to add to this, think aloud, questionnaires; field study methods can also be used amongst others.

The evaluation methods selected for this study were observation, followed with a questionnaire. The observation aims to identify the difference in using the three different methods in this study capturing and sharing experiences in the field. Therefore, the observation could be used to identify the potential positive or negative contributions of using mobile technology in the field.

Moreover, a questionnaire was applied after the observation to clarify the participant's responses. This also contributes to a deeper understanding of the data collection from the observation.

7.3.5 Usability Evaluation Model

The usability evaluation model in this study has been designed based on the definition of ISO (1994):

“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.”

Therefore the three attributes, which would be examined, are effectiveness, efficiency and satisfaction. In this study, each attribute has been defined as:

- Effectiveness evaluates whether the system as a whole can provide functionality effectively. It will be measured by how many tasks have been done.
- Efficiency evaluates whether the system as a whole can be used efficiently. It will be measured using three questions:
 1. How long has it taken to complete the sub tasks?
 2. How much time has it taken to complete the total tasks?
 3. How many tasks have been completed?
- Satisfaction looks into the areas of ease of capture, share and organise. It will be measured using a Likert scale and questionnaire.

Figure 7.2 illustrates the relationship between the evaluation elements in this model. The empirical usability evaluation approach is applied in this study to analysis of these attributes. The objective measures were applied to evaluate the effective and the efficiency; whereas, the subjective measure was applied to evaluate the satisfaction.

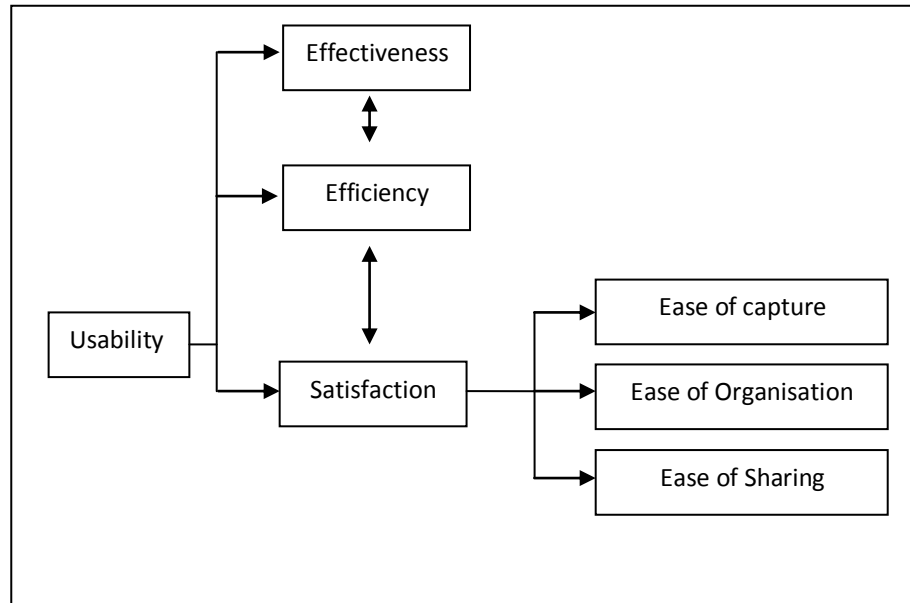


Figure 7.2: The Model of Usability Evaluation in this research.

7.4 The Field Study

7.4.1 Participants

In this study, the participants were undergraduate architecture and geography students in the United Kingdom (UK). 24 participants were recruited into this study; 12 from architecture and 12 from geography. However, as the previous study did not suggest a major difference between the findings of geography and architecture participants, they were treated as one cohort group. Furthermore, the participants were selected after a call for participants from the Geography and the Architecture schools at the University of Nottingham. Two conditions were required when selecting the participants. The first one was that the participants should have at least one year of field trip experience. This ensured that the participants are familiar with field work. The second condition was that the students should be familiar with smart devices. This condition was applied with the students who were selected to use the second and the third methods in this study.

The participants were divided equally between three different studies, so that eight different participants were in each group. Each group was instructed to use a different method to capture and share learning experience (LX) in the field. All participants signed a consent form and the Faculty of Engineering Ethics Committee awarded ethical approval before anyone participated in this study.

7.4.2 The Study Description

During May and June 2013, the study took place around the lakeside at the University of Nottingham, in the UK, with 24 students familiar with field work as described above. Three different groups were established. The first group were required to use traditional paper-based methods which contain notebook, pen, and digital camera (see Figure 7.3).

The second and third groups were provided with only an iPad device and stylus pen as methods to capture and share activities in the field (see Figure 7.3). The main difference between these two groups was that, in the second group, the students were not given a training session on how to use the iPad device in the field, whereas, the third group were given training and instruction on how to use a specific application (Note Plus). In this study, it was decided to use a single application for taking and sharing notes to minimise the application options. The reason for this was that one of the findings of the previous study in chapter six suggested that exchanging between mobile applications disturbed participant concentration in the field. However, The Note Plus application is one of the selected applications, which matched with the requirements established during the early stages of this research.

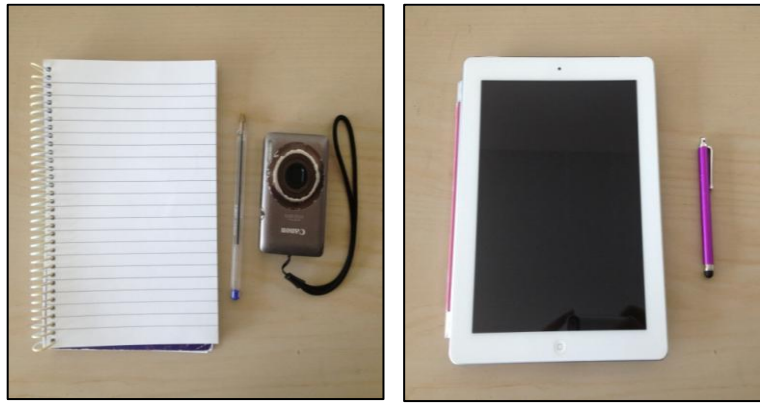


Figure 7.3: The Field methods: Paper based method contains notebook, pen and digital camera (Left), and iPad device with stylus pen (Right).

After preparing the devices so that they were ready to use, the following steps were taken:

1. Each participant was located within a group of eight. The participants worked individually, but followed the same task. The study took place at the Lakeside at the University of Nottingham.
2. Before the study began, each student was provided with a consent form and information sheet, which they read and signed. The information sheet explains what the participants should do in this study; a sample of this sheet is shown in Appendix I.
3. After that, each participant completed the demographic section in the questionnaire (see Appendix J and Appendix K)
4. The participants were given the methods; for example, camera or iPad etc) depending upon which group they were in
5. For students in the third group, a training session was conducted for an hour to teach them how to use the Notes Plus application and to familiarise them with its features so that the application could be used during the study in the field.

Furthermore, the following steps describe the field study tasks. The lakeside where the study took place at is a natural area at the University Park in the University of Nottingham. Figure 7.4 shows the map of the study field trip which has been designed to simulate the real field trips. Letter (A) on the map pointed to the starting point, where Letter (B) pointed to the end point.

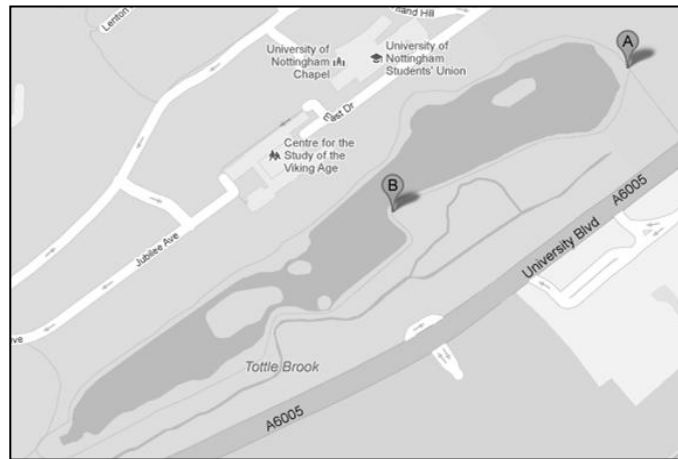


Figure 7.4: The Lakeside at the University of Nottingham.

At each approximately 2 meters, there was a sign showing a specific task to do.

6. The participants would walk for 20 meters to where the line transects from the starting point to the end point. These points were shown on the map.
7. Then after every 2 to 3 meters the participants found a sign that asked them to complete a particular task using only the equipment that they have. These tasks were designed to focus on understanding how these devices are usable to improve the data collection and sharing activities in the fields.

The tasks are listed as follows:

- **Task 1:** Capture a photo for the site.
- **Task 2:** Capture a photo and write down some text about this site, then link them together.
- **Task 3:** Share your notes with a friend on (Email, Face to Face, Social Network).
- **Task 4:** Capture a voice note for 15 seconds.
- **Task 5:** Capture a video for 30 seconds.
- **Task 6:** Check if you received a reply from your friend.
- **Task 7:** organise your findings into one folder.

During this study, the time that the each participant spent to complete each task was recorded. Recording the time started when the participant began doing the task, and finished when the participant completed the task. The time that the participant spent to move from one point to the next point was not recorded. After finishing all the study tasks, the participants completed the post-test questions to explain their user experience (UX) in the field.

7.5 Analysis

The first method applied during this study was the observation method. As in the case studies described in the previous chapters, two types of observation were applied in this study. The first type was direct observation of the students' behaviour when using the three different methods in the field trip. This particular method was employed with the aim of examining how the students use these three methods to capture and share their experiences in the field. The second type of observation was indirect observation and this was employed to investigate the students' output. After the

field trip, the participants were required to answer a questionnaire survey. The questionnaire was conducted to obtain more detailed set of information about their experiences in using these different methods in the field.

After the data collection, the data was transcribed from the observations and questionnaire. Then, it was generated into categories to reflect the relationship to the research concern (data capturing, data sharing, and data organisation). The data was organised separately for each question in the questionnaire to illustrate the key themes emerging for each question. A theme based content analysis method was applied to analyse the qualitative data that was obtained from this study.

7.6 Findings

7.6.1 Observation Finding

The Demographic information for the study participants is presented as follows:

There were 24 participants, 12 of them were geography students and 12 of them were from the School of Built Environment. All of these participants reported that they had experienced a field trip before with the University. However, they differed in the length of their field trip experience. The following table presents the frequency of field experiences for the participants. As it shows, the majority of participants had 3 to 5 years' field experience; while only two participants out of 24 had less than one year field experience.

Table 7.1: the frequency of Previous Field work experience of the participants

Length of previous field work experience	Number of Participants
Less than one years	2
1 to 2 years	8
3 to 5 years	9
Over 5 years	5
Total	24

Moreover, the participants were asked to list the tools they used frequently in their previous field trips. In general, they reported that notebooks and digital camera were the main tools they use. The mobile phone came in second. However, the geography students mentioned that GPS equipment is an essential tool to collect data in the field, whereas, only one participant from the architecture school mentioned use of laser measuring tools to measure the site dimensions and distances. Other equipment mentioned by architecture students is the data logger which is a small monitoring device to record environmental variables, such as temperature and humidity for set intervals of time.

7.6.2 Task Performance

- **Group1: Paper- based Method**

Starting with the participants who used the paper-based method in the field, it was observed that the participants only completed the tasks related to capturing activities. Furthermore, the only example of capturing the experience was that the participants used the digital camera to record

audio notes. However, with regard to sharing their data in the field, the participants were not able to do this due to the limit of the tool abilities. Instead, the participants explained that they would type up their notes using a computer and share their notes and photos digitally once they got back from the field. Moreover, it was also found that the participants tried a number of methods to organise their data. For example, one participant tried to link his notes with the pictures either by describing the photo in his note context or by memorising the relation between them as he explained. Another participant tried to take a picture to his note sheet with the photo and link them together (Figure 7.5).

- **Group 2: iPad without Training**

The next group used the iPad device without training. It was observed that several of the participants struggled with the size of the iPad. As they reported, they considered the size of the iPad to be too large carry in the field. Moreover, the participants were also not confident in taking notes using the stylus with the iPad. So, the majority preferred not to use it at all. However, number of participants chose the following applications to take notes, such as Good Notes, Notes Plus, and the built in notes application in the iOS system.

Moreover, it was found that the participants knew how to use the option of cloud storage services to store and share their data in the field. For instance, the participants used Dropbox application to upload their data while they were in the field. The main problem the participants faced was the poor internet connections in the field, which made the sharing activity difficult.

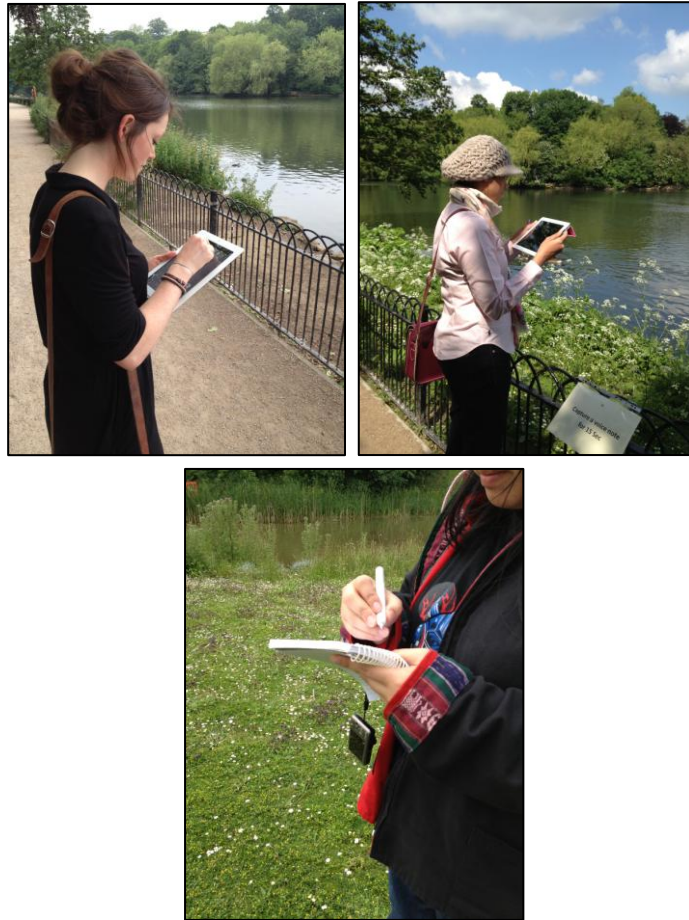


Figure 7.5: The participants used different methods to capture and share experience in the field.

- **Group 3: iPad with Training**

The last group used the iPad device after a training session. The participants in this group had a one hour training session on how to use the device in the field to capture, share and organise their findings. It was observed that the participants were able to use the device as they were familiar with the (Notes Plus) application and the iPad device in general: they knew what to press and what to choose. Moreover, the participants used the stylus pen in taking notes. Thus their notes sheets where tidy and clear. However, the only difficulty the participants faced was the poor internet in the field which made sharing the data mostly unsuccessful.

Figure 7.6, shows three samples of notes that were taken by the participants whilst they were in the field. The left hand picture shows a participant that used the iPad device without training. The right hand picture shows notes written by a participant who used the iPad device after a training session for the Notes Plus application. As the figure illustrates, the notes after the training session are tidier and more organised, while the notes taken by the participant without training are disorganised and messy. Moreover, Figure 7.7 presents a sample of two notes by participants who used the paper based tool. The participant in the left tried to link the photo that he captured with his note by using key words to describe the photo. The one on the right preferred to take his note in bullet style describing the surrounding area.

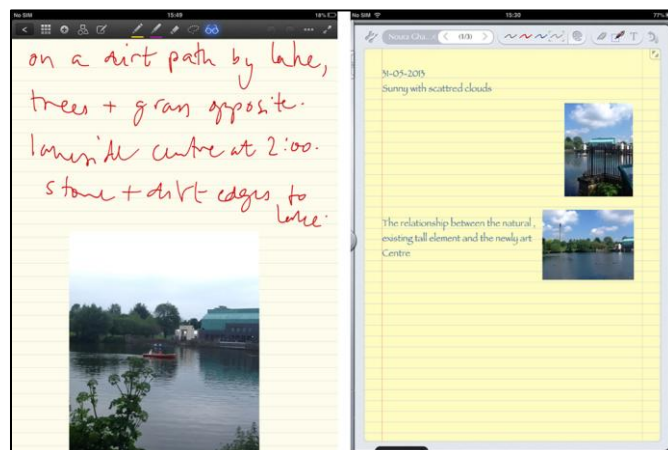


Figure 7.6: Sample of Students Notes taken by iPad Device (Left) Notes by iPad without training session. (right) Notes by iPad device after a training session.

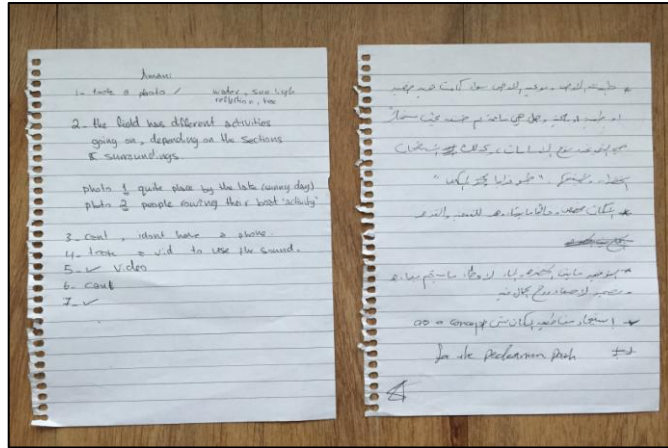


Figure 7.7: Sample of Notes taken by Paper based Method

During the observation, the researcher counted the number of tasks that the participants completed and the time that the participants spent on each task. The total number of tasks are seven. If the participant decided to skip a task, or not complete it, the task and time were not counted. The results showed that all the participants who used the paper-based method completed only four tasks out of the seven. Of the participants who used the iPad without train, three completed all the tasks, three participants completed six tasks, and two participants completed five tasks. All of the participants who used the iPad device with training completed all seven tasks in this study.

Times taken to complete the tasks are shown in Table 7.2. These show the time taken by students in each group to complete each of the individual tasks, added up to present a total time for each of the main activity types (capture, sharing and organisation) where applicable.

Participants using the paper-based method were not required to complete all types of tasks in this study, as tasks 3, 6 and 7

required use of technology, which was not available to them in the field. Therefore, this group spent zero time on the tasks related to sharing and organisation. With regard to the capturing activities, the paper-based group were generally faster than the group using the iPad without training but slower than the group using the iPad with training. With the exception of the data organisation task (T7), the group using the iPad with no training took longest to complete the tasks and the group using the iPad with training took the least time to complete the tasks. That was because this task required the participants to sort all their findings in one folder. This was not a common activity to do by using mobile devices such as iPad. This indicates that the training session enabled the students to complete the tasks using the mobile device more efficiently.

7.6.3 Questionnaire Results

The post-test questionnaire asked the participants to comment on ease of use and useful of the tools used to complete the tasks (see Appendix J and Appendix K). For each question, a five-point likert rating scale was used in which positive and negative descriptors were used at the scale end points, with “neutral” as the central option. For example, the scales ranged from “difficult” to “easy”, or “useful” to “not useful” as appropriate to the question (as can be seen in Appendices I and J). The purpose of these questions was to provide a deeper understanding of the participants’ attitudes towards the study tools they used (see section 7.4.2).

The following sections present the subject’s responses for each question in the questionnaire, in addition to comparing their comments between the study groups. Quotations from the participants are included to help interpretation of these findings.

Table 7.2: Time of Total Tasks Used by Participants to do the experimental tasks

Tasks		Time (Seconds)		
		Paper Based N=8	iPad without Training N=8	iPad with Training N=8
Capturing Activity	T1: Capture a photo for the site	149	132	109
	T2: Capture a photo and write down some text about this site, then link them together	948	939	550
	T4: Capture a voice note for 15 seconds.	402	466	199
	T5: Capture a video for 30 seconds.	358	403	394
	Total	1857	1940	1252
Sharing Activity	T3: Share your notes with a friend on (Email, Face to Face, Social Network).	0	561	430
	T6: Check if you received a reply from your friend.	0	321	258
	Total	0	882	688
Organisation Activity	T7: organise your findings into one folder.	0	710	915
	Total	0	710	915

- **Question 1: The Overall Ease of use:**

The first question asked about the overall ease of use these methods during this study for the methods used and participant responses are shown in Figure 7.8.

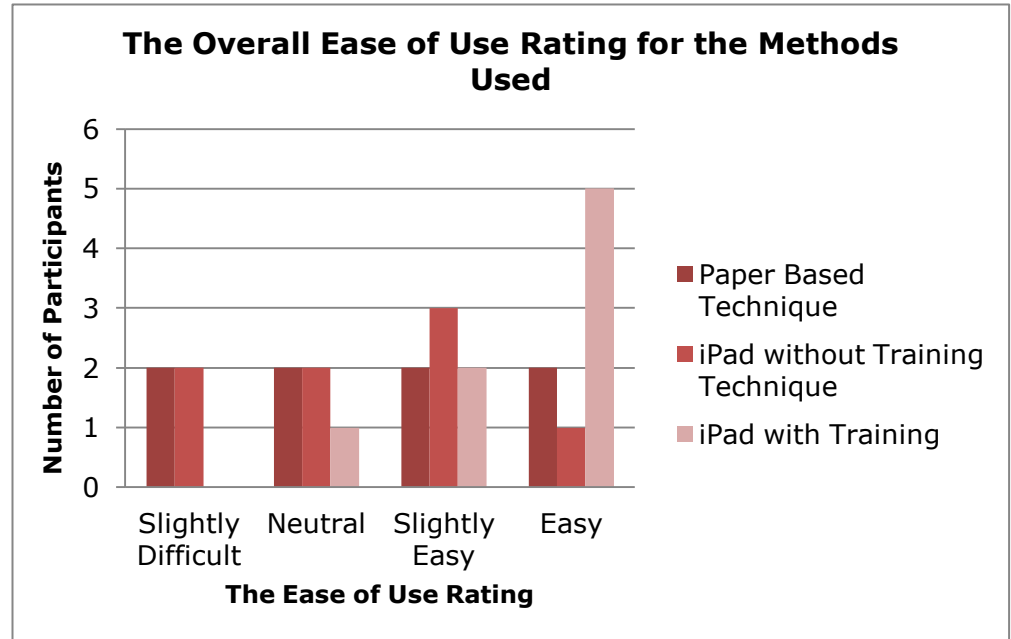


Figure 7.8: Comparison of ease of use ratings between the three study groups

As figure 7.8 illustrates, it is noted that there was an equal mixed responses amongst the groups using the paper based method. The equal rating of the first method made it unclear to detect a particular pattern. Where, the second method has been rated as slightly easy by 3/8 participants. However, the number of participants who rate the second method as an easy to use is larger than the number who rated as slightly different and who chose neutral rating. As a result, the rating pattern for the iPad device without training becomes slightly easy device to use in the field. Furthermore, 5/8 participants, who were given an iPad and a training session on the Note Plus application, rated this device as an easy to use method in the field. Thus, the third method has been considered as an easy method to use in the field. Consequently, using iPad device in the field has been considered as an easy device to use in the field.

Example comments made by participants to explain their ratings are listed below:

First Method: Paper based method:

“It will be difficult to match the photo and the writing or voice, if I take many pictures and notes, it would be nice if I can write a text on my pictures”

This comment above was made by a participant who used the first method. The limitation of the paper based method made the participant mention his need to have a method that assists him in linking his finding together in the field.

Second Method: iPad without training:

In the comments below, participants complained about the inconvenient size of the iPad device as

“iPad device is big for taking photographs and recording videos”

“Camera was fine, struggled with file management”

The comment above from a participant who experienced the iPad without having a training session. The participant used the built in camera to collect the data but he faced difficult issue when he tried to organise all his findings into one folder.

Third Method: iPad with training:

A participant commented below after his rating of the iPad with training as:

“It was a bit difficult for me as a new user, but it is generally easy to use”

This participant was familiar with a mobile smart phone but it was his first experience using Apple products such as iPad in the study. So he considered himself as a new user.

Another quote supported the high rating with the third method:

“With a bit of practice, it is easy”

The participant here referred to the benefit of the practice session which made the use of the iPad easy in the field.

- **Question 2: Usefulness for Capturing Data**

Figure 7.9 shows the substructure results for each group. Four out of eight participants rated the paper-based method and the iPad without training as a useful method for data capturing, whereas seven out of eight participants rated the iPad with training as a useful method to use in the field to capture their experience.

As can be seen in Figure 7.9, the participants' rating between three different levels. None of the participants rated the three methods as unusable or slightly when being used to capture the data in the field. That means, all three methods received a positive rating, suggesting that they are suitable for use in the field, although 3/24 participants gave a “neutral” response to this question. These three participants were from the paper-based or iPad without training groups.

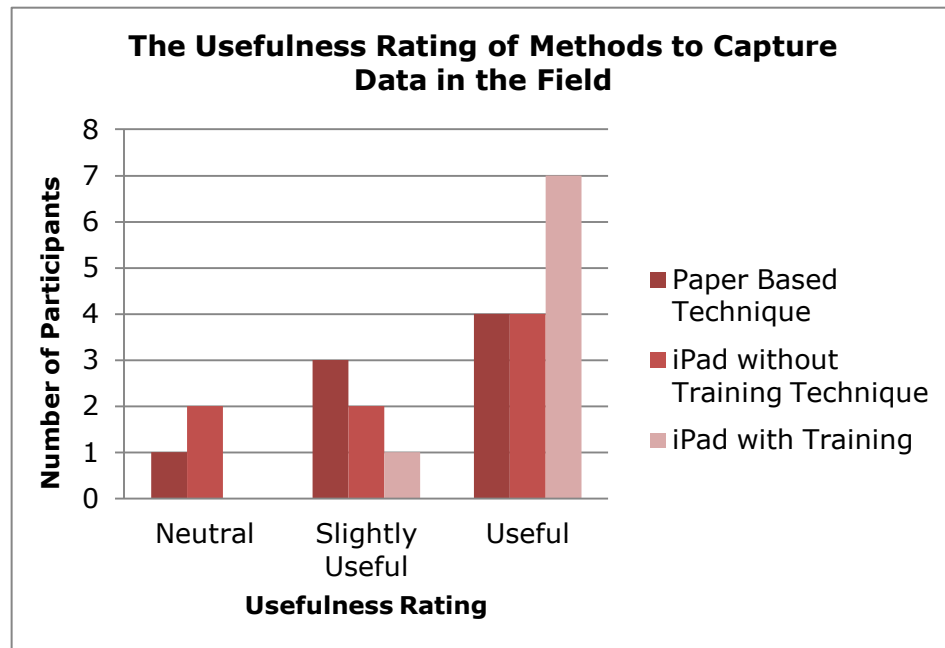


Figure 7.9: Comparing the Usefulness Rating of Capturing Data between the Three Study Methods

On the other hand, in order to study the effect of the training session which the participants had before using the third method, it is noted that 7/8 of the participants in this group rated the method as useful, whereas only 4/8 of the participants in the iPad without training group rated the iPad device as useful. Consequently, it was concluded that training supported participant perception of the iPad as a useful method for capturing experience in the field.

Examples of comments from the participants to explain their ratings are listed below:

Second Method: iPad without Training:

“To gather lots of different types of information and keep them all together”

This participant commented above explaining that the device is useful to use because it allows collection of various types of

data and organising them in the same place instead of having multiple equipment to do the same work.

“Video and photos both were easy to capture”

Here the participant pointed to the ease of use of the capturing function. However, taking notes was not mentioned.

“It captured data quickly and effectively”

This comment above highlights the value of method performance in the field as the participant focused on the speed and the effectiveness of the iPad device in data capturing.

“This iPad was capable of conducting the whole study.”

As this comment shows the iPad device useful because it enabled the participant to do all the study tasks.

Third Method: iPad with Training:

“Time saving! Speed organisation”

This participant complimented the benefit of using this method in saving his time in the field. This comment shows that time plays an important role in collecting the learning experience as the participants focused again on the device performance in doing the task quickly.

“All photos and notes together are handy, better than camera when you have to set photos after recording,”

This comment above compliments having all the functions needed in the same method.

“Capturing videos and pictures was easy, linking them needed some effort. However, Video recording was not possible through the application”

The participants admired using the device for capturing two different types of data. However, linking them together required some time.

“All sorts of data i.e. audio, video and images can easily be captured”

Also a positive comment above about the usability of using the iPad device in the field.

It is interesting to note that the participants themselves did not comment on the effect of training (or absence of training) for enhancing the use of iPad device in the field. Both groups of students who used the iPad (with or without training) complimented in general the use of iPad devices for data capturing in the field trip.

- **Question 3: Usefulness for Sharing Data**

The third question focused on the ease of use of the method for sharing data in the field. Figure 7.10 shows the responses obtained from each participant group.

It can be seen that the ratings for the paper-based method suggest that it was not a useful method at all. 5/8 of the participants in this group rated the paper-based method as unusable method for sharing data in the field. The remaining three participants rated this as “neutral”. The reason behind the low rating would be because the limitation of the method that deprived them from sharing their data in the field.

Moreover, 3/8 of the participants rated the third method (iPad with training) as slightly useful method, where 5/8 of the participants rated this method as useful method for sharing data in the field.

However, the users of the iPad without training gave more of a mixed response to this question. Six participants from this group rated the devices as “slightly useful” (2/8) or “useful” (4/8) but one participant rated the method as “slightly unusable” and the remaining participant gave a “neutral” rating for this question. The reason for the slightly negative responses from these two participants may have been the poor internet signal in the field which made it difficult for the participants to share their experience.

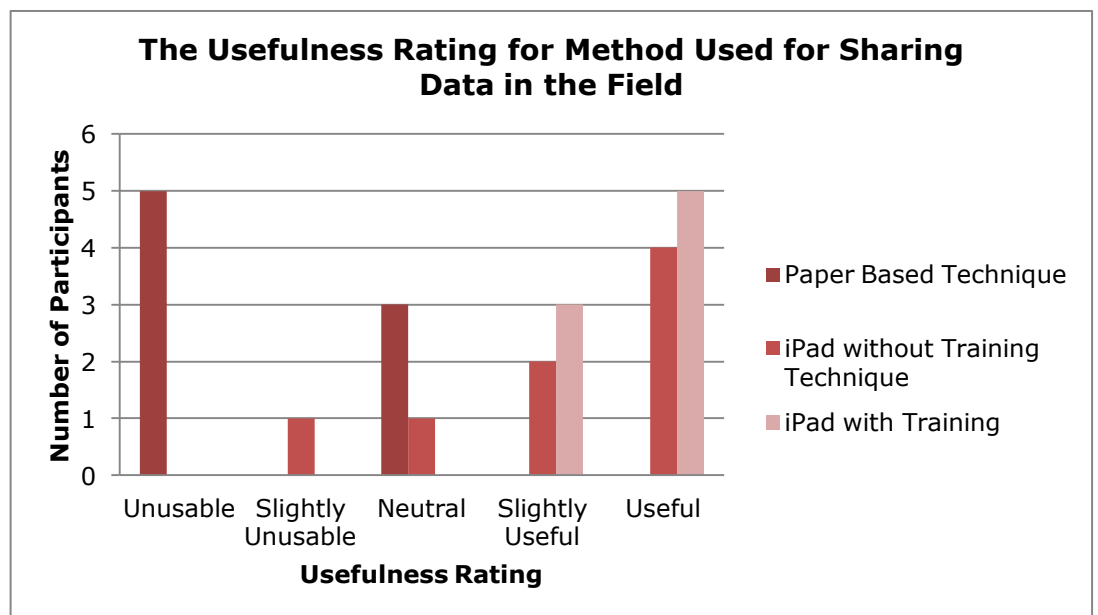


Figure 7.10: Comparing the usefulness Rating of Sharing Data between the three study methods

Overall, the pattern which emerges from Figure 7.10 is that the iPad device in general was considered to be a useful

method for data sharing in the field, with more consistently positive views expressed by the participants in the iPad with training group.

Example comments made by the participants to explain their ratings are given below:

The First Method: Paper based

Comments about the first method:

“It doesn’t allow me to send or share data and communicate with people off site.”

The comment here detected the problem that the participant faced when he would like to share his data in the field.

“Paper and pen: you need to type in the text file again if you want to send every photo, videos and note description together.”

In this comment, the participant described the process of sharing data after the field trip by using the paper based method as it is a time consuming.

Second Method: iPad without Training

“It email data effectively, we tried but failed to share data at once.”

This participant could not share all of his data at once using the iPad. This was because; he had saved each type of data individually, so he could not send them together.

“The iPad is useful in sharing data as it includes a wide range of applications that ease the process.”

This participant complimented the variety of applications that he could use to share his data.

“My friend didn’t receive photo on time.”

This participant above mentioned the how the poor internet signals in the field meant that he couldn’t share his photos with his friend.

The Third Method: iPad with Training

Comments about the third method:

“Easy and quickly to email data but not good if you are in the middle of nowhere”

This comment refers to the difficulty of using iPad for sharing data in the field when there was no internet access.

“Some network problem [already existed], but the sharing features [were] easy.”

As mentioned in the previous comment, the difficulty of connecting with the internet was a problem for the participants.

“I can do it directly from the application, very easy! But there was an issue in getting Internet signal.”

In spite of the internet problem, this participant reported that he could share his data directly from the application (Notes Plus) which he had been trained to use before the field trip.

“All options available intuitively accessible.”

The participants were then asked about the advantages and disadvantages of the features in the different methods. The participants in the group using the first method (paper based method + traditional camera), said that they preferred the method of note taking with the tradition methods because they were familiar with using these methods and could also

take notes anywhere. Moreover, the digital camera was one of the best features the first method provided as the participants commented that they could use it to capture high resolutions pictures, as well as making record video and voice recordings.

However, the participants also commented on some disadvantages of this method. For example, the limited ability of the digital camera for sharing data in the field, and the harsh weather in the field which sometimes causes problems for taking notes using the traditional paper based method in the field. This observation was also made in the first study of this research, where it was observed that the harsh environments of the field trip such as the rainy and windy weather requires the participants to take more care to protect their equipment and makes the activity of note taking difficult.

For the participants who used the second and third methods in this study (iPad without and with training respectively) the main advantages that it is a combination of multiple equipment in one. Using the iPad device the participants were able to access a variety of methods in one, such as camera, GPS, Compass, notes and so on. Moreover, the iPad is an effective tool to share data in the field. Furthermore, the iPad applications give the ability to organise all the collected data in one place which helps the participants to find their data. In addition, these applications also allow the participants to link the collected data with notes either by embedding the photos in the notes sheet or by writing on the captured pictures. These features gave benefits of using this method in the field.

However, like the previous method, some limitations of this method were found. For example, the size of the iPad was inconvenient to use in the field to capture pictures and the iPad is slightly heavy which makes it difficult to carry on long field trips.

- **Question 4: Overall Reaction**

This fourth question concerned the overall reaction rating towards the different study methods used. As can be seen in figure 7.11, most of the participants reported positive responses to this question: responses of 'satisfied' or 'very satisfied' were given by 8/8 participants who used the iPad with training, 6/8 participants who used the iPad without training, and 4/8 participants who used the paper-based method. None stated that they were very dissatisfied with the method, although a few participants using the paper based method reported that they were dissatisfied or unsure. The reason given was due to the method limitation in sharing the experience in the field.

Similarly, the participants who used the iPad without training were generally satisfied or very satisfied with the method. Only one participant stated that they were dissatisfied with this method. The reason given was due to difficulty in using this device, including the iPad size and the poor connection with the internet in the field.

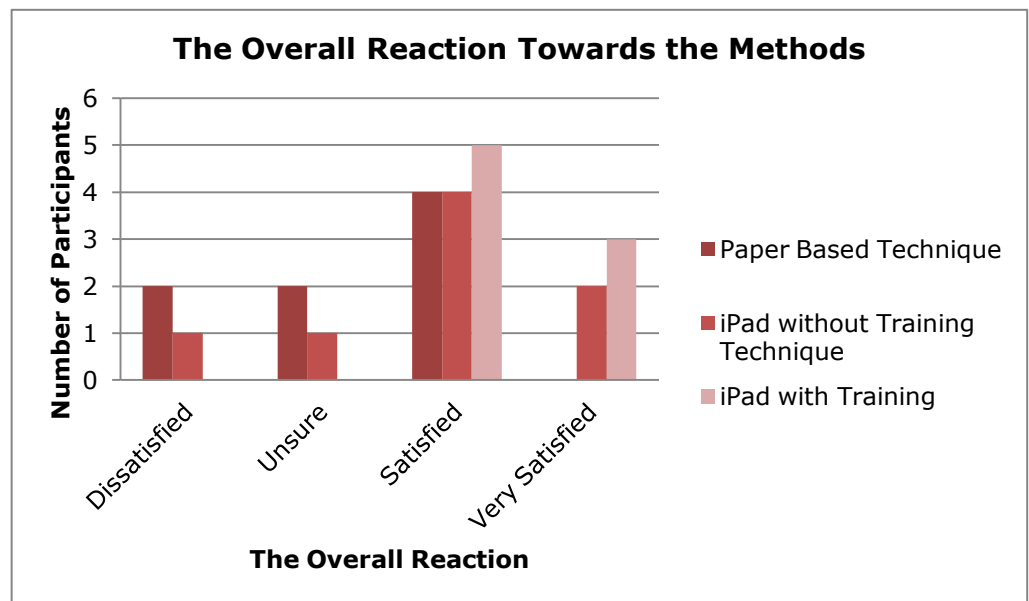


Figure 7.11: The Overall Reaction towards the Three Study Methods

Comments made by the participants to explain their ratings were:

The First Method: Paper Based Method

"It would be more useful to have more equipment, something to communicate (Share data) phone and water proof note pad (digital)."

This participant mentioned the need to make the paper based tool more useful to use in the field. These comments support the finding for user requirements, specifically the need for communication methods such as phones and some method to make waterproof notes, which were established in chapter 4 in this research.

"If everything can be grouped, for example: I take photo and write or record voice in that picture, it might be really helpful."

This participant stated what he wanted to make the field activity useful and mentioned a device that captures all types of learning experience and gathers them in one place.

The Second Method: iPad without Training

"Pretty easy to use and much better to have all data together rather than on different devices"

The comment here complimented the advantage of using iPad in the field to capture the experiences.

"I would like to use an application that connects all the data captured by iPad like images and notes in one place."

"It is not a convenient device."

The comment above here highlighted the disadvantage of using the iPad device. This participant found the large size of the iPad, in addition to the weight inconvenient in the field.

"Overall effective in performing all tasks despite some setbacks."

"The system helped me to collect the pictures, videos, notes and share them easily."

The comments here discussed the point which appeared in the previous points. The iPad device without training was found as a useful method only for capturing experiences.

The Third Method: iPad with Training

"I will definitely use the application in short trips and initial field trips."

The participant commented on his willingness to use iPad device in the field. The effects of the training session which

conducted before the study seems to have contributed to the positive response from the participants.

“Great experience, a bag to protect or so is needed.”

Again, the participant above mentioned the need for waterproof protection of the iPad device in the field.

- **Question 5: The Spatial Isolation**

The final question addressed the feeling of spatial isolation that had been identified in the previous study. As has been described in chapter 6, the participants reported feeling isolated from the surrounding area around them in the field when they use the mobile smart devices. It was considered that this was due to the need to concentrate on using the device in order to complete the task correctly. In this study, participants were asked whether or not they experienced this feeling and the responses are shown in Figure 7.12.

It can be seen that all of the participants who used the paper based method reported that they did not feel isolated in the field. In contrast, 5/8 participants who used the iPad without training, and only 1/8 of the participants who used the iPad with training, reported that they felt isolated while in the field. As taking notes by using the traditional method is familiar to the users to use in the field, the participants didn't report any isolation feeling. This is in contrast to the electronic device which required effort to concentrate with at the same time as roaming in the field.

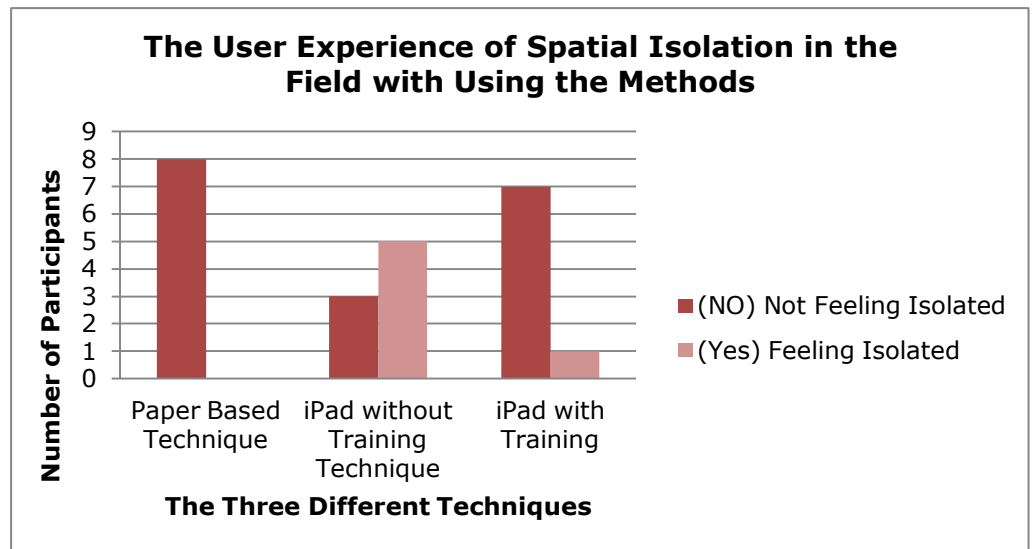


Figure 7.12: The Frequency of isolation feeling in the field during using the three different methods

7.7 Discussion of Results

The outcomes of this study are discussed separately for each of the main tasks that students were required to complete:

- i) Capturing, and
- ii) ii) sharing the experiences in the field.

7.7.1 Use of Methods to Capture the Learning Experience

In this study there were four tasks related to the capturing experience activity:

- Task 1: Capture a photo for the site.
- Task 2: Capture a photo and write down some text about this site, then link them together.
- Task 3: Capture a voice note for 15 seconds.
- Task 4: Capture a video for 30 seconds.

As already mentioned, all of the participants in the study completed these four tasks. However, the time spent in these practical tasks was different.

To start with the first method where the participant used paper based method to capture their experience in the field, all the participants completed the capturing tasks within a total time of 1857 seconds and the subjective rating of this method in relation to the activity of capturing experience was 'useful' or 'slightly useful'. Only one participant in this group gave a rating of 'neutral'. The explanation for this was due to the need to use different equipment to capture different types of data.

For the participants who used the second method, the iPad device with no pre training session to teach them how to use the iPad in the field, the capturing tasks were completed within a total time of 1940 seconds, which is longer than the previous method. Again, most of the participants rated the use of this method for the activity of capturing experience as 'useful' or 'slightly useful', but, two participants rated this as 'neutral'. The reason for this could be because of the limited ability of the participants to take notes effectively with the iPad device. As it has been observed, the notes taken by the participants from this group were not tidy and clear. In addition, comments from the participants indicate that they recommended using this device for capturing different multimedia data such as photos and videos, but not note taking.

The participants in the third group also used an iPad device but they were given a pre training session to learn how to use it in the field. In this case, the participants did the capturing tasks within a total time of 1252 seconds which is shorter than both of the other groups. Moreover, all of the participants in this rated this method for the activity of capturing experience as 'useful' or 'slightly useful', and generally gave positive comments about how this device saved them time in the field and provided them the ability to capture and collect their finding together in one device. In

addition, it was observed that the notes which were collected from this method were tidy and clear.

From these results, there is evidence to suggest that training in using an iPad device prior to going to the field to capture data, leads to more effective data capture. This method was rated as 'useful' by all members of the group (see figure 7.9), facilitated faster data capture (Table 7.2) and notes were better organised by this group than the groups using paper or the iPad with no training as it shown in figure 7.6, and figure 7.7.

7.7.2 Use of Methods for Information Sharing in the Field

The second aspect of field study is sharing experience in the field. There were two tasks related to the sharing experience activity in this study:

- Task 1: Share your notes with a friend on (Email, Face to Face, Social Network).
- Task 2: Share your notes with a friend on (Email, Face to Face, Social Network).

As already mentioned, these tasks were not completed by all the participants as it was not possible to achieve these tasks using the paper-based method. Only the groups using the iPad were required to complete these tasks.

However, subjective opinion was still obtained from students in the first group with regard to use of the method for sharing their experience in the field. Not surprisingly, most of the participants referred to the limitation of the method which prevented them from sharing their experience in the field. Most of this group (5/8)

commented that they would like to have the capability to share their experience whilst they were in the field; however some (3/8) did not consider this limitation as a problem and instead commented on how they share their experience after the field trip. For instance, the participants explained how they transfer their data to the computer and then share them by email and using portable memory sticks.

For the participants who used the second tool - the iPad device with no pre training session to teach them how to use the iPad in the field - 5/8 of them completed the sharing tasks within a total time of 882 seconds.

Most of the participants in this group (6/8) rated this tool as 'useful' or 'slightly useful' for the activity of sharing experience in the field. Of the others, only two participants chose to rate it as 'slightly unusable' and 'neutral'. Reasons for this included poor internet signals in the field, so the participants faced a problem with connecting to the internet to share and check their emails. Another reason given was that they could not send all their data together and they were forced to send their notes and photos in separate emails.

For the final group who used the third method, the iPad device with pre training, all the participants completed the sharing tasks within a total time of 688 seconds which is shorter than the previous group. Accordingly, all of the participants in this group rated the method as 'useful' or 'slightly useful' for the activity of sharing experience in the field. The comments given indicate the success of pre-training to improve user efficiency in using the device to share their experience in the field. Participants commented on the simplicity of the sharing application which

allowed them to share all their different types of data as well as the ease and speed at which they were able to complete these tasks. However, the participants in this case also reported problems with the internet connection in the field.

In addition to these two areas, the overall reaction regarding the use of the three methods indicated that the third method achieved a higher satisfaction rating than the other two methods. Taken together, the results from observation of task performance and feedback from users provides evidence to suggest that use of smart mobile technology, such as the iPad, may be easier for users to capture and share the field study experience and that there is a positive impact of training to enhance usability, efficiency and user satisfaction in use of mobile technology to capture and share experience in the field.

7.8 Conclusion

This chapter aimed to investigate the usability issues related to capturing and sharing experience in the field trips. The findings from the previous study in chapter 6 suggested that three main causes affect the usage of mobile devices in capturing and sharing experience in the field trips. These three causes were: A lack of knowledge concerning the use of different mobile devices and the variety of applications; limited time during field trips forces the students to capture as much data as they can, which means that they have less time to concentrate on how to use the mobile devices; the isolated feeling an individual gets from the physical environment during the field trip when they use the mobile devices as well as the separation from the group. Therefore this study aimed to investigate the effect of training on reducing these effects in order to improve the use of mobile technology in the

field. The main research question that has been answered in this study was: What effect does training have on using mobile devices to enhance capturing and sharing experience?

The study described the usability evaluation of three different methods used for capturing and sharing experiences in the field. These three methods were: the paper based method such as paper, pen and digital camera; the iPad without specifying particular applications to use; and finally, the iPad with a specific application to use in addition to a previous training session to learn how to use it.

Usability evaluation of use of these three methods in the field assessed three attributes: effectiveness, efficiency and satisfaction. These attribute are defined as follows: Effectiveness evaluates whether the system as a whole can provide functionality effectively; Efficiency evaluates whether the system as a whole can be used efficiently; Satisfaction looks into the areas of ease of capture, share and organise. Evaluation of the usability of different methods for completion of field study tasks was achieved using two qualitative research methods: researcher observation and participant subjective ratings and comments via questionnaires.

The findings show that using an iPad device with training resulted in better performance and rating scores than the other two methods. The second method, using the iPad without training achieved higher usability ratings than the first method for both the capturing and sharing activities but less than the third method. The main problems identified by the participants who used the second method were the inconvenience of using this device in the field which consumed a long time to complete the study tasks, in

addition to specific technical problems such as the poor Internet signals in the field.

The results suggest that use of smart mobile technology, such as the iPad, may be easier for users to capture and share the learning experience (LX) and that student experience (UX) in use of these methods is enhanced by pre-training.

These results suggest that the training session, which was run for an hour to provide the participants with guidance on how to use the method and the package, helped to increase the effectiveness, efficiency of performance and satisfaction of use.

It is therefore concluded that mobile devices, such as the smart phone and tablet can enhance the field activities for capturing and sharing experience during field trips. However, this enhancement can be improved if users are given training in how to use the applications on the device, which will make it easier for them to use the device for data capture and data sharing experiences in the field. The implication of this study will be discussed in next chapter.

8. Discussion and Conclusion

8.1 Introduction

This chapter presents a discussion of the findings of the research studies to show how this contributes to current-state-of the-art in this field. After that, it will identify the limitation of this research. Finally, conclusions and recommendations for further work are presented. The overall aim of this research was to investigate whether and how the use of mobile technology in educational field trips can facilitate capturing and sharing of the learning experience effectively.

8.2 Understanding the Context of use

Previous literature has demonstrated the value of field study to facilitate and enhance student learning in several disciplinary areas. Field trips provide popular and memorable experiences for students to understand the different aspects of natural sciences and it is considered as an essential effective method in the environmental studies such as geography, biology and so on (Rieger and Gay, 1997).

In this research, there were three different case studies from different backgrounds: An initial study to establish the research methods was conducted with a convenience sample of undergraduate nursing students from Saudi Arabia. Then, the research focused on undergraduate geography and architecture students attending field study trips in the UK. The main similarity between these case studies was that they all require practical learning in the field. However, the nature of field trips in each of these case studies was different. For example, field trip in the nursing environment refers to the experience of clinical practice in

the hospital. Whereas, the nature of field trips in the geographical learning usually takes place in a rural landscape; and urban vistas in the architectural learning.

8.2.1 Understanding the User Requirements in Context

The first stage of this research aimed to understand the context of use and the user characteristics in higher educational field trips in order to determine how mobile technology could best be applied to this context.

The first research question addressed was:

How do students capture and share learning experience during the field trip?

- **What is the meaning of the learning and field experiences in the field trip?**
- **What kind of tools do the students use suitable to capture and share the learning experience in the field?**
- **What are the user requirements of mobile technology to support capturing and sharing learning experiences (LX) during the field trip?**

In order to answer these questions, two studies were conducted as described in chapters 4 and 5.

The first study aimed to identify the type of information that the students collect and share in their field studies. Detailed observation was made of field study activities conducted by students taking higher education courses in nursing, geography and architecture. These subject areas were selected as they

provide examples of different types of field study. The outcome of these observations provided:

1. Identification of user needs and requirements in different educational field study contexts (See tables 4.3 and 4.4 in chapter 4).
2. Generation of system requirements for use of technology in educational field study (See section 4.4.2 in chapter 4).

This identified similarities and differences between different contexts of use with regard to: the purpose of study (e.g. what type of field experience is to be captured), how this information is used (i.e. what students need to do with this information), and how it is captured (the methods they used to collect and share this information).

It was found that nursing, architecture and geography students use similar techniques to capture and record data including photos, videos, notes etc., but there are some differences in terms of the type of data they wish to record. For example, whilst the majority of geography students collected both qualitative data (for example: notes and sketches), and quantitative data (for example: measuring), architecture and nursing students collected qualitative data only, such as, note taking and sketch drawing.

The analysis also identified how the students use the data that they have collected in order to enhance their learning. The students assigned importance of the field experience to helping them to learn through interacting with the physical environment and with colleagues in the field, as well as gaining a memorable field experience which helps them to improve their coursework. For example, the geography students reported that they would use their collected field experience in writing their field reports,

and the architects to fill their critical diary and portfolios. This finding supports the views of Clark (1996), Emmons (1997), and Fuller et al (2003) which stated that the main objectives of the field trip are the ability of learning through activities such as observing and interacting with the real environments. In addition, students gain practical skills to enhance their learning using different equipment to record, measure, test and analyse the new perspective gained from their experience in the field, in order to evaluate and reflect knowledge and skill development. The field trip experience also enhanced the student understanding of the subject knowledge by sharing skills, interacting socially with colleagues and transferring their experiences.

Moreover, the study examined the nature of sharing experience in the field and found that both sets of students want to share their notes and experience, but that the type of information shared is different for each group. For example, the geography and nursing students share the raw data that they collected from the field, but they don't like to share their analysed data with their colleagues. The architecture students, on the other hand, preferred to share selective data regardless of the privacy issues which the students set by themselves. Privacy issues were the obvious difference between the two case studies. In terms of privacy, the geography and nursing students did not show any concern about avoiding note sharing. Indeed, the results of the geography case study reveal that the student's actually preferred to see each other's notes in order to show support for their data collection. The architects, on the other hand, were concerned about their own ideas and more protective of their individual results. They generally avoided sharing their experiences except with those colleagues who were willing to share their information, such as

close friends who were also on the field trip and work on the same project.

Furthermore, the geography students preferred face-to-face discussion whereas the architects liked using social networks for group discussion. Finally, both groups used USB and emails for sharing their data. However, in addition, the architecture students used cloud file sharing services and online private groups such as Facebook private groups. The explanation for use of different techniques used by each group may be due to nature of the field trip environment that they go to. For example, the geography students work in rural areas which are a harsh environment to use mobile technology in; poor internet connections require the students to use basic techniques such as using USB cables in order to share their data in the field. In addition, the weather plays an essential part in geographical field trips, and it was observed the students protected their equipment and notes with water proof covers during wind and rainy storms. However, the nature of architectural field trips includes both outdoor and indoor environments in urban areas. This means that field trip experience is less affected loss of internet connection and it is easier to find shelter when there is bad weather.

With regards to methods that the students use to capture and share their experience in the field, it was observed that all groups of students take a number of devices with them. These include a mixture of traditional and modern tools such as note and sketch books for note taking, digital camera for capturing photos, and mobile devices for taking photos and videos, and so on. However in addition to these, the geography students used a variety of

measurement tools such as GPS, compass and calculator, whilst the architecture students also made sketches. This observation is consistent with the result of Weng et al (2012) who noted that the list of tools taken on a field trip gets longer the more types of information need to be collected for the field study. In addition, Weng et al (2012) stated that the need to carry a lot of equipment may make it difficult to work effectively on site. Therefore, this research was interested to see whether a single device could be used to capture and share the field experience instead of several devices.

The first stage in the research process was to identify the requirements for a mobile system that could be used by students in the field. Research conducted by Priestnall et al (2009) compared five different mobile devices for data collection in the field and identified a number of issues relating to the usability and design of these technologies. They concluded that there was a need for a design guide to meet user requirements for mobile devices that could be used in the field. This represented a gap in the research literature as most of the studies concerning design guidelines for field study have focused on how to improve the learning experience in the field trip rather than studying how to enhance the use of the mobile technology in the field e.g. Yeh et al (2006), Kukulska-Hulme, (2007), Rost and Holmquis (2008) and Ryokai et al (2011).

Therefore, one of the objectives of this research was to establish system requirements for a mobile device to be used in field study. This objective was addressed through two sources of information; the first by reading literature about mobile devices used in the field trips, the second from observation study, analysis of data

collected and subjective opinion from undergraduate students who carried out field studies. The established requirements covered different aspects related to design of suitable mobile technology to be fit for use in the field for capturing and sharing experience activity (See chapter 4 section 4.4.2).

Consequently, this study developed an overall understanding of the user needs and requirements in field trips, leading to establishment of design guideline for adaptation of mobile technology to assist students in capturing and sharing their experiences.

However, Wentzel et al (2005) report that there is a difference between applying the technology in fieldwork, for the sake of technology and, applying mobile technology to enhance the fieldwork. Thus, it is important that selection of technology and applications for use in field study should be made on the basis of how well it supports the user and requirements of use. Therefore, the work in chapter 5 describes how these requirements were carried forward into a conceptual model which is fundamental to interaction design (Preece et al, 2011). Considering the previous requirements produced a set of conceptual ideas, these need to be developed and evaluated before the design can be prototyped or tested with users. A card sorting method was applied to evaluate the functional requirements established from the previous study. This technique is useful because it is an effective means of discovering the optimal organisation of information from the viewpoint of the potential users (Wood and Wood, 2008). Analysis of the card sorting data identified unified requirements for a mobile system which aims to achieve the needs of the two case study groups undertaking educational field study: undergraduate students in geography and architecture.

In terms of the design activity, due to rapid increase in availability for mobile technology applications, one of the first decisions was whether or not there was a need to build upon existing applications, or develop a new application which could be used in specific studies.

The idea of having one application to do everything that is required does not provide an ideal answer for the research questions. Therefore the research did not test the use of a single bespoke application, but tested the use of applications available on generic mobile devices. This meant that the evaluation focus included how the user switches from one application to another and how using multiple applications affects their activities. This mimics a number of actions observed in use of traditional methods to capture of the field experience, for example, flipping note pages, changing pen colours and carrying different tools such as note books and camera.

As a result of this chapter identified a need to prepare iOS mobile devices (iPad and iPhone) with four applications which were then compared with the system requirements to be tested in the following studies.

Therefore the outcomes of this work are summarised as follows:

1. Understanding the user behaviours in the field which would contribute in enhancing future works that aimed to study embedding mobile technology in the field trips
2. The system design guidelines can be used as a basis for developing and designing new technologies for use in field trips.

8.2.2 Understanding the Use of Mobile Technology in the Field

The work presented in chapter 6 focused on examining the concept of adapting mobile technology in the field to enhance experience capturing and sharing activities by providing an interaction between the users and the developing system. A mobile prototype was designed based on the established requirements identified in the previous study. This chapter aimed to answer the second main research question in this research:

Research Questions Addressed in this Chapter

How does the Mobile Technology Impact upon the Capturing of Learning Experience during the Field Trip?

- **What kind of learning experience do the students capture in the field by using mobile devices?**
 - **What are the usage implications of mobile technology to enhance the field experience in the field?**
 - **What are the key contextual factors that affect the use of mobile technology in the field trip to capture and share learning experience?**
-

This chapter illustrated a comparative study conducted on two separate field trips with participants from geography and architecture schools. The study provided prepared iPhone and iPad devices to the participants for a certain time for them to use for capturing and sharing activities in the field. Qualitative methods including researcher observation and participant interviews were used in order to understand how students used the smart devices to collect their experience in the field. The study identified similarities and differences between the two student

groups in terms of how they used the smart devices. The main similarity between the two groups was their preference for collecting their interest in a multimedia format rather than taking notes. On another hand, the main contrast appeared in the way that they shared their experience and this was affected by the nature of the field environment. In the architecture field trip the participants had the chance to access the internet and therefore they shared their experience via email and social networks. Whereas, the geography students could not share their data or use the internet services in the field, so they chose to be connected with face-to-face communications due to poor internet connection. The limitation that the lack of internet access causes in the geography field has also been addressed by Welsh et al (2012). He introduced the use of three smart phones applications for geo tagging photographs to encourage post-field trip reflection on a landscape. One of the limitations they reported was the impact of poor internet signals. They argue that the geo tagging photographs method would be most successfully by using smart phones when be applied to urban and semi-rural areas and less successful in valleys and rural areas.

A lesson to learn from this study was that several difficulties faced the participants during their mobile usage in the field trip. The study identified three main causes that could affect negatively usage of mobile devices in capturing and sharing experience in the field trips. These are:

- Lack of knowledge

As previously mentioned, the students were familiar with using mobile devices as a connecting device. However, they were not

familiar with using the mobile devices to capture the experience in the field. It was therefore concluded that the participants would benefit from training in how to use the smart device applications before giving them the devices in the field. This finding was also reported in a recent study by Woodcock et al (2012, p. 1) who observed that many undergraduate students who have smart phones were “largely unaware of their potential to support their learning”. Similarly, Chang et al (2012) examined the use of a mobile application called MobiTop (Mobile Tagging of People Objective) for contributing and sharing multimedia annotations via mobile device within a geographical field inquiry. They also concluded that unfamiliarity with mobile phones decreased the motivation of students to use these devices in the field.

- Time pressures

A high percentage of the participants in the study mentioned that, since there is a time limit to visit the field, they have to try to quickly capture as much of the experience as they can. Thus, they focused on photos because that helps them to remember the details more clearly than taking notes, which is also time consuming.

- Spatial Isolation

Many of the participants in both the geography and architecture groups commented that they experienced spatial isolation when using their mobile devices in the field. They found that they lagged behind the group, especially when they typed their notes. However, the feeling of isolation was not as much when they were using the device for capturing pictures. This problem has been detected in other field education contexts. Ruchter et al (2010) examined the impact of a mobile guide system compared with use of traditional tools on different parameters of literacy in

environmental education. The study identified that the children who used the mobile guide system experienced alienation from nature. The study designed an alienation sum scale to investigate the effect of this experience on children's learning. The alienation nature sum scale has been identified as "a sum scale of items relating to prior knowledge on common plants, animals and an understanding for plants as a food source as well as self-reported frequency of direct experience of nature" (Ruchter et al, 2010, p. 1058). The results indicated that the children with lower degree of alienation from nature achieved higher environmental knowledge scores. Tal and Gross (2013) studied the use of smart phones for experiential learning outdoors and also found that using these devices distracted the students from their experience in the field. This was due to the need for the students to be busy with their phones focusing on how to use the instruments, which distracted them from the field experience.

The conclusion drawn from the research study described in chapter 6, and supported by findings from other research studies, is that students are not sufficiently familiar with how to use applications on smart mobile devices to be able to use them effectively in capture and sharing of their field study experience. The next stage in the research was therefore to examine how this could be improved by providing students with training in how to use relevant smart device applications before participating in the field study activity.

8.2.3 Investigating the effect of Using Mobile Technology During Field Trips

The work presented in chapter 7 describes a study which aimed to evaluate the usability issues between three different methods

used for capturing and sharing experiences in the field. These three methods were: traditional paper-based tools such as paper, pen and digital camera; the iPad without any prior instruction specifying particular applications to use; and finally, the iPad with instructions on a specific application to use in addition to previous training to learn how to use it. This chapter aimed to answer the third main question in this research:

Research Questions addressed in this chapter

RQ 3: What is the potential for mobile technology to contribute to the aspects of capturing the learning experience during the field trip?

The usability evaluation model designed for this study was based on the definition of ISO DIS 9241-11 (1994) which recommends to measure three usability attributes: effectiveness, efficiency and satisfaction. In this study, each attribute has been defined as the following: effectiveness evaluates whether the system as a whole can provide functionality effectively. It was measured by how many tasks have been done. Efficiency evaluates whether the system as a whole can be used efficiently. It was measured using three questions: how long has it taken to complete the sub tasks, how much time has it taken to complete the total tasks, and how many tasks have been completed. In addition to, satisfaction looked into the areas of ease of capture, share and organise. It was measured using a Likert scale type questionnaire.

The results of the study found that students in the group who used the iPad after they had received training in general performed the overall task better and more efficiently, and gave more positive

usability ratings than the students who used the other two methods. Students who used the iPad without training generally reported higher usability ratings than the students who used the paper based method but lower usability ratings than the students who used the iPad with training. The main problem the participants of this technique faced was the unfamiliarity with how to use the device in the field which caused them to take a long time to complete the study tasks, in addition to specific technical problems due to poor internet signals in the field.

Thus, provision of a pre-activity training session, which provided the participants with guidance on how to use the method and the package, appeared to increase the effectiveness, efficiency of performance and satisfaction in using the mobile device for capture and sharing of information in the field.

The importance of training was also noted by Welsh et al (2012) who found the reason for not using technology in the field was due to lack of time available to support technology in addition to the lack of user confidence with the technology. Moreover, Chang et al (2012) consider that training is important when introducing new technology even if the participants are experienced mobile phone users, as the participants still need to be familiar with the functions and interface of the device. The work in this research supports Chang et al's (2012) finding, as it has been observed in the second and third studies (chapter 6 and 7). The students who participated were familiar with mobile devices, however, they faced difficulties in using these devices with the field experiences, as they did not use them before in the field context.

However, providing training session for the students on how to use new mobile devices in the field would be time consuming and

costly. Therefore, a recommendation by Beddall-Hill (2010) suggested encouraging the students to use their own smart devices in the field in order to save time and cost for schools.

Jarvis and Dickie (2010) argue that the use of students' own smart mobile devices in a learning context may not be effective as the students may be distracted by the personal and social entertainments which they have in their phones. However, several studies that have examined use of students' own mobile devices in the field found that the students were less concerned about mixing between their personal and academic spaces (Linsey et al, 2010; Beddall-Hill, 2012; Welsh et al, 2012; Welsh and France, 2012). In this research, a similar observation was made during the second study (chapter 6). The students were asked whether, if they own a mobile device, they would use it in the field. Different responses were given by the students. Those students who said that they would use their own device provided several reasons: mobile devices are suitable for taking photos more than notes; mobile devices provide accessibility to the internet in the field trips; and carrying a single mobile device is more convenient than having multiple pieces of equipment in the field.

However, other students said that their opinions were based on the explanations which related to the physical features of the mobile devices such as the cumbersome size of the iPad, the resolution of the mobile device camera compared with a professional camera.

To conclude, a recent study by Maskall and Stokes (2008) examined the idea of using mobile devices to support data collection and analysis in field study. They suggested that using these devices added benefits during the learning process as the mobile devices provide quick feedback between the students and the tutors which could directly facilitate the students' learning. However, this work demonstrated that mobile devices, such as the smart phone and tablet can also add a further benefit to the field study. These devices can enhance the activities of capturing and sharing learning experience during field trips. This enhancement will improve the efficiency of the students, once they are familiar with how to use the applications. The use of mobile devices can also create easier access to data capture and data sharing learning experiences in the field. Moreover, the result of this study provides evidence about the importance of studying the usability of embedded new portable or wearable technologies which the students would use in the field, for example introducing new mobile applications, reconfiguring phones and tablets, or wearable computerised devices such as smart glasses and watches.

8.3 Limitations of the Research Undertaken

There are number of limitations to the research undertaken in this thesis. Firstly gaining access to the field trips which are organised by the universities was difficult. This was because of the limited number of field trips made during the term in addition to the different objectives for each field trip which would not be suitable for this research study. Moreover, the small number of participants in each field trip limited the possibility of having a large set of participants to be studied in this research.

Moreover, the rapid development in smart mobile devices and applications which took place during the course of this research period adds a limitation to this study as this changed the familiarity and user experience in using these devices. When the study began, not many of the student participants had smart devices and so they were not familiar with how to interact with them. However, during the following research years, the number of participants who owned smart devices increased. Therefore, the students who took part in later studies were more familiar with these devices than those who took part in the early studies.

At the early stages of this research, the students did not have the knowledge or previous experiences about how to use these devices in general and in the field context. Most of the participants used their paper based tools to collect their learning experience in the field. A year later, it was observed the number of smart device users had increased in the field trip, and the students started using their smart devices to collect their data. So, the increasing number of students who use these devices would increase the awareness of the benefits to use these devices in their learning. Therefore, the difficulties and problems which the students reported in the previous studies in this research may differ to the challenges identified in this research.

In addition, the increasing number of mobile applications that are available affects the choice of which applications would be suitable for note-taking activities in the field. Large numbers of professional applications have been designed and produced after selecting the applications which were used in this research. Consequently, choosing well designed applications would lead to better reflection on the usage of these devices.

Another potential limitation is that the last study reported in chapter seven could not be embedded into a real field trip context and so did not have the same motivation for students to learn from the inexperience. However, it did provide the opportunity for the researcher to create a controlled setting for the study which made it easier to conduct a comparative observation between the study groups.

Finally, this work offers some guidance on the tools that are generally needed to develop and meet student's requirements. It is recognised that, as technology is rapidly developing, new devices will offer a greater variety of tools and may include many of those recommended from this research. However, the increase in choice of tools available may only add to the complexity of smart devices and increase student confusion regarding how best to use their device to capture and share information in field study settings. Thus, there will be greater need to provide guidance and training in how to make the best use of this technology.

8.4 Recommendations and Future Research

Future studies can be conducted to determine the best practice to follow in assessing mobile technology in educational field trips can facilitate capturing and sharing of the field experience, since this research did not concern itself with best practice. That would include for example:

- Working with larger samples of participants can bring additional validity to the current work by applying different research approaches. This could include quantitative approaches for example to measure the students' performance in the field by using mobile devices.

- Incorporating the latest developed mobile applications that are not used previously in this research, or embedding the research into a real field trip context.
- Moreover, it also recommended focusing on measuring the effect of using these devices on an assessed work that students should submit following the field trip in order to study measurable impacts of these devices on the students learning ability in the field. In addition, future research can encourage teachers to train themselves and their students on how to use these devices in the field, and to design activities that help the students to learn how to use the devices as well as encourage the students to use these devices in the field.

8.5 Conclusion

The research presented in this thesis was focused on three key themes: understanding the context of use (i.e. the nature of field trips and the benefit on student's education), traditional methods for capturing information in field trips (i.e. student note taking) and the potential role of mobile technologies to support this process.

The research addressed several themes through stages of the interaction design life cycle. In the early stages, the work aimed to obtain a comprehensive understanding about the role of mobile technology in supporting note taking activities in the field. In the first study, three different case studies were conducted with nursing, geography and architecture students in order to identify the context of use and understand what aspects of the "field experience" (i.e. what type of information) that the students need to collect from the field. This study identified a number of

similarities and differences between the three case studies related to the kind of activities that are conducted in the field, the type of data collected and student behaviour in sharing their learning experiences during, and after, the field trip event. The outcomes of the comparison between these different case studies lead to a more detailed exploration of the use of mobile technology for capture and sharing of information collected during undergraduate field trips. In addition, the study outcomes also integrated a guidance system for mobile system requirements elicitation, which covers the user needs in the field.

The second stage of this research investigated the kind of support that mobile technology can usefully provide during fieldwork. Unlike previous research discussed in the literature review which had examined the use of bespoke applications and technologies designed for specific field study context this PhD study examined the use and usefulness of typical smart mobile devices. The intention was to determine how easy it is for students to use digital technology that they already own to capture and share information in the field study context. The study identified three main reasons that may produce a negative experience of using the mobile device in a field study context: students have a lack of knowledge about how to use these devices to support their activities in the field; there is limited time in the field, so the students were looking for a faster method to collect their experiences; some students experienced spatial isolation when they used the mobile devices especially when they were taking notes.

The later stage of this research examined these three issues in more detail. A usability study was conducted to explore use of different methods and smart mobile devices (with, and without

prior training) in a field study exercise. The investigation illustrated the positive effects of these devices in the field activities for capturing and sharing experience during field trips. However, this enhancement can be improved if users are given training in how to use the applications on the device, which will make it easier for them to use the device for data capture and data sharing experiences in the field.

This PhD work has demonstrated that mobile devices, such as the smart phone and tablet can enhance the activities of capturing and sharing learning experience during field trips. However, the ease and efficiency of use may be influenced by how familiar the students are with using different applications on their device. This work highlights the importance of studying the usability of embedded new portable or wearable technologies which the students would use within the context of use (i.e in the field). For example introducing new mobile applications, reconfiguring phones and tablets, or wearable computerised devices such as smart glasses and watches.

The overall conclusion is that the generation of mobile devices studied in this research, such as smart phones and tablets, can also create easier access to data capture and data sharing learning experiences in undergraduate field trips. This is more successful when the participants are provided with training to familiarise them with use of the mobile device before going into the field. These findings could influence the education sector to consider the use of smart mobile devices as field equipment and find ways to encourage students to use them in the field.

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Appendices

Appendix (A): List of Semi Structured Interview

These questions have been used to interview the participants in the first study which has been described in chapter 4.

- What kind of data would you usually capture during the field trip? Audio, photos, text, etc.?
- What is the purpose of capturing and collect this data?
- How do you capture the data? What are the tools used? Is there any electronic device that helps you when acquiring your knowledge during the field trip?
- Where and when do you capture the data?
- What do you do with this data?
- How do you transfer this data?
- Are you interested in sharing your knowledge and experience with others?
- If the answer is yes: What do you like to share and how?
- If the answer is No: Why?
- How do you save this data?
- How do you organise this data?
- Do social network sites, such as Facebook, other forums and twitter help you to share, understand and discuss what you usually learn from the field trip?

Appendix (B): Thematic based content analysis for geography students

This table presents examples of code development for thematic based content analysis for geography students which has been described in chapter 4.

Questions	Answers Codes
What Do you want to Capture in the Field?	Note about the surrounded area, (describe the area), information that hard to remember, Directions, Weather, drawing maps, taking photos, calculate the measures, techniques, measuring, calculation, drawing for group working, drawing the review and the area, how to use the equipment, diagrams, mind maps, sketches, drawing small arrows and shapes means something to the students, writing quickly because the rain
Why do you capture (purpose)?	To remind them for later, his habit, easy to back to remember, more clear to follow the process, too much information, not easy to remember, typing for the group, photos: related back and understand what they miss or can't remember, help them in the report, visual learner, learn from photos.
How, what do you use?	Camera, phones, pen and paper, note pack, notes is quickly, all the notes in one place and easy, smart phone for GPS, Compass, search on Google looking to the weather, taking photos, don't use camera one of the group has, they split the work before they start, based on the course hand out, don't like using technology, sketch up notes, depend on the weather, if rain the use photos, if dray use pen and paper, smart phones, sketch up notes, photos and videos by

Questions	Answers Codes
	phone, notes prefer pen and paper
Where and When?	At the field, at the same time in the field
How do you transfer the data?	Keep it as it is, transfer data to excel file, writing on Microsoft Word, same format not change, keep it in folders, print them out, transfer to computer, excel tables for statistic, cloud computing
How do you share?	Sharing the idea not the text. Share their data so most groups have more data to analysis, Using USB cause internet was worst, discussion, share it informally during a chat at the dinner time, show each other some photos, prefer to work with native speakers so his work would improve, face to face working on the report, using msn program to chat, voice call, send file, photos, not using the msn program in the field because the internet signal. Phone text, Facebook to set appointment, if it going to affect the work it won't be shared, using USB then email to for excel file sharing.
How do you save?	All group save their works on one folder, get copies by USB, prefer printing the work, keep it as it is, put in main folder, keep the notes as it is
How do you Organise?	Try to make tables, free hand writing style, different pen colours means something different,
Social Network?	No Internet, all the group in one place, face to face chatting, using social network but not during the trip, using to set appointment, chat, communication tools, discuss the data, organise meeting

Appendix (C): Thematic based content analysis for architecture students

This table presents examples of code development for thematic based content analysis for architecture students which has been described in chapter 4.

Questions	Answers Codes
What Do you want to Capture in the Field?	Response to the site interaction, materials, text, sketches, how to feel about the site, spider diagram, bullets points, small details in the building, plan, photos, 5 minutes short video, draw after the field, iPhone camera, notes on phones, iPhone app to record voice, measure the volume of voice, degree of noise,
Why do you capture (purpose)?	To build up experience, use in course, record data you can't find in websites, remember, take pictures more than to write, pictures won't take time to capture not like writing, to learn for late experience.
How, what do you use?	Pen (black), specific pens, Charcial pen for drawing, pencil, sketch book paper, collect things like tree leaves, camera, professional camera, camera more than phones easy to upload to computer, note sketch up, different pen colours, phone application such as panorama photo application, photos based on that they do sketch up later
Where and When?	Based on trip time, if long: drawing, if short: photos, in the site
How do you transfer the data?	Scan it but take time, keep it on the phone, using drop box,
How do you share?	Group project would share online and see other works, share to classmates, put shared photos on

Questions	Answers Codes
	Facebook, not share it because the bad of handwriting problem, Facebook but not for own collected photos but for chatting, show row data for group working only, Dropbox, emails, create private groups on Facebook, never mind to share unless not affect the work
How do you save?	Soft copies, scan sketches, keep sketch book, photos to laptop, memory cards, hard disk or CD's, print the photos they need for portfolio
How do you Organise?	Scribbling everywhere, free handwriting, organise on folders, in portfolio and critical diary
Social Network?	Facebook sharing group and communicate and chat, Dropbox share Folder, Google documents but not often

Appendix (D): List of Requirements Resources

This table shows the draft of developing the system requirements from different resources which has been described in chapter 4.

- Functional Requirements

Requirement	Literature Review	Observation	Interview
The system must able to write text	X	X	10 students out of 10 mentioned this requirement
The system must able to draw sketch up drawings, figures and charts	X	X	10 out of 10
The system could able to create spider diagrams and mind mapping			3 out of 10
The system must able to capture photos	X	X	8 out of 10
The system should able to record video	X		8 out of 10
The system should able to make a calculation			4 out of 10
The system should contain a campus	X	X	2 out of 10
The system must support the students learning and remembering	x	X	10 out of 10
The system must support the group work		X	10 out of 10
The system should contain a GPS		X	5 out of 10
The system should be able to link on the internet		X	4 out of 10
The system could be linked with another apps such as Drop box a evernote			2 out 10
The system must has long life battery	x	x	1 out of 10
The system could be able to upload files on cloud computing			1 out of 10
The system must support group discussion		x	10 out of 10

The system must support file sharing		X	10 out of 10
The system must contains USB port		X	10 out of 10
The system must provide free hand writing style for writing the notes		X	8 out of 10
The system must split sections between public and privacy notes	X		8 out of 10
The system must contain internal clock	X		
the system could retrieve maps	x		
The system must allow hand to be free	X		
The system must be easy write on by gloves	X		
The system must be Portable lightweight device	x		
The system must Built – in digital camera to capture photos and record videos	x	x	8 out of 10
The system should contain Enough storage memory	x		
The system must be locked with username and password	x	x	8 out of 10

- Data Requirements

Requirement	Literature Review	Observation	Interview
The data must be able to look into bullet points		X	5 out of 10
The system must be able to record quantitative and qualitative data	x	x	4 out 10
The data layout must be clear and simple	x	X	
The data should be stored in a spreadsheet		x	5 out of 10
the time and data should be register automatically	x		
The pages could be numbered automatically	x		

there should be various styles to tag and label data in addition to the ability to create the user's own marks	x	x	
--	---	---	--

- Environment Requirements

Requirement	Literature Review	Observation	Interview
The system must work fast because the weather		x	2 out of 10
The user must be able to safely navigate through the environment while interacting with the system	x	x	
The system should be a waterproof to be protected	x	x	
The system must be suitable for field trip	x	x	10 out of 10
The system should allow taking note at night	x		

- User Requirements

Requirement	Literature Review	Observation	Interview
The system must be used by geography in field trip		x	
The system must not required geography expert skills to be used		x	

Appendix (E): List of the Nine Comparable Applications in Chapter 5

The description of the nine applications which have been selected in chapter 5.

App 1: Note Taker HD: By Software Garden

Note Taker HD is a powerful app for writing and organising handwritten notes, diagram, etc., on the iPad.

(<http://www.notetakerhd.com/>)

App 2: Paper Desk: By WebSpinner, LLC

Paper Desk is a simple, easy to use notebook replacement made specifically for the iPad. The entire design goal behind Paper Desk is to mimic, as closely as possible, a simple pad of paper with no unnecessary frills. (<http://mypaperdesk.com/>)

App 3: Evernote: By Evernote

Evernote is an easy to use, free app that helps you remember everything across all of the devices. It lets take notes, capture photos, create to do lists, record voice reminder and makes these notes completely searchable whether the users are at home, at work, or on the go. (<http://evernote.com/>)

App 4: Paper by fifty-three: By FiftyThree, Inc.

It is iPad application, which captures ideas as sketches, diagrams, illustrations, notes or drawings and shares them across the web. (<http://www.fiftythree.com/paper>)

App 5: Notes Plus: By Viet Tran

Note Plus is a powerful note taking tool that supports handwriting, typing and audio recording. (<http://notesplusapp.com/>)

App 6: GoodNotes: By Time Base Technology Limited

Good Notes allows one to develop handwritten notes, sketch diagrams, mark up PDFs and organise them on a beautiful bookshelf. (<http://www.goodnotesapp.com/>)

App 7: UPAD: By PockeySoft:

It is a note taking, PDF reader and annotating, and photo editing application. (<http://pockeysoft.com/>)

App 8: Noteshelf: By Ramki

Noteshelf for iPad is the handwriting note taker that features super natural digital ink, a stunning UI and a comprehensive toolset that will increase the benefits of owning an iPad by leaps and bounds. (<http://www.fluidtouch.biz/noteshelf/>)

App 9: SketchBook Pro: By Autodesk Inc.

Autodesk Sketch Book Pro for iPad is professional grade paint and drawing application. It delivers a complete set of sketching and painting tools through a streamlined and intuitive user interface designed exclusively for iPad experience. (<http://usa.autodesk.com/adsk/servlet/pc/index?id=6848332&siteID=123112>)

Appendix (F): Comparison Tables

These tables are the applications comparisons over the functional requirements which have been presented in chapter 5.

Table: Comparing the Capturing Features with the Nine Applications

		App 1	App 2	App3	App 4	App 5	App 6	App 7	App 8	App 9
High Priority	Retrive maps	1	1	1	0	1	1	1	1	1
	Link notes to maps	0	0	1	0	0	0	0	0	0
	Write a text	1	1	1	0	1	1	1	1	0
	Capture Photos	1	1	1	0	1	1	1	1	1
	Record Video	0	0	0	0	0	0	0	0	1
AP	Record Voice	0	0	1	0	1	0	0	0	0
	Draw Sketches	1	1	0	1	1	1	1	1	1
Low Priority	Design diagram	1	1	0	1	1	1	1	1	1
	Free handwriting style for notes	1	0	0	1	1	1	1	1	1
	Colours change for Drawing	1	1	0	1	1	1	1	1	1
	Map Overlay	0	0	0	0	0	0	0	1	1
	Provide photo filters	0	0	0	0	1	0	0	1	1
	Measure Volume of Nosie	0	0	0	0	0	0	0	0	0
	Measure Tap	0	0	0	0	0	0	0	0	0
	Total (14)	7	6	5	4	9	7	7	9	9

Table: Comparing the Sharing Features with the Nine Applications

	App 1	App 2	App3	App 4	App 5	App 6	App 7	App 8	App 9
Support Group Works	0	0	1	0	1	1	0	0	0
Support Data Sharing	1	1	1	1	1	1	1	1	1
Access to Emails	1	1	1	1	1	1	1	1	1
Access to Social Network	0	1	1	1	0	0	1	1	0
Map of Group Location	0	0	0	0	0	0	0	0	0
Total (5)	2	3	4	3	3	3	3	3	2

Table: Comparing the organising features with the nine applications

	App 1	App 2	App3	App 4	App 5	App 6	App 7	App 8	App 9
Connect to Cloud Storage	1	1	1	0	1	1	1	1	0
Upload and download to Comput	0	1	1	0	1	1	0	0	0
Split sections into private and pub	1	1	1	1	1	1	1	1	0
Link with other application	0	0	0	0	0	0	0	0	0
Sort Data in Folder	1	1	1	1	1	1	1	1	0
Locable by username and passwo	1	1	1	0	1	0	1	1	0
Total (6)	3	4	4	2	4	3	3	3	0

Appendix (G): List of Semi Structure Interview

These questions have been used to interview the participants in the first study which has been described in chapter 6.

- What did you capture?
- Which application did you use?
- Did you share any experience in the field? If so, how?
- What did you share?
- How do you organise your experience?
- Did you use social networks during the field trips?
- If this is your device, will you use it again in future field trips?

Appendix (H): List of Requirements Resources

This table presents examples of code development for thematic based content analysis for geography and architecture students which has been described in chapter 6.

Table: The illustration of Geography and Architecture Findings

Subject	The Answering Codes	
	Geography	Architectures
What did you capture?	Photos, capture photos for the handout, notes if there is time, photos by phones, one note sheets on the phone, videos	Photos, notes, video, voice notes more than writing, keynotes related to pictures, describing surrounded sites
Which application did you use?	Camera app, Note, Paper Desk,	Camera, Notes, Noteshelf, Dropbox, Google search, Google translate, Wikipedia, Safari, Google map, Autocad to sketch, train schedule
Did you share any experience in the field? If so, how?	No Sharing would be after the field by transfer to computer and email them or by memory stick USB	Share interest information and photos on facebook, sharing location with family, not share data with colleagues, Emails, Dropbox, face to face in the field,

Subject	The Answering Codes	
	Geography	Architectures
		share what collect at the class, use the data in presentation
What did you share?	No, prefer face to face discussion and chatting	Photos and location, notes
How do you organise your experience?	Transfer to computer, organise on computer,	Transfer to computer, save photos to computer, using Dropbox,
Did you use social networks during the field trips?	Not in the field	Facebook, Whatsapp to communicate, twitter
If this is your device, will you use it again in future field trips?	Yes: but not iPad would bring small device to fit in the pocket, iPhone for photos, for notes, not for drawing, using on the coach not in the field,	Yes: comfortable and easy than carry notebook, prefer built in keyboard for typing, taking photos is fast
	No: make behind group, not easy to carry around, feel isolation from the surrounded during	No: Prefer notebook for notes and phone camera for photos If alone would record videos, with

Subject	The Answering Codes	
	Geography	Architectures
	taking notes not during taking photos, hard to take notes difficult to change between apps, isolation when you type because the touchpad, prefer the keyboard pad on the phones, like Blackberry keyboard is easy to type, not convenient in the move, iPhone size is more convenient or mini iPad	colleagues photos, professional camera is better, paper fast and comfortable,

Appendix (I)

The information sheet which has been used in chapter 7.

INFORMATION SHEET

Thank you for taking a part and participating in this study. It aims to understand how people use different techniques to capture their experiences in the field. After you read this you will have a full knowledge that is need to complete the experiment.

- First, the study will take part at the lack side area in the University Park, and you have to go to the site with the experimenter.
- The experimenter will give you the equipments that is need to do the study:
 - Notebook, Pen and Digital Camera
 - Or, iPad with stylist

The experimenter will describe the tools and you will have a plenty of time to get familiar with.

- You have to sign a consent form as you agree to do the experiment before you start.

Field Protocol:

- You have to walk through a 20 meter line transect from Point A to Point B on the map.



- Every 2 meters you will find a sign ask you to a task by using only the equipments that you have:
 - Capture a photo for the site
 - Capture Photo and write down a text about this site, then link them together
 - Share your note with a friend on (Email, Face to Face, Social Network)
 - Capture a voice note for 15 Sec
 - Capture a video for 30 Sec
 - Check if you got a reply from your friend
 - Finally organise your finding in one folder

- After finishing the tasks, you will have to answer a short questionnaire to expound your experience in the field

- Before you go, be sure you get you high street voucher as a compliment

Appendix (J)

A sample of the questionnaire that is related to the first condition which was (paper based method) in chapter 7.

Questionnaire: Group 1

Thank you for participating in this study which aims to understand how people use different techniques to capture their experiences in the field. Please take your time to answer the following questions. Their goal is to measure your experience of using the tools in the field. This questionnaire contains two parts, the first one is the background questions, and the second part about your practice during the study. Thank you

Please answer the following question:

Pre-test questionnaire: General Background

1. What field/ major are you in now?

☐ Geography

☐ Geology

☐ Architecture

☐ Other (Please Specify): _____

2. Have you been in a field trip with the university before?

☐ Yes

☐ No

3. How much experience do you have with respect to field data collection methods and techniques?

☐ NO

☐ Less than 1 year

☐ 1 to 2 years

- ___ 3 to 5 years
___ Over 5 years

4. For your field work, what data capture device or tools do you use, and how often do you use them? **(Please circle your choice of each device)**

	never	rarely	occasionally	sometime s	frequently	usually	Every time
Field notebook	1	2	3	4	5	6	7
PDA	1	2	3	4	5	6	7
Audio Recorder	1	2	3	4	5	6	7
Lap top	1	2	3	4	5	6	7
Video Recorder	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
GPS Device	1	2	3	4	5	6	7
Mobile phone	1	2	3	4	5	6	7
Mobile Tablet	1	2	3	4	5	6	7
Other (Please specify): _____ _____	1	2	3	4	5	6	7

Where: the **Level of Frequency**:

1 – Never

2 – Rarely, in less than 10% of the chances when I could have

3 – Occasionally, in about 30% of the chances when I could have

4 – Sometimes, in about 50% of the chances when I could have

5 – Frequently, in about 70% of the chances when I could have

6 – Usually, in about 90% of the chances I could have.

7 – Every time

Post-test questionnaire:

Please Circle your choice:

1. Please rate the ease of use of the tool (Paper and Pen and Digital Camera)

Difficult	Slightly Difficult	Neutral	Slightly Easy	Easy
1	2	3	4	5

Your comment:

2. Was the system (Paper and Pen and Digital Camera) useful when **capturing** data

unusable	Slightly unusable	neutral	Slightly useful	useful
1	2	3	4	5

And Why: _____

3. Was the system (Paper and Pen and Digital Camera) useful when **sharing** data

unusable	Slightly unusable	neutral	Slightly useful	useful
1	2	3	4	5

And Why: _____

4. What is the best feature(s) of this tool?

5. What is the worst feature(s) of this tool?

6. Your overall reaction to the system:

Very dissatisfied	Dissatisfied	unsure	Satisfied	Very satisfied
1	2	3	4	5

Your comment:

7. What are the significant limitation(s) to the amount of data you capture in the field?

- ☐ Hardware limitation (memory capacity, weight, size)
- ☐ Battery power and longevity
- ☐ Poor application support
- ☐ Field is a harsh environment for electronic equipment
- ☐ Too much data is not useful
- ☐ Lack of time
- ☐ Lack of knowledge
- ☐ Other (please write) _____

8. What are the significant limitation(s) to the amount of data you share in the field?

- ☐ Hardware limitation (memory capacity, weight, size)
- ☐ Battery power and longevity
- ☐ Poor application support
- ☐ Field is a harsh environment for electronic equipment
- ☐ Too much data is not useful
- ☐ Lack of time
- ☐ Lack of knowledge
- ☐ Other (please write) _____

9. Did you feel isolated from the physical environment around you while using the tool?

- ☐ Yes
- ☐ No

Your comment: _____

10. Do you have any other comment to add:

Appendix (K)

A sample of the questionnaire that is related to the second and third conditions which were (iPad, and iPad with pre- training based methods) in chapter 7.

Questionnaire: Group 2&3

Thank you for participating in this study which aims to understand how people use different techniques to capture their experiences in the field. Please take your time to answer the following questions. Their goal is to measure your experience of using the tools in the field. This questionnaire contains two parts, the first one is the background questions, and the second part about your practice during the study. Thank you

Please answer the following question:

Pre-test questionnaire: General Background

1. What field/ major are you in now?

___ Geography

___ Geology

___ Architecture

___ Other (Please Specify): _____

2. Have you been in a field trip with the university before?

___ Yes

___ No

3. How much experience do you have with respect to field data collection methods and techniques?

___ NO

___ Less than 1 year

___ 1 to 2 years

- ___ 3 to 5 years
___ Over 5 years

4. For your field work, what data capture device or tools do you use, and how often do you use them? **(Please circle your choice of each device)**

	never	rarely	occasionally	sometime s	frequently	usually	Every time
Field notebook	1	2	3	4	5	6	7
PDA	1	2	3	4	5	6	7
Audio Recorder	1	2	3	4	5	6	7
Lap top	1	2	3	4	5	6	7
Video Recorder	1	2	3	4	5	6	7
Digital Camera	1	2	3	4	5	6	7
GPS Device	1	2	3	4	5	6	7
Mobile phone	1	2	3	4	5	6	7
Mobile Tablet	1	2	3	4	5	6	7
Other (Please specify): _____ _____ _____	1	2	3	4	5	6	7

Where: the **Level of Frequency**:

- 1 – Never
- 2 – Rarely, in less than 10% of the chances when I could have
- 3 – Occasionally, in about 30% of the chances when I could have
- 4 – Sometimes, in about 50% of the chances when I could have
- 5 – Frequently, in about 70% of the chances when I could have
- 6 – Usually, in about 90% of the chances I could have.
- 7 – Every time

Post-test questionnaire:

Please Circle your choice:

1. Please rate the ease of use of the tool (iPad)

Difficult	Slightly Difficult	Neutral	Slightly Easy	Easy
1	2	3	4	5

Your comment:

2. Was the system (iPad) useful when **capturing** data

unusable	Slightly unusable	neutral	Slightly useful	useful
1	2	3	4	5

And Why: _____

3. Was the system (iPad) useful when **sharing** data

unusable	Slightly unusable	neutral	Slightly useful	useful
1	2	3	4	5

And Why: _____

4. What is the best feature(s) of this tool?

5. What is the worst feature(s) of this tool?

6. Your overall reaction to the system:

Very dissatisfied	Dissatisfied	unsure	Satisfied	Very satisfied
1	2	3	4	5

Your comment:

7. What are the significant limitation(s) to the amount of data you capture in the field?

- ☐ Hardware limitation (memory capacity, weight, size)
- ☐ Battery power and longevity
- ☐ Poor application support
- ☐ Field is a harsh environment for electronic equipment
- ☐ Too much data is not useful
- ☐ Lack of time
- ☐ Lack of knowledge
- ☐ Other (please write) _____

8. What are the significant limitation(s) to the amount of data you share in the field?

- ☐ Hardware limitation (memory capacity, weight, size)
- ☐ Battery power and longevity
- ☐ Poor application support
- ☐ Field is a harsh environment for electronic equipment
- ☐ Too much data is not useful
- ☐ Lack of time
- ☐ Lack of knowledge
- ☐ Other (please write) _____

9. Did you feel isolated from the physical environment around you while using the tool?

- ☐ Yes
- ☐ No

Your comment: _____

10. Do you have any other comment to add:
