List of Contents

Chapter one: Introduction

Chapter Two: Literature Review: Multidisciplinary Perspectives

Chapter Three: Methodology

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, 2013). 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.

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 (Davis, (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 the exploration and observation of 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).

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 2021 (Gartner, 2023).

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

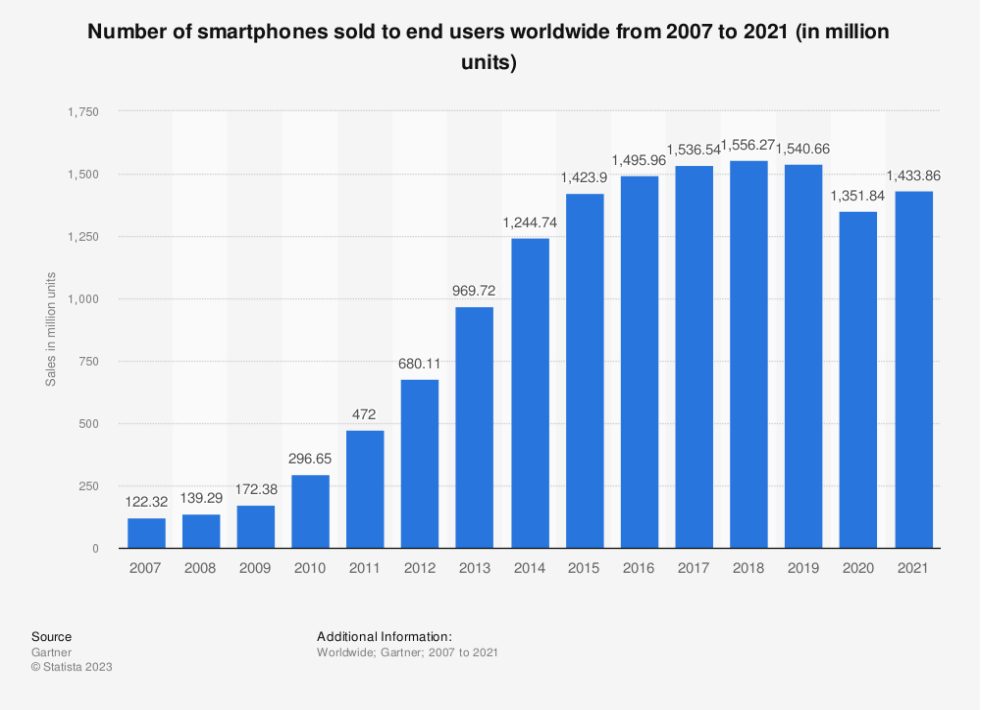

Figure 1.1: Number of smartphones sold to end users worldwide from 2007 to 2021 (in million units) (Source: Gartner Inc., 2023)
https://www.statista.com/statistics/263437/global-smartphone-sales-to-end-users-since-2007

As new network generations are deployed, and as the fourth generation (4G), and currently the fifth 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 organize 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” (Rossi, 2016). In other words, while more mobile applications are being developed for educational settings, little is known, however, how the learning process can be transformed when using them (Rogers et al, 2011).

Therefore, this led us to a very important concept called Technological Pedagogical Content Knowledge (TPACK). During the last decade, TPACK has received great attention from the research community (Angeli, 2014). Where the TPACK framework based on that the effective incorporation of technology into the teaching of a specific content or subject matter requires understanding and addressing the relationships between these three components: technology (Mobile technology), pedagogy (Biology), and content (Field trip).

A teacher who is able to deal with these relationships represents a different form of experience. In general, the Technological Knowledge (TK) defined how teachers demonstrate professional knowledge of technology. While the technological component of TPACK in Technology is most beneficial to learning when it brings a change in

professional teaching practice (Papert, 1996, Polin, 2015) and in learning designs. For teachers, TK is also knowledge of the skills needed to use technology to effectively plan instructions, and not only concerned with knowledge about technology (Mishra, 2008, Bell, 2013) including science teachers (Maeng, 2013, Karadeniz, 2013, Calik, 2014, Canbazoglu, 2016, , FAUZIAH, 2019).

Koehler and Mishra introduced TPACK –Technological Pedagogical and Content Knowledge – in 2005 as model for promoting and understanding the integration of technology in educational settings, primarily in schools and in pre-service teacher education programs. Over time it has become a prominent framework for use by educational practitioners and researchers seeking to enrich the field of educational technology (see figure 1.2). As described by the editors in the introduction, TPACK serves as a lens by which we can make sense of integration as the interplay between technology, pedagogy, and content (p. 4).

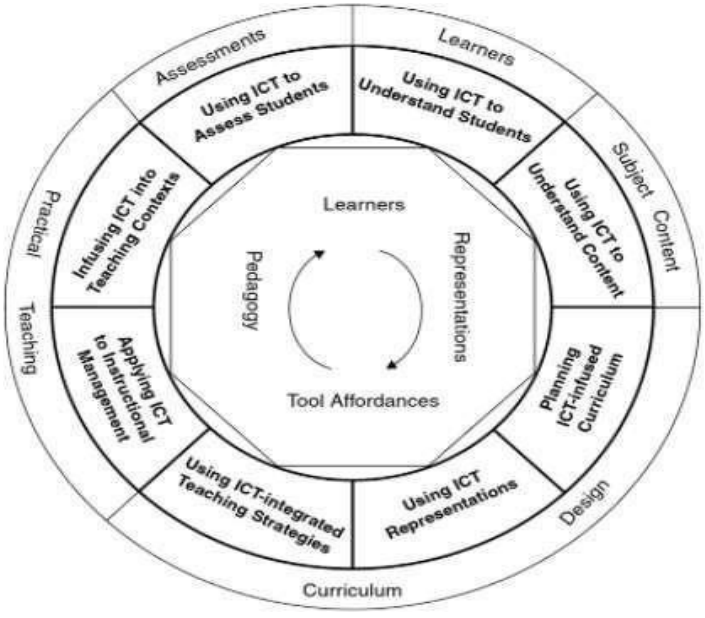

Figure 1.2: TPACK framework for use by educational practitioners and researchers seeking to enrich the field of educational technology (Herring et al, 2016)

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 opinions with others. Rieger and Gay (2013) 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. O'Connell et al (2021) reported that Field learning experiences reach tens of thousands of undergraduate students annually, constituting their importance as components of undergraduate education and potential pathways for STEM education. Reports and planning efforts by national entities have highlighted the need to ground undergraduate field learning experiences in evidence-based practices, and to better understand the impacts of these experiences on students. Nevertheless, there is much yet to understand about undergraduate field learning experiences (p.11).

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.

As Crompton et al (2017) have addressed that the majority of the studies focused on student learning followed by designing systems. Science was the most common subject researched and elementary schools was the most often studies setting. The findings reveal that 40% of the time researchers designed mobile learning activities aligning with the behaviorist approach to learning. This has the students consuming knowledge and not using the full potential of the mobile devices to have students become producers, collaborators, and creators of knowledge. This confirm the Kumar et al (2019) study results, where he has mentioned in the end of his study that future work can be carried out to rank the mobile usability guideline in order of importance.

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. 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. There a gap in studies which tested the use of generic mobile technologies such as the new generation of smart mobile devices (e.g., smart phones or tablets) that have made a rapid growth even during the period of this research.

In recognition of the 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. There is 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) and Kärki, et al (2018). Also, most of studies focused in the school level, and less focused in the undergraduate level. Therefore, there needs to do more studies about undergraduate field learning experiences (O'Connell et al, 2021). Where, Out-of-class experiences provide important learning opportunities for students; however, limited research has explored the value of these experiences to graduate students (Achen et al, 2019).

Since the quality of use is measured by usability, effectiveness, efficiency and satisfaction toward specific goals which can be achieved by specific users performing specified tasks 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 for biology students in university level.

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. 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 intended to focus on biology-specific disciplines to provide an understanding of generic requirements (and biology context-specific requirements) in order to inform recommendations for the use of mobile technologies in field study activities. To achieve this, it was important to conduct two case studies with different student groups in different biological contexts. In this research study, two biology contexts of use for the development of knowledge and practical skills in undergraduate biology students were considered.

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.

In the context of field trips, understanding students' behaviors when capturing and sharing their knowledge leads to identifying the specific meaning of experience. In the first part of the research, the researcher attended a biology field trip 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.

1.4 Research Aims and Objectives

The overall aim of the research was to investigate the impact of 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 biology 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 experiencein the field?

The second research question addressed was:

RQ2: What are the user requirements of mobile technology to supportcapturing and sharing learning experiences during the field trip?

The first and second 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 two different biology contexts of topics (e.g. Botany Biodiversity, and Marin Ecology). This information was used to provide guidelines to enable researchers and designers to integrate the implications within a user centered study.

The third research question addressed was:

RQ3: 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 thefield by using mobile devices?
- What are the key contextual factors that affect the use of mobiletechnology in the field trip to capture and share learning experience?

The third 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 biology field activities.

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-centered 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 smartphones and tablets.

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

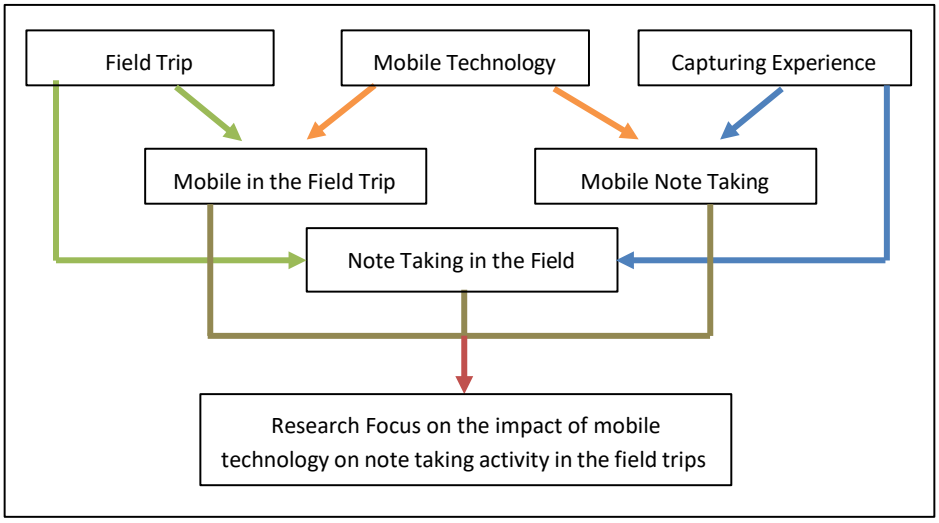

Figure 1.3 Research Focus

In general, this research project is motivated by three considerations. First, there is rare literature investigating the efficiency of mobile technology in outdoor biology education (Kervinen et al., 2018). While 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, but not to test the use of generic mobile technologies, such as the new generation of smart mobile devices. Secondly, it has not been satisfactorily clarified empirically what is the significance of mobile technology at the University level (Grosch & Gidion, 2011; Persike & Friedrich, 2016; Dehne et al., 2017, p.80, Schmid et al., 2017). Finally, studies documenting students' and teacher students' perceptions of their teachers' regarding the integration of digital technology in a student-centered teaching approach remain limited partially in the natural science area (Chang et al., 2014; Fernandes & Rodrigues, 2018).

Teachers' professional development (PD) is seen as the most important aspect of digital technology integration (Mobile Technology), and it has been repeatedly identified as a top priority in education policies, i.e., one of the PD goals for teachers is to be familiar with the emerging issues in digital technology integration (Hsu, 2010). The number of studies on the effectiveness of technologies and how to introduce them into the science curriculum or in PD programs has been increasing annually, however, little is known about its use in science teachers professional development (Fernandes & Rodrigues, 2018, p.3).

Thus, the outcomes of this research have a major and novel contribution to the literature and also to provide recommendations for the teacher training forms policy in integrating mobile technology in a Student-Centered teaching approach.

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 chapter, which describes the main

research activities. The discussion and conclusion chapter make up the remainder of the thesis. A more detailed overview of the thesis.

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, User-Centered Design, and TPACK (Technological Pedagogical and Content Knowledge) 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 two case studies that include on-site observation and interviews of students during biology 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 different methods and techniques the students used to capture and share data in the field.

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.