2. Literature Review:

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 impact capturing and sharing of the learning experience (LX). 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.

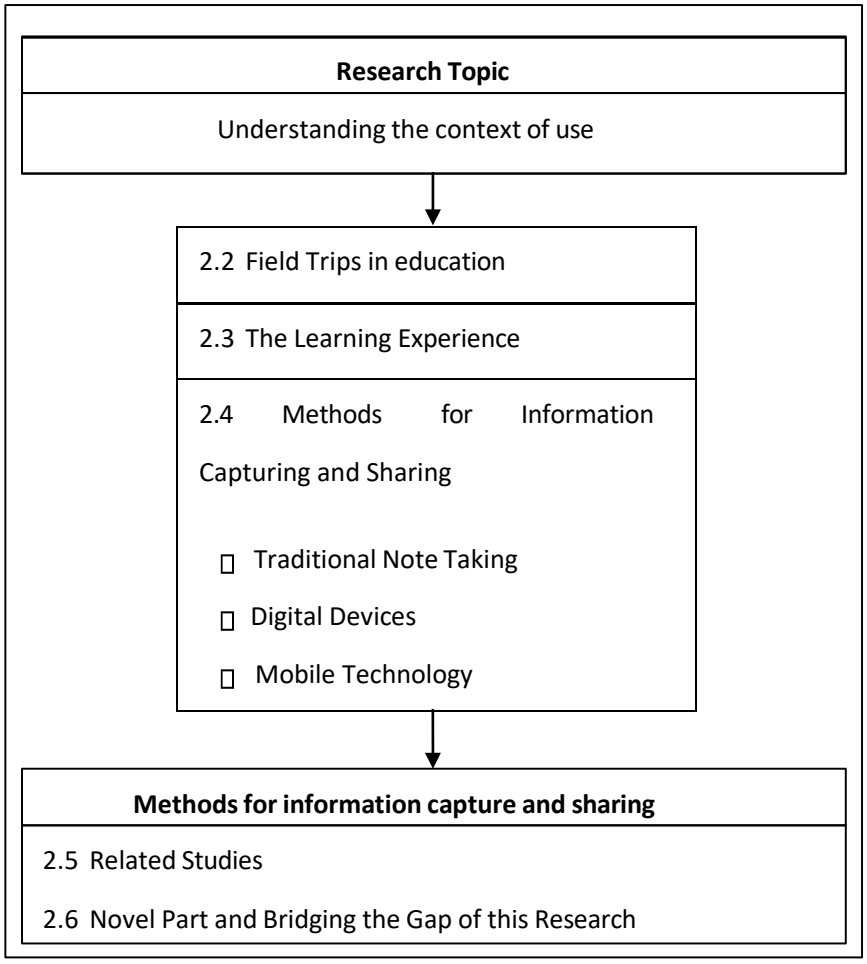

Figure 2.1: Literature Overview

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 mo-

bile 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 behavior of use for mobile technology devices in a human-centered 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 characterize 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 maximize 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

Dando and Wiedel (1971) defined field trips as “a trip made by students, or research workers, to study something at first hand”. The literature provides specialized 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. Bitgood and Stephen (1989) 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” (Maskall and Stokes ,2008). More recently, Erickson et al (2022) 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 behavior and inherent beliefs.

Gold et al (1991) categorized 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 summarized 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 (Green et al, 2014).

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, Kinuthia & Marshall (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 analyzing 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 to 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 in-

creased 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, that continue forwards into the influence of 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), define experience as naturally occurring contexts of everyday life and, in their view, experience is about how people feel about their lives. Experience is often understood as a conscious event in the widest sense. This includes different types of experience such as perception, bodily awareness, memory, imagination, emotion, desire, action and thought (Zalta, 2017). According to the Merriam-Webster Dictionary (2023), the definition of the term "experience" can be expressed as direct observation or participation in

events as a basis of knowledge." In other words, experience is subjective and present. This definition is particularly relevant for excursion purposes.

In another sense, experience does not refer to the conscious events themselves, but to the knowledge they produce (Sandkühler, 2010). It is important for this sense that knowledge comes through direct perceptual contact with the external world (Honderich, 2005). That knowledge is direct means that it has been gained through direct observation.

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. This still fits the new meaning of Learning through Experience which is "learning through reflection on doing" (Felicia and Patrick, 2011, Andresen et al, 2020).

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 environments: affectively oriented (feeling), symbolically oriented (thinking), perceptually oriented (watching) and behaviorally 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.

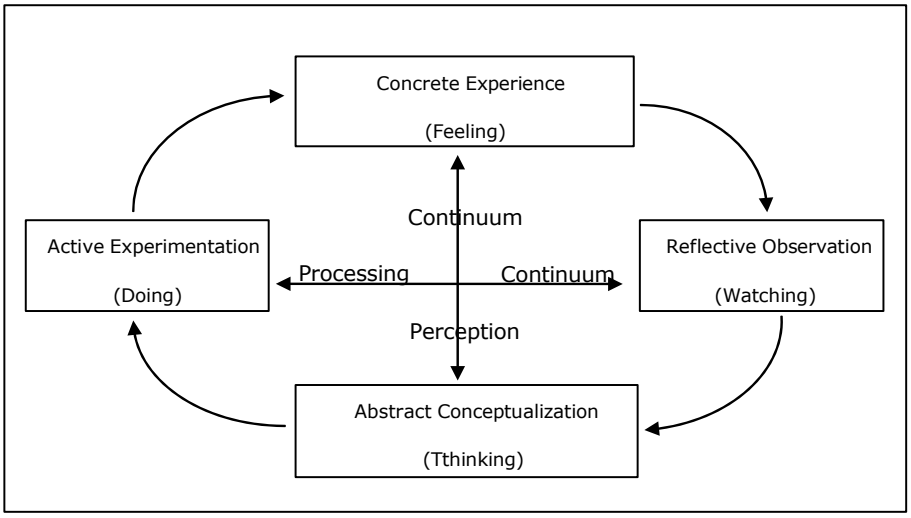

Figure 2.2: Kolb's Learning Cycle

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 behavior, 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 programmers' 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.

A report on a meta-study of 150 research projects on outdoor learning was published between 1993 and 2003 (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 summarized 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 becomes 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).

O'Connell et al (2021) described a research study about the field learning experience, this study described the results of a national survey aimed at better understanding how instructors and directors at biological field stations, marine laboratories, and geoscience field camps are thinking about and designing programs, including learning strategies, student support, desired student outcomes, student assessment and program evaluation. This study is based on an online survey distributed in 2018 to a sample of directors and educators representing 163 undergraduate field learning experiences. The study achieved a satisfactory response rate. The results of the study provide guidance on where support for improvement and research efforts should focus, including more intentional program design that considers student-centered and inclusive approaches and basic research on the impact of undergraduate field learning experiences on student learning more broadly (not just investigated in one program or course), both in terms of what the students learn (broadly defined) as well as how they learn, taking into account affective and cognitive gains. Such research can make productive use of the diversity of program types to investigate the link between student outcomes and student experiences.

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 Definition of Field Notes

The benefit of note-taking, in general, is not in taking the notes themselves, but more in 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 making later analysis and interpretation easier and more accurate. The benefit of using paper notebooks is the ability to provide 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 the 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 smartphones 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 behaviors of users using PDA (Personal Dig-

ital 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 appointments and 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 lists, in addition to recording 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 organized 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 behaviors 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 an 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 in two different biology learning contexts, 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 smartphone 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).

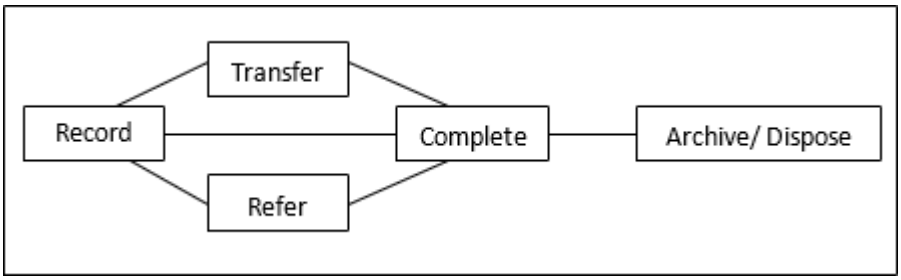

Figure 2.3: The Stage of the micro note lifecycle used as a lens for (Buttfield-Addison et al, 2012) work which has been designed based on Lin et al (2004).

The participants in the study of Buttfield-Addison (2012) were divided into two groups based on their experience of using to the device; the heavy-use users and the occasional-use users. The heavy users were those users who use or attempt to use their tablets 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 behavior observed in past studies. It was found that the users took more notes to keep for a longer period of time, and shared 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 of 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. The study illustrated the life cycle of micro notes in general in addition to the different behaviors in treating these notes. It helped this research in identifying and studying the students' behaviors 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 of mobile technology, over the last decade, has had a measurable 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 as 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 on 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 synchronization channel can be provided over a video conferencing system such as Flash Meeting, which was being 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 applying 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 collectors, 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 were 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 it to a previously established wiki. The students could download the program on their mobile phones 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 (2010) as a tool for collecting data in the field trip supported designing the concepts of this research.

There is a study presented an example of mobile devices in the field comes from research developed by Ryokai et al. (2011). The study presents the GreenHat system, an interactive mobile learning application that helps students learn about biodiversity and sustainability issues in their surroundings from experts' points of view, before participating in unfamiliar debates about their familiar surroundings.

The GreenHat system, 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 biodiversity and 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 to 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 conversations 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 enhance student learning experiences in field trips and predicts what the future might be for the technology.

Also, there is another study worthy of mentioning due to COVID-19, where physical education field trips have stopped being used in education for a long time, but virtual field trips are still increasingly being used to enhance them. Therefore, there is a research study MacCallum & Parsons (2022) that focuses on the use of mixed reality to enhance a physical field trip before, during, and after the field experience as part of a project in teacher professional development. The context is a field trip to a landfill site, where students learn about waste management, recycling, and sustainability. Building on several different themes from the literature to create a single model of pre-, intra-, and post-field trip

digital learning activities, three scenarios are outlined: One where a virtual field trip is used prior to a physical field trip to prepare students for their visit, a second where an augmented reality experience is used during the physical field trip, and a third where students build on their experience of virtual reality to create their own virtual tours. The article highlights how mobile mixed reality offers new ways to deepen the field trip learning experience through student and teacher-created digital artifacts.

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.

There is also another study form Lo & Quintana (2013), this study was conducted during a two-week summer science camp that included two field trips to a local river and to a botanical garden. During the camp period, fifth and sixth graders learned about water quality in the class, collected data using Zydeco (a mobile-based inquiry learning system) on field trips, and reviewed data in the classroom. This paper is aimed to discuss how students make decision to capture multimedia data

(video, audio, photo) and metadata (tag) on the Zydeco system to answer their driving question, and to explore students' perspectives on this type of guided inquiry learning with the use of the supportive mobile-based program.

This study offered students a learning context in which they are able to collect and annotate the data using a mobile-based program. Besides making careful decisions in data collection, students in this study considered more aspects beyond evaluating the value of the data. For instance, when students were asked to capture the data that may be reviewed by other peers, sometimes they would change their original data collection habits. This implies that the complexity of social dynamics may influence students' data collection processes. In addition, some data collection approaches such as audio notes may not be preferred by shy students. Similar findings were reported in RAFT project Kravcik et al (2004) where students hesitated to make audio annotation when using Mobile Collector application. This suggests that designers need to think carefully about students' personalities and offer students flexibility of data collection tools.

As to students' rationales of tagging, the results show that most of the students regarded tagging as one way to facilitate reflection during data collection stage or as one way to foster data organizing and searching. Similar findings can be found from the Zydeco research group's previous work Kuhn et al (2011). These perspectives are also echoed in Ames & Naaman's taxonomy of tagging motivation (2007) which includes two dimensions: "sociality" (in terms of social interaction or self-behavior), and "function" (in terms of data organization or communication). Surprisingly, when students reviewed their data, few students actually used the tag as a key word to search their own or other group's data. This may be due to several possible reasons. First, some students considered tags as an extra form of notes, and therefore they customized tags to fit their own needs. For instance, some groups

created tags in a long-sentence format instead of creating them using short keywords. The use of a personalized tagging approach could have created difficulties for other groups to use the same tag to seek for data. Second, students may not be used to the tagging system that is provided by the program. Therefore, students may not utilize it in the way that designers initially anticipate. To cope with this issue, we suggest that designers may consider incorporating a text-note tool as another data collection approach. In addition, students should be given enough time to discuss potential tags before the field trip and they should practice seeking for data online using tags as searching key words. By doing so, students can become familiar with the use of the tagging system, and utilize it to help them annotate data on-the-go and search the data afterwards.

Another study by O'Connell et al (2021) has highlighted the need to ground undergraduate field learning experiences in evidence-based practices, and to better under- stand the impacts of these experiences on students. In this study, they have described the results of a national survey aimed at better understanding how instructors and directors at biological field stations, marine laboratories, and geoscience field camps are thinking about and designing programs, including learning strategies, student support, desired student outcomes, student assessment and program evaluation. This study is based on an online survey distributed in 2018 to a sample of directors and educators representing 163 undergraduate field learning experiences. The study achieved a satisfactory response rate. The results of the study provide guidance on where support for improvement and research efforts should focus, including more intentional program design that considers student-centered and inclusive approaches and basic research on the impact of undergraduate field learning experiences on student learning more broadly (not just investigated in one program or course), both in terms of what the students learn (broadly defined) as well as how they learn, taking into account affective and cognitive gains. Such research can

make productive use of the diversity of program types to investigate the link between student outcomes and student experiences.

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 organizing the data in a simple archive.

The GeoTool demonstrated that the benefits of using smartphones 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.

All these study projects illustrate innovative ideas 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 educational 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 understand 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 adds 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 biology 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 smartphones or tablet PCs, which have experienced rapid growth during the years this research has been underway.

- 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.