

## 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 two Biology context disciplines: Botany Biodiversity and Marine Molecular biology. Also, this case study conducted to understand the factors that may affect the use of mobile technology in the field trip to capture and share learning experience.

The outcomes were used to develop guidelines for designing a mobile device, which can be used by students during field trips, especially in the biology field trip context to capture and share their learning experiences with each other.

In this chapter, the following questions are addressed:

**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 experience in the field?

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

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

#### **4.2 Case Study 1: Marin Ecology 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, as well as the purpose of this study was to explore how mobile technology could help in capturing and sharing experiences in biology field work.

The study was conducted in three phases:

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 Technical University of Kaiserslautern

to observe their field trips. The Marine Molecular biology field trip took place in an island in northern Germany called Sylt, during Jun 2019 for a period of six days trip. 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.

#### **4.2.1 Participants**

The participants in this study were 14 undergraduate biology students 14 students (three male and eleven female) from the biology department at the Technical University of Kaiserslautern who attended the Marine Ecology field trip. All participants signed a consent form agreeing that the researcher could observe them and their notes during the field trip. They also agreed to participate in post-field trip interviews (only one student has been excluded).

#### **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

In Jun 2019, the study took place during a six-day field trip to an island in northern Germany called Sylt, with 14 undergraduate biology students from the biology department at the Technical University of Kaiserslautern. Every day during the excursion, the students were observed for four hours in the field while they worked in separate groups in the area, then after two hours break, the students were observed for another three hours at the "Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research" (AWI) where they went after their fieldwork. There, in the (AWI) they analyzed samples that they collected from the field during the day in order to write them down in their reports, which they discussed later in a seminar after they got back to their university from the six-days field trip.

They worked as separate groups, and each group included three students working together, which the tutor explained and made a plan for each day before they went on the trip, where they met each morning at eight o'clock in the morning for one hour in the (AWI), where each day there is two students was responsible for preparing and giving a presentation about the subject/s which they were going to work in the field that day, where every day was different subject in the Marine ecology, e.g., Ecosystem salt marsh, the marine strategy framework directive: the balance between ecosystem services and negative anthropogenic effects, Biogeochemistry of mud flat, Birds in the Wadden sea area, formation of the Wadden sea world heritage site, Pelagic food web, osmoregulation.

The observation was conducted with the author joining each group for 20 minutes, recording videos and taking photos of the student's activities in each round.

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

One week after the field trip, students who attended the field trip were invited to participate in a follow-up interview. The one-to-one interviews were conducted with 13 Biology 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. The students were asked to show their field notes during and before the interview session. The majority of students presented their smartphones devices which were used to capture multimedia elements and write notes, in addition to their notebooks. One student presented a camera device that he used to collect photos from the field.

#### **4.2.4 Analysis**

After the data was collected from the observations and individual interview. 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 analyzing 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. In this research the identification of codes was by used the qualitative data analysis software MAXQDA to code the papers. 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. Scenarios are used as a scholarly methodology, they help to challenge existing assumptions, identify novel lines of inquiry, and enable new research opportunities to emerge, thus

opening up a research mode that helps engaged scholars to make sense of and address complex and uncertain contexts and produce interesting findings (Ramirez, Mukherjee, Vezzoli, & Kramer, 2015).

#### **4.2.5 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 Marin Ecology field trip, the students visited different places on Sylt Island to collect and study different animals and plants in the Wadden Sea area. During this six-days trip, participants worked in two types of sites on the same trip. The first site was outdoor, and the second was an indoor laboratory site at the (AWI) Institute.

Observation during the Marine ecology field trip found that the students first divided themselves into four groups and began by measuring the area, collecting samples, taking pictures, and taking 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). They worked in four separate groups but discussed the interesting findings together. After the fieldwork, they mostly shared their experience using Dropbox and Emails. Face to face or by using WhatsApp group.

They carried different tools to capture their experience. The majority of students preferred to capture their experiences by Mobile phone. In addition, the students had notebooks for note-taking and sketch drawing. As well as one student used a digital camera, and two students used their tablets, but only indoors when they returned to continue work in the lab.

A number of problems were faced by the students. For instance, one of the main problems was the wet nature of the field, which constrained

their choices for which tool to use to capture their learning experience by choosing paper or mobile. More details will come in the following sections.

In the evening, the students worked on their group reports and transferred their notes to their laptops, they used Microsoft Word to write the documents and saved their statistical tables in Microsoft Excel. To prepare for power point presentation after the field trip. They also saved their data in Dropbox as well as for sharing the everyday results and data with each other.

After the interviews were analyzed, 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 4.1 shows below. An example of coding development and sorting is given in Appendix B.

Table 4.1: 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. Organizing
Data Sharing	S01. Online S02. Peer-to Peer S03.

### Theme: Data Types

It has been recognized that there are three main types of data the students were interested to collect in the field. During the Marine ecology field trips, students were observed to collect qualitative data as shown in figure 4.1. such as texts which describe the surrounding area. For example, the students were interested in collecting notes to describe and identify different species, like plant and animals in various types of surroundings and conditions. As well as to learn more about the ecosystem, and to see what is special about the ecosystem in the target place for the field work which was in this excursion the Wadden sea area.

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

*“Notes describe the animal or plant we found with the surrounding area, I have to write this down fast because I will forget later”* – The participant described what data he collected in the field.

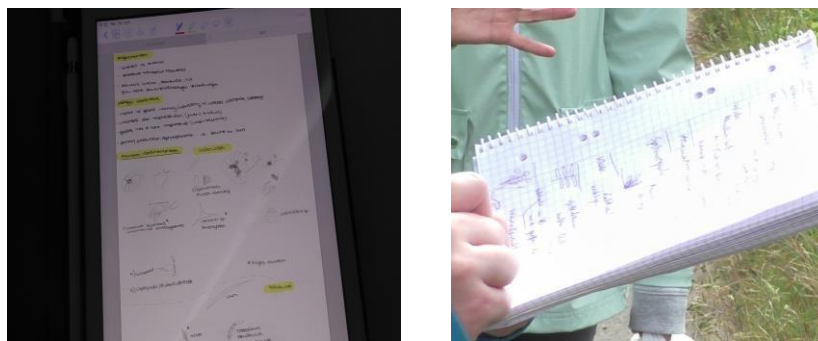


Figure 4.1: The student notes include qualitative data

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



*“I was accounting worms and their movements in one meter square based on timing”* - This participant was collected quantitative data as a part in a group that split the field work between them.

Therefore, the Marin ecology students collected a quantitative data from the field, by using both mobile devices and paper-based tool (figure 4.2).



Figure 4.2: The student's notes include quantitative Data

### **Theme: Objectives**

All participants said that collecting their experience was to memorize the information and reflect on their work to follow the field and technique procedures. The students used these notes to write up their field results in their reports for later presentations. Recording photos and videos support the students in gaining knowledge after the fieldwork.

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

*“Most of the time it is interesting to know what species about this region, of course, we have to do a presentation and write test in the end but some motivation from inside too”.*

*“We have to collect some samples besides information to continue work later in the lab in another half of the day, normally to write up my group report, also I enjoyed it too”.*

*“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, and mostly mobiles phone for note taking, also for capturing photos and sometimes recording videos (Figure 4.3).

Only one student used a digital camera for capturing pictures, but also sometimes in other days, he used his mobile phone.

*“I used my digital camera because I have it anyway, and I thought I could make some cool pictures, quality is better. Sometimes I used my mobile phone because the camera is heavy and it could fall down, this depends on the kind of work I have to do in the field”.*

Some other comments from the students were:

*“Simply be writing down on my notebook, and my mobile phone for taking pictures of some microorganisms and different animals and plants we found”.*

*“I don't want to have my mobile phone in my hands because when we work in the field, my phone could drop from me to the water, and I have important and private things in my mobile phone”.*

*“I took only my mobile phone with me where everything was wet so I didn't want to have a paper with me”.*



Figure 4.3: A mobile phone has been used by a student in the field trip, although difficult to use due to the wet environment

There were some leading causes that rigorized by the author, negatively affected the usage of mobile devices to capture the field experiences, such as the difficulty of using the mobile devices due to the nature of the surrounding wet environment, where for example some of the students mentioned in the interview that difficult to hold mobile phones with wet hands also they were worried that this device could drop in the water.

Many students in the study mentioned that, since there is a time limit to visit the field, they have to try to capture as much of the experience as they can quickly. Thus, they focused on photos because that helped them to remember the details and write later on the same day rather than taking notes and trying to write down all the information at the exact moment, which no time, also they could a bit lose what their group doing.

#### **Theme: Documentation**

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

##### **I. The first activity is transferring the data:**

The students transferred their multimedia data to digital storage media such as their laptops. They also used Microsoft Offices to transfer the data such as Microsoft Excel for quantitative data, and Microsoft Word for Note taking text and writing final reports.

*“Even if I write my notes on paper, I have to transfer everything to my pc, especially we have to write a report and prepare a PowerPoint presentation at the end”.*

## **II. The second activity is saving the data:**

As the Marin ecology field trip participants reported, they preferred to save their work and finding on their laptops, Dropbox, Mobile phone, Tablet and paper.

*“I saved everything on laptop especially photos, and kept information text on the paper”*

*“I save my data in my tablet, that I can see my information more clearly, I transfer what I need from my mobile phone to my tablet after the exertion, also because there is not much storage on my mobile phone”.*

## **III. The third activity is organizing the data:**

In order to organize the learning experiences, the Marin ecology students prefer to manage their experience information in a paper with no change after the fieldwork, or in digital format, with at least one student from each group for course works or field reports. But also, many other students organized their data digitally for their won late experience.

*“I prepare my tables before I start”* – A student described that she organizes his information in tables that he prepared on his notes before he goes to the field.

*“Messy style for taking notes, but I don’t mind to stick in format”* – A student described his behavior in organizing his data. He mentioned that his organizing 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 student mentioned that he likes to organize his notes in free hand writing style on the sheets instead of organizing them in specific format such as tables.

*“I organized my data in folders on my laptop after the excursion because during the excursion I have more important things to do and no time”- One main problem this student mentioned, the time pressure during use the mobile phone in the field work.*

### **Theme: Data Sharing**

It was noticed that the Marine ecology field trip participants did not mind sharing their raw data with others all the time. The raw data is the data that they collect in the field before they analyze it. Therefore, there was a lot of information and photos to share in the field and after the fieldwork. Students used different ways to share, like Dropbox, email, and social media such as WhatsApp group, but nobody used Facebook, for example, to share with their society outside the class. Besides, there was face-to-face communication to share and discuss their experience.

The following are some comments from the participants:

*“Well, that depends, sometimes we share our data face-to-face when you see something interesting and you want to show it to everyone”.*

*“We send information to all groups by email most of the time, but when there are a lot of pictures, that does not work to send by email, so we use Dropbox also, that's faster and easier”.*

*“We do this presentation in the end, and we have to send data to each other”*

### **4.3 Case Study 2: Botany biodiversity field trip**

This case study has the exact purpose of the previous one in section 4.1. The study was conducted in three phases and followed the same procedure developed in the previous case study.

To facilitate this case study, the author was invited to accompany undergraduate students from the University of Saarland to observe their field trips. The Botany separate six days field trips took place during the summer semester of 2019 in different landscape areas in Germany i.e., Dudweiler forest for Spring flowering excursion topic, Niedergailbach for Lime dry lawn excursion topic, and Oberthaler Bruch for Moor excursion topic.

In order to facilitate the analysis of the outcomes from this case study, the details of participants, study design, and analysis are presented in the following sections.

#### **4.3.1 Participants**

Biology (Teacher) students from the center for teacher education.

The participants in this study were 14 (Teacher) students, 14 students (four male and ten female) from the Teacher Education department at the University of Saar-land, who attended one class called ("Advanced field trip" in Zoology and Botany) in the Human and Molecular Biology department, the author followed the student during the Botany part field trip part of, which took part on Thursdays one time every two weeks through the semester.

All participants signed a consent form agreeing that the researcher could observe them and their notes during the field trip. They also agreed to participate in post-field trip interviews.

#### **4.3.2 Methods**

To gain preliminary understanding of user requirements in this field study context, the same methods used in the previous Marin ecology 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** Botany biodiversity field trip

In May 2019, the study began with a separately six-days field trip, which took place on Thursdays during the 2019 summer semester: 02.05.19, 23.05.19, 06.06.19, 13.06.19, 27.06.19, 18.07.19. With 14 teacher-students the as a part of one course called ("Advanced field trip" in Botany). A few days before each trip, the teacher and his assistant emailed all of the students to give some necessary information i.e., the location of the meeting point, time, and quick review of the topic. The teacher planned all topics for all the field trip days and given within the syllabus.

On every time excursion day, all the students, with the teacher and his assistant, met in an agreed-upon location in the morning near the interface where the excursion in Botany Biodiversity matter topic was. The students were observed for approximately three hours in the field while following the teacher from one place to another. The teacher explained the excursion target topic, plants in their natural habitat, while the students took notes, took pictures of the plants, and collected plant samples from the field. After the excursion, the students were returned on the same day to a Lab in the Human and Molecular Biology Center at the University of Saarland with the samples they collected from the field, for sorting, by checking out the type of each plant, name and family. Also, to do plant drying technique for the plant samples they collected, to get back to them any time. Notebook fails for each group of students consisting of types of plants they looked for in the field and collected.

#### **4.3.4 Analysis**

The same analysis methods used in the previous case study in section 4.2.4 were applied in this study.

#### **4.3.5 Findings** Botany biodiversity field trip

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. Scenario methodology enables producing usable, rigorous, and interesting research findings (Ramirez, Mukherjee, Vezzoli, & Kramer, 2015).

The students before each field trip were required to travel individually by train or car for students how to have a car, to meet one certain location point with their teacher, how had sent a group email a few days before each trip for some information regarding the trip also, the location, which was usually near the target field trip location, the students had a WhatsApp group for planning to the trip and contact each other with any updates or changing on the plan, also for direct sharing information during the field experience, which was not many times not working because of the poor internet signal and this was since the students were usually working in a rural area, this prevented them from sharing their data over the WhatsApp in the field.

Another problem faced by the students, for instance, one of the main problems, was the Sunshine weather which perverted students clearly see the screen of their mobile devices. This is one reason many students prefer to write their text notes using pencil and paper rather than mobile phones. Some students still prefer to use mobile phones for different reasons, as will be in the following sections.

Usually, the Botany Biodiversity field trip takes place in a harsh rural area with intermittent access to internet connections. Therefore, there needed to be better internet in the field, which mostly made sharing the data by the WhatsApp group unsuccessful. This study observed that the students walked together with their tutor around the fields, they mainly worked individually to collect their own experiences and interests, i.e., plant samples and photos, but they discussed the interesting



findings together in the field face to face most of the time. Besides a short group face-to-face presentation at the start of each trip to discuss the goals and a summary of the excursion topic before starting work in the field, this was done by different students on each trip who were pre-arranging.

Students carried different tools to capture their experiences. Most students preferred to capture photos of a plant using Mobile phones. However, they already took a sample of the plant to dry and save it later in the Lab at the university. The reason was when they were asked during the interview to confirm their memory field experience to take a picture of the plant with its surroundings. When students later transfer the information, they collected to their computers or laptops, they write down all the descriptions about each plant with a picture.

In addition, many students had notebooks mainly for note taking, as well as for sketch drawing. Instead, several students used their phones to take notes.

One student outdoors in the field used a regular size tablet to show some photos to the other students during the introductory lecture in the field.

All of the students carried their smartphones for photo taking from the field. Only one student used to capture photos and videos using a special and expensive device called “DJI Osmo Pocket” camera, which can connect to a mobile phone for the best resolution and stabilize taken pictures and videos as showed in figure 4.4. Another student beside the professor held a standard digital camera for the same reason.



Figure 4.4: Student use standard digital camera (left), or what called an DJI Osmo Pocket” camera, which able to connect to the mobile phone for easier and better captured photo

Although many of the students carried smartphones, many preferred to capture their written information from what the teacher was talking about, target plant or flower, by writing down in their notebooks. Four students prefer to write their written captured information using the mobile phone, with some Applications, i.e., Note App.

But also, no one has recorded the teacher talking using the mobile phone during the six separate days duration of the field trip.

Students captured photos of the landscapes and plants. They preferred this method to save time instead of drawing a quick sketch and missing the details, as they answered later in the interviews. Although stilled some students drew quick sketches of the plant or flower parts using their notebooks and not by mobile phone, on other days, they switched to using the mobile phone to collect learning experiences and vice versa. This depends on some factors such as nature of surrounding environment (see figure 4.5). These factors described in the following sections in more detail.



Figure 4.5: Difficulty in using and carrying paper-based tool in the field

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 group. Thus, they preferred to use the devices to capture photos

so they would not get left behind. So, capturing pictures was more frequent than writing notes on smart mobile devices.

After the interviews were analyzed using MAXQDA software, codes were developed to identify new themes. The themes were combined, split, or moved, so the final version of the codes presents five main themes as table x shows below. An example of coding development and sorting is given in Appendix C.

The themes that emerged from the analysis, the emergence of similar themes is not surprising, as Marine Ecology and Botany Biodiversity field trip 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 4.2: Themes, and codification of subthemes originating from the thematic analysis

Main Theme	Sub – Themes
Data Type (Form of Information)	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. Organizing

Data Sharing	S01. Notebook S02. Online S03. Peer-to Peer
--------------	---

**Theme: Data Types**

During the Botany Biodiversity field trips course for the biology teacher-students, they were observed to collect qualitative data such as texts which describe the surrounding area and plants. The student's notes included describing different plants and their names, families, and some other plant characteristics with their surroundings. The notes were a combination of text and sketches, in addition to collecting different plant samples from the visited sites.

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

*"Photos for small details in the plant parts, such as Rose petals, or leaf veins"* – This participant took photos to capture the small details of the plant parts.

*"I was recording video as much as I could, 5 minutes approximately. And I drew after the field"* – This participant used to record videos of the area with different plant that he observed. He would postpone drawing his sketches until after the field trip to save his time on the site.

On the other hand, when other students were asked during an interview why they captured their multimedia in the field based on photos and not on videos when they used their mobile phones, most of the answers were because of big memory which could take from the phone, cleared and focused details in the photo more than video, some other answers also mentioned that their mobile phone would be faster

run out from battery during all these hours in excursion especially when they make videos as well.

### **Theme: Objectives**

The participants reported that the purpose of collecting their experience was to memorize the information to reflect later on their works to follow the field and technique procedures. Students used these notes to fill in their critical diaries and portfolios. Recording photos and videos support the students in gaining knowledge after the field-work.

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

*"Not only to collect plant samples but also seeing the surroundings and environment of the plant will make sense for me as a teacher in the future. I need a mobile phone to collect these field experience memories."*

*"When I am alone and don't know what the plant is, I take a photo, and then I can look it up later; that's easy".*

*"I wrote some notes and drew some sketches below to relate back and understand what I missed or can't remember, this helps in the final report".* – This student collects qualitative data to come back to it later and prepare his final report.

*"I have learned a lot about plants, which took a lot of time. I think knowing how to attract my students to this topic, for example, is an important part of my job" – This student collects his learning experience not only for the final results but also experience as a teacher in the future.*

### Theme: Tools

The participants used notebooks mainly for note-taking but still some students used their mobile phones to take their text notes. Also, mobile phones were used mainly for capturing photos and recording videos as shown (Figure 4.6). Also, two students used a digital camera.



Figure 4.6: Students taking notes with different tools during Botany Biodiversity field trip.

The comments from the students were:

*"I use my mobile phone to capture pictures because it's more clear than drawing and easier to transfer these pictures to my laptop later."*

*"In the field, I write everything in the phone because I don't need to have a pencil and paper, then carry everything around. Also, I can switch from the write text App i.e. Note, to the Camara directly."*

*"Depending on the weather, when it windy, then difficult to use paper."*

*"The tool I use in the field depends on the type of information, when it's just pictured, I use my mobile, but for text information, it's hard for different reasons, like I can't see clearly in the field what I am typing on my phone screen"*

*"There is no reason why I used paper, it's just more easy"*

*"The most important for me is to get my information, doesn't matter how, I use paper most of the time to write my text information but to use my phone to write down everything is not practical at all during fieldwork, it takes my focus then I will miss the next information, or I would be isolated from what my group doing"*

Therefore, most students got their text data by using paper-based tool, while the multimedia information, such as photos and videos by using mobile devices as shown in figure 4.7.



Figure 4.7: Students carry both tools simultaneously; paper-based for writing text information and mobile devices to capture multimedia data such as photos and videos.

About mobile applications, 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, i.e., Plantnet App, Note App

*"When I don't know the plant or want to know more details, I use the PlantNet App, it's easier and more practical than looking up in the book in the middle of the field, although it's not 100% correct every time".*

This study identified some causes that could restrict the student's usage of mobile devices in capturing and sharing experiences on field trips. Such as the nature of the surrounding context, i.e., sunshine was

a reason that mobile screen was not much visible during writing some notes texts or showing some captured photos to each other in the field.

### **Theme: Documentation**

Three main activities were identified in order to document students experience after and during field trips.

#### **The first activity is transferring the data:**

The students transferred their multimedia data to digital as cloud storage services, or on their mobile phones or tablets, and transferred later to their laptops.

*“Photos I transferred to my laptop, but I kept my text information on my notebook”* -Student described how he transferred his learning experience.

*“I don’t need to transfer anything. Everything is on my phone, but for the final report, I can look up what my group, at least one of us has to transfer data in digital form”* -Students show that the transfer for the group report work otherwise everything remains on paper or phone.

#### **The second activity is saving the data:**

The Botany biodiversity field trip students behaved differently in saving their data, where many students kept their notes and sketches in their notebooks. Besides, multimedia data and main information texts describing each plant species are saved in folders on their computers. They also preferred to print out their data after they had been organized in paper form for the final group work notebook report, as well as in cloud sourcing services such as Dropbox.

*“I keep my photos on the phone, or Dropbox for long saving”*- A technique to save the field collection data by the student.



*"I had my laptop, all the group save their work in one folder, and then I take one softcopy on my USB" – A 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 organizing the data:**

Regarding organizing the data, the students organized their field experience in, a computer folder, and Excel, which contained all the six days field trip reports from each group of students.

*"I have several folders on my PC, each trip day has one folder"*

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

*"My notes could be organized, but I couldn't! I prefer to collect everything on paper, then rearrange and number the sheets"-* The participant could not organize his notes on the mobile device because he did not know how to do that.

When students were asked during the interviews why they did not use a Voice note App and preferred to write after the tutor their notes, the answers were that they hadn't thought about it or they needed to learn how to organize their notes in any voice note App, because their notes would be scattered and unorganized, or they cannot trust such an application to write up behind the tutor.

**Theme: Data Sharing**

It was noticed that the students preferred to share selective data with their group for their group project work.

Furthermore, the Botany biodiversity field trip participants preferred face-to-face communication to share their experiences in the field. The

lack of internet signals could be one of the causes that made the students use only Bluetooth to share their data in the field. However, when the students returned from the field trips, they used Dropbox to share data information with the whole group.

Finally, students use social networks such as WhatsApp only as a communication means to organize group meetings.

They use it as a communication tool to discuss, announce, and set their meetings, but mostly this was after the trip because there worked on The Biodiversity field trips, which usually took place in harsh rural areas with intermittent access to internet connections.

At the end of field trips, the students made final groups work notebook, which was possible to share results with others.

Moreover, they also use emails and cloud services such as Dropbox to share their data.

*“I transferred all information I got from the field, from my mobile phone to my computer, then to Dropbox, which is two parts, one private only for me and one to share with my group”*

Also, no student used public social networks such as Facebook or Instagram for data sharing. Sharing the information and photos was just for the group and not for the public.

#### **4.4 Discussion of Cases Studies**

There is a large amount of similarity, but also some contrasts, between the two case studies when students capture and share their knowledge and experiences in the field setting.

The first is the type of data captured in the field; both student groups collect almost the same kind of data, mainly multimedia, such as photos, samples from the field area, and text information. Marine ecology

students sometimes collect numerical data as well. Students were interested in collecting qualitative data from the field.

The second is the tools the students use to collect these data. They all use mobile phones at least once during the seven days of fieldwork and paper-based tools. However, in addition to these, sometimes they used different tools such as Tablets, digital cameras, Magnifying binoculars, magnifying lenses, and calculators.

The third theme is how the students organize their data. This was for designing a field report and final presentation. As can be seen, most students, especially in the Marin ecology field trip, put their notes and multimedia in a digital edition, such as Dropbox, computer folders, and emails. Also, many students would like to organize their data in the original format, keeping it in their mobile phones and notebooks, especially the Botany biodiversity field trip students. The explanation of differences here is the nature of the student's final work results form, where the first field trip was a presentation which would be any way in digital format. In contrast, the other field trip was a final group work notebook.

The next theme is sharing data. Where the type of data that the students shared is the raw data collected from the field. They want to share the analyzed data at the end of the semester when the group's results are presented. Moreover, they favor face-to-face discussion, partially the botany field trip, whereas the Marin ecology students like using social networks for group discussion, the reason here was based on the nature of fieldwork and place. Where in the Botany field trip all students were roaming together with their teacher, also was difficult to use social networks because of poor internet signals 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.

In contrast, the other field trip students were separated in five groups working in different places, and they needed a social media like WhatsApp group to communicate and share collected data directly and there were no problems with the internet network compared with a Botany field trip.

Moreover, all students from both groups shared their notes and experiences and also used emails and cloud services such as Dropbox to share their data after the field. Also, no student used public social networks such as Facebook or Instagram for data sharing. Sharing the information and photos was just for the group rather than for the public.

During the post-field trip interview session, participants were asked about some observed factors that could affect the use of mobile technology in the field, such as mobile devices being more suitable for taking photos than notes. Besides, carrying a single device, such as a mobile device, is more convenient than having multiple equipment's in the field.

On the other hand, some participants had different views regards using mobile devices in the area. Their explanations include that the size of mobile devices is too small, especially to write text notes in the field. When participants were asked why they had not then used Tablet to write their text not by using as well special pencil for this issue, the answers were that a mobile phone is easier to carry, also possible to connect it to the internet, and having one device is more practical than have multiple devices, especially during work in the field. In addition, the limited time of the field trip led them to choose a quick way to collect their experience, for which they considered the traditional tools more suitable than mobile devices.

However, an issue raised during the interview was that participants sometimes felt isolated from the physical environment and their group

or the tutor in what they were discussing when using the smart mobile devices. That was because the touchable keyboard in these devices makes the typing function difficult and requires concentration to type correctly. In addition, it was observed, as well as students mentioned in the interview session, that the mobile screen was not very clear under sunshine outside in the field (see figure 4.8), especially on sunny days, while capturing data information. In addition, carrying these devices around a harsh or wet environment, such as on field trips, was considered not convenient or safe to use (see figure 4. 8).



Figure 4.8: Difficulty to write text information by using the mobile device, such as in the sunny weather in the left, or wet environment in the right

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

- Time pressure

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

- Difficulty of use in the context

The mobile device's difficulty in the context was due to the nature of the surrounding geographic environment. For example, many participants mentioned in the interview that difficult to hold mobile phones with wet hands. Also, they were worried that this device could drop in the water during the Marin biology field trip or down from far away while climbing some rocks in the Botany Biodiversity field trip group. As well as the nature of the outside environment partially, the weather played a significant role in many students choosing the use of mobile devices paper base tools to collect learning experiences. For example, when the weather was a bit windy, some paper-based students faced a problem using it. On the other hand, the mobile screen was not much visible during sunny days, so some students switched to a paper base tool on these field trip days.

- Spatial isolation

Many participants commented that they experienced isolation when using their mobile devices in the field. They found that using the mobile device, especially when writing text notes, could take from their focus, which makes it difficult to continue and follow up on what their group is doing or discussing. However, the feeling of isolation was much less when they used the device to capture pictures.

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.

#### **4.5 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 Biology 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, 2015). 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 analyzing the data collections of the previous study with the undergraduate students. The draft of developing these requirements is shown in Appendix D.

**4.5.1 Methods of Analyzing the System Requirements** The expression of requirements analysis, as Preece et al. (2015) and Rogers et al. (2023) explain, is to describe the activity of investigating and analyzing 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 (2015) and Rogers et al (2023). According to Preece & Rogers 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 organizational 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 prioritize 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 prioritization methods, one of them is MoSCoW. The study examined the methods by three criteria: ease of use, the time to complete the prioritizing process and the user's confidence which means how deeply the user believes the prioritizations 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 prioritizes the requirements into diverse priorities categories. But the requirements which are in the same group appear equal in priority. (Ma, 2009).



#### **4.5.2 System Requirements for Developing Mobile Technology to Support Capturing and Sharing Learning Experience in Biology Field Trips**

The lists below present the requirements for developing and designing a mobile system, which enhance the capture of information and the subsequent sharing of experience during the University students Biology field trips.

##### **I. Functional Requirements for the Mobile System**

- The system must have a writing text function convert from voice speaking
- 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 split the screen in to a multiple screen
- 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 or both options.
- The system must provide a high-resolution camera
- The system must be able to measure the volume of the voice and the degree of noise
- The system must provide a color drawing function for drawing sketches
- The system must support group work
- The system must offer photo filters

- The system must sort the data automatically into requested folders
- The system should allow an uploading file function to the computer
- The system should provide expanded storage memory (able to connect to the mobile device)
- The system should offer direct social networks connection from App.
- The system should provide a video recording function
- The system should provide a stabilizer for photos and videos
- The system should offer an email access function
- The system must take clear photos and videos under the sunshine
- The system should support the visual content with zoom and pan options
- The system should contain a built-in GPS
- The system must offer a stronger capture for the internet signals
- The system must offer a bigger rang for the Bluetooth connection.
- The system must provide different camera lenses such as have a magnifying glass
- 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 must link programs and applications together
- The system should offer linking with the cloud storage service
- The system must provide a GPS link function to automatically link notes with maps (record in which place different note was taken)

## **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 the recording of qualitative data
- The system should offer a spreadsheet layout function to sort the data
- The system should register time and date automatically

- The system should number the notes pages automatically
- The time and data on the system should be registered automatically
- The system should offer various styles of labeling and tagging data
- The system could offer to create a unique marker function to allow the user to create their own marker to mark the data
- The system should allow saving and sharing copies of the data to be embedded directly into an electronic portfolio or Dropbox

### **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 and useful in the field setting and environment, i.e., under different conditions of UV lighting
- The system must be suitable for use in the field
- The system should be indoors and outdoors 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 of 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