THE ROLE OF INTERACTIVE MAPPING IN GEOGRAPHY FIELDWORK FOR IMPROVING GEOGRAPHICAL UNDERSTANDING

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ABSTRACT

Fieldwork is known to be an integral part of learning geography. Geography fieldwork takes place outside the classroom and gives the students an opportunity to interact with the environment and observe how it is affected by human culture as well as other activities. The overall purpose and learning objective of the type of geography fieldwork that is the subject of this research is to increase the students' understanding of the geography of an area. This geographic understanding can be measured using various techniques such as mental mapping. Mapping activities are now an integral part of this type of geography fieldwork. Students make use of different mapping tools such as digital maps and paper maps to aid them while carrying out the fieldwork. In the past, mapping was done through field sketches etc. on paper, but nowadays interactive digital tools are available for that.

The objective of this research is to find out what the usability of interactive mapping is in increasing the understanding of the geography of an area during fieldwork. This research involved test persons who were selected after taking part in an online survey which was meant to gather information about their background and mapping experience. They were divided into two groups with one group using digital mapping tools and the other group using paper maps of the area. Both groups took part in a comparable mapping activity which exposed them to the history of Enschede which was formerly known for textile production. They were exposed to the changes in the urban landscape of the case study area and how it has been affected by the industrial era in the past. Their geographical understanding of the case study area was tested before and after the fieldwork to see if it improved or not.

At the end of this research, a great deal of data was obtained and analysed. This included results of the online survey, prompts and unstructured interviews, pre and post-fieldwork mental maps, and video recordings. A lot of interesting observations resulted from these different sources and at the end this research concludes that there is an improvement in students' understanding of the geography of an area after mapping activities. This research also came up with various recommendations on the use of mapping in geography fieldwork.

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LIST OF ACRONYMS

POI	Point of Interest
TP	Test Person
VGI	Volunteered Geographic Information

1. INTRODUCTION

1.1. Background

Fieldwork is central to the discipline of geography. Fieldwork has enjoyed a long standing tradition within geography teaching and research (Rod & Chuan, 2000). Pattison (1964) identifies fieldwork as one of the five basic elements of the geography discipline. The purpose of geography fieldwork often times is to gain knowledge and deepen understanding of an area. Fieldwork can lead to development of knowledge and skills (Rickinson et al., 2004). Geography has been described as an empirical science and observations from the real world form the data of geographic research (Holt-Jensen, 2009). These data are most times collected outside the classroom by engaging the students in various activities such as field teaching, field trips, field research or field excursions (Dando & Wiedel, 1971). In doing this, the students make use of various forms of cartographic aids to assist them before, during and after the fieldwork. Students are also involved in various forms of mapping activities during fieldwork. In the past, cartographic tools used by students included field sketches, maps drawn with paper maps as a base, paper posters etc. (Kneale, 2013). Others are aerial photographs and remotely sensed imagery (Stoltman & Fraser, 2000). Nowadays, new geospatial technologies have transformed the way spatial information is handled (Connors, Lei, & Kelly, 2012). Fieldwork has not been rendered obsolete through these new technologies but has rather been enriched through them (Phillips & Johns, 2012).

The mapping activities carried out by geography students could be considered as "neocartography". According to Jobst & Döllner (2009), neocartography encompasses ubiquitous cartography, user participation as well as the use of geo-media techniques and tools. With these techniques and tools, maps are now being produced by laymen who are not professional cartographers (Faby & Koch, 2010). Nowadays a lot of mapping options are available to make mapping easier (DuVander, 2010). Examples of such options include OpenStreetMap (URL 1), Google Maps (URL 2), Yahoo Maps (URL 3) etc. With these options, students can create maps, showing what they want and by so doing they are exposed to the geography of the mapped area. As Hennig (2012) would put it "they make the maps for themselves just because they can" (slide 18).

Geo-media mapping techniques and tools are available for executing geography fieldwork conducted by students at different educational levels. These options vary in style and contents depending on the vendor. With these tools students can be engaged in "interactive mapping" during geography fieldwork. Although some literature have classified paper maps as interactive maps (e.g. Bertin, 1983), interactive mapping in the context of this research means mapping which involves an interaction between a person and a map

through a digital device (Roth, 2013). However, a second group of test persons who use paper maps would equally be involved in this research. The composition of both groups would be comparable and I will try to see if one of the groups shows a different improvement of geographic knowledge than the other.

1.2. Motivation and problem statement

The effect which mapping tools have on improving the students' understanding of the geography of an unknown area has not been dealt with in past researches. Also, there are no scientific reports indicating that research was carried out with test persons to study what effect interactive mapping in geography fieldwork would have on their understanding of the geography of an area. Hence this research. I intend to measure the effects that an exercise involving interactive mapping would have on the change of a students' knowledge of the geography of an area. At the end, I intend to also come up with recommendations on the possible use of interactive mapping activities during field work.

Looking at geography fieldwork, this research is motivated towards taking a look at the mapping tasks during geography fieldwork and trying to find out what the usability of interactive mapping is in helping to improve the understanding of the geography of an area. This research would also hopefully contribute to the broader PhD project of Xiaoling Wang which is "The role of cartographic visualizations to improve spatial cognition in geography fieldwork". Her PhD project is aimed at establishing the roles of cartographic visualizations in improving undergraduates' spatial cognition in geography fieldwork and at the end, proposing guidelines for combining geography fieldwork with cartographic visualizations. Her hypothesis is that the current cartographic visualization potentials, brought about by technological, social and scientific developments, are not optimally applied in current geographic fieldwork in order to help students to acquire new knowledge and understanding. The results of my research will be used by her to formulate proposals and requirements for new ways of cartographic visualization to be applied in human geography fieldwork. These new designs would however be subject to actual user research in the field.

1.3. Research identification

The main issues to be addressed in this research are captured through the following research objectives. Those objectives would be reached by answering a number of research questions.

1.3.1. Research objectives

The main objective of this research is to find out what is the usability of interactive mapping in increasing the understanding of the geography of an area during fieldwork for graduate students. To reach the main objective, the following sub-objectives are defined:-

1. Develop an exercise on the use of interactive mapping in fieldwork.
2. Determine the usability of this exercise with test persons.

In this research, graduate students in geo-information science were selected as test persons. This field of science focuses on acquisition, manipulation, management, presentation and analysis of geographic data (Kemp, 2007). Also in my case study, I am limiting myself to an urban area because the main elements of human geography are more discerning in urban areas.

1.3.2. Research questions

During this research, the main and sub-research questions would include:-

1. What is geography fieldwork?
2. What are the purposes and learning objectives of geography fieldwork?
3. How can a person's understanding of the geography of an area be measured?
4. During geography fieldwork, what mapping activities were carried out in the past?
5. What mapping tools are currently being used in geography fieldwork?
6. Do students understand the geographic area better after taking part in interactive mapping?
7. Is there a difference in the improvement of geographical understanding as a consequence of paper mapping, compared to digital mapping in geography fieldwork?

1.4. Innovation aimed at

The innovations this research aims at include:-

1. Using actual test persons to research if interactive mapping during geography fieldwork would lead to better geographic understanding.
2. The above aim would then lead to recommendations on the use of interactive mapping in geography fieldwork.

1.5. Thesis structure

Chapter 1: Gives a background to the research, states the research problem as well as the research objectives and questions and finally the innovation the research aims at.

Chapter 2: This chapter deals with geography fieldwork and geographic understanding, indicating the purpose of geography fieldwork, learning objectives and mapping activities involved during fieldwork. It also discusses the understanding of the geography of an urban area as well as how it is measured using mental maps as a tool. And finally, the mapping tools, their roles during fieldwork and their usability.

Chapter 3: In this chapter, the general methodology is discussed. It includes the various techniques to be implemented in the research.

Chapter 4: This chapter deals with the actual implementation of the research methodology. It describes in details the overall set-up of the geography fieldwork including the various tools used, user tasks and instructions.

Chapter 5: The results are analysed and discussed in this chapter. This includes the outcomes of the online survey, pre and post task mental maps, the think-aloud recordings as well as the videos.

Chapter 6: This chapter discusses the findings of the research, overall conclusions, challenges encountered during the research, suggestions for further research as well as recommendations for the future use of interactive mapping in geography fieldwork.

2. GEOGRAPHY FIELDWORK AND GEOGRAPHIC UNDERSTANDING

2.1. Introduction

This chapter gives an overview of geography fieldwork including the different types of geography fieldwork and purpose and learning objectives of geography fieldwork. In order to ascertain improvement in geographical understanding, this chapter looks at the meaning of an urban area and how to measure the understanding of the geography of an urban area. Mental maps, a tool widely used when measuring geographical understanding, are also discussed in this chapter. The last part of the chapter is about the mapping tools currently used during fieldwork and also about the usability of these tools.

2.2. Geography fieldwork

2.2.1. Definition and types of geography fieldwork

In QAA, (2014), the Geography Subject benchmark statement by the UK Quality Assurance Agency, defines fieldwork as "active engagement with the external world" (p. 12). Furthermore, fieldwork may include field teachings, field trips, field research or field excursions (Dando & Wiedel, 1971). As stated by Bland et al (1996) "Geography without fieldwork is like science without experiments" (p. 165). Frew (1993) also defines fieldwork as the ideal way to put geography into practice. According to Stevens (2001) "Geography fieldwork renews and deepens our direct experience of the planet and its diversity of lands, life, and cultures, immeasurably enriching the understanding of the world that is geography's core pursuit and responsibility" (p. 66). In geography, processes are divided into 'social' (economic, cultural, political etc.) and 'biophysical' (biological, chemical, geophysical etc.) and are often separated as human geography and physical geography (Gregory et al., 2011). Geography fieldwork can be classified in correspondence with these two branches of geography. Pidwirny & Jones (2009) further sub-divided the two branches into major sub disciplines as shown in Figure 2.1 below: -

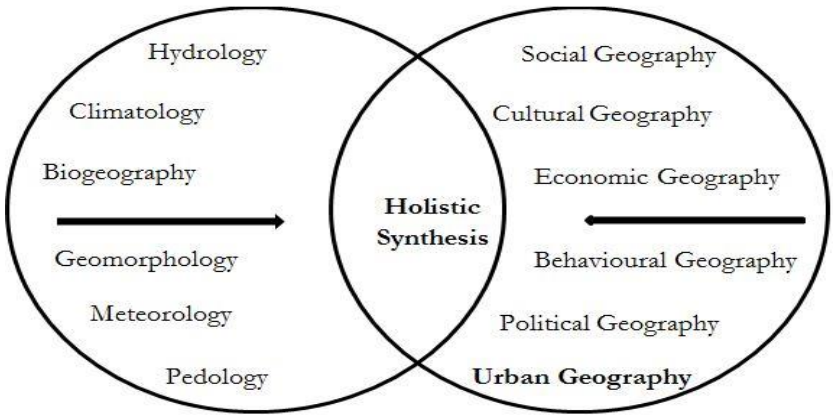


Figure 2.1 Sub-disciplines of physical (left) and human (right) geography(Source: Pidwirny & Jones , 2009)

The case study in this research focuses on urban geography fieldwork. This sub-discipline of human geography often deals with the study of cities in relation to their geographical environment (Sharma, 2015). This study will be carried out using interactive mapping in geography fieldwork with the aim of discovering whether it will improve the students' geographical understanding or not.

Fieldwork execution can be divided into three main stages namely: preparation stage, fieldwork stage, and follow-up stage. The preparation stage involves reviewing the fieldwork objectives, proper task distribution, ensuring proper understanding of individual roles etc. (Nefzaoui et al., 2007). Another important aspect of fieldwork preparation is an initial site visit in order to get acquainted with the fieldwork area before commencement of actual fieldwork (Lambert & Balderstone, 2010); the actual-fieldwork stage involves actual field visits to carry out direct observation of nature through various activities; and finally the follow-up stage involves analysis and interpretation of the fieldwork results, report writing etc.

2.2.2. Purpose and learning objective of geography fieldwork

Various kinds of fieldwork exists, one of which is geography fieldwork in education. Next to this, there are other kinds of fieldwork. Maskall & Stokes (2008), lists other kinds of fieldwork in the environmental and natural sciences to include rocks description on the field, geological mapping, sampling biophysical characteristics of the landscape, surveying human behaviour and perception etc. The overall purpose and learning objective of geography fieldwork in education is to increase the participants' understanding of the geography of an unknown area. This view is shared by many authors and researchers in the past. Israel (2012), described geography fieldwork as a cognitive process through which geographic knowledge and skills are acquired. Stoltman & Fraser (2000), gave two main goals of geography fieldwork. First is that students have a better understanding of geographic concepts by having a direct tactile experience with reality and, secondly, that they develop skills in observation, research techniques, as well as in the use of specialized equipment such as GPS devices. This out-of-classroom experience enables them to interact with their environment and relate what they learnt in class with real examples in the field in order to understand them better.

At the University of Wolverhampton, a research which involved students studying environmental sciences was carried out to ascertain whether they find fieldwork a valuable way of learning about the environment (Besenyei et. al., 2004). At the end it was discovered the students felt the main benefits of fieldwork were as follows:

- Boosting understanding of the environment
- Puts theory into practice
- "Hands-on" experience
- Enhanced confidence

• Learning and applying new techniques
• Learning to work in groups
• Opportunity to visit new places

In Table 2.1 below, the Royal Geographical society (2009) highlights a broad range of purposes which geography fieldwork may have. Out of this broad range of purposes, this research focuses on the conceptual purpose. It can be seen from the table that the conceptual geographical fieldwork aim is to develop knowledge and understanding of geographical processes, landforms, issues. Similarly, this research will try to investigate the role of interactive mapping in geography fieldwork for improving geographical understanding.

Broad educational purpose	**Geographical fieldwork aim**	Outcomes for learners
Conceptual	Developing knowledge and understanding of geographical processes, landforms, issues	• Improved academic performance • A platform for higher order learning.
Skills related	Proficiency in data acquisition, presentation and analysis.	• Development of skills in different environments • The capacity to handle anxiety.
Creative	Creating awareness to and appreciation of man-made and natural environments	• Influence and advanced motivation. • Encourage resourcefulness
Values related	Appreciation and care of the environment	• Expansion of environment administrators
Social and personal development	Personal, learning and thinking skills	• Active learning for young people. • Freedom to take risk. • Improved attitudes to learning.

Table 2.1: Aims of carrying out geography fieldwork (Source : Royal Geographical society, 2009)

2.3. Understanding the geography of an urban area

2.3.1. Definition of urban geography

According to Dìlǐ (2009), "Urban geography addresses the development of cities – from their origins and organizational principles to their evolving infrastructures and policies" (p. 2363). Urban geography can be approached in two basic ways: firstly, the way cities are distributed spatially and linked together, this is referred to as *the system of cities*; and secondly, the study of the way a city works, referred to as *the system within a city* (Brightside, 2013). Urban geography tries to demystify the socio-spatial differences as well as affinity between different cities (Pacione, 2009).

Hartshorn (1992) summarized the important elements of urban geography as in Table 2.2. Out of all the elements listed in Table 2.2, this research would try to see if mapping activities during geography fieldwork would help the student to have a better understanding of the following: transportation, major landmarks, cultural image of the city, regions/land use categories and typomorphology of the city.

Elements of Urban geography	Components
Geography of sale and retail outlets and services	1. Location of small and large retail outlets as well as their services. 2. Isolated convenience stores 3. Neighbourhood business centres
Transportation - Characteristics of road network structure of the city	1. Nodes 2. Traffic light points 3. Rail tracks distribution
Structure and distribution of population	1. Related to social and economic activities
Housing pattern in the city	Linear or cluster etc
Classification of building forms in the city	1. Two dimensional – distribution of buildings within the town. 2. Three dimensional analyses -by structure, style etc.
Major landmarks	Cues to way-finding and understanding the city
Cultural image of the city	1. History of the city 2. Social meaning of the city 3. Function of the city
Regions/land use categories	1. Residential 2. Transportation space 3. Commercial 4. Industrial, agricultural etc. 5. Public land 6. Car parks 7. Undeveloped 8. Public facilities
Typomorphology of the city	Explaining how the built environment evolves by a methodical distribution of the elements which structure the physical form of cities over time.

Table 2.2: Elements of Urban Geography (Source: Hartshorn, 1992)

2.3.2. How to measure the understanding of the geography of an urban area

In order to find out if geographic understanding changes after interactive mapping, it is important to look at how the understanding of the geography of an urban area can be measured. Bennetts (2005) illustrates the meaning of "understanding" using Figure 2.2 below. He defined understanding as a product of experiences, ideas and mental processes, and the relationship between them.

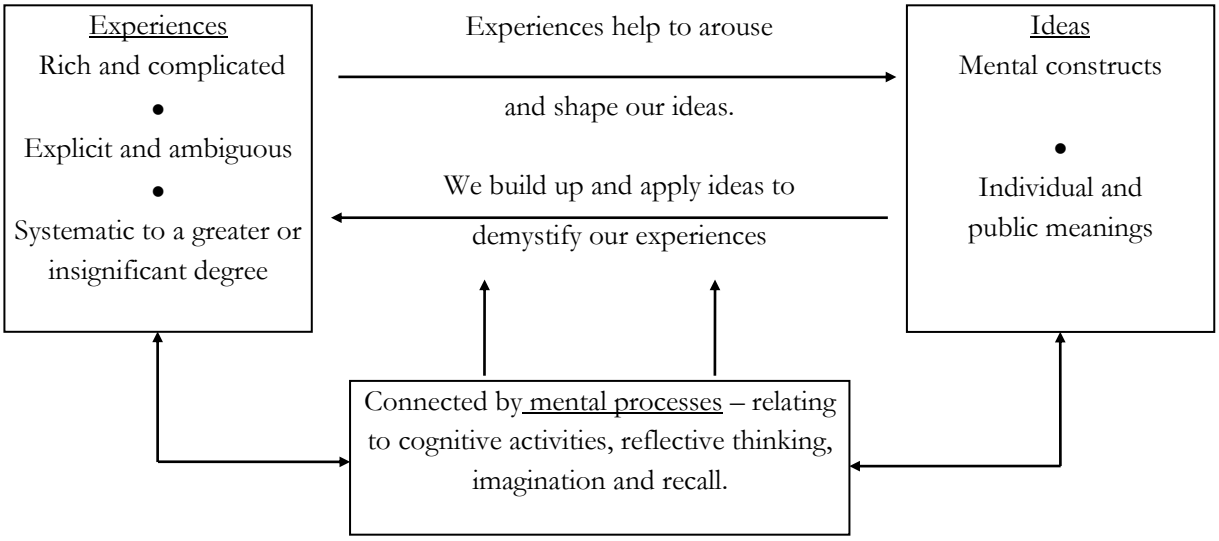


Figure 2.2: Meaning of understanding (Source: Bennetts, 2005)

Measurement of geographical understanding can be described as being fuzzy. This is because it involves the working of our senses when we are exposed to information about a place or physically visit such places. Also, different authors have suggested that geography has diverse sub-disciplines which evolved over time (egs. Benko & Strohmayer, 2014; Holt-Jensen, 2009). Geographical understanding can be understood differently when applied to the different sub-disciplines. This research focuses on urban geography which is a sub-discipline of human geography (Pidwirny & Jones, 2009). The major elements of urban geography were earlier discussed in Table 2.2. Measuring the understanding of the geography of an urban area would therefore mean measuring the student's understanding of some of these elements. In the case study selected for this research (see chapter 4), the urban geography of the study area (part of Enschede, the Netherlands) will be studied with respect to the textile industry collapse. The study will be carried out by looking at some of the elements of urban geography as listed in Table 2.2, such as transportation, major landmarks, cultural image of the city, regions/land use categories and typomorphology of the city. Students are expected to learn about the changes in the urban landscape which have been caused by the collapse of the textile industry. Their knowledge of the old remnants as well as relatively new developments in the area would be assessed to see whether this knowledge and the geographical understanding increase through mapping activities during fieldwork.

In some literature, geographical knowledge and understanding is encompassed in the term "environmental cognition". According to Downs & Stea (1973) environmental cognition is a summation of perceptions, preferences, memories as well as other psychological factors. Environmental cognition can also be defined as the study of the subjective information, images, impressions, and beliefs that people have of the environment as well as the way in which these concepts arise from experience (Moore & Golledge, 1976). Environmental cognition can be expressed through cognitive mapping. Cognitive mapping can be defined as the portrayal of spatial relations or geometric information (Bermudez, 2005). Techniques in cognitive mapping include: - surveys, interviews, freely drawn maps, oriented recall map drawing, data collection based on existing maps and images (Letenyei, 2005). The application of these techniques before, during and after geography fieldwork can help in determining the effects of the fieldwork on geographic understanding.

While carrying out a research on how people absorb information of the city, Lynch (1960), concocted the word "imageability" or "legibility" to describe a quality in physical objects which evokes a strong image in an observer. At the end, he concluded that the observers' understanding of their surroundings could be predicted in two ways namely: - physical form and cultural image. The physical form according to him can be seen by mental maps which they form with five elements namely: - paths (streets, trails, other channels); edges (boundaries such as walls, buildings etc); districts (relatively large sections); nodes (intersections, loci); and landmarks (identifiable reference points). The cultural image is about the social meaning, function or history of the city.

2.3.3. Mental maps and geographic understanding

Mental mapping is not new in geography (Soini, 2001). Mental maps have been operationalized using various techniques which mainly include sketch maps, route descriptions and distance estimates (Foreman and Gillet, 1997). According to Rosenberg (2005), a person's perception of the world is known as a mental map. He went further to state that this can be explored by asking for directions to a landmark, asking someone to draw a sketch map of an area, or by asking a person to name as many places as possible in a short period of time. Mental maps express our knowledge of spaces and places we have visited or learned about (Bell & Jennifer, 2011). This expression comes in the form of maps drawn by free hand and they differ among individuals (Tuan, 1975). Kuipers (1982) opined that a mental map portrays the spatial knowledge and spatial understanding in the memory of human beings. Five major geography themes, namely: Location, Place, Human-Environment Interaction, Region and Movement can be expressed in mental maps (Bowman, 2005). Different techniques displayed by humans often represent different aspects of a person's understanding of a place. Topological and metrical aspects are revealed through sketch maps; spatial knowledge is revealed through route descriptions, and knowledge of metrical information is expressed through distance estimates (Els, Davy, & Geert, 2006).

2.4. Mapping tools during fieldwork

2.4.1. Mapping tools used during fieldwork

In the past, cartographic tools used by students included field sketches (maps drawn with paper maps as a base), paper posters etc. (Kneale, 2013). Others are aerial photographs and remotely sensed imagery (Stoltman & Fraser, 2000). Nowadays, digital resources including digital maps and mapping tools make fieldwork a lot more interesting. According to Connors et. al., (2012), the recent proliferation of geospatial technologies, including web-based mapping tools, Global Positioning Systems (GPS), and smart phones, is transforming the collection, representation, distribution, and use of spatial information. In addition, technologies such as Google Maps (URL 2), MapQuest (URL 4), Multimap (URL 5) can be used to support fieldwork (Holmes, 2014). These digital technologies are consumed using mapping aids such as smart phones, iPads, Digital Navigation Systems etc. In addition, mapping software such as ArcGIS (URL 6), AutoCAD (URL 7), ILWIS (URL 8) are also used by students to make their own maps and show what they want as it relates to the fieldwork.

Different mapping resources and tools are being used during different fieldwork stages. For example, during the preparation stage, maps and photographs can be used to introduce students to the fieldwork area before commencement of the actual fieldwork; Digital technologies such as geographical information systems (GIS), global positioning system (GPS), and remote sensing (RS) help to enhance the actual-fieldwork stage ("RGS Field Techniques: GISci Manual," 2013); while mapping tools such as ArcGIS, AutoCAD, ILWIS can be used in the follow-up stage for processing the geo-spatial data acquired during the actual fieldwork.

2.4.2. Usability of mapping tools

During geography fieldwork involving mapping tools, the usability of such tools may have an impact on the activities performed by the students. This view was opined by Tversky et al., (2002) who stated that carefully designed and appropriate graphics which correspond to the conveyed contents facilitates comprehension, learning, memory, communication and inference. Torguson (1997) examined the relationship between the subjective reactions of map users and the amount of geographic information communicated from the maps in an educational "laboratory" setting. He argued that when it comes to animated and virtual map environments, the interface becomes a significant factor in using such maps.

With the advancement in technology, digital devices with GIS and mapping software allows easy collection of a wide range of data during fieldwork, storage of such data in databases and with this data, updating of digital maps in real time (Whitmeyer et. al., 2009). According to (Sing, 2003) most of these digital devices have interfaces which are user-friendly and can be customised based on the concern of the user. So far, the usability of these tools in terms of helping to improve geographical understanding has not been done before now.

2.4.3. OpenStreetMap

This research involves interactive mapping activities in geography fieldwork. As such, maps would be very useful throughout the entire research. Nowadays, maps are produced from geospatial data collected through crowd sourcing by volunteers(Maxwell, 2014). This is a bottom-up approach rather than the top-down approach in the past when geospatial data collection was only done by trained professionals (Howe, 2009). One major example of VGI (Volunteered Geographic Information) is OpenStreetMap. It is readily available and freely accessible (under the Open Database License) to all. The geospatial data is contributed voluntarily by a rapidly growing population of over 1.8 million registered OpenStreetMap contributors by using various mapping tools such as GPS, aerial photographs, digital cameras etc. ("OpenStreetMap.org - OpenStreetMap Wiki," 2014).

The mapping activity in this research would involve the use of both paper prints of OpenStreetMap as well as a digital device equipped with mapping software with OpenStreetMap as basemap. According to Haklay & Weber (2008) many software developers are busy developing software tools which would make OpenStreetMap data available for use by different application domains, software platforms, and hardware devices. The software used in this research is Locus mapping application developed by Asamm software (Locusmap, 2014).

2.5. Conclusion

In this chapter, fieldwork has been defined as the ideal way in which geography can be put into practice while renewing and deepening our direct experience. There are different aspects of fieldwork one of which is geography fieldwork meant for educational purposes. The overall purpose and learning objective of geography fieldwork is to increase the participants' understanding of the geography of an unknown area. This geographic understanding can be measured using mental maps. Mental maps have been operationalized using various techniques such as sketch maps. Various mapping tools are used before, during and after geography fieldwork. The usability of these tools may have an impact on activities carried out during geography fieldwork. In the next chapter I would be discussing the various techniques and tools to be used in the different stages of my research in order to answer my research questions.

3. GENERAL METHODOLOGY

3.1. Introduction

In the previous chapter, I wrote on the definition and different types of geography fieldwork, the educational objectives of fieldwork, the measurement of the understanding of the geography of an area and mapping tools used in geography fieldwork. I would then try to discuss some user research techniques used in geography fieldwork which I also intend to use in the course of my research.

3.2. User research techniques in geography fieldwork

A number of user research techniques can be used in human geography fieldwork to acquire useful data for analysis. Such techniques include: - online surveys, mental mapping, think aloud recordings, video observations, and prompts. As this research deals with geographical understanding, all the other techniques are centered round mental mapping. This is because a mental map is a key to decipher the way people understand their surroundings (Warf, 2006). In the following sections, the application of these techniques is discussed separately to justify their selection for use in this research.

3.2.1. Online survey to establish the background of test persons

Nowadays, acquisition of relevant data about individuals is facilitated by the proliferation of internet services (Reynolds et. al., 2006). This can be done using different online survey platforms. Researchers now have access to a large number of tools for online survey (Hooley et. al., 2012). Online surveys can be sent out via emails which inform the participants about the purpose of the survey. This can help to improve the rate of feedback on the survey (Porter & Whitcomb, 2003). The contents of the online survey would depend on the nature of information required for the research. Some of the survey tools available online are free (Bhaskaran & LeClaire, 2010). An example of a prominent free online survey tools is Survey Monkey (URL 9).

3.2.2. Mental mapping

A mental map is the way a person perceives the world. It is an internal map which an individual has about their world (Rosenberg, 2005). Another definition of a mental map by (Sarre, 1972) is "a model of the environment which is built up over time in the individual's brain". According to Letenyei (2005), "when a researcher does mental mapping, he is interested in mapping maps, that is collecting and interpreting maps in our minds". He went further to list the data collection techniques in cognitive mapping to include: - surveys, interviews, freely drawn maps, oriented recall map drawing, data collection based on existing maps and images.

Mental mapping has been a major source of primary data collection in the past (e.g. J Wheeldon, 2011; JP Wheeldon & Faubert, 2009; Burgess-Allen & Owen-Smith, 2010). According to Blades (1990), drawing of mental maps is frequently used to express an individual's environmental knowledge. He went further to

state that most of the studies in the past only collected one map from each subject but a subject might produce different maps when asked to repeat the map after some days. Graham (1976), states that an individual's mental image differs after a week or even a day from his first attempt. Bowman (2005), also states that mental maps are based on a person's perceptions and experiences.

From the foregoing, it can be seen that an individuals' understanding of an area can be expressed through mental maps. If a person has no interaction or information about an area, he may not be able to develop a mental map of the area. Also, a person who visits or gathers information about an area (e.g. through mapping) is expected to have a revised or updated mental map.

3.2.3. Think aloud method

The think aloud method was first introduced by psychologists around 1920 and is still used today as an important research tool to explore human thoughts (Clark, 1999). This technique is said to be one of the most effective ways to assess the working memory (Olson et al., 1984). Through this method, a lot of information can be retrieved from test persons for analysis. Thinking aloud has little or no interference with the execution of the task (Ericsson & Simon, 1993). It involves the study of man's casual structure as well as events taking place in human consciousness (Someren et al., 1994).

When implementing the think aloud method, test persons are asked to say out whatever they are thinking when carrying out a task, as long as it does not affect their performance during the task. Their utterances would be recorded during the mental map drawing task as well as during the mapping exercise in the field. Their thoughts are later analyzed to extract useful information. In most cases however, test persons are always busy concentrating on the task and forget to think aloud. The instructor has to keep reminding them to do that at different intervals. To avoid a total loss in information extraction, the thinking aloud process can be combined with prompting the test persons at different intervals

According to (Nielsen, 2012), the method has the following advantages: - It's easy to learn; It's cheap because no special equipment is needed; It can be used for any type of test and this makes it flexible; Data would always be extracted no matter how poor the experiment is set-up. He also listed the disadvantages of the method to include: - filtering of statements by those who want to be seen as being smart and as such wouldn't speak monotonously; and in unnatural situations, people would feel uncomfortable to keep talking as they would be seen as being awful.

3.2.4. Video observation

Video recordings are a useful method of secondary data collection. Footages from video recordings can sometimes replace written records (Laurier & Brown, 2011). This method gives very useful documents for research in ethnography (Geertz, 1973). Videos have both visual and audio components and are thereby operating on two out of the five senses at the same time (Jarvie, 1987). Garrett (2010), argues that video

analysis has the potential to enhance cultural understanding in geography and that it is an important component of contemporary fieldwork. Jackson, (1974) opines that videos reflect man's awareness and serves as an avenue of perception into feelings and thoughts. Recorded videos are raw materials which can be transcribed to obtain direct quotes (Barbash & Taylor, 1997).

While drawing mental maps and carrying out the mapping tasks in the field, test person's actions can be recorded using a video camera. This would be later reviewed and analysed as part of their overall performance. Video recording is used because the behaviour of each participant as well as their interaction with the mapping tool would give insights into his/her performance. The video also records the participants' face expressions as well as what they focus on at every point in time. Videos are complemented using other methods which provide further details (Scriven, 2013). Such methods include notes taken on the field which can later be used in analysing the videos (Simpson, 2011). Apart from all the benefits of video observations discussed here, one major demerit of the video observation technique is the high cost of video recorders. Researchers especially students' may not be able to afford a good quality video recorder (Lindsay, 1997).

3.2.5. Prompts and questioning

While taking part in any given tasks, participants can be interrupted at different intervals by prompts and questions. This is useful because different participant's utterances may vary in quantity and quality (Charters, 2003). This includes asking them to say out what they are doing and in some cases state why they had to do what they did. Use of prompts helps in exposing some key knowledge areas which may be useful in analyzing the participant's performance and making inferences. Unstructured interviews generates greater data breadth than other types (Fontana & Frey, 2000). The participant is compelled to give answers immediately rather than taking time to think over questions or skip some of them. However, the use of prompts has the demerit of prolonging the time used in solving a given task (Chi et al., 1989).

3.3. Conclusion

In my research, I intend to make use of all the user research techniques discussed above. The mental mapping will be done before and after the mapping activity on the field, video observations will be used during the mental map drawing as well as during the fieldwork. Think-aloud will also be used during the mental map drawing and in the field it will be combined with prompts and questioning. The implementation of the techniques is further explained in the next chapter.

4. USER TEST SET UP

4.1. Introduction

In the previous chapter, I looked at some user research techniques used in geography fieldwork. I would then try to set up a geography fieldwork in which test persons would take part in mapping activities using both paper and digital maps. The case study is introduced and selection of the case study area is justified. The mapping activity in this research is then discussed in relation with my research objectives. Thereafter, the different tools used during the mapping activities and their application are also discussed. I also discuss the organisational aspects of the mapping activity as well as the hardware and software used.

4.2. The case study in this research

4.2.1. General introduction to the case study

As stated in section 1.3.1, the main objective of this research is to investigate the usability of interactive mapping in increasing the understanding of the geography of an area during fieldwork. In order to investigate geographical understanding, I had to set-up the case study in an area where the important elements of urban geography listed in Table 2.2 are visible. I initially considered the important elements of the structure of the entire city of Enschede, the Netherlands before selecting a smaller part of the city as a case study area.

The structure of Enschede was studied with focus on the textile industry collapse. The city of Enschede was once a main producer of textile but in the 1960's, the industry came to a halt when the manufacturers left to the far east due to cheap labour ("The history of Enschede," 2005). While discussing the collapse of the textile industry, Mommas & Boom (2010) stated that the transformation of a city such as Enschede from an industrial to a post-industrial city is symbolized by transformations in the city's morphology and demography and that the city eventually gains a new profile after the transformation. This research is focused on a part of the city whose urban landscape has been affected by the textile industry collapse.

The theme of the fieldwork was "Examining the effects of the textile industry collapse on the geography of part of Enschede". A fieldwork involving mapping activities was organised to expose test persons to the urban landscape of the area to show them what is still visible from the textile industry and the relatively new developments in the area. Using the user research techniques discussed in chapter 3, the test persons' geographical understanding of the case study area was measured before and after the fieldwork to see whether it improved or not. During the mapping activities, both digital and paper mapping groups were given maps of the case study area of which they were expected to enhance by adding reminders of the old industrial era and relatively new developments in the area. The digital mapping group had a Samsung tablet equipped with locus mapping software with the base map covering the study area, while

the paper mapping group had printed maps of the study area. The field mapping activity was preceded by a brief lecture meant to introduce test persons to the case study area.

4.2.2. The case study area

As stated in section 4.2.1, the urban landscape of the case study area still reflects the textile industry past of the city. Remnants of the industrial era can still be found in the area. This includes the Schuttersveld villa which belonged to a former textile tycoon, the old factory wall along Tubantiasingel, the bistro which was formerly a coach-house etc. Before taking part in the fieldwork, test persons had to individually take part in a brief lecture which I organised to introduce them to the history of the textile industry in Enschede as well as changes in the urban landscape after the textile industry had collapsed (Figure 4.1).

Figure 4.1: Pre-fieldwork lectures

Furthermore, they were also introduced to the case study area which still has some remnants of the textile industry as well as relatively new developments. The lecture was a scaffolding strategy to give the test persons a better understanding of the case study area and to foster a greater independence of the students throughout the mapping process. The introductory lecture was brief as the test persons were soon expected to discover that geographical understanding on the field replaces traditional lectures.

The case study area is around the ITC building and is verged red in Figure 4.2. Test persons were individually taken round the area along the verged route and also the U-shaped Fortuinstraat (verged yellow).

Figure 4.2: Aerial photograph showing the case study area (verged red) and Fortuinstraat (verged yellow)

The lecture began with a general introduction to the geography of Enschede as a whole followed by development and collapse of the textile industry. Students were shown old photographs (e.g. Figure 4.3) as well as old maps (e.g. Figure 4.4) of the city during the industrial era to expose them to what the city looked like in the past before the collapse of the textile industry. The lectures were concluded by showing them some remnants of the industrial era such as the rail tracks which was used to transport goods.

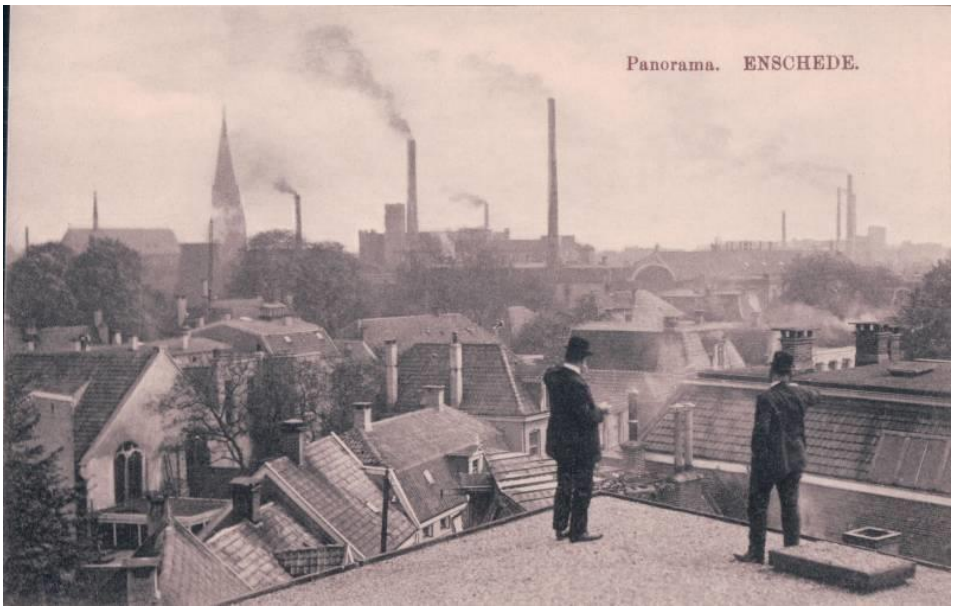


Figure 4.3: 1920 photograph of Enschede showing old textile factory chimneys (Source: Janssen, 2013)

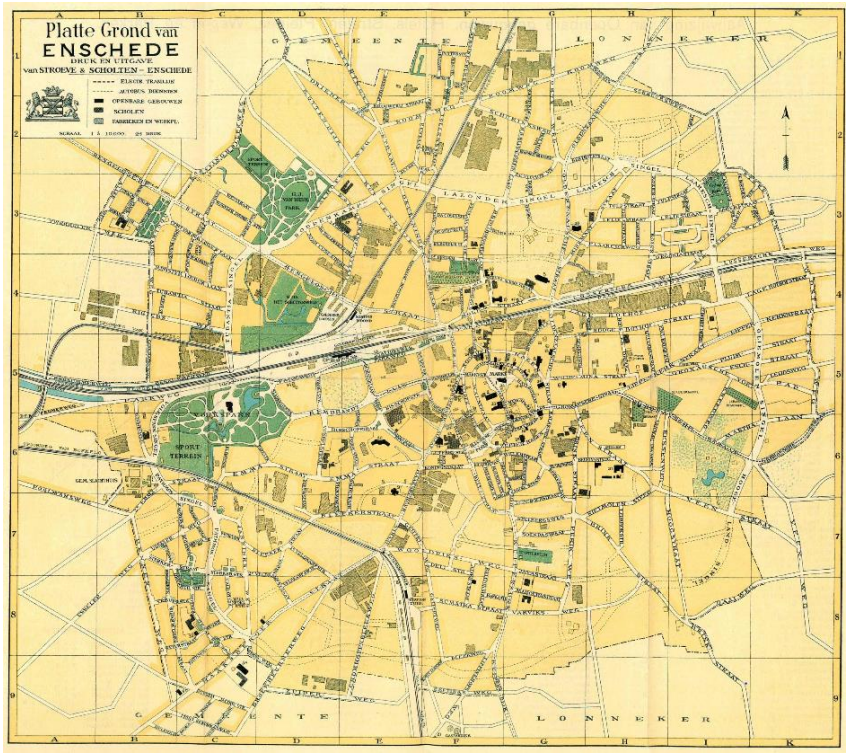


Figure 4.4: 1923 map of Enschede (Source: "Enschede in ansichten," 2014)

4.3. Mapping activity

During the fieldwork, both groups were involved in a comparable mapping activity aimed at exposing participants to the case study area in order to discover the remaining remnants of the textile industry as well as to see features that are relatively new in the area. They were asked to keep observing patterns and interrelationships in the area in order to see the changes in urban landscape after the textile industry collapsed. A set of fieldwork instructions was given to them (see Appendix 4a & 4b) to guide them on the tasks they were expected to perform. Test persons were taken round the area and asked to add some POIs from the remnants of the textile industry era as well as relatively new features which they discover during fieldwork (Figure 4.5). The group using Locus software added the POIs (point and line features) including their description to a specific folder created for each participant. Under the description, they were told to specify if the features were relatively new or old remnants. Those in the paper map group had a printed map of the area. They were asked to mark out the POIs and indicate the old and new features. Current land uses were also noted on the paper maps during fieldwork. At the beginning of the fieldwork, features in the digital and paper maps of the case study which was used by both groups were without labels. This was deliberate as the test persons were expected to find out the names, land uses and other details of features as it relates with the fieldwork theme. Most of the test persons in the digital group were able to use locus independently while others needed one form of assistance or the other. Some test persons wasted so much time in fixing their first point but subsequently improved and were able to fix points faster.

The aim of this mapping exercise was to see if exposing the test persons to the geography of the area would lead to an improvement of their geographical understanding of the area. One major tool used to test this improvement was asking the test persons to draw mental maps before and after the mapping exercise. The pre and post-fieldwork mental maps were accessed to see if there was an improvement or not. Other techniques used in this research included video observation of the mental mapping activity as well as the field mapping activities. The test persons were also asked to think aloud during execution of the entire tasks. Prompts and unstructured interviews were also used during the various activities.

Figure 4.5: Interactive mapping activity using paper map and tablet with Locus software

4.4. Selection and grouping of test persons

Test persons were selected from new students of the ITC Faculty of the University of Twente. It is believed the new students have little or no idea about the geography of the fieldwork area. A total of 12 students took part in the exercise. This number is assumed to be enough to do a qualitative research. Test persons were invited by asking them to fill an online survey (see Appendix 1) which took about 5 minutes to complete. The online survey was sent via email to a total of 153 new students of ITC including the MS.c, Masters and PhD students. Their responses to the online survey revealed their background and determined how they were grouped (see also Section 4.3.1). Questions revealed their mapping experiences, their computer literacy as well as their knowledge of locus mapping application.

Test persons were divided into two groups of 6 members each. This number is quite sufficient because according to Nielsen (2000), "as you add more and more users, you learn less and less because you will keep seeing the same things again and again and after the fifth user, you are wasting your time by

observing the same findings repeatedly but not learning much new". Also, this research does not aim at quantitative results which can be validated but intends to explore and discover new findings so as to be able to formulate recommendations for further research.

4.4.1. Outcome of online survey

Out of 153 invitations sent out, a total of 20 students responded (see Table 4.1 and Figures 4.6 to 4.15). From the respondents, I was able to get the needed 12 participants for both the digital mapping and paper mapping groups (6 in each group). These included 3 female and 9 male. As stated earlier in section 1.3.1, all the test persons in this research are graduate students currently studying geo-information science. As such, it is believed they have all been exposed to geographic concepts and mapping and could fit into any of the two groups. The responses which I got from the online survey also provided some basic information about the test persons as well as their background and mapping experience. (See Table 4.2 for responses from selected test persons).

It was discovered that all the test persons stay at the ITC hotel and have lived in Enschede for less than 6 months and as such I assume they may not be very familiar with the geography of the city. From the responses, test persons also had other similarities. For example, All the respondents said they had heard of OpenStreetMap in the past; none of them ever heard of the Locus mapping application; apart from TP 11, none of the test persons has been involved in any form of human geography fieldwork in the past; when I asked test persons if they were familiar with the geography of the area around ITC building, all the test persons said "YES they had either seen maps of the area or had been taught about the area in class"; when I asked test persons if they knew what industry Enschede was known for in the past, two respondents skipped the question, TP 7 said "it was known for farming" while the rest knew it was known for the textile industry.

In order to separate the students into digital and paper mapping groups, I asked if they prefer working with paper or digital maps, 14 students preferred working with digital maps while 6 of the students selected the option "any of the two". This 6 were placed in the paper map group. Also, test persons were asked if they ever made maps on their own, 5 out of the remaining 14 respondents said 'Yes, I made digital/interactive maps' while the 6 earlier selected for the paper map group either said 'No' or 'Yes, but static maps'. The 5 who said they have made digital/interactive maps were placed in the digital mapping group and to complete the group, the earliest respondent from the remaining 9 was selected. Participants in the digital mapping group were given the identity TP1 – TP6 while those in the paper mapping group were identified as TP 7 – TP 12.

After responding to the online survey, selected participants were invited for the actual mapping exercise and asked to pick a schedule through Doodle scheduling software. Those who failed to respond were sent reminders.

Online survey questions	**Answers by 20 respondents**
Q1. Where do you live in Enschede?	
- ITC hotel	20
- Stadweide apartments	0
Q2. How long have you lived in Enschede?	
- Less than 3 months	4
- 3-6 months	16
- Over 6 months	0
Q3. Did you attend any course(s) in human geography after secondary school?	
- Yes	5
- No	15
Q4. Have you been involved in any form of human geography fieldwork in the past?	
- Yes	5
- No	15
Q5. How often do you use paper maps in daily life?	
- Never	2
- Seldom	11
- Daily	1
- Several times per week	0
- Several times per month	2
- Several times per year	4
Q6. How often do you use digital maps in daily life?	
- Never	0
- Seldom	8
- Daily	6
- Several times per week	6
Q7. Do you prefer working with paper maps or digital maps?	
- Paper maps	0
- Digital maps	14
- Any of the two	6
Q8. Did you ever make maps yourself?	
- Yes, but only static maps on paper	4
- Yes, but only digital/interactive maps	6
- Yes, both static and digital interactive/dynamic maps	5
- No	5
Q9. Have you been involved in any human geography fieldwork in Enschede?	
- Yes	10
- No	10
Q10. Are you familiar with the geography of the area around ITC building?	
- Yes, I have maps of the area	13
- Yes, I have been taught about the area in class	4
- No, I only know of the ITC and Menzis buildings	3

- No, I have no idea	0
Q11. How often did you work with a tablet computer in the past two years?	
- Never	2
- Seldom	3
- Daily	12
- Weekly	3
- Monthly	0
Q12. Have you heard of OpenStreetMap?	
- Yes	20
- No	0
Q13. Have you used OpenStreetMap in the past?	
- Yes	11
- No	9
Q14. Have you heard of locus mapping software?	
- Yes	0
- No	9

Table 4.1: Responses to the online survey by all respondents

Test person	**Where do you live in Enschede?**	**How long have you lived in Enschede?**	**Have you been involved in any form of human geography fieldwork in the past?**	**For what industry was Enschede known for in the past?**
TP 1	ITC hotel	3 – 6 months	No	Textile
TP 2	ITC hotel	Less than 3 months	Yes	Textile
TP 3	ITC hotel	3 – 6 months	No	Textile
TP 4	ITC hotel	3 – 6 months	No	Textile
TP 5	ITC hotel	Less than 3 months	No	Textile
TP 6	ITC hotel	3 – 6 months	No	Skipped
TP 7	ITC hotel	3 – 6 months	No	Farming
TP 8	ITC hotel	3 – 6 months	No	Textile
TP 9	ITC hotel	3 – 6 months	No	Textile
TP 10	ITC hotel	3 – 6 months	No	Textile
TP 11	ITC hotel	3 – 6 months	Yes	Textile
TP 12	ITC hotel	3 – 6 months	No	skipped
Test person	**Have you heard of OpenStreetMap in the past?**	**Have you used OpenStreetMap in the past?**	**Are you familiar with the geography of the area around ITC building?**	**Have you heard of Locus mapping software?**
TP 1	Yes	No	Yes, I have seen maps of the area	No
TP 2	Yes	No	YES, I have seen maps of the area	Skipped
TP 3	Yes	No	YES, I have seen maps of the area	No

TP 4	Yes	Yes	YES, I have seen maps of the area	No
TP 5	Yes	Yes	YES, I have seen maps of the area	skipped
TP 6	Yes	No	YES, I have been taught about the area in class	No
TP 7	Yes	Yes	YES, I have been taught about the area in class	No
TP 8	Yes	Yes	YES, I have seen maps of the area	No
TP 9	Yes	No	YES, I have seen maps of the area	No
TP 10	Yes	Yes	YES, I have seen maps of the area	skipped
TP 11	Yes	Yes	YES, I have seen maps of the area	No
TP 12	Yes	No	YES, I have seen maps of the area	No

Test person	**Did you ever make maps yourself?**	**Do you see OpenStreetMap as an effective mapping tool? Give reasons**
TP 1	Yes, but only digital/ interactive maps	Yes, it serves as quick guide although it cannot be totally relied on
TP 2	Yes, but only digital/ interactive maps	Yes, serves as a base map
TP 3	No	Yes, it provide me with the information I needed
TP 4	Yes, but only digital/ interactive maps	Yes, reference tool
TP 5	Yes, but only digital/ interactive maps	Yes, it is more detailed
TP 6	YES, but only static maps on paper	Yes, Because is a collaborative project to create a free editable map of the world
TP 7	No	Yes, it helps very much in guiding travellers and visitors
TP 8	YES, both static and digital interactive/dynamic maps	Yes, Open Source and ease of acquiring and updating geographic data
TP 9	No	Skipped
TP 10	YES, both static and digital interactive/dynamic maps	Yes, it is Open source
TP 11	YES, both static and digital interactive/dynamic maps	Yes, It is detailed and also open source so it's easily accessible and convenient to use
TP 12	YES, but only static maps on paper	Skipped

Table 4.2: Responses by selected test persons to the online survey

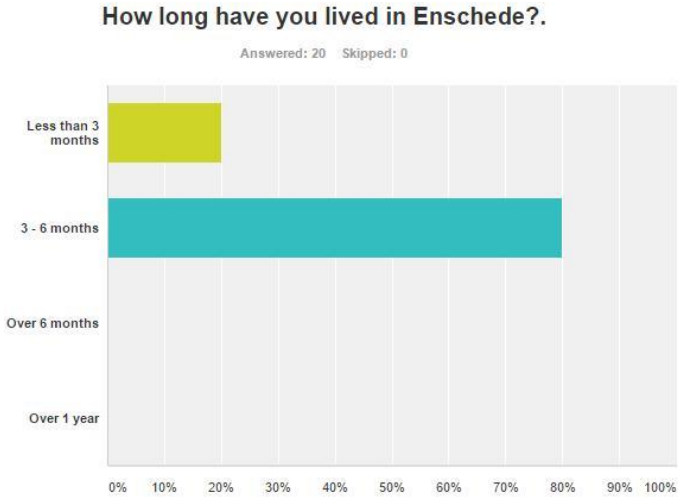


Figure 4.6: Responses to the question "How long have you lived in Enschede?"

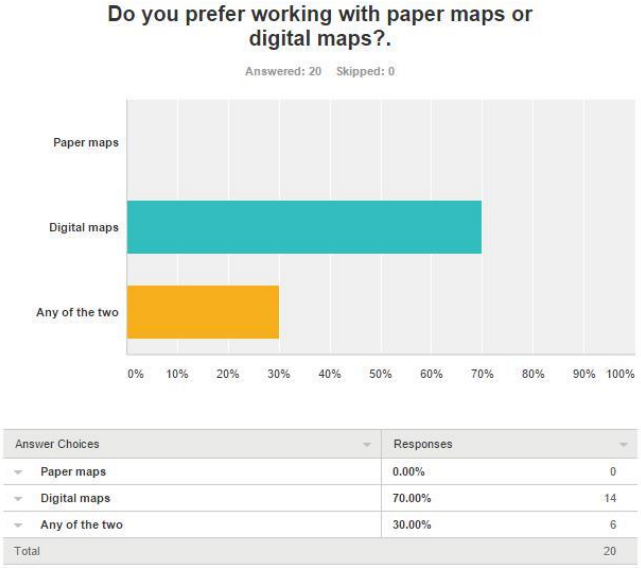


Figure 4.7: Responses to the question "Do you prefer working with paper maps or digital maps?"

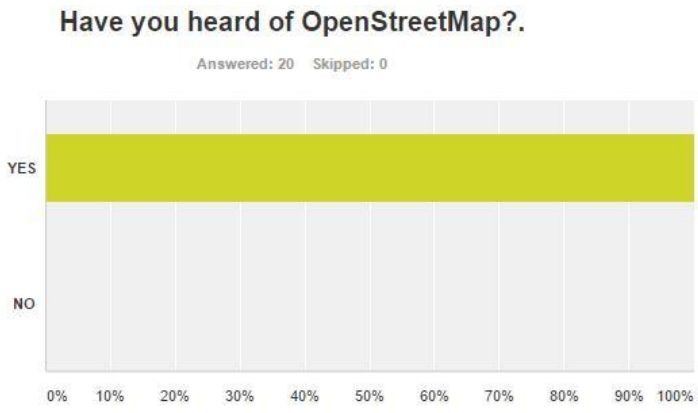


Figure 4.8: Responses to the question "Have you heard of OpenStreetMap?"

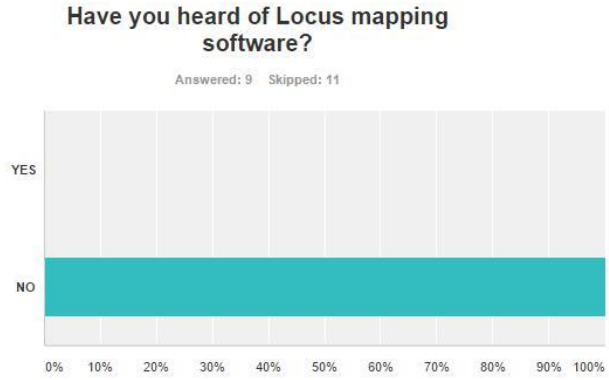
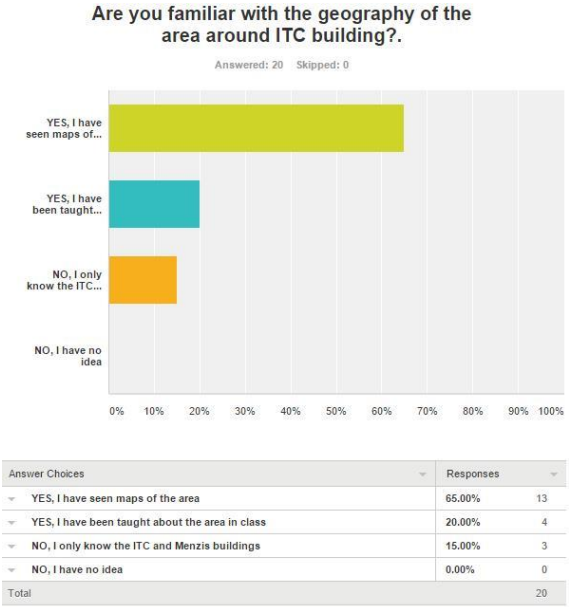
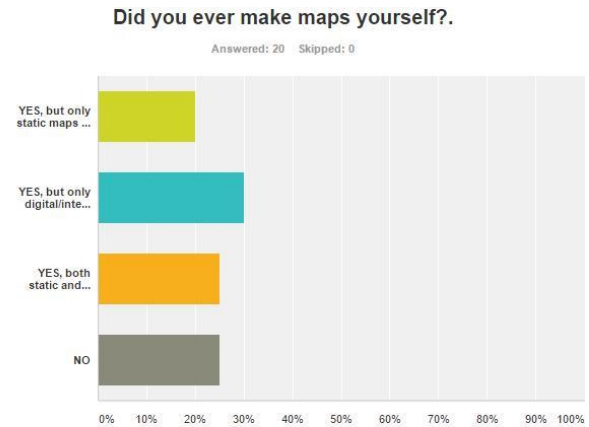


Figure 4.9: Responses to the question "Have you heard of Locus mapping software?"



Answer Choices	Responses	
YES, I have seen maps of the area	65.00%	13
YES, I have been taught about the area in class	20.00%	4
NO, I only know the ITC and Menzis buildings	15.00%	3
NO, I have no idea	0.00%	0
Total		20

Figure 4.10: Responses to the question "Are you familiar with the geography of the area around ITC building?"



Answer Choices	Responses	
YES, but only static maps on paper	20.00%	4
YES, but only digital/interactive maps	30.00%	6
YES, both static and digital interactive/dynamic maps	25.00%	5
NO	25.00%	5
Total		20

Figure 4.11: Responses to the question "Did you ever make maps yourself?"

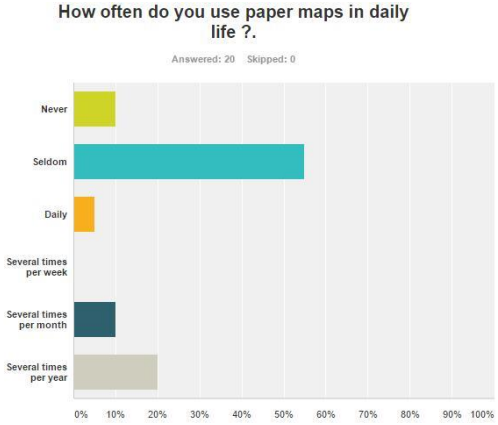


Figure 4.12: Responses to the question "How often do you use paper maps in daily life?"

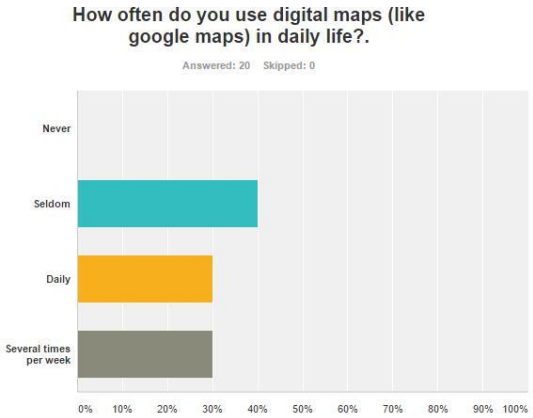


Figure 4.13: Responses to the question "How often do you use digital maps in daily life?"

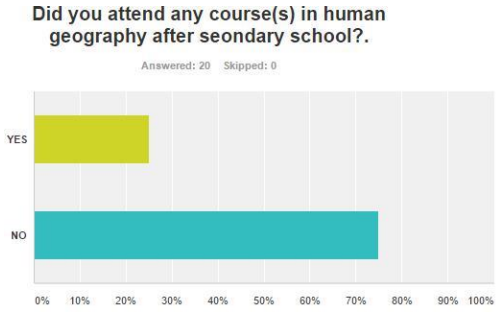


Figure 4.14: Responses to the question "Did you attend any course(s) in human geography after secondary school?"

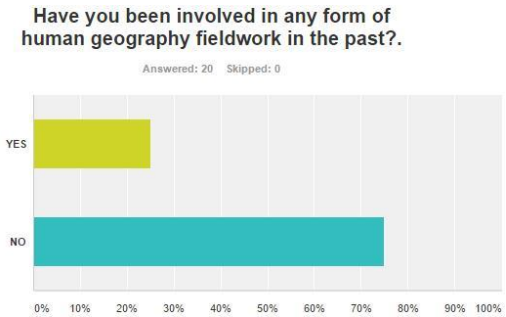


Figure 4.15: Responses to the question "Have you been involved in any form of human geography fieldwork in the past?"

4.5. Pilot test

Before commencement of the mapping activity, I carried out a pilot test with my advisor. The pilot testing was done to see how feasible the entire mapping exercise would be as well as to uncover potential challenges. I did the introductory lecture with her and afterwards introduced her to the Locus mapping application. She was given every other set of instructions prepared for the test persons before we proceeded to the field. At the end of the pilot test, I adjusted the number of features to be mapped and also made final decisions on the fieldwork route. I was also able to estimate the time it would take test persons to complete the entire mapping activity.

4.6. Mapping aids used

4.6.1. Locus mapping software tool

Locus is an easy-to-use mapping application developed for the Android platform by Asamm software. It is widely used for mapping and navigation (Locusmap, 2014). The application can be used by amateur mappers. During fieldwork, the active group mapped with Locus mapping software. This application was chosen because it uses a variety of background maps, one of which is OpenStreetMap. Also the application is user friendly and as such participants would not need much assistance while using it on the field. The application offers offline OpenStreetMap which can be downloaded from the store and used in the field without internet connection (Figure 4.16). Locus mapping software provides some interesting mapping tools which allow users to centre the map on their position, add POI's of different geometry (including their description) into various folders, export and import in various formats such as KML and GPX etc. It is believed that these mapping tools as well as the offline OpenStreetMap background would give the participants a better understanding of the geography of the case study area. Test persons in the active group were introduced to the use of Locus mapping software. A set of instructions was prepared and given to the test persons to aid them in the mapping task (see Appendix 2). After the introduction, they were asked to do a trial mapping of one feature on their own before the actual fieldwork commenced.

Figure 4.16: Locus mapping application

4.6.2. OpenStreetMap paper prints

Apart from the Locus mapping software used by the active group, the second group mapped using a print out of OpenStreetMap of the case study area. The map was fitted into a map template (see Figure 4.17) and printed out for use on the field.

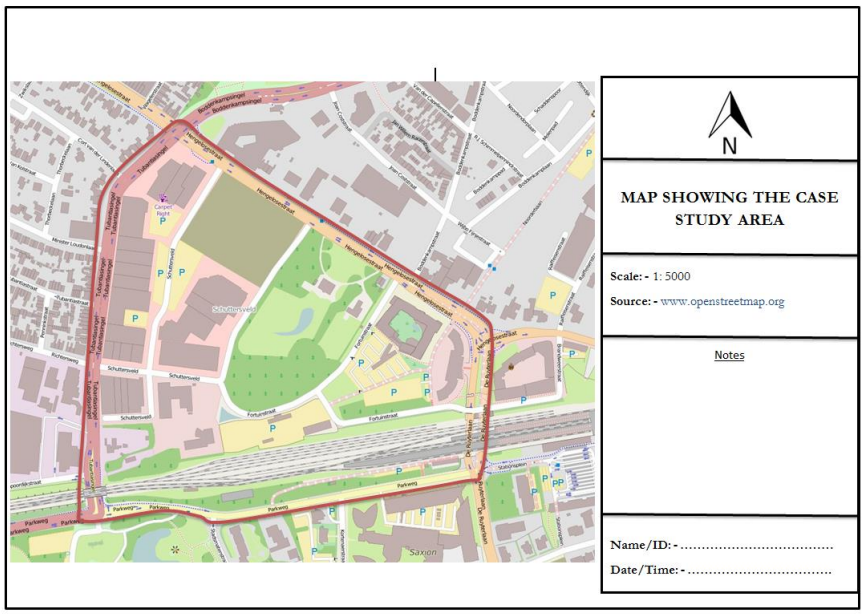


Figure 4.17: OpenStreetMap of the case study area used for fieldwork

4.7. Mental mapping

To measure peoples' understanding of the geography of an area, they were asked to draw mental maps just after the pre-field work lectures (before visiting the case study area) and immediately after returning from fieldwork. The mental maps produced can be described as a model of the geographical structure of the case study area. Both mental maps were compared to ascertain whether their geographical understanding has improved or not. This was done by accessing the key image elements namely: - paths, edges, districts, nodes and landmarks (Lynch, 1960) in relation to the remnants of the textile industry and new developments in the area. The mental map drawing task was videoed for later analysis. Test persons were also instructed to think-aloud while carrying out the task (Figure 4.18).

Test persons were presented with same instructions to draw both mental maps (see Appendix 3). They were given some time to go through the instructions before they began drawing. The mental map was to cover the case study area introduced to them during the introductory lectures. The instructions also gave a description of the area's coverage. Sufficient information was contained in the instructions to enable test persons carry out the task independently. They were told to draw the map without looking at any other map of the area. They were given a mental map drawing template to use for this task. The template had provision for the test person's name/ID and the date/time the map was made. The rest of the template was left completely blank.

Figure 4.18: Mental map drawing activity

On the mental maps, test persons were instructed to indicate important remnants of Enschede's textile history as well as relatively new features which have replaced old historical remnants. While drawing the mental maps, test persons were asked to use a pen or pencil and told that the map maybe just a rough sketch; as such no special training/instruction was needed. While carrying out the task, they were asked to think-aloud and those who forgot were reminded to do so. I tried as much as possible not to interfere during the task execution except when necessary, like when some test persons drew maps covering a different area, I had to remind them to concentrate on the area described in the instruction sheet.

4.8. Organisational aspects

Before inviting the test persons to take part in the mapping activity, I ensured that every necessary modality was put in place. I made prints of the pre and post-fieldwork mental map drawing templates, the introduction to locus mapping software, the fieldwork instructions for both groups, and copies of maps of the case study area (for the paper map group). I also ensured that the introductory lecture power point was ready. Participants took part individually in the test which lasted for about three weeks.

4.9. Hardware and software tools used

Hardware used in the course of this research included: -

- A Samsung Galaxy Tab 7.0 (7 inch TFT LCD with resolution of 1024 x 600 pixels)
- A Sony handy video camera for recording test persons actions when drawing mental maps and while carrying out the mapping tasks on the field.
- An HP laptop for pre-fieldwork lecture presentations.
- Projector for fieldwork lecture presentations

Software used included: -

- Locus mapping application
- Microsoft windows 8 operating system
- OpenStreetMap website for planning and downloading of paper maps of the case study area
- Adobe reader for viewing maps of the case study area
- Microsoft power point for pre-fieldwork lecture preparation and presentation
- Microsoft excel for preparing fieldwork schedule of test persons
- Microsoft word for preparing mental map instructions, introduction to Locus and thesis reports etc.
- Video editing software
- Google chrome browser

4.10. Conclusion

In this chapter, the overall set-up and execution of the mapping activity were discussed. Selection and grouping of test persons was done using their responses to an online survey. Test persons were divided into two groups of 6 each. Both groups took part in the mapping activity using paper maps and Locus mapping software. A pilot test was carried out before the actual mapping activities commenced. The overall performance in user tests was assessed using mental maps as well as recorded videos and the TPs think-aloud utterances. The results will be discussed in the next chapter.

5. RESULTS

5.1. Introduction

In the previous chapter, I discussed the overall set-up of the fieldwork involving mapping activities as well as the tools used. This chapter deals with the overall data gotten from the research. The data includes the outcome of the online survey, pre and post fieldwork mental maps, videos recordings of the mental mapping activities and fieldwork including voice recording from think-aloud sessions. I try to analyse the outcome of the data and also relate the outcome to the overall research objective and research questions.

5.2. Video recording including think-aloud and prompts

The mental mapping activities as well as the fieldwork were recorded using a video camera. I tried my best to ensure that all test persons were at ease to enable them to freely say out what they were doing and thinking. I also tried to assure them that their privacy would be respected and that I had no ulterior motive for the video apart from using it for my research. After each test, the recorded videos were downloaded from the video camera and stored in different folders created for each test person on a hard disk. All recorded videos were in good condition although some had little sound interference due to vehicular traffic. Most of the verbal utterances of test persons were quite ambiguous and as such only parts of the videos and audio recordings which I saw as being relevant to the research objectives were transcribed. After all, in a qualitative research, the number of interpretations depends on the number of researchers (Kvale, 1996). Also while carrying out the different tasks, I ensured the participants kept talking by prompting them at different intervals. By using prompts, a lot of useful information was gathered from test persons. In this way, they were also engaged in some form of unstructured interviews while performing the various tasks.

5.3. Outcome of the mental mapping activities

In this research, test persons produced two different mental maps, the first one just before the geography fieldwork which involved mapping, and the second one after the fieldwork. Despite being given the instruction sheets, some of the test persons still saw mental map drawing as a difficult task. However, all the participants were able to produce both mental maps (see Appendix 5.1 – 5.12). As stated in section 4.7, a mental map is a model of the geographical structure of the case study area. Some participants got the boundaries of the case study area correctly but had a wrong shape or orientation. Others, after drawing the boundaries, could only remember very few features in the area. All the participants were able to remember the ITC building and all except TP 7 and TP 11 were able to remember the Menzis building as well. This was expected as test persons are all students of ITC and Menzis is the building next to the ITC building. Also, most of the test persons remembered and labelled Hengelosestraat (the street where the ITC

building is located) although some were not able to spell it correctly. Some of the maps had topological displacements as features were wrongly placed.

The mental map drawing task was meant to test the test persons' knowledge of the geography of the area before and after the fieldwork. They were asked to reflect on the main theme of the fieldwork by indicating important remnants of Enschede's textile history as well as relatively new features, their current uses and to properly label the features. The mental mapping task was also videoed to record their thinking-aloud as well as other actions. No specific time limit was given for both mental maps drawing tasks. Test persons were given as much time as they needed to complete the task. During the pre-fieldwork mental mapping task, TP 6 used the least time of 1min: 01secs while TP 1 used the highest time of 11mins: 06secs. TP 1 wasted so much time because at some point he cancelled the entire map and started again. When he was asked why he did that, he said "I felt I drew the outline of the area wrongly". During the post-fieldwork mental mapping tasks, TP 6 again used the least amount of time of 02mins: 51 secs while TP 5 used the highest time of 12mins: 12secs. TP 5 spent so much time because he tried to make a very detailed and neat map rather than a rough sketch.

Apart from TP 2, all other participants spent more time in drawing the post-fieldwork mental map than they did during the pre-fieldwork mental maps. TP 2 spent more time on the pre-fieldwork mental map because he initially made a map starting from the ITC hotel, covering most parts of the city but later had to start all over again when his attention was drawn to that. Spending more time on the post-fieldwork mental maps was an indication that the test persons put in extra effort. Another reason they spent more time is that, while thinking-aloud, some test persons were now able to give more information about the area as well as its history. For example, TP 5 mentioned that the villa was owned by a textile tycoon and that the old factory site is now a shopping area.

At the end, all the participants had post-mental maps which were substantially more detailed than the pre-fieldwork mental maps (e.g. Figures 5.1 and 5.2). Also, Tables 5.1 and 5.2 show the features drawn and labelled by each test person in both pre and post fieldwork mental maps. The level of details is assumed to be a reflection of an individual's familiarity with the case study area before and after the fieldwork. Apart from general familiarity with the area, most of the features drawn and labelled indicated that after the fieldwork, the test persons later had an impression of the influence of the textile industry on the structure of the case study area. Although the participant's drew more detailed mental maps after the fieldwork, some of the maps had some technical errors. For instance, TP 5 drew the Schuttersveld villa outside the U-shaped Fortuinstraat in his post-fieldwork mental map.

Looking at the pre-fieldwork mental maps, most of the test persons drew the outline of the case study area wrongly (e.g. Figures 5.1 and 5.2). However, in the post-fieldwork mental drawing task, all test persons

apart from TP 3 were able to correctly draw the main outline of the case study area using a proper orientation.

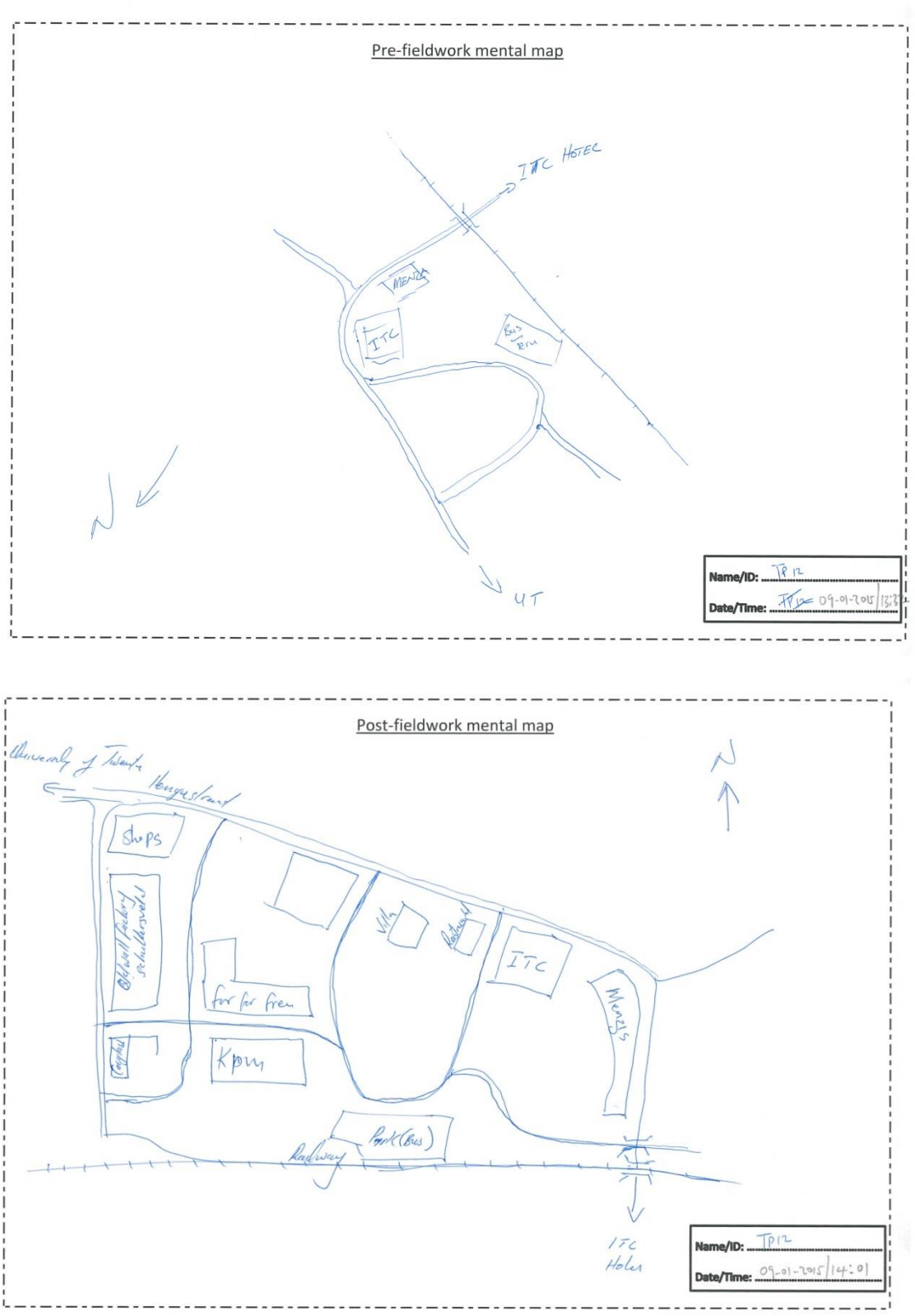


Figure 5.1: Pre and post-fieldwork mental maps of TP 12

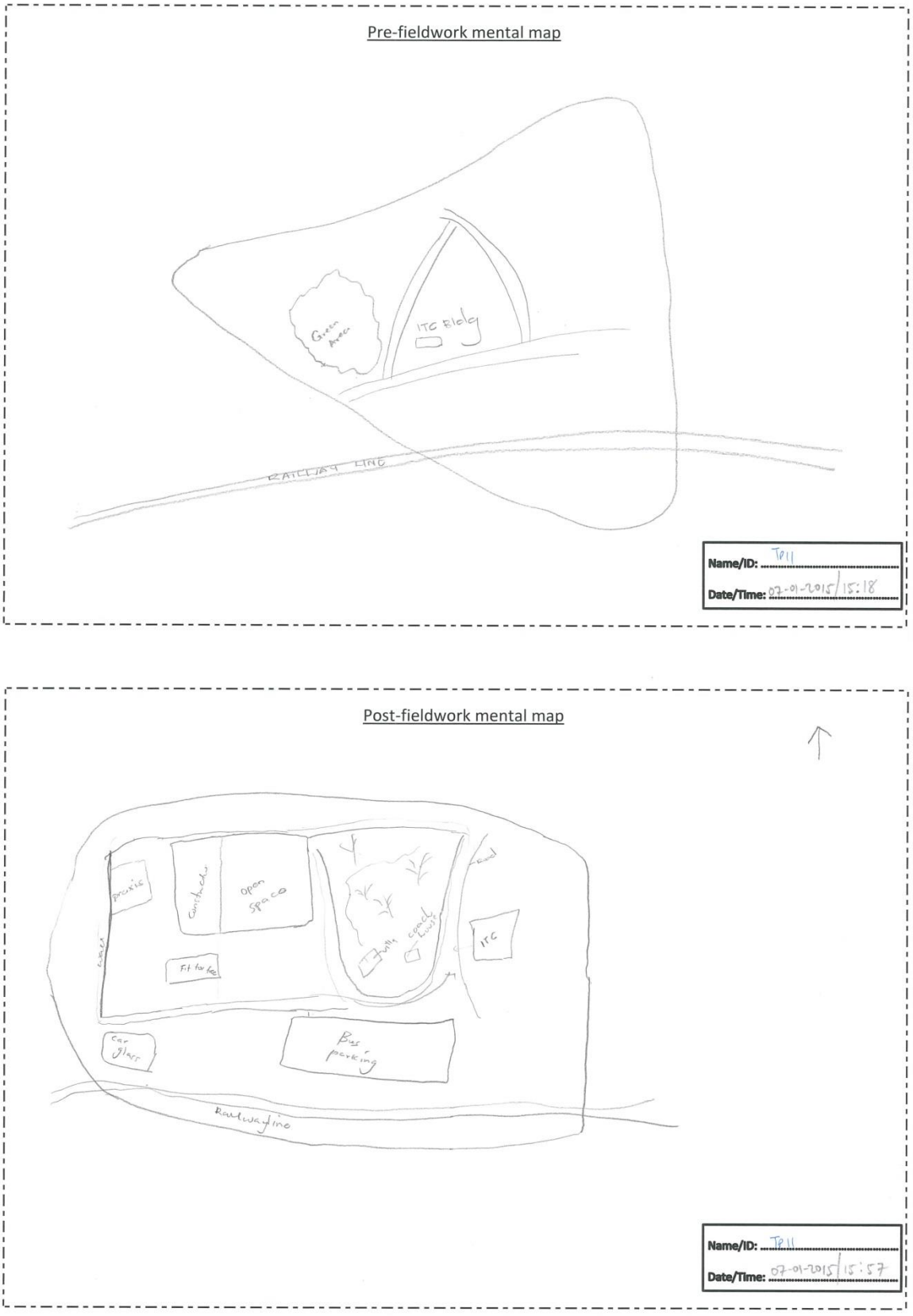


Figure 5.2: Pre and post fieldwork mental maps for TP 11

Feature	**TP1**	**TP2**	**TP3**	**TP4**	**TP5**	**TP6**	**TP7**	**TP8**	**TP9**	**TP10**	**TP11**	**TP12**
ITC building	+	+	+	+	+	+	+	+	+	+	+	+
Menzis building	+	+	+	+	+	+		+	+	+		+
Princesse tunnel	+	+		+	+			+	+			
Schuttersveld villa	+		+	+	+		+					
Coach-house										+		
Leen bakker shop												
Carpet right shop												
Praxis shop												
Car glass office												
KPN												
Fit for free												
Bus stalling												+
Railway line							+				+	
Hengelosestraat	+	+	+	+			+	+				
Ring road				+								
Parkweg												
Old textile factory wall												
ITC's parking lot										+		
Construction site										+		
Fortuinstraat										+		
Bus lane												
Schuttersveld road												
Open space (after villa)												
Total number of features	**5**	**4**	**4**	**6**	**4**	**2**	**4**	**4**	**3**	**6**	**2**	**3**

Table 5.1: Features drawn and labelled by each test person in the pre-fieldwork mental maps

Feature	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP9	TP10	TP11	TP12
ITC building	+	+	+	+	+	+	+	+	+	+	+	+
Menzis building	+	+	+	+	+	+	+	+	+	+		+
Tunnel				+	+			+	+			+
Schuttersveld villa		+	+	+	+	+		+	+	+	+	+
Coach-house (Bistro)	+	+	+	+				+	+		+	+
Leen bakker shop	+	+	+		+	+	+	+	+			+
Carpet right shop							+					+
Praxis shop		+				+			+		+	
Car glass office											+	+
KPN						+	+	+		+		+
Fit for free					+			+	+	+		+
Bus stalling	+		+		+	+	+	+	+	+	+	+
Railway tracks			+	+			+	+			+	+
Hengelosestraat	+	+	+				+	+		+		+
Ring road	+			+	+			+				
Parkweg	+				+			+		+		
Old textile factory wall	+	+	+	+	+	+	+	+	+	+	+	+
ITC's parking lot				+						+		
Construction site					+	+	+			+		
Fortuinstraat			+	+	+					+	+	+
Bus lane				+	+							
Schuttersveld road					+			+				+
Open space (after villa)										+	+	+
Total number of features	**9**	**8**	**10**	**11**	**14**	**9**	**10**	**15**	**10**	**13**	**10**	**17**

Table 5.2: Features drawn and labelled by each test person in the post-fieldwork mental maps

5.4. Understanding the Influence of the textile industry on the geography of the case study area

As stated earlier, the main task during fieldwork was to make a model of the geographical structure of the case study area and to reveal the influence of the textile industry on the structure. After the fieldwork, most test persons were able to construct a better model (mental map) than they did before the fieldwork. However, some of them drew some features which they were unable to label or they used general names such as shops or offices. The number of features included in the pre and post fieldwork mental maps as well as the labels of the features reveal the test persons' knowledge about the case study area and its history.

The pre-fieldwork mental maps showed that some test persons were unaware of the current land uses as well as the influence of the textile industry on the structure of the case study area. In the pre-fieldwork mental maps, the existing railway track was only drawn by 3 test persons but after the fieldwork 9 out of 12 test persons included the tracks in their post-fieldwork mental maps. Also, TP 5 labelled the old

Schuttersveld villa as 'white building' but after the fieldwork labelled it as 'Charles villa'; TP 9 initially labelled the premises of the Schutersveld villa as a park but after the fieldwork labelled it as 'villa'; TP 11 initially labelled the same area as 'green area' but after the fieldwork he was able to draw and label the 'villa' and 'coach house' (see Figure 5.2). TP 10 expressed that "I once passed behind the villa but only saw trees and never knew it was the back side of the villa"……also, "I never noticed the bus stalling and the fact that Menzis had a C-shape which I've seen from behind".

The old factory wall which is another important remnant of the textile industry era was left out by all the test persons in their pre-fieldwork mental maps. However, they all included the wall in their post-fieldwork mental maps. Also as seen from the post-fieldwork mental maps, TP 4, TP 7 and TP 8 indicated that there was an old factory just after the Schuttersveld villa.

When I mentioned to TP 10 that the villa was later sold to Van Heek, she immediately said that "the name is famous and that I read that he has a house in the centre". She also noted that "history shapes a city and that I was into conservation heritage courses in my country and love reading about the history of any place I visit newly". A look at the pre-fieldwork mental maps shows she had the most detailed one, perhaps because of her interest in the city's history. TP 9 stated that "during the core module I was only taught in class that they were textile industries which existed in the past" and also "I did a case study on the impact of industrialization on Enschede". He went further to state that "the mapping activity has opened my eyes and that I now know at least one factory site". TP 2, while drawing the post-fieldwork mental map, pointed out that "I now have a better understanding of the area after the fieldwork". He said the "ITC building is new" and mentioned that "I now know old remnants such as the villa, the coach house, the factory wall and that the fieldwork was an eye opener for me". TP 5, when thinking-aloud during the post-fieldwork mental map drawing, stated that "I now have a better view of what the area looks like and this is reflected in my new map". While drawing the maps, some test persons were able to indicate directions using arrows and descriptions. For example, most of them showed the direction to the ITC hotel.

5.5. Geography fieldwork involving mapping with two groups

With the aid of the OpenStreetMap background in Locus software as the printed paper maps, some of the test persons were able to identify the features which they were familiar with and they also discovered new features, thereby getting familiar with the overall geography of the area. Also while going round the case study area, the test persons were exposed to the old remnants of the textile industry and became interested in knowing more about the past. For example, TP 1, after seeing the old textile factory wall asked "if the wall had gone round the factory". Also, after going round the area, TP 1 was surprised at the size of the Schuttersveld villa premises, and pointed out that "the premises is quite large". After showing her the bus lane which was formerly a rail track, TP 3 asked "what happened to the rail tracks?" and I informed her it

must have been removed. TP 7 was curious about what happened to the former textile industries and asked "were the industries sold off at a certain time?"….I informed him that the industries moved to the Far East because of cheap labour. TP 7 also observed that "the case study area in the past had no provision for staff accommodation".

5.5.1. Comparing the digital and paper mapping groups

Test persons in the Locus mapping group used an average of 32min: 46secs to complete the fieldwork while the test persons in the paper map group used a lesser average time of 20mins:32secs. This was because the digital mapping group spent more time trying to use the Locus mapping application in the field. Some test persons got stuck at some point and asked for assistance while others found the software very easy to use (example TP 3). TP 4 was interrupted when he mistakenly clicked on one of the adverts running alongside the application. After a series of attempts to stop the interruption, I eventually had to restart the tablet before the interruptions ended. This took about 5 minutes to resolve and eventually TP 4 used the highest time of 38mins: 59 secs during fieldwork. Also, TP 5 at some point had a very faint screen and I had to restart the tablet before the screen was restored. I assisted when test persons got stuck to prevent them from being distracted from observing the urban landscape of the area which was the main aim of the fieldwork. A look at the post-fieldwork mental maps of the TPs affected by the technical issues show that there was still an improvement in their geographical understanding.

After the mapping activity in the field, it was discovered that test persons in the Locus mapping group added fewer POIs than those in the paper mapping group (e.g. Figure 5.3). As a matter of fact, some of the test persons in the digital mapping group only added the POIs listed in the fieldwork instruction while others added less POIs. However, test persons in the paper mapping group added more POIs than what was listed on the instruction sheets. This observation reflected in the post-fieldwork mental maps drawn by both groups. A look at the mental maps of test persons in both groups shows that test persons in the Locus mapping group only labelled features which they added with the aid of the device during fieldwork. However, those in the paper mapping group had more detailed post-fieldwork mental maps. Also, a look at Tables 5.1 and 5.2 shows a better overall improvement in the number of features drawn and labelled by those in the paper mapping group than those in the Locus mapping group.

Most of the test persons in the digital mapping group found it easy to locate their position at every point as this was shown to them during the introduction to the software. Also the GPS position indicator keeps changing as you move along with the application. This was even observed and pointed out by TP 3. She also mentioned that "OpenStreetMap was quite detailed and would go a long way in aiding people find directions". Members of the paper mapping group had more difficulties in identifying their location as there was no GPS indicator like the Locus mapping group had. These difficulties led to problems in route as well as feature identification.

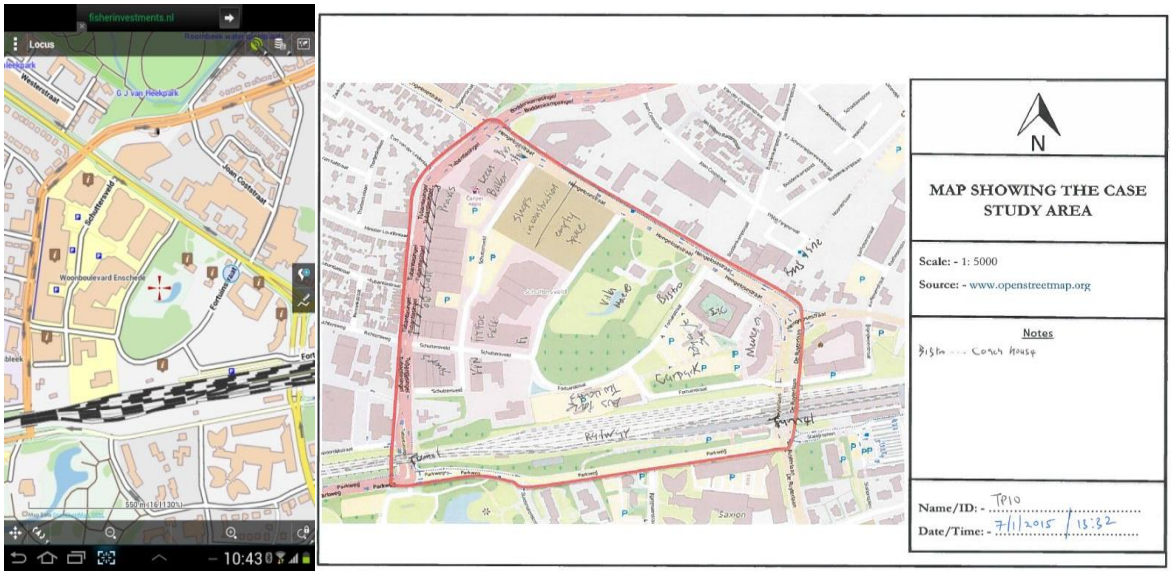


Figure 5.3: POIs added using Locus software (left) and paper map (right)

5.5.2. Map use and geographic understanding

The use of mapping tools during the fieldwork also made most of the test persons conversant with the case study area. At different intervals, I tried to ask test persons directions to see if they understood. Most of them got the directions correctly, some even explained the landscape of the area without being asked and others were able to explain the direction back to our starting point. After the fieldwork, I asked TP 8 if he understood the area better….He said "before the fieldwork I only saw a couple of buildings but during fieldwork, I saw more buildings and could memorize the whole route". Also I asked him if he still had questions about the geography of the area…..He responded by saying that "it is perfectly understandable and it is better because I had the map and went round to identify what was on the map". Also, TP 9, when asked if the map was useful, replied by stating that "I knew my way round with the help of the map and that I could match what I saw on the ground with what is on the map and finally that my knowledge of map reading has improved".

5.6. Conclusion

A lot of information can be extracted from the different materials obtained from this research. These include the outcome of the online survey results, the pre and post fieldwork mental maps, the video recordings which also contain the think-aloud protocols as well as the prompts/ unstructured interviews. I tried to look at certain dimensions of the data which are relevant to my research and also extracted some useful observations from them. Analysis of the mental maps produced by test persons showed an improvement in their geographical understanding. Also, comparison of the mental maps shows that test persons in the paper mapping group had a better improvement in geographical understanding than test persons in the Locus mapping group. Combining the mental maps with the other collected data show that the test persons' understanding of the case study area with relation to the theme of the fieldwork increased.

6. CONCLUSIONS

6.1. Conclusions

Mapping has always been an important part of geography learning. Different mapping techniques have been explored by geographers in the past. Nowadays geospatial technologies aid and have changed the way in which mapping is carried out. However, the main objective of mapping in geography fieldwork has remained the enhancement of a student's understanding of an area.

Interactive mapping has been used in the past during geography fieldwork (see Connors et. al., 2012; Holmes, 2014). However, in the past, there are no scientific reports indicating that fieldwork was carried out with test persons to study what effect interactive mapping would have on their understanding of the geography of an area. This would be the first attempt in geography. This research was carried out using actual test persons who happen to be graduate students. Their geographical understanding of the area was measured before and after the fieldwork.

As stated in the first chapter, the main objective was to find out the usability of interactive mapping to improve the understanding of the geography of an unknown area during fieldwork. To reach this objective, two sub-objectives were defined. These included developing an exercise on the use of mapping in geography fieldwork and determining the usability of this exercise with test persons. To support this research, a number of research questions were formulated at the beginning and have been addressed as follows: -

Question 1 - What is geography fieldwork?

In chapter 2, the definition of geography fieldwork was discussed in details. Fieldwork is a core part of geography learning and enhances the students' understanding of the subject. Fieldwork puts geography into practice by direct experience of the planet, life and cultures.

Question 2 - What are the purposes and learning objectives of geography fieldwork?

As stated in section 2.2.2, the overall purpose and learning objective of geography fieldwork addressed in this research project is to increase the understanding of the geography of an unknown area. This is achieved when students have an interaction with their environment and relate what they learnt in class with real examples in the field in order to understand them better.

Question 3 - How can a person's understanding of the geography of an area be measured?

In order to ascertain if a person's geographical understanding improves after interactive mapping, I tried to address the measurement of geographical understanding in section 2.3.2 and more

explicitly in section 3.2. Looking at the outcome of pre and post fieldwork mental maps, a persons' understanding of the geography of an area can be measured. The number of features included in the pre and post fieldwork mental maps as well as the labels of the features reveals the test persons' knowledge about the case study area. The pre-fieldwork mental maps showed that some test persons were unaware of the current land uses as well as the influence of the textile industry on the structure of the case study area but after the fieldwork, they improved in that regard.

Question 4 - During geography fieldwork, what mapping activities were carried out in the past?

Section 2.2.2 tries to highlight some of the mapping activities carried out in the past. These include making sketches in the field, map drawing with paper maps as base maps, paper posters, aerial photographs, topographic maps used for map reading and interpretation.

Question 5 - What mapping tools are currently being used in geography fieldwork?

Mapping tools currently being used in geography fieldwork are discussed in section 2.4.1. Different mapping resources and tools are being used during different fieldwork stages. For example, maps and photographs can be used during the preparation stage to introduce students to the fieldwork area; Digital technologies such as geographical information systems (GIS), global positioning system (GPS), and remote sensing (RS) can be used during the actual-fieldwork stage; and mapping tools such as ArcGIS, AutoCAD, ILWIS can be used in the follow-up stage for data analysis and presentation.

In addition, technologies such as Google Maps (URL 2), MapQuest (URL 4), Multimap (URL 5) can be used to support fieldwork. These digital technologies are consumed using mapping aids such as smart phones, iPads, Digital Navigation Systems etc.

Question 6 - Do students understand the geographic area better after taking part in mapping activities?

From the analysis of the various results discussed in chapter 5, this research concludes that there appears to be an improvement in the students' understanding of the geographic area after taking part in mapping activities during geography fieldwork. This conclusion is arrived at based on the observations discussed in chapter 5, some of which are also discussed in section 6.2.

Question 7 – Is there a difference in the improvement of geographical understanding as a consequence of paper mapping, compared to digital mapping in geography fieldwork?

From the results discussed in section 5.5.1, I observed that in a mapping activity of this nature, addition of POIs with their descriptions takes a longer time when using digital mapping tools than when using paper mapping tools. This could lead to addition of more points when using a paper map than when using a digital map on the field. The paper mapping group showed a higher level of improvement in geographical understanding when compared to the digital group.

Based on observations on the use of mapping activities in geography fieldwork for the improvement of geographical understanding, this research makes the following recommendations: -

- Engaging students in mapping activities as part of geography fieldwork can lead to the increase in their geographical understanding of the area.
- During geography fieldwork, a map (in digital or analogue format) is a useful tool to enhance geographic understanding.
- The use of digital mapping tools should always be backed up with paper maps. This is because unexpected system failures might occur on the field which might disrupt the learning process and also interrupt the mapping activity abruptly.

6.2. Discussions

Looking at all the pre-fieldwork and post-fieldwork mental maps, a substantial difference can be seen in the level of details drawn and labelled. This improvement was noticeable in the mental maps produced by all test persons. The pre-fieldwork mental maps showed that some test persons were unaware of the correct description or land uses in the area but after the fieldwork, there was great improvement in that regard. The mapping activity was useful in improving the test persons' geographic understanding as most of them were able to identify features as well as routes with the aid of the maps. Some test persons attested to this and stated that the mapping activity aided them to understand the area better.

With a little introduction, most of the test persons were able to independently make use of the mapping tools while on the field. However, as discussed in section 5.5.1, a few of them had some system challenges which needed my assistance. I did this to ensure they were not distracted from observing and learning about the environment which was the main aim of the fieldwork. It was also observed that the digital mapping group spent more time on the field than the paper mapping group.

In the course of the research a number of challenges were encountered. These included: -

Language barrier when sourcing for information: - Most of the places which I visited to source for information such as the museum, the city council, De Spinnerij etc., all had information mainly in Dutch. I had to find a way to translate most of the information which I got from these places.

Weather: - Planned fieldwork around the case study area was sometimes rescheduled due to poor weather conditions. For example, we could not make use of the tablet, video camera or paper maps when it was raining.

Morale of test persons: - The timing of the mapping activities fell around the Christmas period. As such, most students were already in the holiday spirits and felt reluctant to engage in any intellectual activities. After much persuasion, I was lucky to get the required number of test persons.

6.3. Further research

As stated in section 1.2, this research would also hopefully contribute to the broader PhD project of Xiaoling Wang which is aimed at establishing the roles of cartographic visualizations in improving undergraduates' spatial cognition in geography fieldwork. The results of my research will be used by her to formulate proposals and requirements for new ways of cartographic visualization to be applied in human geography fieldwork.

Furthermore, enormous data has been made available from this research. This includes the individual appraisal of every test person that took part in the usability testing. For this reason, it is necessary to carry out further research in future. This would be beneficial to the generality of geographers. The following areas can be addressed: -

- The target group of this research was graduate students in geo-information science. I wish to propose that in future, similar tests be carried out with different target groups such as primary or high school students and the results compared.

- The fieldwork in this research involved mapping and from the analysis of results, it was discovered that the mapping activity helped in improving the student's geographic understanding. I wish to also propose that a similar fieldwork be organised without mapping activities and then the results be compared.

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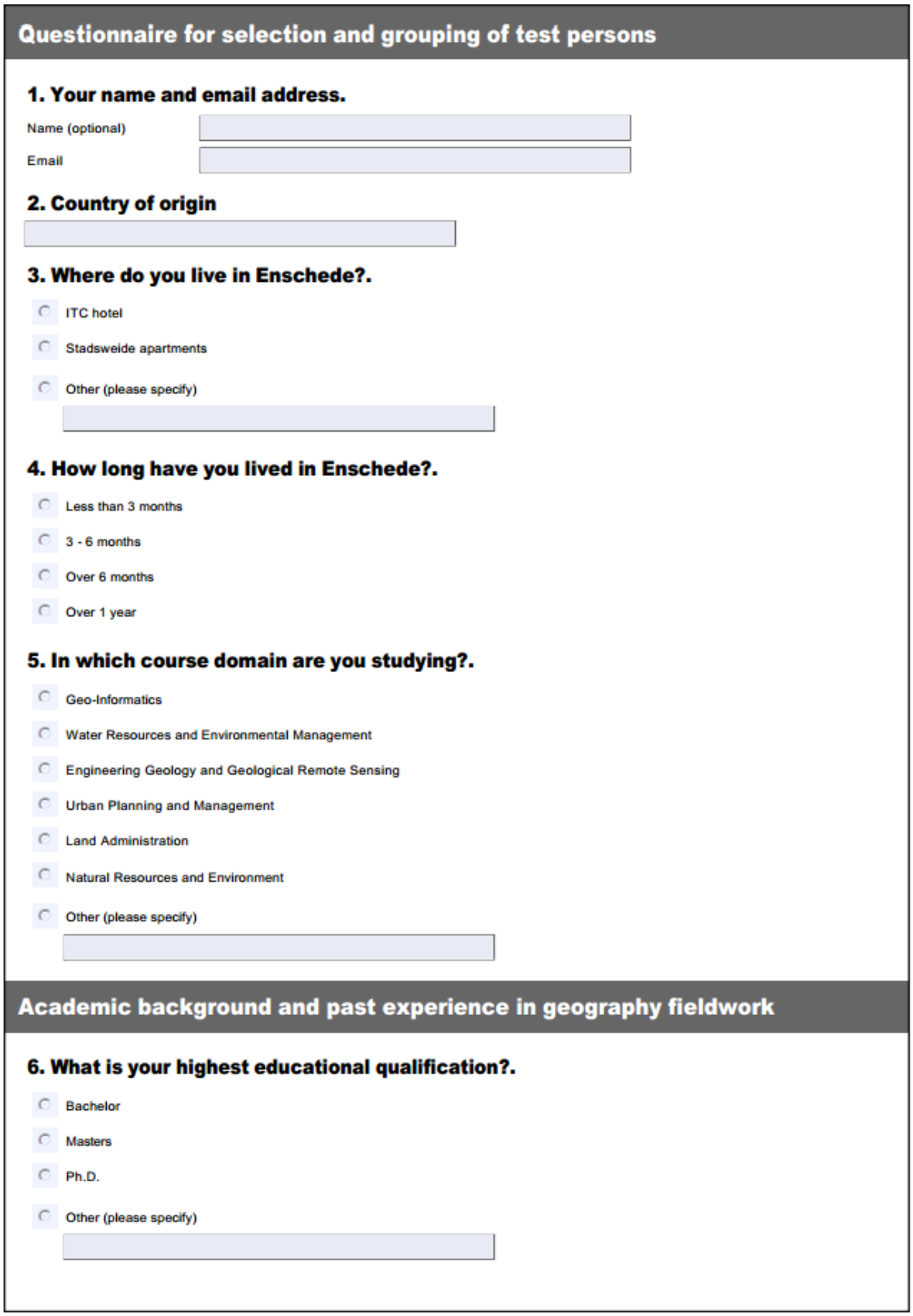
URLs

1. OpenStreetMap *http://www.openstreetmap.org* (accessed 03-11-2014)
2. Google Maps *https://www.google.com/maps* (accessed 03-11-2014)
3. Yahoo Maps *https://maps.yahoo.com* (accessed 03-11-2014)
4. MapQuest *http://www.mapquest.com* (accessed 11-12-2014)
5. Multimap *http://en.wikipedia.org/wiki/Multimap.com* (accessed 11-12-2014)
6. ArcGIS software *http://www.esri.com/software/arcgis* (accessed 16-12-2014)
7. AutoCAD software *http://www.autodesk.com/products/autocad/overview* (accessed 16-12-2014)
8. ILWIS software *http://www.ilwis.org* (accessed 16-12-2014)
9. Survey Monkey *https://www.surveymonkey.com* (accessed 02-12-2014)

Appendix 1: Online survey for the selection and grouping of test persons



Questionnaire for selection and grouping of test persons

1. Your name and email address.

Name (optional)

Email

2. Country of origin

3. Where do you live in Enschede?.

- ITC hotel
- Stadsweide apartments
- Other (please specify)

4. How long have you lived in Enschede?.

- Less than 3 months
- 3 - 6 months
- Over 6 months
- Over 1 year

5. In which course domain are you studying?.

- Geo-Informatics
- Water Resources and Environmental Management
- Engineering Geology and Geological Remote Sensing
- Urban Planning and Management
- Land Administration
- Natural Resources and Environment
- Other (please specify)

Academic background and past experience in geography fieldwork

6. What is your highest educational qualification?.

- Bachelor
- Masters
- Ph.D.
- Other (please specify)

7. In what field of study did you obtain this qualification?.

- Human geography
- Physical geography
- Cartography
- Engineering
- Computer science
- Geo-Information science and Earth Observation
- Education
- Humanities and arts
- Social Sciences
- Business and Law
- Other (please specify)

8. Did you attend any course(s) in human geography after seondary school?.

- YES
- NO

If Yes, please specify

9. Have you been involved in any form of human geography fieldwork in the past?.

- YES
- NO

Academic background and past experience in geography fieldwork

10. At what location did the field work take place?.

11. Was the fieldwork meant for educational purposes (improving the geographical understanding of an unknown area)?.

- YES
- NO
- Other (please specify)

12. Please briefly describe the activities you were engaged in during that fieldwork:

13. Did the fieldwork involve any form of mapping activities?.

- YES
- NO

Academic background and past experience in geography fieldwork

14. What form(s) of mapping activities were involved?.

- Sketch map production on paper
- Map production using GIS and mapping software such as ArcGIS, ILWIS, Autocad etc
- Contributing to neocartography maps (OpenStreetMap, Flickr map etc)
- Other (please specify)

Academic background and past experience in geography fieldwork

15. Was the fieldwork effective in learning about the area? State reasons for your answer.

- YES
- NO

Reasons:

Mapping experience

16. How often do you use paper maps in daily life ?.

- Never
- Seldom
- Daily
- Several times per week
- Several times per month
- Several times per year

17. How often do you use digital maps (like google maps) in daily life?.

- Never
- Seldom
- Daily
- Several times per week

18. Do you prefer working with paper maps or digital maps?.

- Paper maps
- Digital maps
- Any of the two

19. Did you ever make maps yourself?.

- YES, but only static maps on paper
- YES, but only digital/interactive maps
- YES, both static and digital interactive/dynamic maps
- NO

Mapping experience

20. What software did you use to produce the digital map(s)? Please mark all that apply.

- ArcGIS
- ERDAS
- Ilwis
- AutoCAD
- Photoshop
- Illustrator
- Corel draw
- QGIS
- Other (please specify)

21. On a scale of 1 - 5, what is your proficiency with the mapping software(s) you selected above?.

	1	2	3	4	5
ArcGIS	○	○	○	○	○
ERDAS	○	○	○	○	○
Ilwis	○	○	○	○	○
AutoCAD	○	○	○	○	○
Photoshop	○	○	○	○	○
Illustrator	○	○	○	○	○
Corel draw	○	○	○	○	○
QGIS	○	○	○	○	○

Other (please specify software and scale)

Knowledge about the geography of the study area and Enschede as a whole.

22. Apart from ITC building and the place where you live, which other places do you often visit in Enschede. Please list.

i
ii
iii
iv
v

23. For what industry was Enschede known for in the past?.

24. Name some recreational parks in Enschede and their locations.

Park name (A)
Park location (A)
Park name (B)
Park location (B)
Park name (C)
Park location (C)
Park name (D)
Park location (D)

25. Have you been to the Twenste Welle museum?.

- YES
- NO

26. Have you been involved in any human geography fieldwork in Enschede?.

- YES
- NO

Knowledge about the geography of the study area and Enschede as a whole.

27. In what part of the city did the fieldwork take place?.

28. Was the fieldwork effective in learning about the geography of the area? State reasons for your answer.

- YES
- NO

Reason(s)

Knowledge about the geography of the study area and Enschede as a whole.

29. Are you familiar with the geography of the area around ITC building?.

- YES, I have seen maps of the area
- YES, I have been taught about the area in class
- NO, I only know the ITC and Menzis buildings
- NO, I have no idea

30. Do you know how old the ITC building is?.

- YES
- NO

if YES, specify number of years

Computer skills

31. Before coming to ITC, how often do you use a desktop or laptop computer?.

- Never
- Seldom
- Daily
- Weekly
- Monthly
- Few times in a year

32. Do you have a smart phone?.

- YES
- NO

33. How often did you work with a tablet computer in the past two years?.

- Never
- Seldom
- Daily
- Weekly
- Monthly
- Few times in a year

OpenStreetMap experience

34. Have you heard of OpenStreetMap?.

- YES
- NO

35. Have you used OpenStreetMap in the past?.

- YES
- NO

OpenStreetMap experience

36. How often do you use OpenStreetMap?.

- Just once
- Hardly use it
- Regularly

37. What mapping activities do you use OpenStreetMap for?.

- Adding points to the map
- Getting mapping data
- Finding my route
- Other (please specify)

38. Do you see OpenStreetMap as an effective mapping tool? Give reasons.

- YES
- NO

Reasons

LOCUS mapping software

39. Have you heard of Locus mapping software?

- YES
- NO

LOCUS mapping software

40. Have you used Locus mapping software in the past?

- YES
- NO

If Yes, what did you use the software for?

Appendix 2: Instructions for Mapping with Locus software

I. Tap the Locus icon to launch the application (see yellow circle in fig. 1)

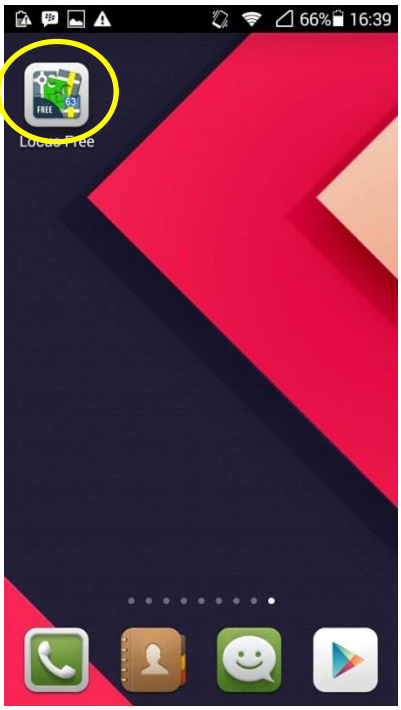


Fig. 1

II. Ensure that the GPS on the device is switched on.

III. You can always centre the map on your position by pressing the bottom-left button. (See yellow circle in fig. 2).

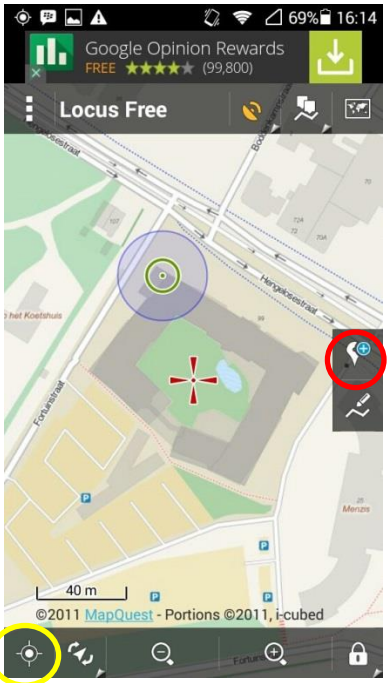


Fig. 2

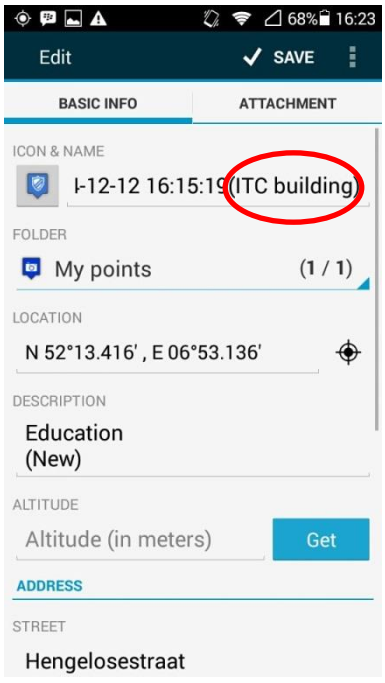


Fig. 3

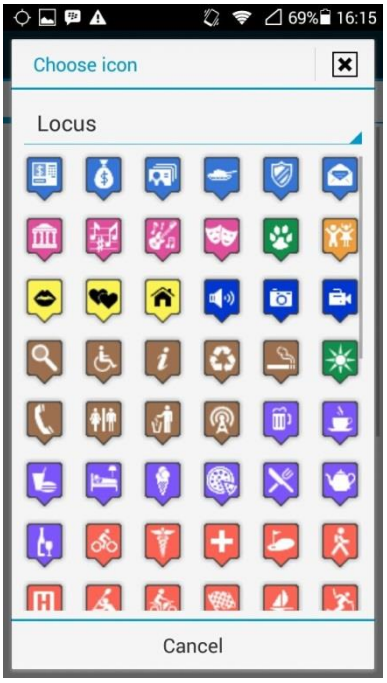


Fig. 4

IV. When you get close to a POI which you want to add, move your background map in such a way that the red crosshair is on top/at the centre of the building (see fig 2).

V. Press the “add new point” button on the right side of the screen (see red circle in fig. 2). This will take you to the section where you can add basic info about the POI.

VI. Enter the name (eg. ITC building) beside the date-time label (see red circle in fig. 3).

VII. You can change the icon by clicking on it and selecting an appropriate icon for a POI (see fig. 4)

VIII. Ensure that all your data is stored in the folder named …….

IX. Do not edit the location (coordinates); these are stored automatically by the app.

X. Enter the description of the building (eg. Education) and specify if it’s a new (post-industrial era) or old (during industrial era) structure.

XI. To add a line feature, move your background map in such a way that the red cross hair is at the beginning of the line.

XII. Press the “add new route” button on the right side of the screen (see yellow circle in fig. 5)

XIII. Click on the “add or remove point” buttons (see red circle in fig. 5) to fix or remove points (at every change of direction) along the route.

XIV. Click the finish button when you get to the end of the route (see blue circle in fig. 5).

XV. Add the route name and description.

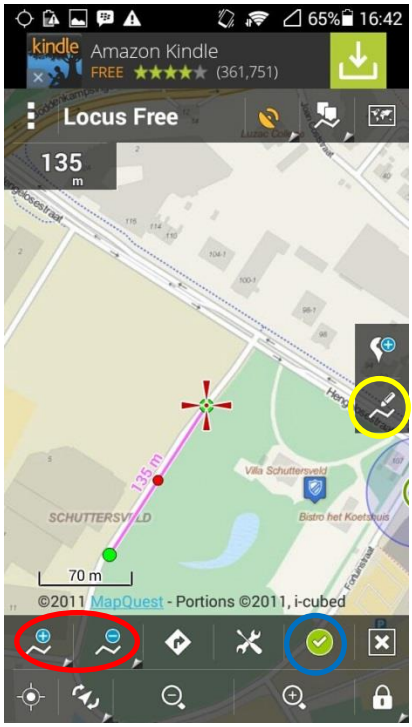


Fig. 5

Appendix 3 – Instructions for drawing mental maps

I. Without looking at any other map of Enschede, draw on a plain sheet of paper a map depicting the urban landscape of the area around ITC building.

II. The area should cover the Hengelosestraat up to the ring road, following the ring road southwards down to the rail tracks (Parkweg), then eastwards to the prinsesse tunnel and back to ITC.

III. The map may be just a rough sketch.

IV. On the map, indicate key elements such as pathways (roads, railway tracks etc.); major landmarks (eg. ITC building); boundaries and edges; and nodes (roundabouts etc.).

V. As far as you know, indicate important remnants of Enschede's textile history as well as relatively new features which have replaced old historical remnants.

VI. Also use keys or symbols to indicate current "land uses" or uses of the features shown on your map.

VII. Label major features such as buildings, street names and other POI.

Please remember to think aloud while drawing

Appendix 4a. - Instructions for fieldwork (Locus mapping software group)

Introduction

- This fieldwork aims at exposing you to the case study area in order to discover the remaining remnants of the textile industry as well as to see features that are relatively new in the area.
- While on the field, you would have to keep observing patterns and interrelationships in the area in order to see the changes in urban landscape after the textile factory collapse.

Tasks (active group)

I. Using LOCUS software, add (to the base map) the following Points of Interest (POI) that represent Enschede's textile industry past:-
    - The Schuttersveld villa along Hengelosestraat.
    - The Coach-house (now bistro) along Fortuinstraat
    - The Schuttersveld factory wall along the ring road
    - The bus lane opposite ITC (former rail track).

II. Also add the following Points of Interest (POI) which are new developments after the textile industry collapse.
    - ITC building
    - Menzis building
    - Connexion busstalling
    - Leen bakker/carpet right stores

III. In addition to the listed POI's, you may also add other features which you feel would enhance your geographical understanding of the area.

IV. After adding a POI, add some basic information about the feature such as Name, description (use) etc. and specify if it's a new or old remnant.

V. Select an icon which corresponds to the POI's use.

Remember to always think aloud

Appendix 4b. - Instructions for fieldwork (paper map group)

Introduction

- This fieldwork aims at exposing you to the case study area in order to discover the remaining remnants of the textile industry as well as to see features that are relatively new in the area.
- While on the field, you would have to keep observing patterns and interrelationships in the area in order to see the changes in urban landscape after the textile factory collapse.

Tasks (paper map group)

I. Using a pencil or pen, highlight on the map the following Points of Interest (POI) which are remnants of Enschede's textile industry past:-
    - The Schuttersveld villa along Hengelosestraat.
    - The Coach-house (now bistro) along Fortuinstraat
    - The Schuttersveld factory wall along the ring road
    - The bus lane opposite ITC (former rail track).

II. With a different colour of ink, highlight the following Points of Interest (POI) which are new developments after the textile industry collapse.
    - ITC building
    - Menzis building
    - Connexion busstalling
    - Leen bakker/carpet right stores

III. In addition to the listed POI's, you may also highlight other features which you feel would be relevant to enhance your geographical understanding of the area.

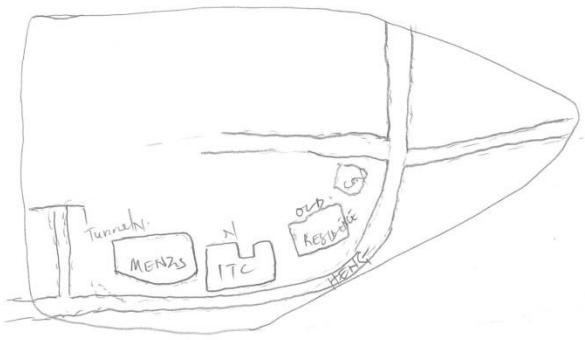
IV. Use symbols to indicate current use of POI's as well as other land uses.

V. Label the POI's correctly and add a little description where necessary.

Remember to always think aloud

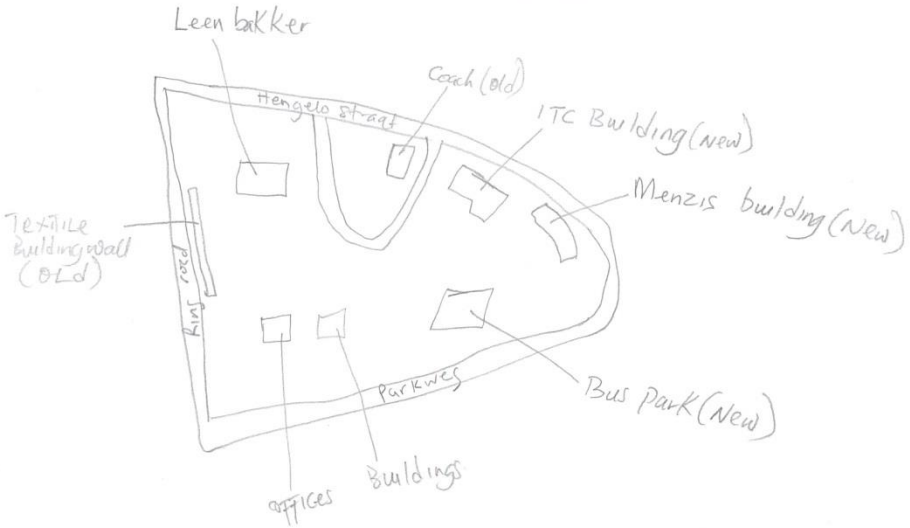
Appendix 5.1 - Pre and post fieldwork mental maps for TP 1

Pre-fieldwork mental map



Name/ID: TP1
Date/Time: 20-12-2014 | 15:02

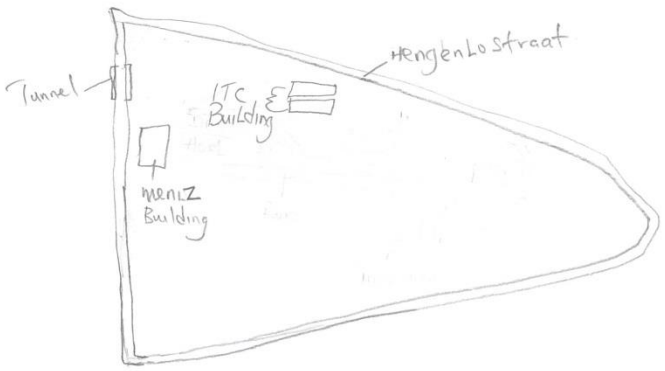
Post-fieldwork mental map



Name/ID: TP1
Date/Time: 22-12-2014 | 13:58

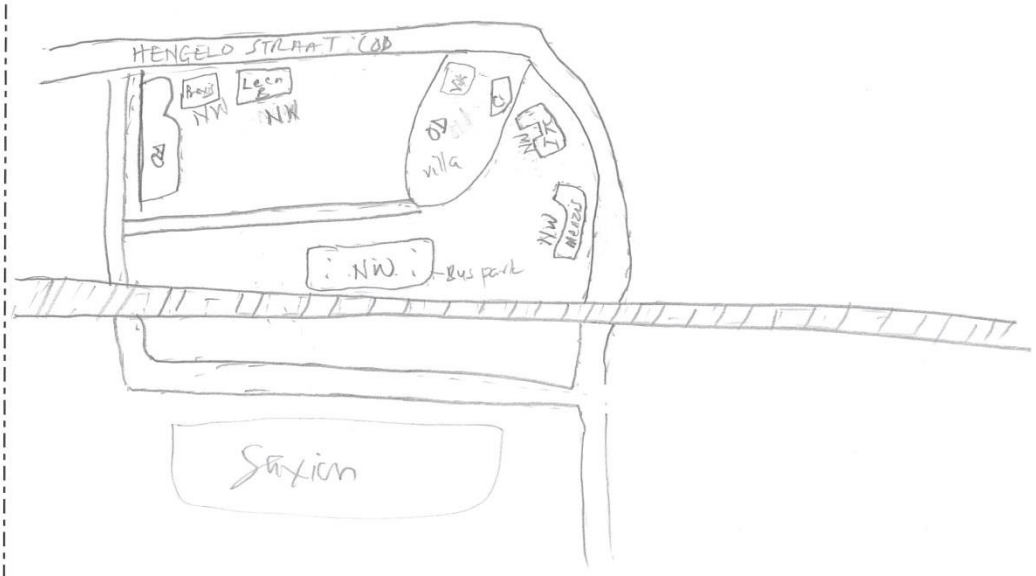
Appendix 5.2 - Pre and post fieldwork mental maps for TP 2

Pre-fieldwork mental map



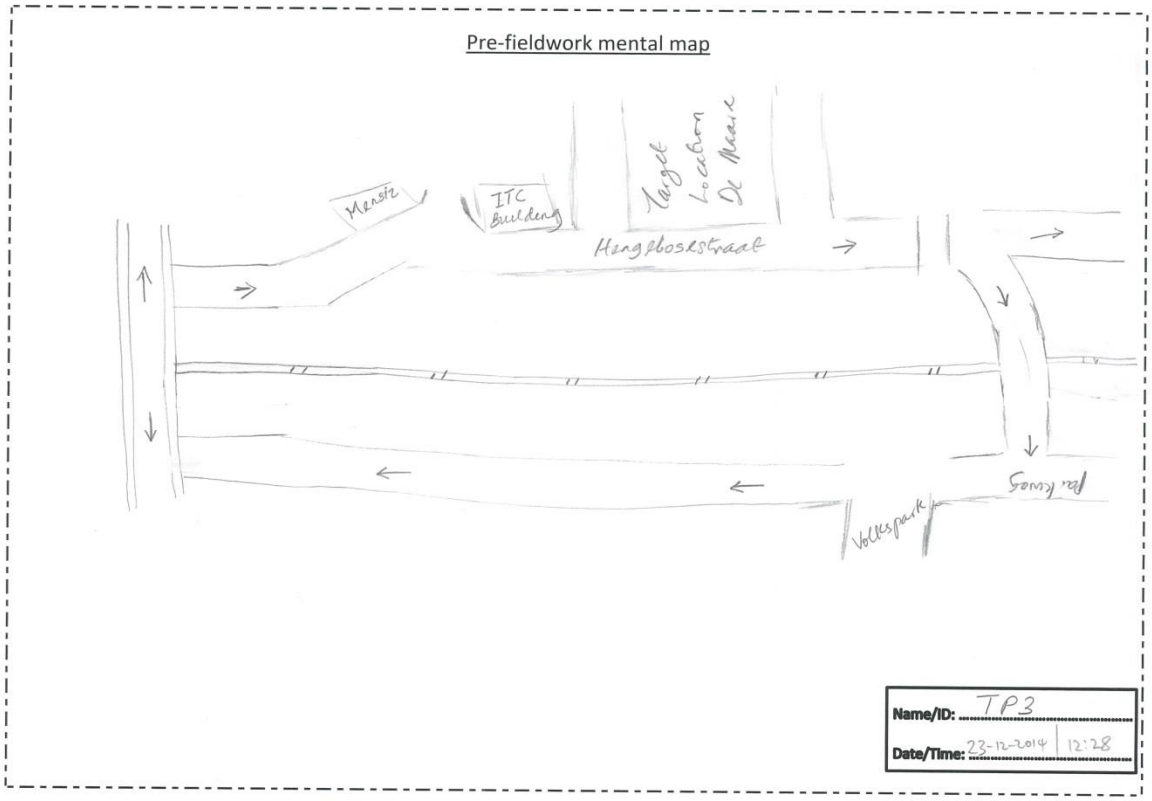
Name/ID: TP2
Date/Time: 20-12-2014 | 14:22

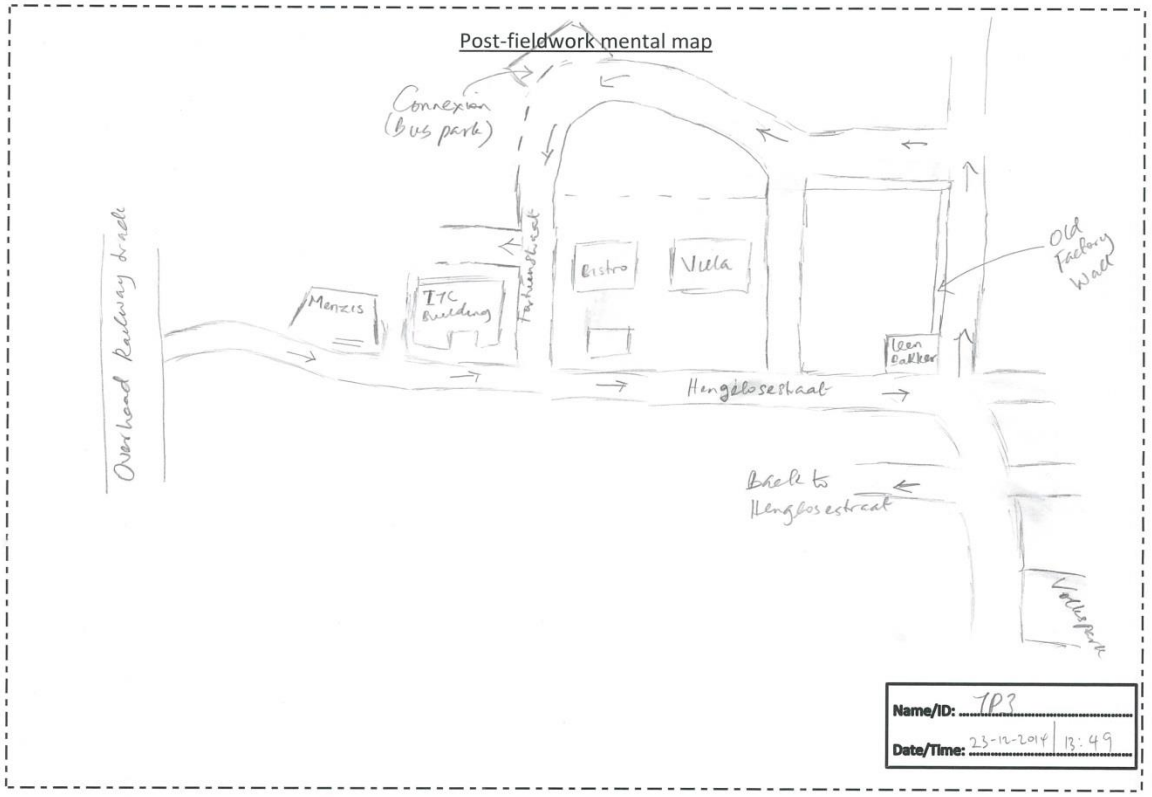
Post-fieldwork mental map



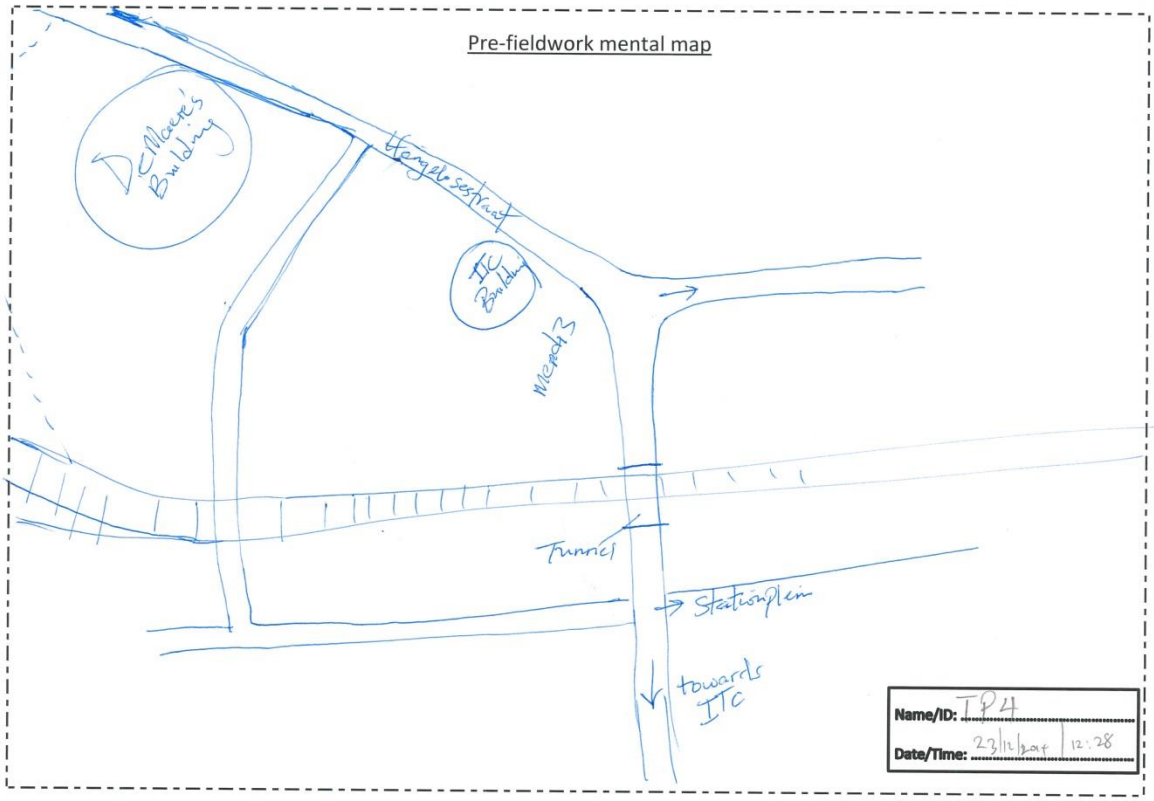
Name/ID: TP2
Date/Time: 22-12-2014 | 14:56

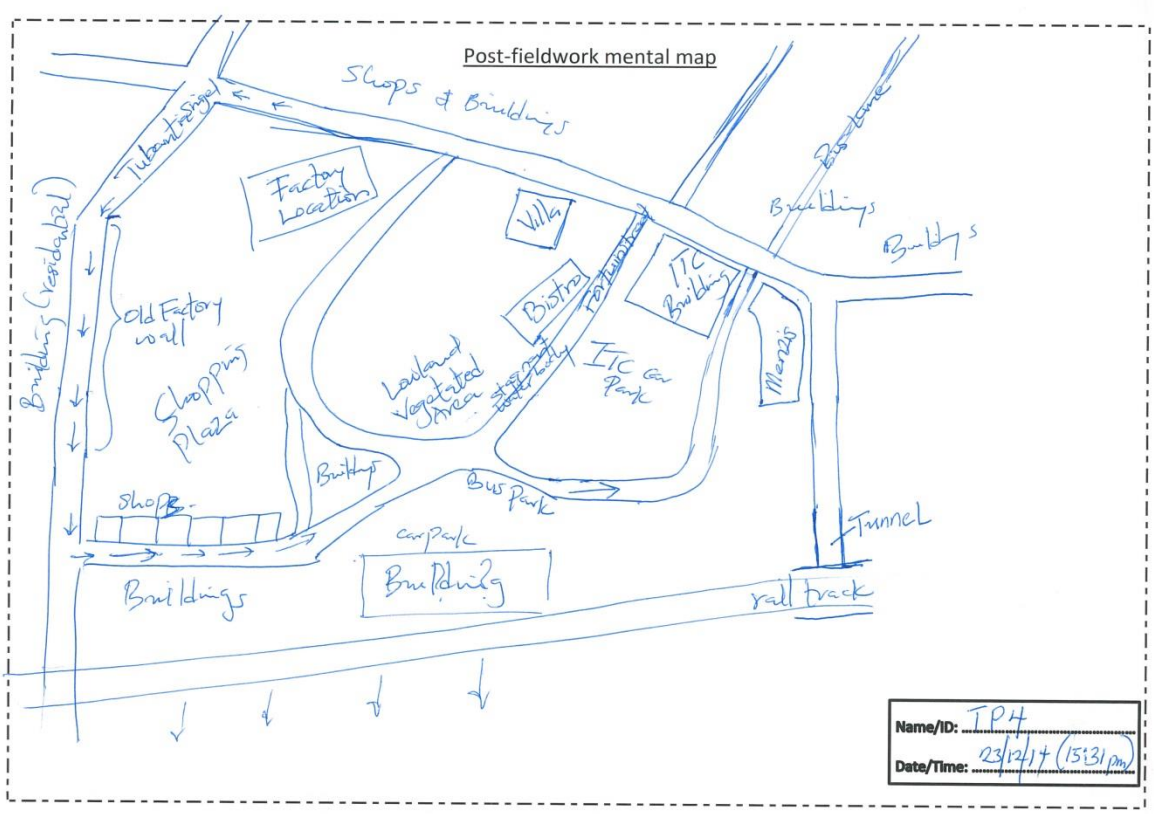
Appendix 5.3 - Pre and post fieldwork mental maps for TP 3



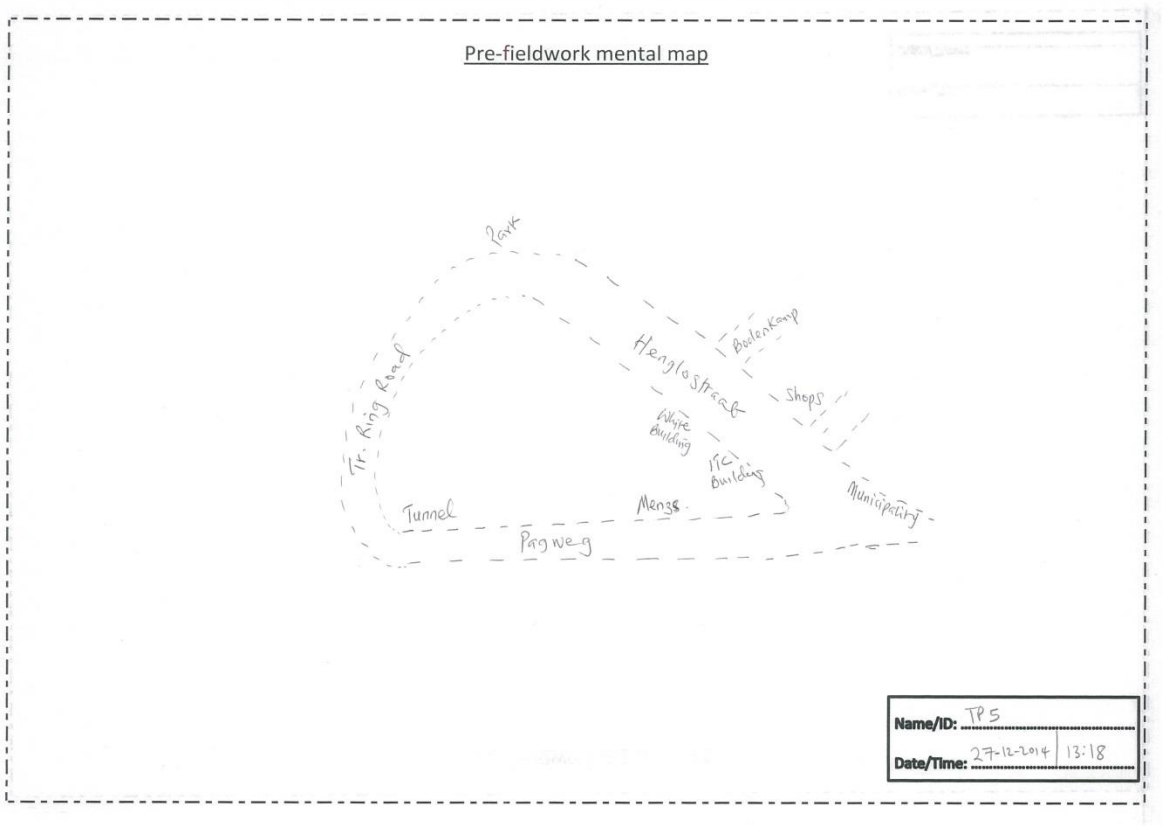


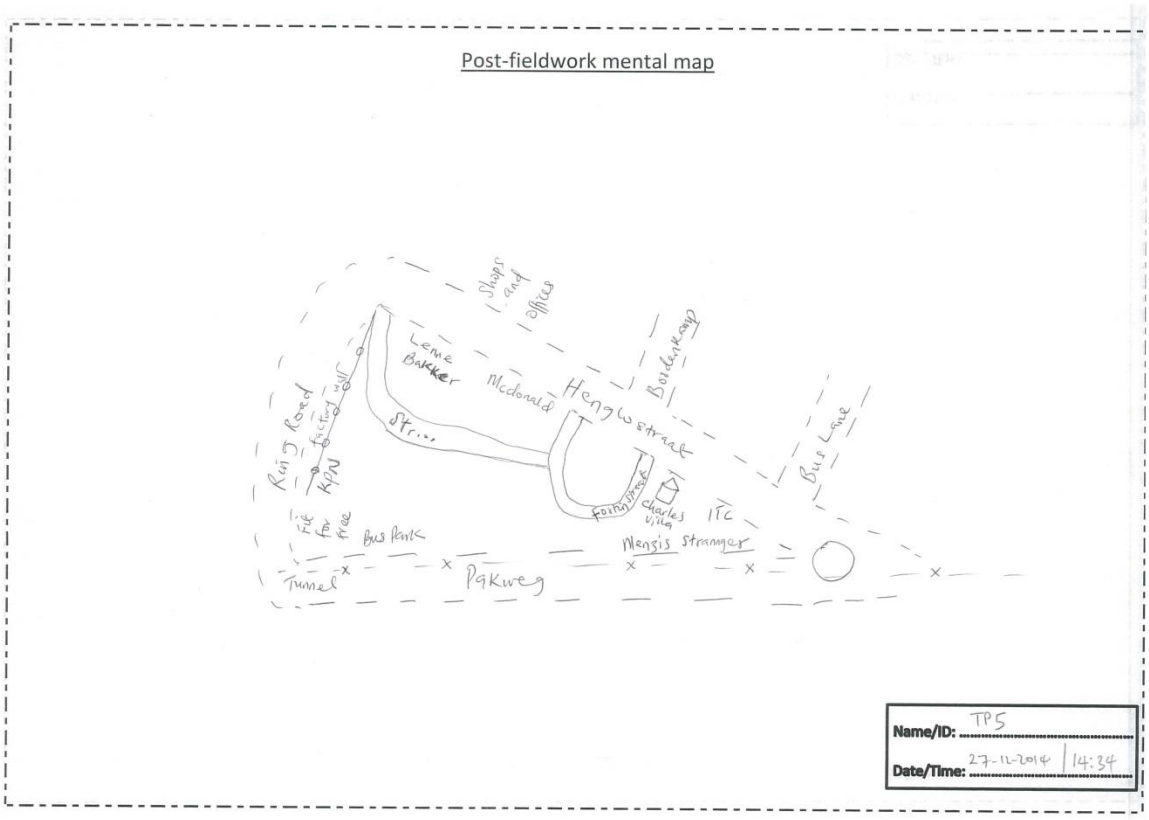
Appendix 5.4 - Pre and post fieldwork mental maps for TP 4



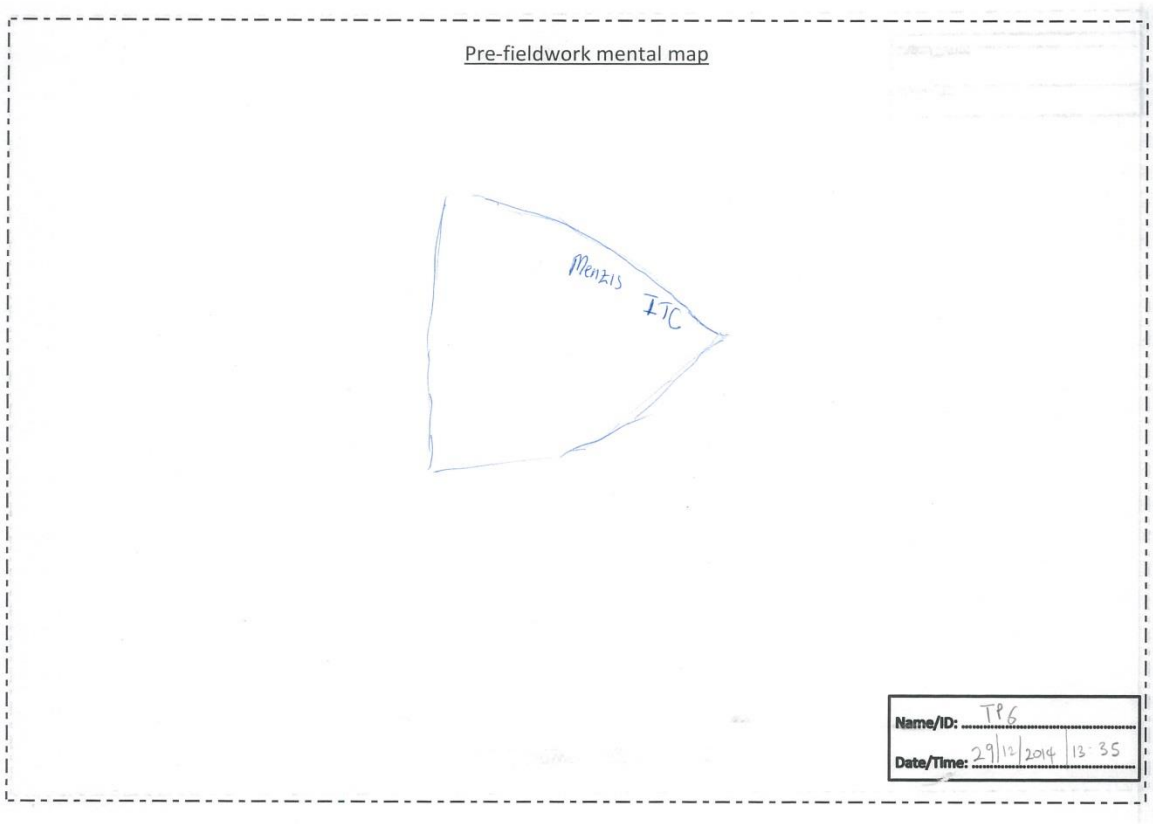


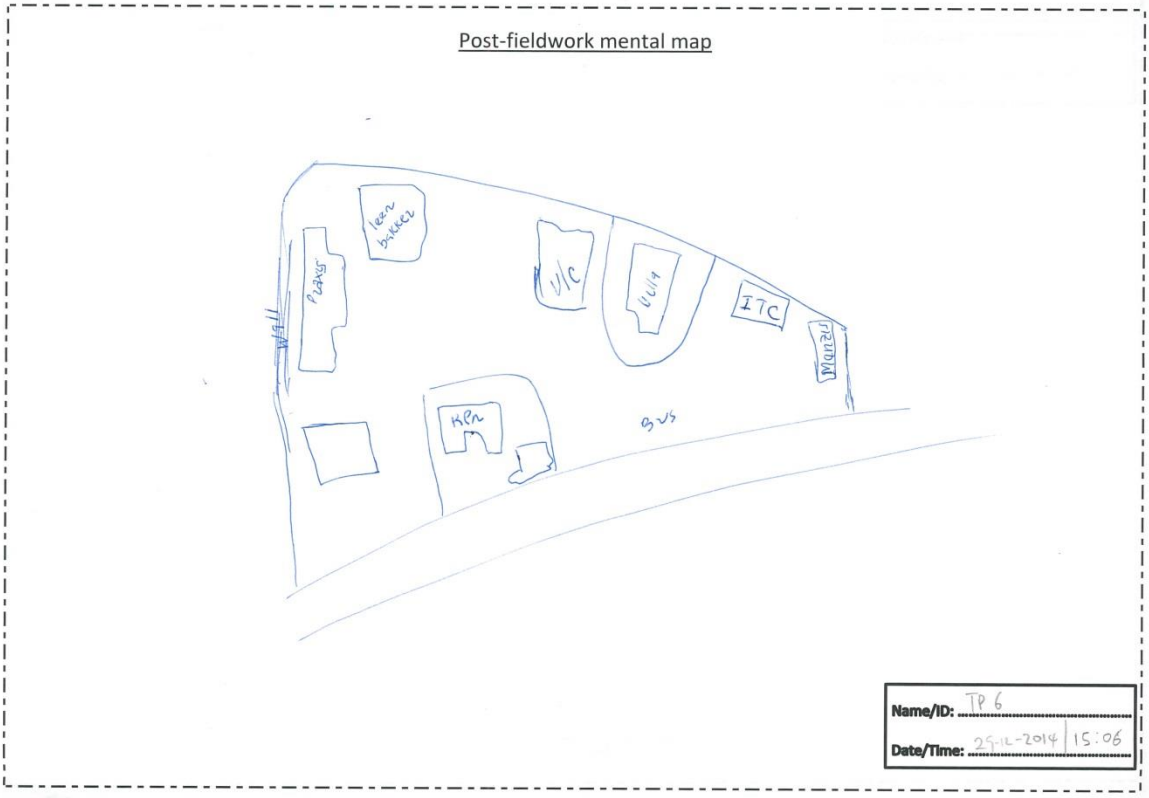
Appendix 5.5 - Pre and post fieldwork mental maps for TP 5



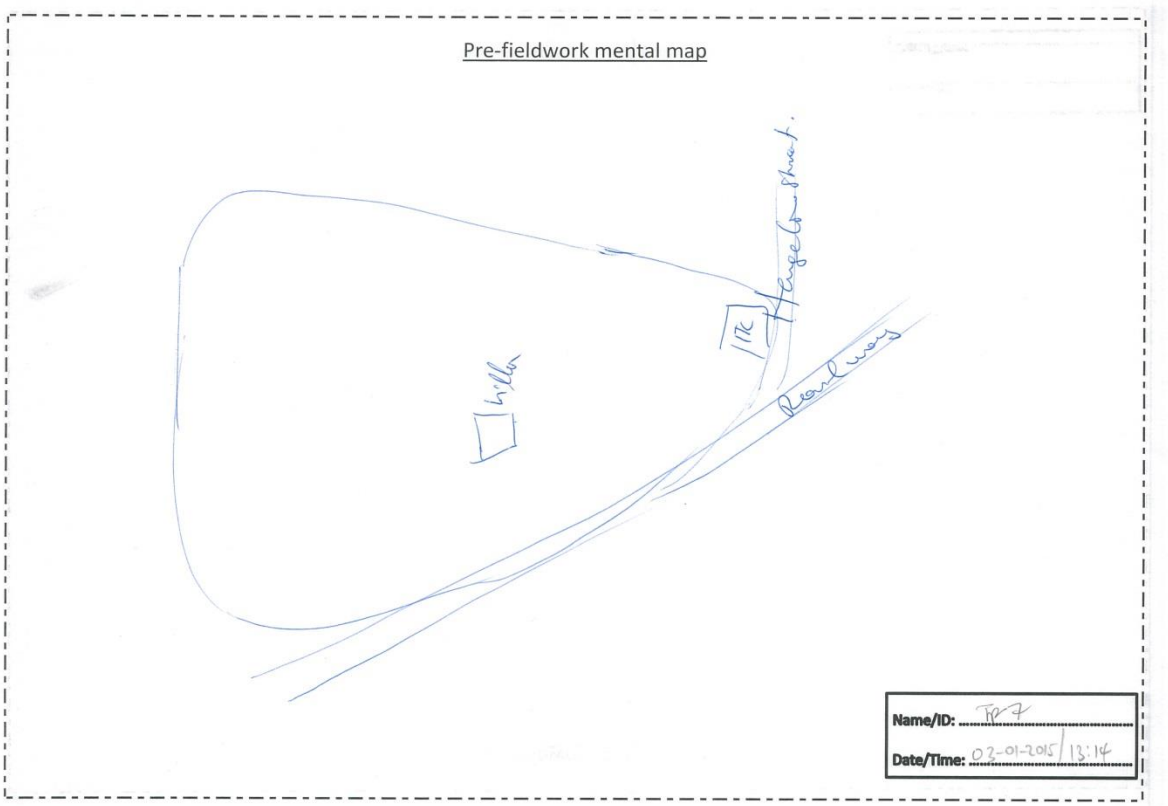


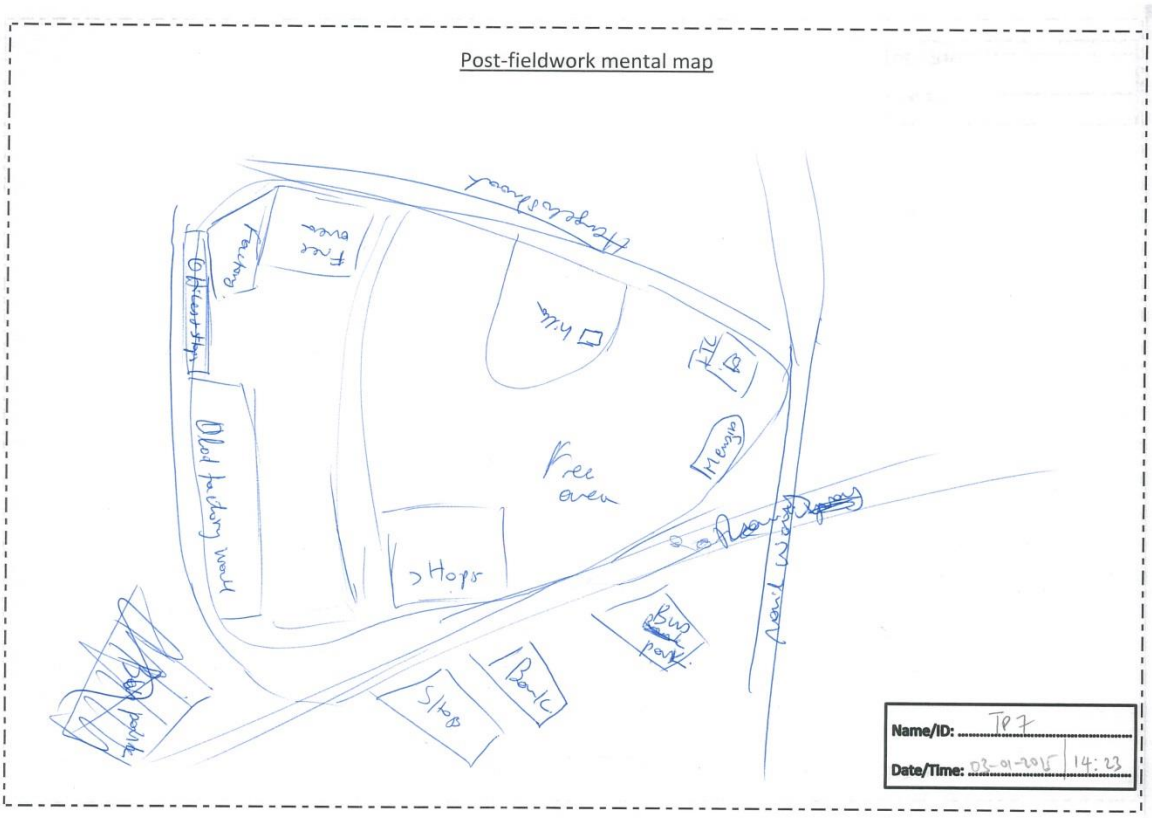
Appendix 5.6 - Pre and post fieldwork mental maps for TP 6





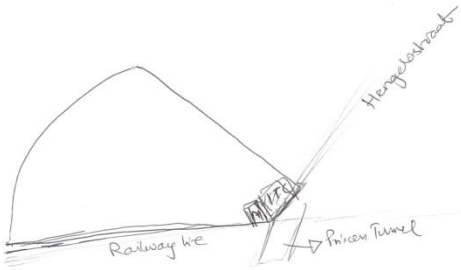
Appendix 5.7 - Pre and post fieldwork mental maps for TP 7





Appendix 5.8 - Pre and post fieldwork mental maps for TP 8

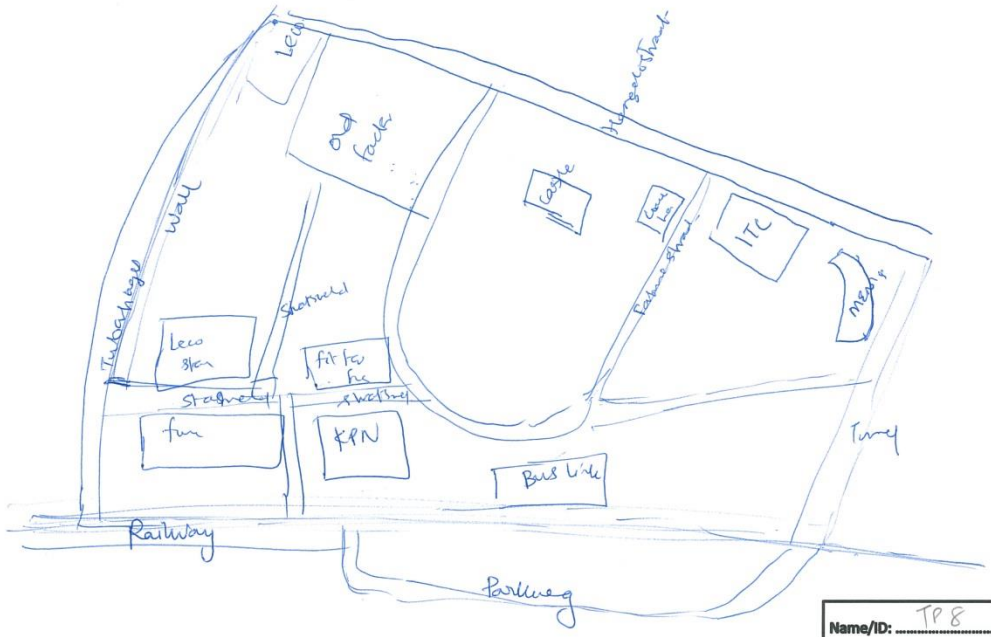
Pre-fieldwork mental map



Name/ID: TP8

Date/Time: 05-01-2015 12:14

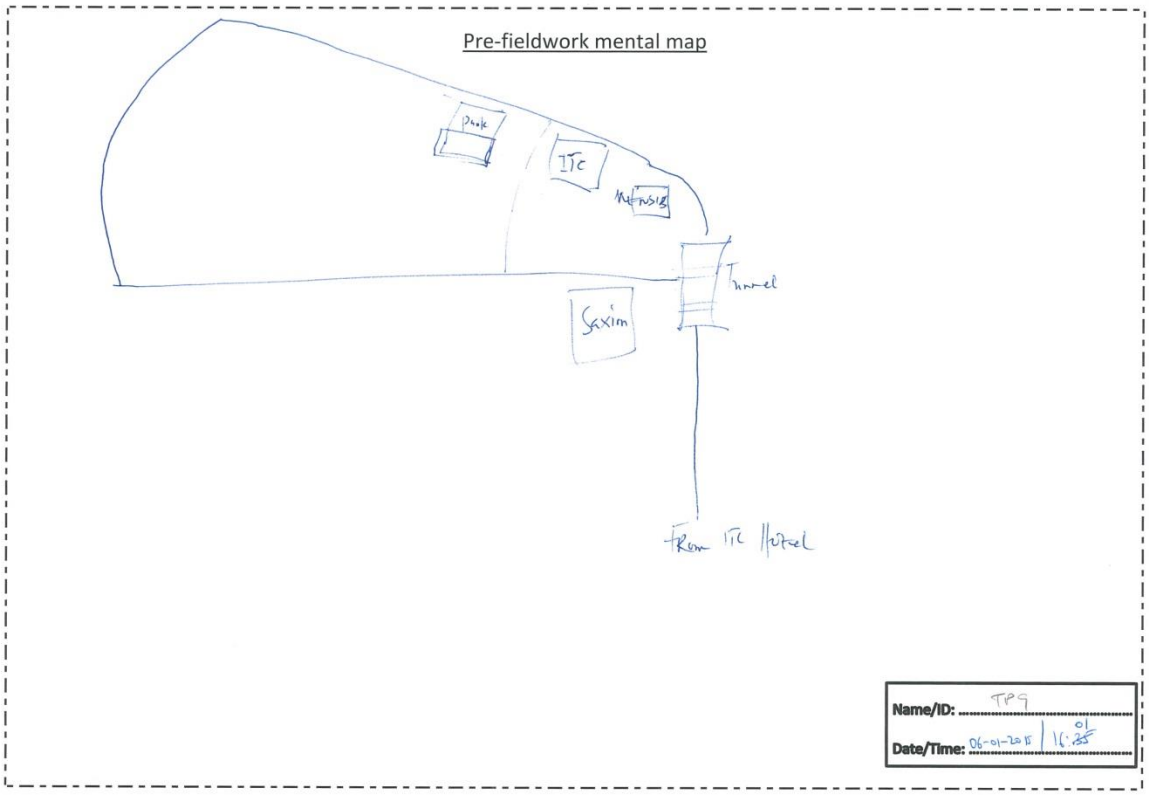
Post-fieldwork mental map

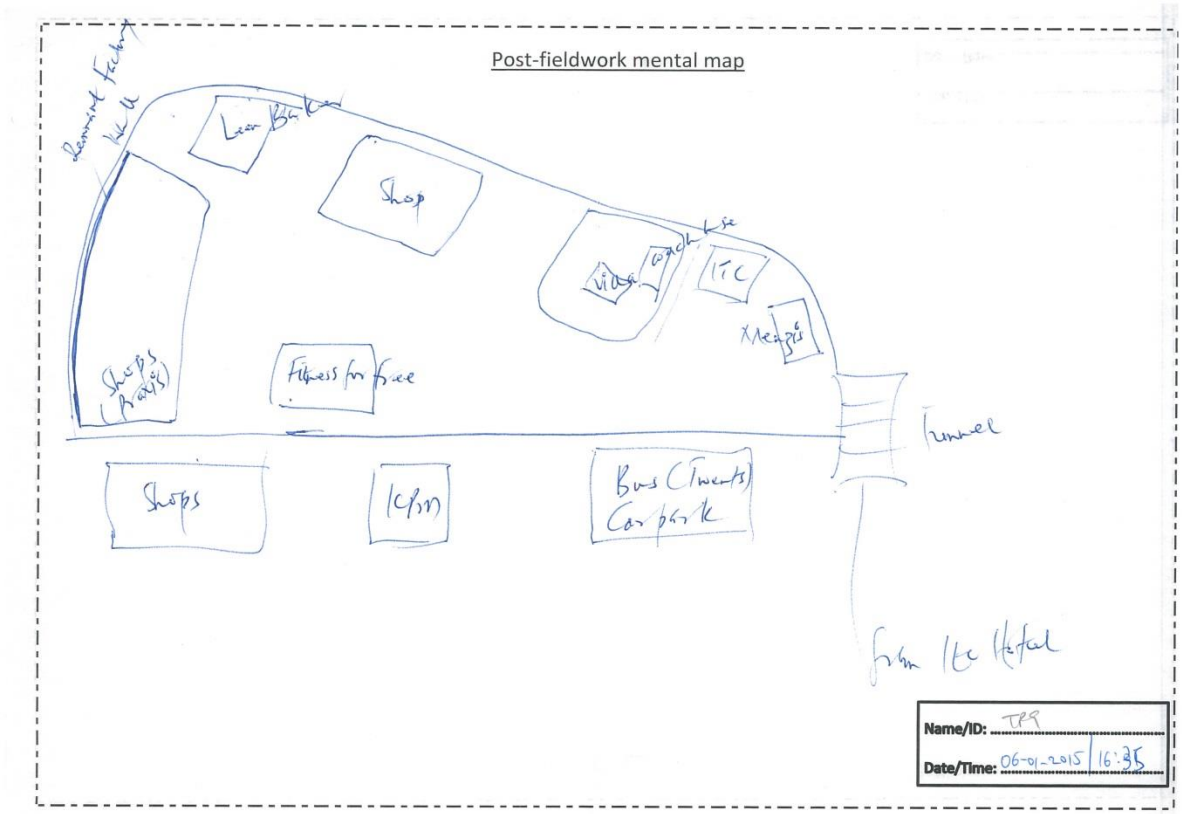


Name/ID: TP 8

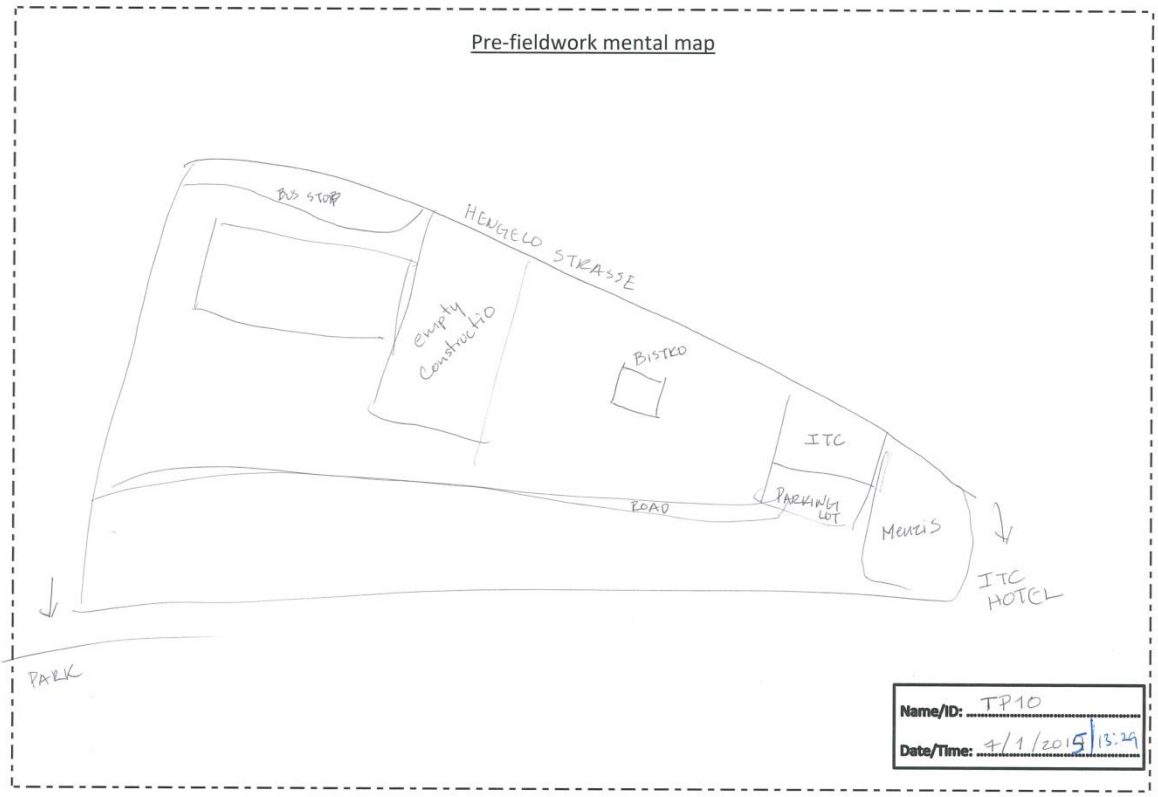
Date/Time: 05-01-2015 13:53

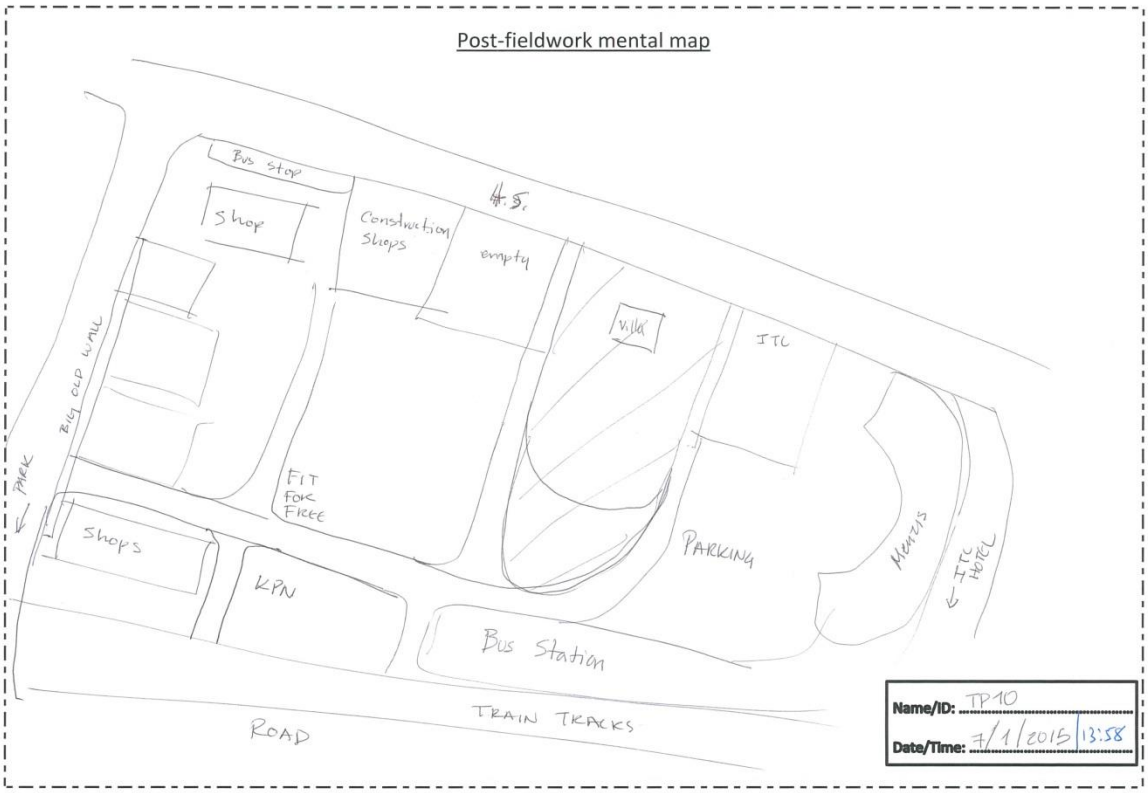
Appendix 5.9 - Pre and post fieldwork mental maps for TP 9



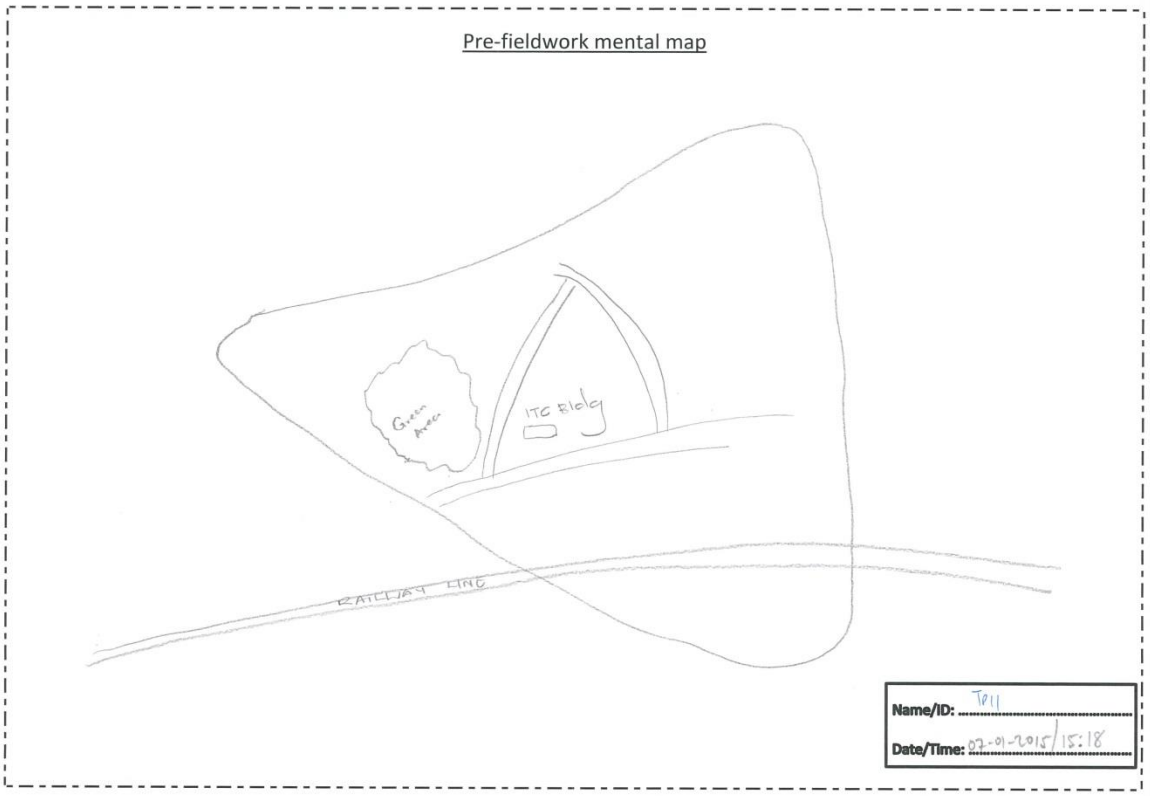


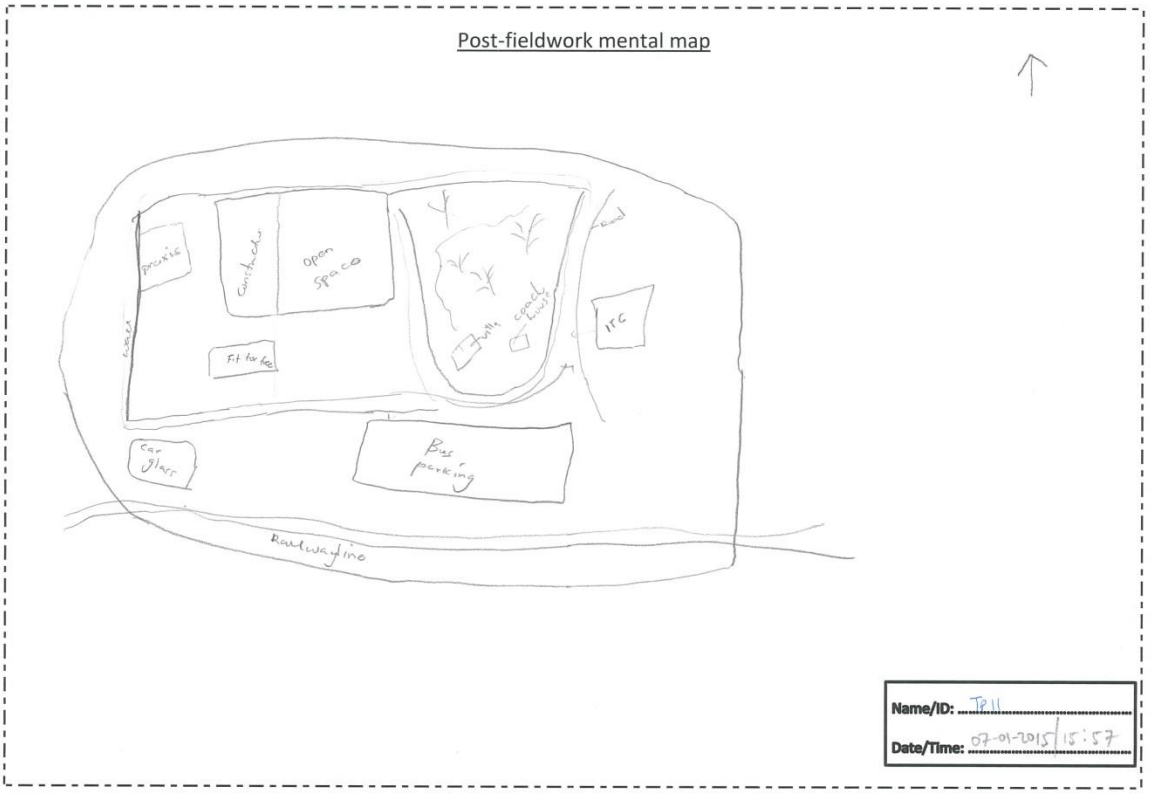
Appendix 5.10 - Pre and post fieldwork mental maps for TP 10





Appendix 5.11 - Pre and post fieldwork mental maps for TP 11





Appendix 5.12 - Pre and post fieldwork mental maps for TP 12