2016

Searching for a contextualised framework to inform testing methodology in the mobile arena

DOCTORATE IN INFORMATION SCIENCES

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2016-17

ABSTRACT

Smartphone take-up has grown exponentially, a growth that far exceeds any consumer technology in history. The growth of these technologies has created a cultural shift. Users are accessing, storing and retrieving digital information on more portable devices and doing so on the move. This cultural shift away from the stationary context (at home or at work) to a more mobile 24/7 way of accessing and consuming information is creating challenges.

Today's developers and shapers of digital information (businesses, marketers, advertisers and web agencies, to name a few) need their applications to be workable to support the consumer in all contexts; at home, at work, in the lift, on the bus. When developing applications for these kinds of situations, changeable technological configurations and contexts are crucial to support the user experience and device interaction. In the early days of mobile computing researchers and usability professionals identified a range of challenges facing a tester's ability to accurately map a mobile users experience. Testing strategies have stood the test of time, working extremely well in many lab-based configurations, but how do they fare in an increasingly mobile information society?

This Professional Doctorate aims to support and contribute to the mobile testing evolution and will adapt some existing practices to help keep pace with the phenomenon. This research will present a strategy that explores the development of new a framework (via a systematic review) to inform mobile testing. The framework builds upon themes within Human Information Behavior (HIB) and Mobile Human Computer Interaction (Mobile HCI). The research takes an interpretivist approach to investigate how this framework is applied to build and contextualise methods informing testing methodology in the mobile arena.

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ACKNOWLEDGEMENTS

Firstly, I would like to thank the participants for their input and for making this research possible.

Secondly, I am grateful to my supervisors Dr Alison Pickard and Dr Geoff Walton for all their helpful advice and suggestions throughout the course of this Professional Doctorate.

Finally, this thesis is dedicated to my wonderful family. Sian, for her support and encouragement throughout this process. Her support has really helped and the thesis would not have happened without her. Also to Sandy and Blu, providing me with a release outside the grind of qualitative data.

DECLARATION

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work.

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ABBREVIATIONS

Full title:	**Abbreviated**
Computer-supported cooperative work	CSCW
Global Positioning System	GPS
User Centered Design	UCD
User Interface	UI
Usability Evaluation Methods	UEM
Human Computer Interaction	HCI
Human Information Behavior	HIB
Information Seeking Behaviour	ISB
Information Behaviour	IB
Responsive Web design	RWD
Personal Digital Assistant	PDA
Short Message Service	SMS
E learning Platform	ELP
Information Retrieval	IR

1. CHAPTER ONE: INTRODUCTION

This Professional Doctorate in Information Science (ProfDocIS) is designed to inform teaching practice with a view to supporting both professional development and advancements in mobile testing. It aims to bring about a new way of contextualising Smartphone testing using models adapted within Human Information Behaviour (HIB) and Human Computer Interaction (HCI). The study investigates a group of students and their understanding of a prototype test model based upon these two research fields. The model complements the learning and teaching strategy of a Computing Science module based within the Faculty of E & E aiming to support and guide students' ideas when planning, designing and executing their own application tests in field conditions. Testing a Smartphone application in field (real) conditions has multiple considerations such as the ergonomics, motion, spatial factors and even the weather. This model supports critical thinking and decision making in test planning forming a contextualised approach to the overall strategy. The final output will be a model that synthesizes HIB and HCI practices to support Smartphone testing within natural/real contexts. This approach helps to galvanise the research aim, which will answer the question; what impact does this prototype model have on the development life cycle of a Smartphone application?

Smartphone take-up has grown exponentially, a growth that far exceeds any consumer technology in history. Weiser (1991) and Messter et al. (2004) used the term ubiquitous computing, with ubiquitous access to digital information through a wide range of mobile and embedded technologies, the Smartphone has taken this to the next level. The growth of these technologies has created a cultural shift, users are accessing, storing and retrieving digital information on more portable devices and doing so on the move.

This cultural shift away from the stationary context (i.e., at home or at work using a desktop PC) to a more mobile 24/7 way of accessing and consuming information is creating challenges. Today's developers and shapers of digital information (businesses, marketers, advertisers and web agencies, to name a few) need their applications to be workable to support the consumer in all contexts; at home, work, café or even a bus. When developing applications for these kinds of situations, changeable technological configurations and contexts are crucial to support the user experience and device interaction. In the early days of mobile computing researchers and usability professionals noted a range of challenges facing a tester's ability to accurately map a mobile users experience, this has been acknowledged by a number of researchers within the HCI field, Lindroth, Nilsson and Rasmussen (2001), being a prominent example. They analysed the implementation of

mobile tests, discussing a range of environmental contexts and configuration factors that "might make the result irrelevant since it fails to take the context of its use into consideration" (Lindroth et al, 2001, p. 1). They looked at different contexts confirming that a setting can be easily arranged and manipulated within a lab, which are more or less the same context as office and home environments. But what about being on the move? All users interact with their devices in different spatial contexts and varying modalities. Kwang & Grice (2004), Oulasvirta & Nyyssonen, (2009) De-Sa & Carrico (2011) note that past studies tend to focus on users of static devices, the tester has control over the context i.e. the environment in which the device is used. Clearly, as stated in one of the earliest papers evaluating mobile interactions on the move, Johnson (1998) discusses how well equipped we are to model cognitive aspects of users, their tasks and to model aspects of collaborations (p2, 1998). These models have stood the test of time working extremely well in many lab-based configurations, but how do they fare in an increasingly mobile information society? De-Sa & Carrico (2011) discuss mobile/smart usability evaluation needing to re-invent itself to keep pace with this evolution. The mobile context is very different with so many influences on the tester and the user of the mobile device (Kjeldskov, Skov, Als, & Hoegh, 2004; Kwang & Grice, 2004; Oulasvirta & Nyyssonen, 2009; De-Sa & Carrico 2011). This Professional Doctorate aims to support and contribute to the mobile testing evolution and will adapt some existing practices to help keep pace with the phenomenon.

1.1. Methodology

When looking at methodological approaches an appraisal of the origins and paradigms will support this research identifying approaches that a fit-for-purpose in the evaluation of mobile test practice. This chapter will acknowledge the different approaches distinguishing the empirical orientations of positivist & postpositivist, interpretivist and design sciences.

The research question is exploratory and in some ways descriptive. The use of the prototype model by students on a taught module takes place in their own space as they plan, design and execute tests. These tests will take identify in contexts that are true to the application and the spatial factors are shaped by this choice of context, for example, a student timetable could be used whilst walking to University or seated in the Students Union. The methodology will provide a platform to investigate their interpretations as they critically think, plan and execute mobile tests, this is interwoven into the prototype model and forms the basis of this investigative research.

1.1.1. Systematic Review (Informing Test Practice)

Aimed to seek and "push beyond the original data to a fresh interpretation of the phenomena under review" (Thomas and Harden, 2008, p8). This interpretation culminated in the

prototype test model aiming to support, re-invent and shape mobile test practice and experimental design to support learning and teaching approaches. A systematic review of HIB and HCI models and informed practice movement within the research fields which will complement the aim of study. This activity provided a critical analysis of practices supporting test practice design based upon theoretical models in HCI and HIB.

1.1.2. Models and methods to support mobile evaluation

Models in HIB and HCI provide an excellent platform for an evaluation of user behaviour and devices interaction in context. Key characteristics and commonalities are discussed within the literature review and critically anlysed within the systematic review supporting the learning opportunities that form this research. The core commonalities are based around "Information Needs" which drives both HIB and HCI. HCI research acknowledges a users' motivation is based around information, essentially the information drives the need to interact with the computing device (Johnson, 1998). From the HIB perspective models start with information needs underpinned by Maslow's Hierarchy of Needs. Pickard (2002) examines the role of information needs in the provision of learning opportunities and states the need to develop a conceptual framework. The role of a framework supports this study and the prototype model is applied as a framework guiding students through test development, it is also used as a conceptual framework providing the researcher with clear signposts to support data collection and comparative categories aiding the coding of the analysis.

The systematic review identified two models with commonality and characteristics which support the research and test prototype design. Models of user behavior notably Wilson's (1997) Model of Human Information Behaviour (HIB) will be discussed along with information seeking practices within Chapter 4, this is complemented with Kristoffersen and Ljungberg's (1999) "Reference Model for Mobile Informatics" which supports contextual and mobility factors within HCI. This model will be discussed along with Wilson's work to show the commonalities supporting and informing this research. Both of these models will be critiqued using a grounded approach to show how they shape professional practice and how they evolve to support the learning opportunities with this Professional Doctorate.

1.1.3. Auto-ethnography

The impact of this investigative research is determined by an evaluation of mobile application tests. The researcher uses a reflexive "auto" ethnography discussed in Chapter 3 to support the evaluation and this is divided into two separate observations. Firstly, in-class observations take place evaluating the test design and piloting within controlled lab conditions. The second observation is set within the field with no interaction or input with the

students. The research evaluates how the prototype model has been applied looking at the contexts and the conditions set specifically at test practice. This approach galvanises the research aim helping to improve the planning and strategic thinking in experimental design and development of mobile application tests.

1.2. Contextualizing Learning and Teaching

Improving learning and teaching practice is a key motivation underpinning this research, and utilises the learning opportunities within a final year module to develop innovative teaching and experimental practices. Applying a solid learning and teaching foundation provides in-class and field opportunities to improve mobile testing. This will ultimately support the research aim evaluating the relative impact a mobile testing model will have on supporting the student learning experience. De-Sa & Carrico (2011) discusses a need to re-invent experimental methods which keep pace with mobile interaction, designing new testing methods and experimental practice will help improve the learning and teaching experiences. These new practices provide a suitable environment to evaluate impact, impact on teaching and also impact of the prototype test model.

The researcher began the professional doctorate based upon a module delivered to computing students. The module is integral to the degree and using the learning outcomes fitted with this studies aim. For example, *"examine models of **user behavior** within different **social settings"*** demonstrates a need to understand theory and principles of user behavior and interactive design where this needs to *"implement methodologies that **track user experiences** within different social settings (Field and lab)"*. Using these outcomes as a starting point codes emerged forming a structure to the literature review which was based upon, context (social and physical), human information behaviour and usability evaluation.

1.3. Aims and objectives

The research presents an investigation the investigation focuses upon a test model. The model supported test case development and the research evaluates the impact of the model on mobile experimental practice.

Aim:

- To investigate the influence of mobile contexts (social, physical, mobility and psychological) on user behaviour and mobile interaction to provide a new approach to support user testing. (Objective 1, 2, 3 and 4)
- To propose a new model which can be applied as a pedagogical and professional tool supporting testing in a mobile context. (Objective 5 and 6)

Objectives:

1. Critically review HIB and HCI literature evaluating the influence of user context user context on behavior in order to inform experimental practices. The review identifies theories and practice exploring the importance of context in mobile tests and experimental design.
2. Develop a prototype test model that supports testing practice, the practices focus upon a user's context helping to guide application tests. The model is based upon the critical and systematic review of experimental practice appreciating user testing in a mobile context.
3. Apply the model to test a mobile applications set within a range of contexts – laboratory and field. Applying the prototype model will provide a vivid representation of student practice as they design and execute context aware experiments.
4. Use appropriate methods to reflect and inform professional practice by observing students' understanding of the prototype test model. The methods support the evaluation of practice assessing the interpretation of theory and how this interpretation has been applied using a prototype model supports the student experience on the module.
5. Present a new testing model that synthesizes theory and practice to support mobile testing within different situational contexts. The evaluation of findings will highlight key features and practices which will be evaluated in the final test model supporting the overall aim of study. This objective will provide a tangible output which will go back into the research communities.

2. CHAPTER TWO: LITERATURE REVIEW

A study of 5013 people in the US found that 87% used their mobile telephones whilst commuting to work or walking from one place to another and 72% consume media as part of their own entertainment (Google, 2011). As developers test mobile applications the space and movement of user is seen as a serious inhibitor to current testing practices (Lindroth et al, 2001), it is hard to model and difficult to evaluate in context.

A user's motion and their modality (standing on the train or walking the street) are important considerations in testing, as we can see most people use their devices on the move. One of the most important aspects of context in mobile computing is mobility itself (Barnard et al., 2007). The mobility phenomenon is nothing new everyone is mobile it just depends how it is viewed. The term is actually quite subjective and can have multiple variations and mobility is one of those words that is virtually impossible to define in a meaningful way (Kristoffersen and Ljungberg, 1999). A user's mobility is something that has manifested in our lives as they user mobile computing devices, life styles have become increasingly mobile as we interact with information. A users' transportation and geographical reach is dramatically augmented by modern technological developments (Kakihara and Sørensen, 2002). This increasing reliance on Smart devises has brought a multitude of challenges and user interaction is influenced by context (personal, social and physical) and mobility.

The exponential growth of this technology within society is credited with creating a "global village" (Kristoffersen and Ljungberg, 1999). The Oxford Dictionary (2015) defines the Smartphone as something that performs many computer-based functions, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded applications. The flexibility and portability has surpassed the old desktop PC which are now less appealing and convenient for everyday Internet access. Smartphones have become a key entry point to information surpassing all other static devices as the core tool for online communication (Noughton, 2012). The ubiquitous nature of mobile computing enables access to relevant information whenever and wherever in an active and/or passive manner. This technology is an empowering concept to many people (Barnard et al., 2007) recording their whole lives using applications for education, banking, shopping, lifestyle, gaming to name just a few.

The Office for National Statistics (ONS) reaffirms the cultural shift in computing use and internet access, "using a mobile phone to access the internet more than doubled between 2010 and 2013, from 24% to 53%". In 2015 "accessing the internet 'on the go' using a mobile

phone, portable computer and/or handheld device" has reached 74% of the British population. This growth in our society is having a huge impact on the way people conduct themselves online, shaping browsing behaviour and changing the way information is aggregated and presented. The impact is evident in a study conducted by ThinkInsights (2011) commissioned by Google™, the findings clearly show how mobiles are shaping our online behaviour. This study found 89% of Smartphone users use phones throughout the day, 79% used their phones for shopping and the most popular websites visited was the search engine at 77%. Steve Jobs predicted that people need the real web experience on their phone (Block, 2007; West, J., & Mace, M, 2010) this has transpired and mobile browsing has surpassed the PC and mobile usage continues rise.

To support this investigation this chapter introduces three themes to explore the aim of study and will begin the search to form a contextualised framework informing mobile testing within this professional doctorate.

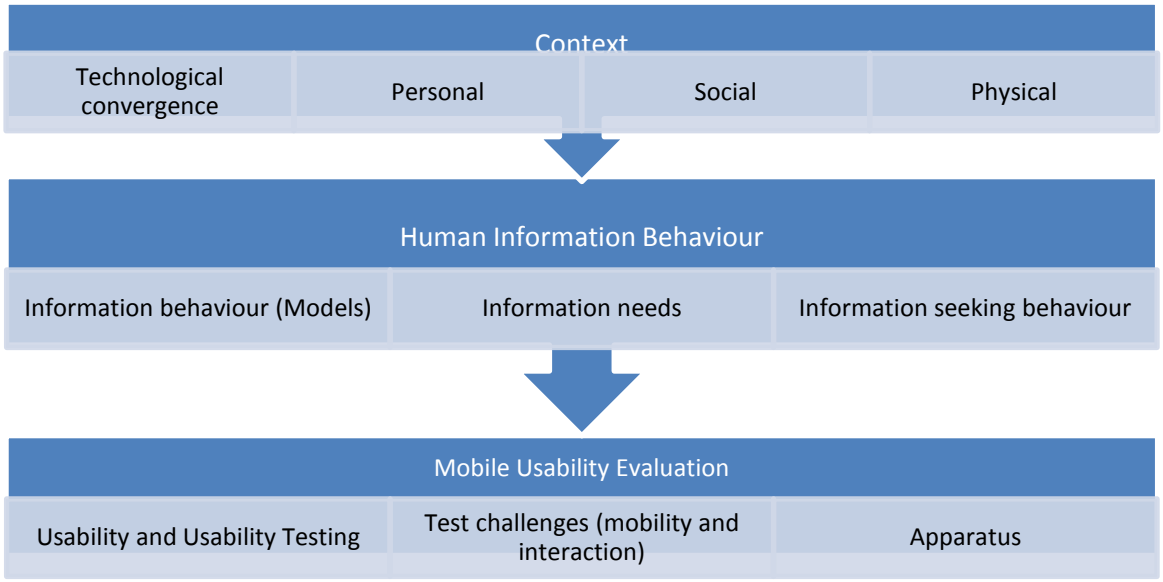


Fig 1: Literature Themes

2.1 CONTEXT

The term “context” has different meanings across subjects and disciplines, however there is a clear synergy between HCI and HIB, which is the user and their experience with information and technology. HCI and HIB are extremely important field within this investigation and Johnson (1998) points out that a user is driven to interact with a system on a mobile computing device to fulfil a need or demand for information. However, context is more than just an information need requiring interaction but is also central to most theoretical approaches to information seeking (Johnson, 2003; Case, 2012). Coupled with information need and seeking Chua et al., (2011) adds another layer of complexity to seeking in context introducing the situation of a place, person or physical objects. The situation characterised by Chua et al. can greatly influence or impair behaviour as a user interacts with a mobile device. These “situational impairments” are triggered by a range of contextual factors exerting effects on performance (Kane et al., 2008), impairments could be a users’ ability to read whilst walking (Barnard et al., 2007) or inputting data into a form whilst walking. Example like these can explore potential design changes that may ameliorate these situational effects (Barnard et al., 2007; Kane et al., 2008). Keshavarz (2008) describe the contextual importance in the design process considering context-based aspects such as task, environment and the organisational setting are of substantial importance. As Dervin (2003) points out that attempting to understand these different contextual variables research sees context as “taming of an unruly beast”.

This section will discuss some of the core influences, some historical, that have shaped mobile computing in today’s Smartphone market. The literature will evaluate context from the following perspectives, technological, personal, physical, social, and collaborative working environments. Following these perspectives aims to avoid what Johnson (2003) calls research becoming embedded in a ‘taken for granted’ reality in which contexts become a set of initial assumptions or limiting conditions on their area of inquiry (p738, 2003). Context is extremely important and establishing the correct settings will assist in the design of mobile tests.

2.1.1 TECHNOLOGICAL CONVERGENCE

Convergence between media and mobile communications created a mobile user needing up-to-date and timely information on the move (Nilsson et al., 2001). The preferences and behavioural changes to mobile interaction are having a huge impact on the evolution of Smart technologies. Consumer criteria is influenced by a variety of divergent arguments, for

example weight and size of the phone, the presence of specific functions (e.g. WAP), as well as optic features (e.g. colour, design) or socially prestigious values (e.g., price, brand) (Ziefle, 2002). Apple, HTC, Samsung and Microsoft are all vying for the consumers' attention pulling on existing product loyalty and innovation. The strong emotional attachments create a "must have" whirlwind nurtured throughout the products lifecycle and continues release-by-release with new features, updates and new interaction methods aim at improving user experience. The investments made on creating attachments are looking beyond the design as a whole to forge an emotional link between consumer and product (Norman, 1998). This emotional link is obviously working, research shows that Smartphones have become a hub and used by consumers with two thirds (66%) of UK adults, up from 39% in 2012 (Ofcom, 2015) owning and using phones daily. The Communications Market Report (2015) found that the smartphone is the most important device for accessing the internet (33% of internet users in Q1 2015), closely followed by laptops at 30% (Ofcom, 2015). With these products becoming an extension of ourselves this is all adding to the growth making the Smartphone integral to society.

The feverous competition does not end with consumer ownership. The visceral and behavioral traits filter into the operating systems (IOS, Android and Windows environments). Smartphone applications and browser preferences are adding to the intense rivalry. Similar to the browser wars in the early 90's the browser market on Smart devices has been shaped by the hardware providers, each provider competing for a share of the expanding browser market. In the past, using the desktop as an example, Internet Explorer (IE) held the monopoly at 76.2% in 2004. The market-share in 2016 this has dropped for IE from the heights of 72.2% to 5.7% with web users moving to Chrome at 71.4% (w3Schools, 2016). These technological shifts have primary taken place due to the popularity of the Android device which is a Google/Chrome browser.

Technological convergences are "one of the most interesting eras of mobile computing […] different types of specialised mobile devices began converging into new types of hybrid devices" (Kjeldskov, 2014). Different handheld devices share features and applications (e.g., instant messages, calendar, email, radio etc.) using similar metaphors and functions so users understand the interaction and purpose on the device (Nilsson et al., 2001). The Smartphone is continuing to pioneer convergence integrating the PDA, digital radio, music players, media streaming, cameras all wrapped up within a traditional mobile phone this created a plethora of devices. Nokia and Sony pushed mobile convergences, Sony attempted to bring back their past glories with a Sony Walkman for the 00's (see the Sony Ericsson W600) and Nokia a range of miniaturised phones with embedded cameras and

camcorders (see the Nokia N90). There are criticisms to technological convergences seen as weak and poor on usability comparable to the Swiss army knife: clumsy with a wide range of functions, none of which are ideal in isolation (Norman, 1998; Buxton, 2001; Murphy et al., 2005). The convergence of hardware, software and services, particularly mobile services requires network connectivity, mobile networks support interaction with applications online supporting communication, information sharing and information seeking via networks (like WI-FI and later 3G networks). In the early days, SMS was main source of communication with limited web access via a WAP browser using devices like the Nokia 7110. WAP never lived up to expectations due to slow data transfer and poor usability (Kjeldskov et al., 2002; Nielsen, 2006; Kjeldskov, 2014). SMS and basic online communication was improved through a 2G network using a circuit switching mechanism, as data transmission increased faster services were introduced (i.e., packet switching rather than circuit switching for data transmission) to increase the data transfer. Data transfer demands have not reduced and service demands from 4G networks are increasing, "during 2014, 4G subscriptions have leapt from 2.7 million to 23.6 million by the end of 2014" (Ofcom, 2015). This surge driven by the increasing take-up of 4G mobile broadband aiming at faster online access is good but comes with challenges at meeting this increasingly mobile community.

Technological convergences and mobile service networks continually challenge a users' experience, having an awareness of these possible challenges will improve test design. For example, travelling by train from Newcastle to York, mobile networks are at best intermittent and the signal varies in strength. Appreciating these issues will improve test case design and help tester prepare for these events evaluating the reactions and coping strategies of users in this context.

2.1.1.1 APPLICATIONS (MOBILE APP'S)

There are points in consumer markets when there is a "tipping point" this could be an upturn or a down turn within a market (Gladwell, 2006). The iPhone revolutionised the Smartphone market with a clean design and new interaction style. The multi-touchscreen, new gestural controls (pinch and swipe) and embedded context sensors that change screen orientation, created reflective appeal to the user but also changed interaction behaviour. The convergence of two popular mobile technologies (i.e. the phone and the iPod) created a goliath of the mobile market - however this makes part of the success story. The iPhone was not just a fashion accessory with reflective appeal but Apple's business model created a new "open" mobile application market (AppStore). Open in this context does not mean "open source" but a more open market for developers to build software for the iPhone. The

AppStore enabled developers to build a range of application; social environment, media streaming, games, life style applications to name a few. This was made possible using the software development kit (SDK) for the Apple IOS and created a business model controlling the flow of applications into the store and handled payments where creators received 70% of the profits (Apple, 2015). In 2014, Apple stored 1.3million apps within the AppStore (TechCrunch, 2015) and worldwide in June 2014, Apple announced that 100 billion app download from App Store (Statista, 2015).

The impact of the Apple's business model has had far-reaching effects on the mobile marketplace especially on the development of software. Looking back at recent developments the emphasis has been software development indicating a level of stability in terms of physical form factors, basic input and output capabilities, in favour of a focus on applications content and context of use (Kjeldskov and Paay, 2012). The evolution and technological conversion of applications has made smart contexts more complicated. Currently there is very little in the assessment application convergence, user experience and user needs within these dynamic contexts. This research aims to address some of these issues. For example, what influence does multiple applications have on the users' needs and their behaviour? How does movement between applications on a Smartphone impact on users' memory load as they attempt to fulfil a need? These types of questions influence mobile context research and greatly influence application functionality and design.

2.1.2 Personal Contexts

To truly understand a users' needs identifying the key aspects of the person, his/her social environment and his/her interaction with information that would facilitate their own personal requirements (Hepworth, 2004), especially in a mobile setting. Contexts that involve people, things, events or ideas that process psychological importance for the individual build into their personal context creating different levels of certainty (Atkin,1973). A personal context is something you swim in it like a fish, it encapsulates the situation and relates back to their own personal needs and goals (Dervin, 1997). The users' interaction with a mobile application is of great importance, their personal state of mind and the influences around (socially and physically) will influence the way a user interacts with the device. Within information science, research has shifted its emphasis away from information needs from an institutional information sources (libraries) towards individuals encountering and make sense of information in their own personal context (Case, 2012). An individual's environment or personal context is challenging to model and offers levels of complexity as information needs on mobile device are competing for their limited attention (Heikkinen et al., 2009).

Within this investigation personal contexts are extremely important, establishing the “person” in a social and physical context can impact on interaction, for example, at home alone will differ to interaction is a group context, their own technical competence will influence their personal state of mind whilst interacting. Understanding the personal contexts supports this research by identifying possible personal user settings, needs and goals - aiding test sampling – all of which will have an impact on device use in context. Establishing these influences will support data capture adding to the evaluation methods of the user as they use the application within a test.

2.1.3 PHYSICAL CONTEXTS

An individual is embedded in a physical world, a world involving recurring contacts with interpersonal networks of co-workers and computers providing internet access (Savolainen, 2009) all situated within a personal and physical context. The architectural and institutional context needs to be identified (Agre, 2001) and will support test case design providing a place to test the mobile application. It is also worth noted that the physical objects within a physical context will also have an effect on device interaction (Kristoffersen and Ljungberg, 1999). For example, a Smartphone user on a train is influenced by being on a moving train (the physical context) but there are other physical objects i.e. tables, chairs, doors etc. These objects are context bound and influence user interaction and possibly constraining interaction, Paay and Kjeldskov (2005) explain a user does have a strong ability to make sense of the physical space in which they are situated, physical contexts influence personal and social context i.e. distracted by objects, people, tasks or movement like walking or by driving (Negulescu et al., 2012).

Mobile HCI and IB acknowledge the role of the user within a physical context, physical environment will impact on users’ experience with information, their understanding and behaviour (Kristoffersen and Ljungberg, 1999; Agre, 2001; Paay, J. and Kjeldskov, J. 2005; Oulasvirta and Nyyssonen, 2009; Savolainen, 2009). Sonnenwald (1999) presented the information horizon, which maps information sources a user needs and the perceived importance of information with a physical context. Savolainen (2009) sets a “realistic and pragmatic approach to spatial factors emphasising the way in which information sources are available in different places to support information seeking”. Dix et al. (2004) make a clear connection between the user’s physical surroundings and the information presented creating a clear synergy to HIB and HCI. Savolainen (2009) and Sonnenwald (1999) both use information sources set in physical surroundings, the surroundings can influence a user’s

understanding of information putting them in a mobile context helps to depict how a user behaviour, interaction and use creating a clear connection to the fields aiding this research.

Past studies have focused on a variety to physical contexts, using real work contexts like the working environment for example a network engineer (Kristoffersen and Ljungberg, 1999). This research presented a model acknowledging physical contexts to support mobile/hand held computing device tests. The model helped to present wider environmental constraints to testing from a HCI perspective. Their "Mobile Informatics Model" was seen as a reference point and has influence many other context-driven tests (Lindroth et al., 2001; Nilsson et al., 2001; Kjeldskov & Stage 2004; Beck et al., 2003; Goodman et al., 2004; Roto., 2004; Kallio et al., 2005; Kaikkonen, A, 2008; Oulasvirta et al., 2005 & 2009; Barnard et al., 2007; Chua et al., 2011; Hussain and Kutar, 2012; Sun and May, 2013). Bouwman and Van De Wijngaert (2002) set their research within two contexts one being at home and the other at work evaluating communication and seeking approaches. Another popular context and one that is not surprising was the academic environment and the physical objects within the surrounding area, this was a popular physical environment applied by Kjeldskov & Stage, 2003; Beck et al., 2003; Barnard and Yi, 2007; Kane et al., 2007; Burnford and Park, 2012; Redondo et al., 2013. In some of these cases the research took a comparative stance to compare the lab environment against the field to see if there was value in field testing when identifying usability problems. The Mobile Informatics Model is seen as a platform which has the potential to support mobile testing, even though this model was presented to the community in 1999 the principles are still relevant today and has had a strong influence within the community.

2.1.4 Social Context

Social context is central to all explanations of social science and social action, which must occur in a context (Bateson, 1972; Goffman, 1974; Johnson, 2003). Chua et al. (2011) identified four influences, which shape a social context; location, time, activity and social surroundings. Identifying social qualifiers, especially within a mobile context is demanding within everyday life, the way users seek and share information are less directly influenced by norms and role expectations which are expected in work related tasks (Savolainen, 2009). Seeking and/or searching behaviour have altered over time, space and location, time and the social contexts have all influenced search behaviour (Teevan et al., 2011). Teevan et al. noted that collaborative searches appear to often have been triggered by social means, such as a conversation or group need.

Appreciating social contexts and applying these to support a user test requires an understanding of peoples physical and social constructs together and as Paay and Kjeldskov (2008) point out an understanding of the interplay between tests and the situations a user finds themselves. Dervin (1997) and Johnson (2003) discuss the persistent problem of accounting for an individual's action in a social context and this is seldom explicitly addressed, we are unaware of the different senses of context of use. As Smart devices facilitate peoples' social lives in and out of working environments there is a clear need to have a better understanding of the physical and social context of the user situated social interactions (Donath, 1996; McCullough, 2004). Capturing the context of use is challenging and it is difficult to get a rounded view of the user in these social settings, which would provide a better understanding of device interaction.

2.1.5 Working Context and Cooperative Work

Computer-Supported Cooperative Work (CSCW) has seen a rapid and accelerating move towards mobile technologies providing individuals and organizations with the tools to work in novel and previously unanticipated ways (Perry et al., 2001; Kjeldskov, 2014). Portable computing not a new phenomenon even before the "Smart" generation mobile computing devices (PDA, net-books and early mobile phones) have supported large organizations. It is it is widely accepted that commerce, back then and now, are witnessing the emergence of newer forms of organisation, in particular the fragmented or disaggregate organisation consisting of dynamic networks (Luff and Heath, 1998). This disaggregation has created contexts allowing employees to work portably, and the growth of mobile computing is centered around "cooperative" working where project team promote cooperative communication within portable environments increasing "IT bridging" distances (Dahlbom and Ljungberg, 1998). These changes have the potential and have provoked "even more radical changes in work practices and encourage an even greater level of mobile work and distributed collaboration" (Perry et al., 2001, p324).

CSCW has created seismic changes altering information and communication behavior, which has changed the working and social landscape. Traditional mobile phone use (a main stay in connecting and communication) has seen a dip the number of actual calls made from mobile phones. A fall of 1.1% on 2010 figures and subsequent falls have continued. Mobile voice revenues fell by 0.9% to £10.5bn while messaging and handset data revenues increased 5.5% to £4.6bn (Ofcom, 2012). This "downturn" in call numbers and voice messages coincided with the "up-turn" in social networking. The social movement on the Smartphone driven by mobile websites and apps it has become a key source of information

and has surpassed email as the core communication mechanism (Google/IPSOS OTX Media CT, 2011). Grouping the social networking statistics from the Ofcom report puts total mobile usage to 53% meaning that most mobile users' time is tweeting, re-tweeting, liking, sharing etc. This has continued to be the case in 2015 social media usage on the phone is at 76% in the UK (Bolton, 2015) and social communication is seen as the hub for most mobile usage.

In summary, personal, physical and social contexts are extremely important and something that underpins the aim of this research. Taking a pragmatic approach to spatial factors and the influence this has on a user's ability to seek for information is important in understanding the effects on user interaction in context (Savolainen, 2009). A context significantly influences behavior and interaction. For example, a busy café has a number of possible distractions affecting user engagement and interaction. A social cafe setting where a friend talks to the user as they interact fragments their attention. This cognitive division between interaction and responding to the friend impacts on the way the user behaves with the device. These distractions are of relevance to a tester planning a mobile experiment for a social networking application. The application, predominately used in a social setting (like a café), will support the data collection appreciating possible distractions in this context aiding usability evaluation.

CSCW outlined how a collaborative mobile society is influencing interaction behaviour. The principles around portable working and communication appreciate spatial factors with the emphasis on context of mobile use. Placing this emphasis on context will significantly improve the accuracy of how user interaction with information in everyday settings. To support the students' experience as they plan context-aware tests applying the "Mobile Informatics Model" puts tests in context (Kristoffersen and Ljungberg, 1999). The model considers social and physical influences to interaction and places an emphasis on physical objects within a physical space. Layering this with IB's personal context provides a rounded context rich experience to test.

2.2 HUMAN INFORMATION BEHAVIOUR (NEEDS, SEEKING AND BEHAVIOUR)

Human Information Behaviour (HIB) research is a complex and evolving covering many different fields such as; library and information science (LIS), health information, marketing, psychology, cognitive sciences and computer science. The complexity with HIB occurs because each field has its own scholarly stance investigating the subject with different interpretations and aims from different perspectives (Wilson, 1997). The primary aim behind HIB is its ability to describe how people need, seek, manage, give and use information in different contexts (Savolainen, R. (2007). Information needs and information seeking is core to HIB and has different brands across the information science community described as information-seeking behavior or information behavior (IB). There are clear synergies between each component of HIB, for example, Case (2012) explains that the information need is somewhat a cause of information seeking (pp. 80). An information need is the primary starting point which requires a seeking strategy the information need is seen as a motivator for a user to interact with their Smartphone. This information need is what Johnson (1998) explains drives user interaction, this research aims to use these principles to support mobile test design and information needs enables students to identify features they want to test, capture and evaluate.

2.2.1 MODELS OF INFORMATION BEHAVIOUR

Modelling is essential for "effectively understanding the IB of users" (Hamid, 2013, pp.1) and helps to express the fundamental elements of HIB. A model is described as a framework for thinking about a problem, which may evolve into a statement of the relationships among theoretical propositions (Wilson, 1999). Models are most useful at the description and prediction stages of understanding a phenomenon (Fisher et al., 2005). In the general field of IB models are statements often in the form of diagrams, statements that describe activities noting cause and effect to a user's need for example, a seeking activity, or the relationship among stages in IB (Wilson, 1999). Appreciating these activities within IB help to improve awareness and identify influences affecting user cognition and/or affective behaviour. These factors may predict possible changes in IB explaining a user's interaction with information different contexts. Explaining the influence and interaction changing in user behavior will complement and support mobile test design whereby a tester will identify and plan IB capturing interaction in a personal, social and physical context.

There have been numerous models of IB which have evolved over the years (Hepworth, 2004). The increase of communication platforms, mobile being one, has seen a rise in

models within HIB**,** Fisher et al. (2005) acknowledged 70 HIB theories and models, later Houston (2009) completed a list of about 108 theories and models relating to HIB in his doctoral dissertation. Having such lists and sources, there is now a better picture of HIB models and theories but this also adds a level of complexity identifying the ones that are fit-for-purpose for a researchers need.

2.2.1.1 MODELS THAT SUPPORT IB STRUCTURE AND CONTEXT

In an attempt to focus and narrow down IB models Table 2.1 supports this area of research. The table is not an exhaustive list but one that informs this chapter and future work within this research, the table aims to contextualise IB models. Whilst there are 108 theories and models the one listed in Table 2.1 are based upon citation popularity and their use of contexts; personal, social and physical. The table supports the research objective to "investigate the influence of user contexts (natural environments, ergonomics and motion) on their behavior". Appreciating IB models, which apply information in context will add value to this research and support contextual mobile practices setting the personal, physical and social contexts to mobile interaction behaviour. Evaluating models in IB support professional practice and help to support students testing practices where information behaviour is a core element to the modules learning outcomes.

Author	**Models focus**	**Approach**	**Context variables**	**Information Behaviour**	**Citation No.** **Taken (04/03/16)**
Saracevic (1996)	Stratified interaction model and theories a (simplified) three level structure: surface, cognitive, and situational.	Objectively searching – information retrieval.	Situational and environmental contexts.	An series of steps interacting at different levels to adapt and use the information from a IR system	217
Ellis (1989, **1993**, 1997)	Behaviour Model Structuring information seeking flows	Information Needs (Research Project comparing two different user groups)	User activity: start, chain, browse, differentiate, monitor, extract, verify, end	Fulfilling needs in a series of steps (sequence is not fixed)	562
Bystrom & Jarvelin (1995)	Task based information seeking	Need and seeking	Personal and situational factors (environmental contexts)	Information needs analysis; choice of action; implementation; evaluation.	201
Wilson (1981)	Information Seeking behaviour	Need and Seeking	Seeking information and purchasing via an	Information demand; success; failure; use; transfer	1337

			information system		
Dervin (1983, 1996)	A set of assumptions, a theoretic perspective, a methodological approach, a set of research methods, and a practice.	Information seeking – seeking clarity in the world around us	Sense-making; base on users situation (environmental contexts)	Situation > Gap > Outcome	444
Savolainen (1995, 2005)	Information seeking: Everyday life – keeping order of oneself	Information needs and methods of seeking in real life conditions	Mastering life; individual activities/projects and real life situations (environmental contexts)	Keeping things in order; problem solving behaviours	699
Wilson (1996, 1999)	Human Information Behaviour – Holistic view of need and behaviours	Context; person-in-context	Psychological; demographic; role inter-related; environment; source characteristics	Passive attention and search; active search; ongoing search; seeking, use and processing.	1301
Taylor (1968, 1986) Eisenberg (2008)	Value-Added model (User criteria > values > processes)	Needs of; people, Information and systems.	Contextuality; planning trips; Flexibility; PC or Mobile	User needs and preference	788

Table 2.1: Models that have the characteristics needs, seeking, information behaviour and context

Stratified Model: Saracevic's (1996) "Stratified Model" presented a model mapping information retrieval (IR) approaches and processes. The primary aim of this model charted out user interaction within a system reviewing the types of queries created to inform retrieval behaviour. An interesting characteristic within this model is the situational and environment contexts which could influence IB and a user's ability to conduct the IR queries and request relevant information.

Behavioural Model: The "Behavioural Model" created by Ellis et al. (1993) applies structure to the seeking approaches to IB as a user takes follows these steps to fulfil their information need. The model provides a clear direction supporting the information flow via "chaining" to make connections between materials via an iterative process monitoring developments throughout the chaining process.

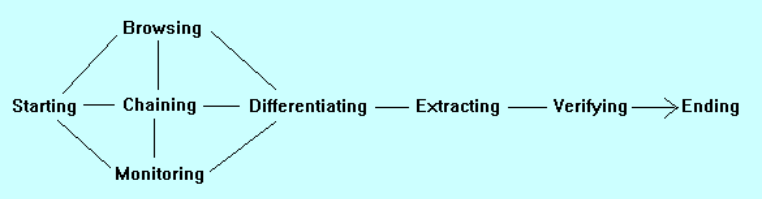


Fig 2.1. Wilson's Interpretation of Ellis's Behavioural Model. Source: Wilson (1999, p. 255)

Case (2012) supports the contributions made by the behavioural model making it clear that seeking sequences are not set in stone and actions within the model can be iterative and

adapted depending on the context. The model provides a clear flow with actions between events which show how a user interacts with an information system, which could be a mobile system.

Task-level analysis model: Byström and Järvelin (1995) designed a task-level analysis model charting the effects of task complexity on information seeking. The model examined information needs and behaviour initiated by a "choice of action", the model included situational factors set in a public administration setting with "organization" as an environmental attribute providing context to the model.

Information Behaviour Model: The model explained information needs and seeking within the context of Information Systems (IS) retrieval, the model also introduced "holistic" ideas to information seeking in context outside IS retrieval practices (Wilson, 1981). These ideas around the model acknowledge the importance of IB and information needs but also a need to explore external factors, "as living and working in social settings which create their own motivations to seek information" (pp.10, 1981). These context are becoming more and more important. Appreciating a user's context especially in this mobile society where many information needs, requests and demands are required in social and work settings.

Common Sense Model: Dervin (1997) created what appears to be a simple common sense model, the common sense to the model is the fact that information research needs to consider the situation where this takes place in an everyday setting. The idea of "Sense-Making" was not simply depicted as a model but a theory (Wilson, 2000) this theory is implemented using four components, for example;

1. Situation: time and space, which defines the context where information problems arise.
2. Gap: differences between contextual situations and the desired situation (e.g. uncertainty).
3. Outcome: consequences of the sense-making process.
4. Bridge: closing the gap between situation and outcome.
   (Dervin, 1997)

Sense-Making: Sense-Making theory helps to establish the user need for information, behaviour and the context – which could be a different environmental setting - where this takes place helping the research "make sense" of each given situation. Dervin cited in Case's work explains that "context is central to the transfer of information seeking research and demonstrates that people strive towards a holistic view of their world" (p376, 2012).

Everyday Seeking Model: Savolainen (1995) developed his model via interviews with people undertaking "non-work activities" noting that a lot of IB research neglected everyday

activities that require information seeking practices. The model considered the role of social situations and cultural factors that influence information seeking. Savolainen also considered personal and situational factors like psychological orientations to life and the influence time had on the seeking process. The idea that “everyday” things influence user behaviour is important and will impact on their approach. Wilson (1996, 1999), like Savolainen, also used psychological factors citing influences from academic disciplines, like psychology and health.

Human Information Behaviour Model: Wilson set a broad context of information need defining this as an “information type”, type being an information need, request or demand from the system (Chowdhury and Chowdhury, 2012). The model is then broken into distinct stages building into a framework with activation mechanisms which aims to capture influences on the user cognition (i.e. stressing/coping and the rewards in achieving the right searched result) and intervening variables helping to profile the user which supports the seeking approaches and what the user does with the information. The broadness of this model (Fig 3.) was in Wilson’s response to “the range of contexts within which information behaviour now studied showing that the field has expanded well beyond…. service needs of scientists” (Wilson, 2000). Wilson (1999) has proposed that his model is seen as a “global model” of the IB field (Wilson, 1997). In summary, this model builds into a flow that ensures: problem recognition, problem definition, problem resolution, and (where needed) solution statement (Wilson, 2000).

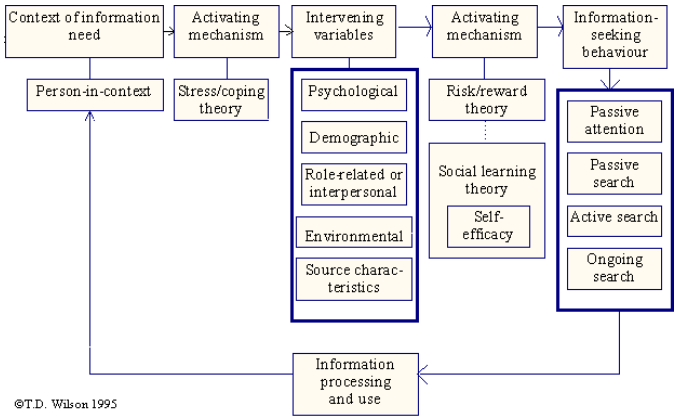


Fig 2.2: Tom Wilson’s Model in Information Behaviour

Value-Added model: The adapted version of Taylor’s ambitious Value-Added model by Eisenberg (2008) reviews the core principles of Taylor’s model and contextualizes the principles with more up-to-date systems and platforms, like the web and mobile interfaces. The work in this paper acknowledges what Nielsen (2000) set of within usability (predominately web usability) that there are many changes in technology but there is still one

user**.** Wilson's model helps this research builds upon HIB and help to contextualise this within the way users interact and use information. The next section to this chapter builds upon HIB and adds more context to the environments.

The IB models used as part of this literature review apply information research in context but this mainly in a traditional information and library environment, Table 2.1 demonstrates (by the number of citations) the value of IB within the information research field. This research aims to contextualise user behaviour and its many forms as a way of informing theory within mobile testing arena. The model that encapsulates this "holistic approach" to IB is Wilson's (1997) HIB model. Whilst the model is 20 years old and there have been many iterations supporting information research this model as a framework for IB has stood the test of time. The HIB model pulls together the personal, social and physical characteristic to information behaviour in a structured approach to IB. The model provides this research with the correct framework that has the potential to inform user behaviour in a mobile test context. The HIB model also supports the professional practice (driven by modules learning outcomes), and as such, a more detailed systematic review of HIB in practice will create a deeper understanding of the models applicability in building test practice examples.

2.2.2 INFORMATION NEEDS

Models with IB create frameworks to appreciate user behaviour with information but the trigger to IB models is the need for information. Exploring information needs as a trigger to drive searching is seen as a potential starting point for a mobile test. This section will review literature to support information need as a starting point.

People discover information everyday while monitoring the world (Wilson, 1977, pp. 36-7) and with the ubiquitous nature of Smart devices, this is a significant access point for all information activities (Burford and Park, 2014). The Internet, which is now more widely accessed via a Smart device than a Desktop PC is a metaphor for IB and has changed our view of information and how this is accessed (Case, 2012, pp. 4). The Internet is the information gateway of choice and the cultural shift to Smart devices connects the users to information in any context. As such, the design of positive mobile experiences requires a deep understanding of the information needs, behaviours and underlying motivations of mobile users (Church and Oliver, 2011).

Exploring philosophies around information needs in the context for this research will help form a clear starting point for mobile interaction. Case (2012) establishes information needs

based upon a number of sources one being Grunig's (1989) motivational need driven by an inner-state motivating users into action (1989, p.209). This "inner-state" uses Abraham Maslow's theory where humans go through various states in a Hierarchy of Needs to feel self-fulfilled in the world. This hierarchy is a significant representation for understanding human motivation and could be used to show the point where a user feels the need to find information on a smart device.

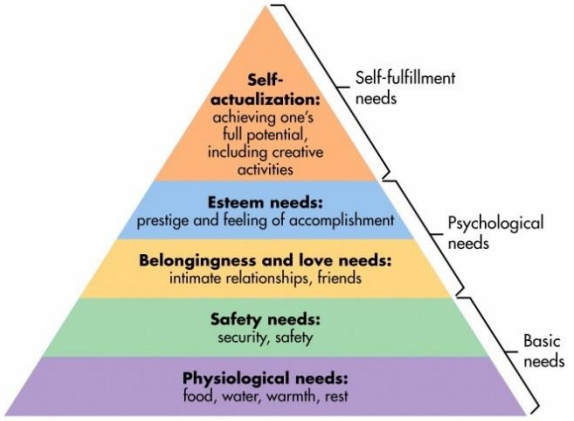


Fig 2.3: Maslow "Hierarchy of Needs"

Humans are motivated by needs and Maslow identified 5 basic human needs within a hierarchy; physiological, safety, belongingness, esteem, and self-actualization. Each need becoming a motivator after the preceding need has been satisfied (Weiler, 2004). The most basic survival needs evolved over thousands of years starting at the base of the pyramid looking at physiological needs (Maslow, 1954; Poston, 2009). Only when the most basic needs are fulfilled (food, safety, shelter etc.) can humans move up the hierarchy to a point where the higher order needs influence personal development. The hierarchy provides a set of building blocks which help to evaluate and establish possible changes in human behaviour.

Researchers are able to use Maslow's hierarchy to indicate all human needs within their context of research - information need being one. Weiler (2004) evaluated students' information seeking behaviour on a University campus, where "physiological and safety needs are for the most part provided; the other needs are in an ongoing process addressed at different levels" (pp47, 2004). Capturing information needs is problematic and continues to challenge information research (Belkin and Vickery, 1985; Case, 2012). An information need exists inside someone's head and must be inferred by any interested observer while a search is in process or after it has taken place (Case, 2012). Wilson (1981) believes that the notion of an information need is an unrealistic concept and cannot be observed. Not only is this a hard or an unrealistic concept there needs to be a distinction between need and

demand for information. Information demands setout initially in early works by Brittain (1970) tie demands to requests made within an information system. Data regarding demands such as a database request are relatively easy to measure and help to evaluate a systems performance. Taylor's 1968 Value-Added Model (VAM), which was revised by Eisenberg and Dirks (2008), evaluated information needs based upon information system requests. Taylor's typology contextualises needs identifying; people, information and systems establishing that systems are in essence processes, algorithms and features that need to meet a users' need. As technologies evolve and converge the information activities and changes to user behaviour within different context requires a clear understanding (Church and Oliver, 2011; Burford and Park, 2014). The mobile device and the systems used fall into Taylor's typology, a mobile user will request or demand information to meet their needs this research wants to contextualise the information needs to capture the user interactions and behaviours a natural context (personally, physically and socially).

A users' information need drives this research and IB models create a framework to model a mobile test. Maslow's hierarchy contextualises information needs as a motivator to user interaction on the Internet, which is now the main information access point (Case, 2012; Burford and Park, 2014), this can be applied to a mobile setting. Using the theories and principles set out within information needs, mobile tests can be positioned around Maslow's human behaviour and depending of the contexts influence self-actualisation as a user fulfills a need. Human behaviour adds another contextual layer (supporting personal contexts) and used within a mobile context the student (as a tester) can reflect upon the personal state of the user as mobile tests are planned.

2.2.3 Information Seeking Behaviour

Improvements in mobile technologies in recent years have led to a dramatic change in how and when people access and use information this is having a profound impact on how users address their daily information needs (Church, K & Oliver N, 2014). Information Seeking Behaviour (ISB) a fundamental practice within Information Science is a process of finding information to meet a user's need, defined as the attempt to acquire information from selected information carriers (Johnson, 2003). ISB can take place when a person has knowledge stored that precipitates an interest (Lerbinos, 1990) or a knowledge gap motivating an individual to acquire new information (Dervin, 1983). Historically, ISB is a common data gathering activity on either users or potential users' (Hepworth, 2004). This behaviour differs to that of information searching, there are commonalities however to align this research information seeking behaviour provides a more holistic approach capturing the wider external context to an individual's behaviour. Wilson (1999) defines ISB as the general

behaviours surrounding the actual initiation of information seeking (1999, p. 12), evaluating external influences outside the search within information retrieval systems. Shih et al., (2012) explain that this type of seeking behaviour obtains information from existing resources in both human and technological contexts noting that past research applied information seeking behaviour of users to determine their needs. Shih et al. established that the seeking act can take place in many ways and are becoming more technologically driven, this could be a request from a database in a library or a database accessed via a mobile device. Seeking behaviour also has the ability to influence system design principles and not just the searching strategy providing clarity to developers on the navigational routes identifying exactly what kind of information is needed to be in the record and of rules for the design of interactive systems driven by information behaviour (Wilson, 1999).

To evaluate seeking practice that is appropriate for this research Case (2012) offers a breadth of research contextualising needs and seeking without bias. Case established four categories supporting seeking behavior whereby an individual; seeks answers, reduces uncertainty and makes sense and spectrum of motivation, which establishes the types of objective and subjective seeking practice adopted. These types of behaviours provide this research with an approach, which can be planned and adopted within mobile tests to support the test planning and anticipated outcomes from a test within context.

2.2.3.1 SEEKING ANSWERS:

Seeking answers was based around a topology of needs developed by Johnson (1962, 1968) whilst working as a librarian on a library reference desk. Johnson divided users' seeking needs into four, to articulate the topology the description is based around a user seeking for answers to a Network connection via Freeview:

1. **Visceral**: A user has a conscious or unconscious need whereby the user is unable to articulate in linguistic terms. This could be for example, a product search; the user has swapped broadband supplies but cannot connect to Freeview because the box is not "hardwired" to the router. The user needs a "Powerline Adapter" but they are not sure this is what they need Powerline Adapter and resort to a Smartphone exploring suppliers via FAQ's and blogs to fact find components needed.
2. **Conscious**: Johnson's Library experience depicted this as a user's rambling statement - slightly incoherent. Using the Freeview example, this could be a search within the broadband supplier's website, they user have a search idea or theme (Cannot connect to Freeview) but not a definitive category (i.e. searching for

adapters but not the powerline adapter). This is a conscious need resulting in a request for help online or reviewing installation videos, via YouTube.

3. **Formulised**: They are able to construct a formulised statement of need, this case established the connectivity problems been found and the user does not have a Powerline Adapter, at this point they still do not know whether the need can be solved by the current Freeview site but they have identified a knowledge gap to solve this connectivity problem.
4. **Compromised:** The right search terms have been established the user can use a search engine or mobile application (Amazon) to find the product to fulfil the need. This may also be an opportunity for the user to scope out options to index and find the best deal, surveying and evaluating products options.

2.2.3.2 REDUCING UNCERTAINTY

ISB is most commonplace and not an object of concern until time pressures make it so (Belkin & Vickery, 1985; Lerbinos, 1990); time pressures psychologically trigger a need to acquire information to change any uncertainty (Burnkrant, 1976; Maity et al., 2014). Shannon and Weaver (1949) polarized information and uncertainty and as research and scholarly dialogue explained how uncertainty was a motivation for information seeking. Within IB research Belkin et al., (1982) encapsulated information needs, seeking and uncertainty in the Anomalous State of Knowledge model (ASK). Initialising ASK occurs when there is, as Belkin calls it, an “anomaly” gap or uncertainty in an individual’s state of knowledge. The individual hits an anomaly and face a level of uncertainty addressing the anomaly by requesting or consulting information.

Using the Powerline example, a user is now installing the Powerline Adaptor but does not understand the jargon presented in the user guide. This jargon presented to them creates feelings of uncertainty, feel there is a gap in knowledge, and this needs clarification. These are also levels of stress about plugging this into the wrong connection and could over power the adapter. An ASK is generated to reduce this uncertainty, the individual accesses a YouTube line in the user guide for a video walk through reducing the levels of stress.

2.2.3.3 MAKING SENSE

Making sense of information in the world around has connections to communication theory in particular is semiotics. Case (2012) used Artandi (1973) to introduce making sense theory as a framework to reduce uncertainty. An individual would apply semiotics to create meaning or “make sense” of the information deconstructing the linguistics signs meaning to the

information presented (Artandi 1973; Case, 2012). Within a mobile context with could be scanning the information looking for information hooks which help them make scene of the need. Dervin et al., (1993) and Savolainen (1995, 2009) contextualised sense making by researching how individuals made sense of world events implying that information needs was a compulsion supporting the individual's current situation. This compulsion arose when faced with problems and/or worries to make choices to understand something (Burnkrant 1976; Dervin et al., 1993; Maity et al., 2014). Savolainen (1995) followed a similar pathway as information seeking takes place in "everyday" contexts, and to make sense of seeking practice the user needs to make sense of the environment where this seeking takes happens. Making sense of information especially in a mobile context of "everyday searching" will effect on the way seeking practice conducted. For example, information seeking practice is different sitting at home compared to travelling on a train or walking to work. These situations contextualise an individual's "everyday world" influencing their physiology to complete a task and psychologically is set in these different social and physical contexts.

2.2.3.4 SPECTRUM OF MOTIVATIONS

Information research recognises information seeking as a general process to find something. However, an individual's motivation to fulfill the need requires some reflection before the process can actually begin (Case, 2012). An individual's motivation to seek for information is determined by a number of factors, i.e. the pressure, physiological and psychological constraints to the seeking activity. Case forms seeking activities into two spectrums:

1. **Objective:** The individual is uncertain about something and needs to make some form of rational or objective judgement call to reduce uncertainty. A typical objective would be to retrieve a fact and make a decision or solve a problem, a "non-instrumental" seeking motive (Atkin, 1972).

   Based upon Powerline Adapter example this could be that the individual's product is faulty and they need to locate the PDF receipt to send to customer services. They also need to find the contact services email to send the PDF for a refund – the information need is fixed, it's an objective task.

2. **Subjective:** By its nature, is a search like many on Google promoted by a vague feeling of unease and the individual is seeking to find answers to support which will formulise a need. They sense a gap in knowledge, or are anxious about the situation and driven to "make sense" of the situation, subjective is not about merely finding a

fact or piece of data. This situation is a discovery of information in everyday life while monitoring the world (Wilson, 1977; McKenzie's 2003).

For example, the individual is totally lost about the return and refund process for the Powerline adapter. They do not want vouchers and want a cash refund and they need to put all the information together to meet the need. They are puzzled need to make sense of the returns process i.e. repackaging, returns procedure and acquiring the online receipt. The individual starts by typing into the search engine "faulty product returns" and this subjective term returns a wealth of information regarding fixing a product, refunds and returning procedures. The individual has to make sense and put together all these disparate bits of information to fulfil the need and get the correct refund.

There are areas that overlap between objective and subjective seeking and as such, research should not stereotype from one end to the other. However, it is worth noting that objective tends to focus on the psychological aspects of processing information or data. Whereas, subjective holds that an understanding of the receiver as making sense of the world lead to more accurate picture of when and how messages are received. These seeking approaches are by no means exhaustive of all seeking behaviours but the categories contextualise the how, when and where ISB will happen and how it will influence user behaviour.

In conclusion, Wilson (1997) explained that the HIB model is a springboard to research based upon a wider, holistic view of the information user. This view encapsulates the individual not just as someone who drives to seek for information but as an individual living, working, communicating and sharing information in context (socially and physically). This creates different motivations on the individual and Wilson later proposed that ISB is a goal-determined behaviour (Wilson, 1997; 2000). The HIB goal creates as a framework that pulls together attributes of human behaviour, information needs and seeking mapped upon mobile device use. To add value to the HIB model Dervin et al., (1993) and Savolainen (1995, 2009) acknowledge spatial factors where these seeking activities will take place in context. Spatial contexts support this research and appreciating space, whether personal, social or physical will affect user behaviour and the users' space will inform the development of a contextual mobile test.

Modelling IB encourages of problem solving which will help to explain multiple search episodes, as the information seeker moves through the stages of recognition, identification

and resolution (Wilson, 2005; Fisher et al. 2005). Problem solving ISB in different mobile contexts will identify preferred search strategies that are passive, active and ongoing depending on the situation and movement of the user. These mobile contexts will also create levels of seeking behaviour to seek answers, reduce uncertainty and make sense (Case, 2012) each will inform and evaluate mobile use case design. The outputs from these use cases inform the data gathering, analysis and discussion within this thesis. Therefore, taking a wider and more holistic view to needs and seeking, Dervin et al., (1993), Savolainen (1995) and Wilson (1999) reflect upon everyday information use to make sense of a mobile context. Evaluating everyday use of a mobile application will develop a deeper and richer understanding mobile use in context. The "springboard" created by the HIB model will build upon the information philosophies supporting test practice and will influence possible user needs as they interact with mobile applications. It is clear that these theories and principles will help to initiate mobile tests and create a set of seeking strategies supporting requirements gathering informing test case design.

2.3 MOBILE USABILITY EVALUATION

Capturing interactions within a physical and social context has been challenging. To create an evaluation platform to test mobile interaction within diverse contexts, test methods and practices need reviewing. Identifying relevant strategies will inform students' as the research and build up experimental practice to capture everyday experiences with their mobiles applications in context. Test methodologies will inform experimental design and testing approaches contributing to professional practice. This section will provide a clear overview of approaches informing test design, data capture and evaluation in mobile contexts.

Capturing user experience and behaviour in natural contexts is problematic and this continues to challenge research design and practice (Wilson, 1981; Belkin and Vickery, 1985; Kejeldskov and Stage, 2003; Beck et al. 2003; Case 2012; Kejeldskov, 2013). Evaluating applications on a mobile or desk-based has similar challenges, on the surface, the user experience is aesthetically pleasing but as they begin to interact, functions and design create usability problems challenging the user. As mobile applications evolve and users become accustomed to new interactions (like the swipe and pinch) new challenges emerge which lack in flexibility and robustness affecting user experience. To capture mobile experiences HCI and HIB call upon a range of theories and practices; usability, user experience design, interaction design, user studies, user behaviour, user centered design and participatory design. These theories and practices all relate to this research however the researcher is not able to exhaust all methods but attempts to keep

them specific to the aim of study focusing on the user behaviour and user context (personal, social and physical).

This section will identify research that considers contexts and the technologies used to support experimental design. Evaluating theories and practices based upon academic papers will inform this research providing a broad picture of how past test strategies have been applied. Table 2 accompanies this discussion pulling together data capture methods and technologies used to support experimental design.

2.3.1 USABILITY

Usability is a quality attribute that assesses how easy user interfaces (UI's) are to use and the methods applied to improve ease-of-use during the design process (Nielsen, 2012). A truly usable product or service should be useful, efficient, effective, satisfying, learnable and accessible (ISO, 1998; Rubin & Chisnell, 2008). The goals of usability also evaluate the extent and accessibility of a systems functionality understanding the users' experience and interaction identifying any specific problems (Dix et al., 2004). In general terms usability can be summarised as a "quality that many products possess, but many, many more lack, it is only an issue when it is lacking or absent" (Rubin & Chisnell, 2008). Rubin (1994) states that within a usable system a user can do what he or she wants to do the way he or she expects to be able to do it, without hindrance, hesitation, or questions.

The novelty of mobile applications (apps) and the unique features of mobile devices has become key a challenge in usability evaluation (Hussain and Kutar, 2012). The quality and ease-of-use of a mobile interface has created lot of interest and past research has proved right that most information accessed online will take place using small, wireless devices, providing "anytime, anywhere" access (Buchanan, 2000). The prevalence of anytime anywhere is central, McGregor, M. et al. (2014) discuss this growth as a platform for computing which is difficult to dismiss, the continuous innovation and new technical opportunities increase opportunities to integrate applications and services a single mobile environment (p2336, 2014). Dredge (2016) also warns that all the big tech companies need to balance stability and usability with the rapid development of new technology. The speed of this development is challenging and research needs to be adaptive to support usability in the design process.

2.3.2 USABILITY TESTING

Usability testing has been widely used to develop and modify solutions answering questions around technology adoption and use (Laser et al., 2010). Testing strategies use a range of traditional research methods (qualitative and quantitative) to support data gathering, Goodman et al. (2004) emphasised the importance of taking a range of different measures to identify usability issues. Usability research found that participants often make trade-offs which can only be discovered from applying a range of measures.

Qualitative methods include think-loud, walk-through observations and observation techniques from ethnography are all commonplace within usability testing. Quantitative experimental methods include; the measurement of task performance, time performance, errors, key strokes or logging and click-stream analysis (Shneiderman & Plaisant, 2005). However, there are differences between "classic research" and usability testing, usability testing primarily focuses on improving UI and there are extensive guidelines that describe how such tests should be conducted within a laboratory setting (Nielsen, 1993; Rubin, 1994; Dumas and Redish, 1999; Beck et al., 2003; Rubin and Chisnell, 2008). The testing process can provide quick and comparatively low cost method of identifying key problems in a UI but cannot guarantee all critical design problems can be identified (Lazar et al., 2010). Lab testing is promoted as a way to minimize the cost of service calls, increase sales through the design of a more competitive product, minimize risk, and create a historical record of usability benchmarks for future releases (Rubin, 1994).

2.3.3 TESTING AND INSPECTIONS

User testing by its very nature is practical and can use a variety of inspection techniques or methods, this could be; expert led, automated or user driven. User driven tests tend to be a representative user attempting to complete a representative set of tasks in a representative environment (Shneiderman & Plaisant, 2005).

2.3.3.1 EXPERT LED TESTING

Asking colleagues for feedback is a natural starting point when evaluating a new or revised interface (Molich et al., 1998) this can take place informally or formally in the UI development. Experts need to exhibit a level of sensitivity and discussion should be constructive and comprehensive. This type of approach uses the same experts for consistency on a project as well as fresh experts to offer alternative less influenced opinions. There are a number of approaches at a testers disposal:

1. **Cognitive walkthrough:** The walkthrough establishes how easy a system is to learn (Dix et al. 2004). Experts walkthrough a sequence of actions which refer to core or known tasks that meet the user needs within the UI and system i.e. searching for a train time, finding product information or purchasing a ticket.
2. **Heuristic evaluation:** Originally proposed by Nielsen and Molich (1990) as a discount method for quick, cheap, and easy evaluation of the UI. The evaluation requires that a small set of experts (or "evaluators") examining the UI. The experts judge the UI's against a checklist based upon recognised usability principles (the "heuristics"). Evaluations identify UI issues addressing them as part of an iterative design process.
3. **Consistency inspection:** Evaluates the consistency of the UI across a range of similar interfaces this could be A/B testing of prototype designs, comparing current design or the new design against UI patterns as part of a competitive review. The inspection could also be an automated process, for example using a colour checker tool (Webaims contrast checker - http://webaim.org/resources/contrastchecker/) to evaluate consistency and contrasting colours between the typeface and background.
4. **Guidelines review:** Reviews against organisational guides i.e. the corporate branding, web accessibility policies. Automated checks help to benchmark UI designs against standard rules the W3C's code validation service (https://validator.w3.org/) is on such service checking the UI syntax against formal design guidelines.
5. **Formal usability inspections:** A team presents a possible UI solution to the experts and face questions, the questions answered use evidence supporting their UI decisions. Team members should see this as an educational experience. This process takes time and can be personal and contentious.

Several user studies have shown that inspection methods are able to find usability problems, perhaps overlooked by user testing. However, user testing also finds problems overlooked by inspections, meaning that best results are often be achieved by blending several methods (Nielsen, 1993). Each inspection method has a value to a project, outputs from each exercise provides what Rubin and Chisnel (2008) call "baseline usability data". This data can be compared against a "representative" user sample interacting with a UI . It is worth noting that experts come in all shapes and sizes, Shneiderman & Plaisant (2005) explain that experts come with conflicting advice which can confuse the situation "for every PhD there is an equal and an opposite PhD" (pp. 142, 2005). So all the experts in the world will have difficultly knowing how a typical user especially a first time user will interact. Using real users

is particularly important when studying novel, variable and less understood situations, such as those involved in mobile devices (Goodman et al., 2004).

Within mobile context, inspections and reviews are extremely important, for example, a cognitive walkthrough of an early mobile design will help to identify functional problems before any time consuming coding takes place. The heuristic evaluation provides a set of principles, which can to pinpoint design and feedback problems within the application. Applying the evaluation on recognised usability principles will guide students as they primarily lab test the application before the time-consuming user tests. Using a range of methods provides a richer testing experience and brings methods together usability methods showing students the potential within their strategy.

2.3.3.2 USER TESTING

User testing is probably the most commonly used method to empirically test and evaluate a UI (Nielsen, 1993), relying mainly on the experience and comments of users conducting scenario-based activities (Tan et al., 2009). This type of testing method can be difficult and expensive, especially when the project needs to recruit and representatively sample user. Project managers favour the other cheaper inspection methods, like expert led tests instead of real users (Shneiderman & Plaisant, 2005). As an activity, user testing can take place several times throughout a project a UI team could run tests:

- **Exploring** new wireframe design ideas, the scenario is about discovery exploring options that will inform a future prototype. In this case, the UI team walk-through designs asking the user to think-aloud about aspects of the design they like i.e. a navigation model and its placement within the design.
- **Validating** prototype designs and recommending the most usable based upon user feedback. The scenario is more contextualised using core system processes like a product search facility and this is usually benchmarked against usability principles (memorability, ease-of-use, errors etc.).

  Scenario example:
  "You have heard about an offer to Barcelona on the radio. Browse around the website and find something about the offer. Tell the facilitator when you have found the offer".

"Once you have found the offer put this into the basket and now find car hire for you and your three children"

- **Verifying** a UI demonstrating to the stakeholder that there are significant performance improvements by comparing the new system against the old systems KPI's. The aim is to verify the process evaluates a cognitive walk-through process, perhaps finding a suitable offer and a hire car that meets a users' needs. The output from the user test evaluates the pathways taken and verifies that there is an improvement in the number of steps against previous site.
  (Rubin and Chisnel, 2008).

The test scenario is a core component of an overall test plan and details all the logistics for each test session helping to orchestrate and keep tests keeping consistent. The plans focus on what has to be done allowing multiple moderators run the same test, consistently (Rubin, 1994). Elements to a test plan include; pre-post interview, scoping questionnaire, times for tasks/scenarios, an example of a test plan is in Appendix B: Sample Scenario and Test Plan.

Test planning is an important deliverable within the context of this research each student needs to design a test plan. The test plan uses principles set out by Rubin and Chisnel (2008) to develop scenarios, which can then be applied within a field context.

2.3.4 TESTING ENVIRONMENTS

The emergence of usability testing in a laboratory setting, since the early 1980's, is an indicator of the profound shift in attention to user needs. The Usability Evaluation Methods (UEM's) of stationary computer systems have grown to be an established discipline within usability research (Johnson 1998; Kejeldskov and Stage, 2003; Beck et al. 2003; Rubin and Chisnell, 2008). In the past laboratory testing was seen as a development life cycle luxury however organisations began to see the benefits and actually found testing at different stages of the development increased project efficiency (Shneiderman & Plaisant, 2005). Usability within a laboratory setting applies test plans with the outcome of evaluating a UI's performance against key indicators such as; speed, accuracy, and errors in addition to user subjective evaluations like the user thinking aloud.

These established concepts, methodologies, and approaches are being challenged by the increasing focus on systems for wearable, handheld, and mobile computing devices. (Luff and Heath, 1998; Beck et al., 2004; Kejeldskov, 2013). Testing practice needs to now move

beyond office, home, and other stationary settings created a need for new approaches to design and evaluate mobile systems (Beck et al, 2004).

2.3.4.1 CONTEXTUALISING USABILITY TESTS (LAB VS. FIELD BASED EXPERIMENTS)

When an application gets to the stage of testing common questions (i.e., timescales, rigor, number users, costs etc.), arise from various parties. However, additional challenges are facing testers; for example, can we get away with just lab testing or do we need to field test the application? Mobile interaction typically take place in highly dynamic contexts (Kejeldskov and Stage, 2003) challenges in the design are not isolated general ergonomics and processing power, but innovative ways of evaluating user interaction on the move (Nilsson, 2001), in essence the need to field test.

There has been considerable debate over whether mobile interactions should be investigated in the field (Sun and May, 2013; Kejeldskov, 2014). Users' interacting while being mobile doing things differently and their cognitive attention is divided between physical motion and the use of the system (Beck et al. 2003; Kejeldskov and Stage, 2004; Negulescu et al. 2012; Sun and May 2013). A number of studies have compared the merits of lab and field tests and there are pros and cons for each environment. Lab testing is far more the post used environment, Goodman et al., (2004) explain that a possible reason for the low usage of field experiments is the lack of a clear, carefully worked out methods for running such experiments. Evaluating mobile usability in the field is not easy (Nielsen, 1993; Brewster, 2002; Kjeldskov and Stage, 2004; McGregor, M. et al., 2014) challenges include development of workable prototypes, capturing accurate data and recruiting participants. Sun and May (2013) conducted a comparative study evaluating the UX of a personalised mobile application at a sports event conclusions found lab experiments were preferable when the focus is on the UI and application-oriented usability issues. However, a significant point found field experiments more suitable when investigating wider holistic factors affecting acceptability of the application. Kaikkonen et al., (2005) ran lab and field experiments indicating that the time-consuming field test may not be worthwhile when searching for UI flaws to improve user interaction, but recommend field-testing when combining lab usability tests with a contextual study to support contextual interactions (pp.4, 2005). Including the contextual study alongside the lab has been significant providing baseline data used as a benchmark to compare against field data (Beck et al., 2005; Kjeldskov and Stage, 2004).

The field test should be in addition to conventional lab tests (Schmiedl et al., 2011), a common approach is a lab pilot and a controlled field test gathering data providing a benchmark for the field-tests (Goodman et al., 2004; Kane et al., 2008; Schmiedl et al., 2011; Sun and May, 2013). In summary, the need for lab testing should "move beyond usability evaluations, and to engage with field studies that are truly in-the-wild, and longitudinal (Kjeldskov and Skov, 2014) this reaffirming a clear need for mobile field-testing.

2.3.5 Mobility and Interaction

Mobile computing users have the ability to move and fulfil their needs "on-the-go" and is a part of everyday life at work and at home (Kristoffersen and Ljungberg, 1999). Mobile application developments need to "uncouple" the once close relationships between the activities and place previously imposed by physical lab space (Agre, 2001). To appreciate how users allocate available cognitive and physical resources using mobile devices is very important (Barnard et al., 2007). The growth in mobile networks and social networks is now allowing this flexibility and uncoupling from the desktop pc making access to information online and mobility as a norm when interacting with mobile applications. As users' attention divide between physical motion and user cognition the role of context becomes very important within a mobile test. The predefined route within a lab (Kejeldskov and Stage, 2003; Beck et al., 2003) and predefined route within the field (Barnard et al., 2007; Kane et al., 2008) are common methods to researching these user challenges. These types of experiments have the ability to evaluate cognition and interaction within a mobile context. A common behaviour exhibited but mobile users is "fragmented attention", which is divided attention and the impact this has on performance (Schmiedl et al., 2011; Oulasvirta et al., 2005; Harvey and Pointon, 2017). Schmiedl et al., (2012) designed experiment on a driving simulation creating tasks challenging cognitive and physical resources of the user as they also interact with a mobile. In a purely field experiment Oulasvirta et al., (2005) explained how mobile situations compete for cognitive resources leading to depletion and dividing of resources resulting in the breakdown of fluent interaction (p.1, 2005). Mobile devices are commonly used in situations where attention must be divided, such as when walking down a street and research suggests that this increases cognitive impacting on performance (Harvey and Pointon, 2017).

The experimental practices used to inform mobility research creates test environments and contexts supporting this research. The lab pilot creates baseline data supporting comparative mobile studies and students can recreate these experiments (like the

predefined routes) to support their experimental practice. The mobility experiments used also complement the learning outcomes supporting professional practice. It is also worth noting the importance of test simulations, like the driving example. Providing this awareness to the students in research design is important, for example, if the student is unable to use a real driving context due to logistical reasons or even health and safety simulations will help test design and practice.

2.3.5.1MOBILE INTERACTION

Using mobile applications challenges interaction and the styles of interaction adopted which might unsuitable for a mobile context (Kristoffersen and Ljungberg, 1999). Kjeldskov & Stage, (2003) revealed that interaction techniques are challenged as users moved and missed navigation options unintentionally hitting the wrong options due to their motion (pp. 615, 2003). Technological aspirations to make computing hardware smaller and the convergence of applications compound this interaction and interaction styles (Atkinson, 2005). Brewster et al., (2002) conducted a number of lab and field studies and noted that small screens become cluttered with information and widgets (buttons, menus, windows, etc.) concluding that presenting the desktop UI on a mobile device does not work (Brewster, 2002). Users prefer comprehensible, predictable, and controllable environments (Greene et al. 2000) whereby a UI can be changed and become responsive presenting the most important features and information – not everything at one go.

Small screens combined with increasingly complex of mobile tasks creates obstacles (Chae & Kim, 2004; Brewster, 2002; Harrison et al., 2013), poor connectivity and limited input modalities also challenge usability. This is not isolated to these papers and information presented on small screens is a problem affecting user interaction (Brewster, 2002; Chae & Kim, 2004; Chittaro, 2006). As a device shrinks there is a limited space to display information, screens physically cannot be made bigger as the devices must be able to fit into the hand or pocket to be easily carried (Harrison et al., 2013). There have been clear warnings of this since 2002 and it is still causing problems on Smart devices today. It is therefore clear that taking the desktop interface and implementing it on a mobile device does not work well. Solutions to this problem have emerged one being a design methodology “mobile first” (Wroblewski, 2012), based around Responsive Web design (RWD) allows websites to dynamically adjust layouts, architectures and content to the screen size of a user’s device.

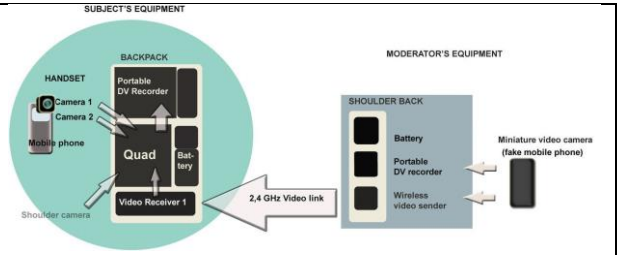
2.3.6 Test Apparatus and Data Capture

Within mobile field testing apparatus has been unwieldly and data capture problematic, high-quality video data turned out to be very difficult to capture (Kejeldskov and Stage, 2003). Table 2 pulls together a summary of tools used to support mobile tests, this table acknowledges the types of technologies used in the field and data capturing approaches. The table supports this investigation which provide practical examples used in class, student will evaluate apparatus and data capture to inform their own test design.

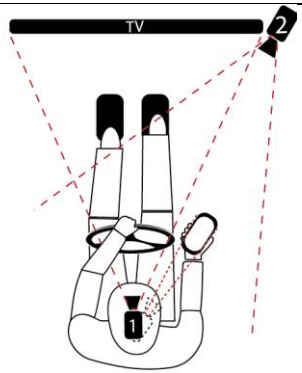
2.3.6.1 METHODS AND TECHNOLOGIES USED

Research Paper	Research Aim	Data Capture	Technologies used capture data
Kristoffersen, S. & F. Ljungberg (1999)	Two empirical research studies 1. Mobile service engineers at Telenor IT Service and Installation AS in Oslo, Norway. Staff primarily engaged with installation and maintenance of telecommunication equipment in the field. They may receive work orders on the Ericsson MC-12 mobile computer, with which they were equipped in a recent project to replace paper-based work orders with access to centralised information. 2. DNV (Norwegian Veritas) a leading maritime classification society. Inspections of ships and the internal tanks take place they carry out checks using technical drawings. A PDA inputs the checks and requires a flat surface, using the hands for input and relying on good light, even a high-contrast small screen to see is simply unusable. The user has to "make place" by interrupting the work and finding a suitable environment.	Ethnographic techniques for data collection. A common practice in CSCW research. Nine engineers participated in the study, which was done for the purpose of design.	No additional data capturing technologies. Pure research methods used not AV recording used as part of this research.  a situation where a handheld computer could have been put on the floor of the room in which he is, inspecting the cables, but he still needs one hand free to hold the electric torch, without which he can see nothing to report.
Nilsson et al. (2001)	Research on media convergence in natural settings. Follows three examples demonstrating the present state of mobile media usage.	Ethnographic techniques for data collection. For example, at the Swedish Rally the researcher attended one of the race stages to observe the audience gathered in the woods waiting for news about the race.	No additional data capturing technologies. Pure research methods used not AV recording used as part of this research. The researcher mentioned that "As the night rolled in and darkness settled over the crowd, the back-lit WAP phones proved easy to use in the dark for checking the programme. Ten minutes after the first car should have turned up, it became obvious that the race was delayed, but no reason for the delay had been announced on the radio. Then the mobile phones started to beep! SMS messages were being received,

			informing subscribers the delay was due to spectators crossing a photocell, thus disturbing the race-timer, and that the race should start any minute, which it did." (Nilsson, 2001)
Kjeldskov & Stage (2003) & Beck et al., (2003)	Ran two experiments (lab and field) to identify usability problems, performance and workload. 1. Lab: Evaluates six usability evaluation techniques for mobile computer systems purpose of these techniques is to facilitate systematic data collection in a controlled environment and support the identification of usability problems that are experienced in mobile use. 2. Field: Evaluates six usability evaluation techniques for mobile through two usability experiments where walking in a pedestrian street was used as a reference. Each of the proposed techniques had some similarities to testing in the pedestrian street, but none of them turned out to be completely comparable to that form of field-evaluation.	Observations and used NASA Task load index to assess the performance Researchers analysed the video recordings individually in random order and produced three lists of usability problems with severity ratings of critical, serious or cosmetic in accordance to the definition proposed by Molich(2000)	Used Cam-recording equipment to support the other data collection methods. This was hard to get data of the screen whilst moving. 
Goodman et al., (2004)	Ran experimental evaluation of location-based services, such as mobile guides, in the field. It identifies advantages and disadvantages of using such field experiments over and against other evaluation methods.	The research described a specific method of running field experiments that they found to be useful. Used various evaluation measures, tools and scales these include timings, errors, perceived workload, distance travelled and percentage preferred walking speed (PPWS). Used Comfort Rating Scale (CRS) and NASA TLX to rate emotion, harm and anxiety of the tasks developed. Applied the "experimental observer" method and recommended not overloading the user with kit to record and use multiple observers.	No additional data capturing technologies. Pure research methods used not AV recording used as part of this research. A pedometer can be used to measure the distance travelled (although not the route taken). It is small device attached to the waistband at the hip, which counts the number of steps taken.
Rotto et al. (2004)	Quasi Experimentation – moving the lab into the field. The goal was to record users actions and interaction with the mobile on a 1.5hr city tour.	Using a range of data capture methods and technologies to simulate lab capture in the field	Combination of cameras with portable DV recorder and video received.

			
Rieh, (2004)	What environmental factors of the home influent everyday life Information seeking. Self-reported Search Activity Diary (3-5 day period)	Analysed based upon home environment, seeking goals retrieval interaction and search query.	No additional data capturing technologies. Pure research methods used not AV recording used as part of this research.
Oulasvirta et al., (2005)	Run range of tasks within the field (walking, café, escalator etc.). Compare these to lab tests. The researchers explore the cognitive resources used whilst on the move and are reserved partly for passively monitoring and reacting to contexts and events, and partly for actively constructing them. The research builds upon the Multiple Resources Theory exploring mobile situations and how these compete for cognitive resources with the depletion of resources for task in hand.	Observations using ethnographic techniques for data collection. Used the Resource Competition Framework (RCF). RCF predictions were tested in a semi-naturalistic field study measuring attention during the performance of assigned Web search tasks on mobile phone while moving through nine varied but typical urban situations.	Mini camera attached to the phone capturing display and keyboard, Mini camera attached to the phone capturing face and eyes Mini camera attached to the backpack facing forward Experimenter had a camera to check the overall environment. 

Kaikkonen et al., (2005)	Comparative Study (Lab Vs. Field) using common tasks on a phone. The usability of an application was tested assessing the types of problems found. The same problems were found in both environments, differences occurred in the frequency of findings between the contexts.	Observations and the think Aloud protocol used with four moderators. Data capture results indicate that conducting a time-consuming field test may not be worthwhile when searching user interface flaws. It is possible that field testing is worthwhile when combining usability tests with a field pilot or contextual study where user behaviour is investigated in a natural context.	Moderator unit - 6" LCD service monitor, a video camera, a wireless video transceiver and a battery. Camera recorded user surroundings from the moderator's perspective. Monitor enabled the moderator to see what the user was doing with the mobile application when the user was walking or was otherwise in a position where it would have been impossible to see what was going on without additional equipment. 
Barnard and Yi (2007)	Investigate the specific effects of changes in motion, lighting and task type on user performance attempting to address the disconnect between the actual use and the evaluation of mobile devices by varying contextual conditions and recording changes in behaviour.	Surveys used before and after tests and the NASA TLX used.	PDA with an attached triaxial accelerometer
Kane et al., (2008)	Two investigations - evaluating the performance of walking user interfaces that adapt their layout when the user is moving. Exploring walking interaction and walking performance.	Log files were transmitted wirelessly from the prototype to the experimenter's console and recorded in a single XML file. XML logs were later parsed using Python scripts, and the parsed comma-separated files were analysed with a commercial statistics package.	Experimenter controlled changes to the user interface in the adaptive condition, using another Sony UX2 device with custom software. Both devices were connected wirelessly using an ad-hoc 802.11b network. The experimenter's an application that allowed him to change button size, start and end tasks, and record participants' walking speed and events.
Schmiedl et al., (2011)	To find an efficient approach to test the usability of mobile applications in scenarios of fragmented attention. How can we effectively observe this scenario and measure the usability of applications used in it? How can we control	The close-up of chest and head that allowed the research to capture data to observe the driver's eye movements. This enabled the researcher to notice even the slightest glimpse to the phone.	Recorded tests using two video cameras. Testers wore a robust wide-angle helmet camera (Camera 1) to record the driver's view. A second camera was positioned next to the TV set pointing at the driver (Camera 2). As the driver's ability to move was limited, we could adjust a close-up of chest and head that allowed us to observe the driver's eye movements. Thus it was easy for us to notice even the slightest glimpse to the phone.

	and reproduce environmental conditions in this mobile scenario?		
Hussain and Kutar (2012)	Examine the usability of SatNav applications inside the mobile phone. Results from the experiment can provide an indication of whether SatNav apps are usable in mobile phones. Used the TomTom One and CoPilot Live SatNav system installed in an O2 Orbit mobile phone device and the experiments were conducted inside a car in order to mirror the way such apps are used in practice. Participants did not drive the car during the study for safety reasons.	The researchers used the mobile Goal Question Metric model (mGQM) to evaluate the usability of such applications for example. They specify the goals for the SatNav application and overall project, then trace those goals to the data that are intended to define those goals operationally, and finally provide a framework for interpreting the data with respect to the stated goals. The experiment is divided into two parts; 1. Collect the objective data through usability test, 2. Collect subjective data via questionnaire and interview to assess the perception of participants on SatNav app.	Recorded tests using DV camera positioned in the back of the car. Recorded the users voice via the SatNav 
Sun and May (2013)	Lab vs. Field experiments to evaluate UX of personalized mobile devices in sports event.	Encouraged but not required to Think Aloud Data gathered: subjective rating of tasks, a verbal report and observational data.	Video camera to record interactions with mobile prototypes.
Redondo et al., (2013)	Three case studies to evaluate a student's performance with a Augmented reality application	Pre and Post Assessment questionnaire based upon ISO 9241-11 & student mobile surveys. Designed based upon the Likert Scales	No capturing technologies used just what the lecturer observed and from the survey information to support learning and teaching.

	Initial hypothesis was confirmed that ICT used in the web 3.0 environments; allow improving learning processes and reducing its temporality without previous experience at a very low cost. AR Technology in this area combined with Cloud computing development, creates a new paradigm of continuous training and self-learning though the use of AR technology.	Each experimental group (EG) has been able to visualize a virtual model created by them or their teachers, in order to evaluate an architectural proposal or a construction detail, on site, as part of their own learning process. Students without the required devices, still in the ordinary course, configured the control group, (CG). Virtual models generation and augmented scenes preview on site, provided evaluation tools for better assessment and knowledge of student's proposals prior to any intervention	

Table 2: Mobile field study and test apparatus

In summary, experiments used video equipment as the primary data capture tool, however the environments of the experiment affected a researchers' ability to accurately capture interactions whilst mobile (Kejeldskov, and Stage 2003). Oulasvirta et el. (2005) explained in their field apparatus forced the participant to hold the device at hand all the time, inevitably reducing the threshold for looking at it whilst moving (p. 8, 2005), coupled with the effects of video also influence the participant in the experiment.

Goodman et al. (2004) evaluated Global Positioning System (GPS) but the limited network coverage negatively influenced tests. Network problems were not just isolated to GPS, Nilsson et al. (2001) expressed media streaming issues and Hussain and Kutar (2012) experienced connectivity issues. As mobile users are more reliant on Smart devices networking is a core factor in user experience, networking challenges is still affecting mobile users, co need to be factored into a mobile test especially if the experiment is out of a WI-FI hotspot.

The time taken to set up and orchestrate field tests was another interesting issue (Kaikkonen et al., 2005; Kejeldskov, and Stage 2003). Kaikkonen et al. (2005) spent a lot of time setting up the equipment using a backpack with the recording apparatus adjusting configurations for each user (p.13, 2005). Kane et al., (2008) captured data using a secondary mobile device connected wirelessly allowing the experimenter to change device configurations and record participants' walking speed (p. 113, 2008). Schmiedl et al. (2011) used two video cameras pointed at the user and screen and found that this configuration is not suitable for mobile screen capture. Google's user experience research team attached a stationary high-resolution camera pointing on the device from atop should be an appropriate solution. This helped the capturing quality, however in bother of these examples this did come at a cost affecting on experiment. The camera interfered with tasks and participants felt intimidated by the camera pointing on the screen as the moved.

Table 2 summarises possible experimental setups and outlines the past challenges faced by research. This summary helps to inform students' test practice providing real cases conducted in the field. The table supports professional practice and students can be problem solve (and event simulate) these experiments to inform their own experimental design. Using this historical overview of mobile experimental design feeds into test practice whereby students reflect and critically analyse research practices and will inform their own test experiments. Following setup examples listed in this table will encourage students to read around the mobile testing topics improving awareness of possible challenges and how test setups inform mobile tests strategies and their analysis of options.

2.3.7 INTERACTION MODELLING

Model based evaluations aim to understand mobile interaction, creating cognitive models of user interaction supporting data capture. Models provide not only an approach to understand interaction but used as a mode of analysis supporting justifications within the student reports. To articulate the data from an expert inspection, in particular a walk-through a model based evaluation presents a users' interaction in a mobile context The most popular cognitive modelling tool available are GOMS and KLM (Keystroke Level Model). GOMS defines a user's interactions as a set of *Goals, Operators, Methods,* and *Selectors* (Card, Moran and Newell, 1983). It widely used in HCI enabling designers to model behaviour.

GOMS starts with a high-level goal (G) and is broken down into smaller sub-goals. These sub-goals can contain various methods (M) taken by the user to achieve the desired goal these are accomplished via user operators (O). There are also selection (S) rules mapped to a method this is dependent upon the route taken by the user (Card, Moran and Newell, 1983; Cox and Peebles, 2008; Rice and Lartigue, 2014). The KLM is a simpler version of GOMS, but its purpose differs slightly, to model: "the time it takes a user to perform a task" (Card, Moran and Newell, 1980).

These models have been excellent in evaluating user interaction and identifying possible usability issues early on. However, these prominent models do not adequately capture new styles of interaction on mobile platforms (Harrison et al., 2013). Mobiles have new interactive styles and GOMS-KLM does consider these new operators (Rice and Lartigue, 2014). Rice and Lartigue (2014) refined GOMES incorporating new operators to support interaction styles on a mobile device catering for touch operations. Appendix A (Touch-Level Model (TLM) Operators) provides an example of this model.

Navigational Mapping - Example of GOMS in practice:

Applying the GOMS-KLM provides a model that students can use to gather data showing interaction mappings and preferences. In this example, initial lab tests found user's preferred the category search when walking and the search engine whilst stationary. These different sub-methods fulfilled the same overall search goal. However, this research aimed to see if this search preference is true in a field setting and if there are other challenges that impact on user interaction? Students' use the lab data (as baseline) and compare this data against the field experiments, students are able to see if this hypothesis is true and if there are any differences in performance as a participant interacts in the field?

In summary, cognitive models approximate how a user will interact with an interface i.e., cursor movements, keystrokes or in the case of mobile environments the touches, swipes,

pinches etc. (Kjeldskov, J., & Stage, J. 2004; Rice and Lartigue, 2014). Using adapted GOMS models will help to improve evaluation and analysis of mobile interaction

2.4 SUMMARY

The manner in which context affects user behaviour poses an interesting line of investigation and findings have significant implications for enhanced context-aware mobile applications (Chua et al., 2011). Studying mobile applications used in everyday contexts provides a sense of meaning to a mobile test, evaluating what a user does in a particular situation (Savolainen, 2007, 2009) will improve test awareness. Identifying everyday use also appreciates user experience of place as they interact (Paay & Kjeldskov, 2008; Kjeldskov, 2014). The literature also identified user needs, behaviour and seeking as supporting aspects to application use in contexts from a personal, social and physical (Wilson, 1981; 1997).

The supporting theories and principles recognise user-testing challenges, especially in a field context. The review established methods and approaches to support testing and modeling of interaction (Kjeldskov, 2014); Shneiderman & Plaisant, 2005; Rubin and Chisnel, 2008; Rice and Lartigue, 2014) providing a knowledge based where the researcher applies practices to inform mobile test design within the module. The experimental methods analysed in Table 2 provide a test platform whereby students use the experiments within this table to create and simulate mobile experiments capturing users in a mobile context interacting with information.

The literature noted that mobile interactions take place in highly dynamic contexts (Kejeldskov and Stage, 2003) and the need for innovative ways to evaluate users in context (Nilsson, 2001). There is a need for lab testing and the suggestions made that testing “moves beyond usability evaluations engaging with field studies that are truly in-the-wild (Kjeldskov and Skov, 2014), reaffirming the need for field-tests within this investigation. These holistic factors to mobile use fit clearly with Wilson (1997) which clearly influence user needs for information and is something this research wants to investigate to support the aim associated with user behaviour in context.

In some cases, lab experiments were preferable when the focus is on the UI and usability issues but field experiments are more suitable for investigating a wider range of holistic factors (Sun and May, 2013). Lab testing is extremely useful in the creation of “baseline data” (Brewster et al, 2003, Rubin and Chissnel, 2008) this data can be used to compare against field data. Approaching the research in this way fits with the researches philosophy and adopting a lab and field approach provides students with something to compare against.

Kaikkonen et al., (2005) reaffirm the need for lab and field experiments whist noting that it is a time-consuming exercise recommend both lab and field-testing being worthwhile.

As part of the literature review the researcher constructed a map of the literature, this map helped to chart practices based upon the themes, Context, HIB and Mobile usability testing. As the researcher mapped out the research practice two models kepts appearing as influence on their own research practice. Wilson's (1997) HIB model and Kristoffersen and Ljungberg (1999) Mobile Informatics Model these model support the research aim where User behaviour and mobile computing use in field context were important. Figure 4.2 helps to portray this as a snap shot showing the influence these models have within the research fields.

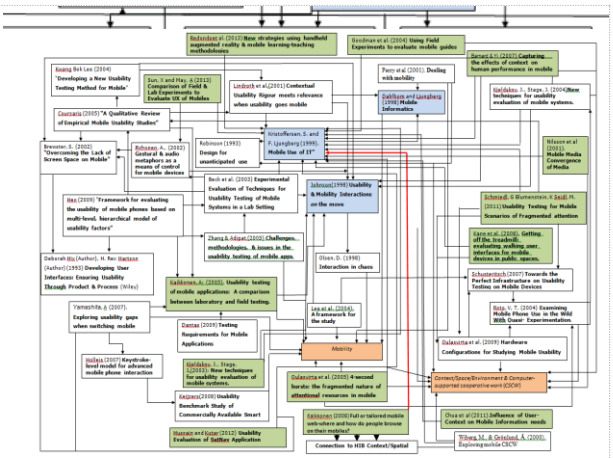


Fig 2.4: Snapshot of the literature review

Wilson's (1997) HIB model illustrates the broad holistic nature IB in context an extremely important characteristic within this investigation. The model is a useful heuristic diagram for designing empirical studies of information seeking (Case, 2012). Information seeking

activities are the most popular activities on mobile applications as users look for information to support their needs.

Applying Wilson's model as a "heuristics diagram" and using Dervin's (1996) "making sense" model provides a clear set of theories to support IB research, which clearly support the module learning outcomes. Making sense of information especially in a mobile context of "everyday searching" will effect on the way seeking practice conducted (Savolainen, 1995). To provide a context of use from a computing perspective Kristoffersen and Ljungberg's (1999) "Mobile Informatics" model supports mobile computing in context another requirement set out in the modules learning outcomes. Using Mobile Informatics model will support test practice and students can empirically study their own mobile applications using this model.

The literature review has provided a broad philosophical overview to this investigation. To contextualise these models to mobile test practice, a more detailed exploration of experiments within field contexts will provide and evidence practice movement within the research field. The Systematic review of literature based upon these two models will help shape practice and build into working examples informing experimental design. The concept model below summarises the literature themes presented at a conference demonstrating synergies between HIB and HCI to support module test case design.

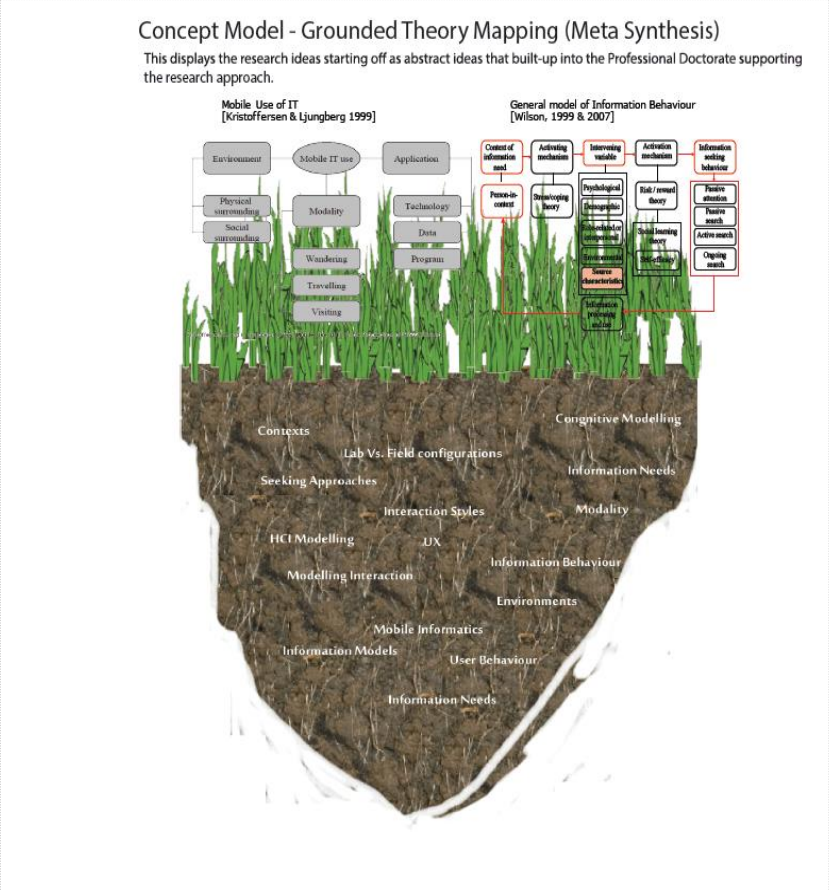


Fig 3.2: Visualisation of ideas that shaped the literature review and synthesis (Presented at the iSchool conference, Berlin 2014)

3. CHAPTER THREE: METHODOLOGY

All research is based on some underlying philosophical assumptions about what constitutes 'valid' research and which research method(s) is/are appropriate for the development of knowledge in a given study (Blanche et al., 2006). Research design that is credible and trustworthy requires well-considered decisions on the types of methodology and data collection methods. Appreciating methodological approaches will form a solid epistemological foundation or stance to research.

This chapter aims to establish what Lincoln and Guba (1985) call the “three questions” to research paradigms, which aim to establish the ontology, epistemology and methods. The ontology being the actual reality of the research, epistemology or the nature between the knower and the known based upon these realities, and methods that help the research find out these phenomena. Boundaries need to be set to explore and build answers to these questions, these boundaries focus the research and support the aim overall of study. It is essential that any research undertaken underpins and theoretically justifies choices made; the choices support the research design process as the researcher gathers and analyses data to support the aim of study.

This chapter will present a strategy which will explores the potential developments of new a contextualised framework to inform mobile testing. The methodology will galvanise the overall aim helping present a suitable approach this chapter will apply the research onion (Saunder et al, 2012).

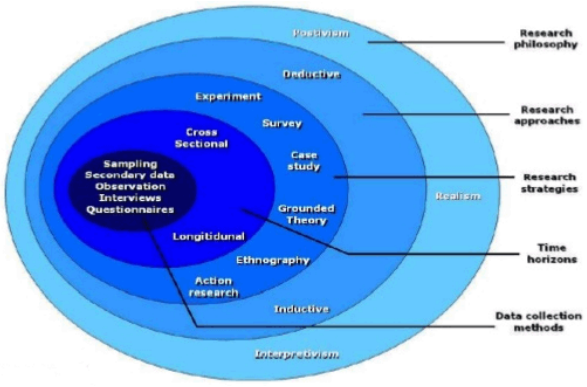


Fig 3.1: Research onion (Saunders et al, 2012).

3.1 RESEARCH PHILOSOPHY

A research paradigm is a way of explaining a set of beliefs that the researcher has at a philosophical level shared as a conceptual framework within the research community. Each element of the framework provides models for examining problems and finding solutions. Evaluating the philosophies helps to reflect and identify the most suitable approach at a practical level. Flick (2009) categorised paradigms into three philosophies; positivism, interpretivism and critical postmodernism each offering guidance and support within qualitative research.

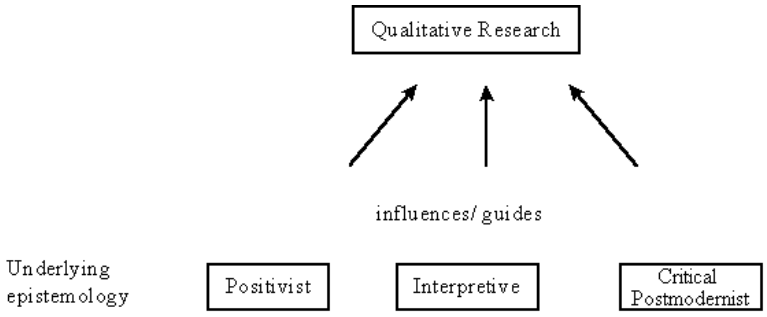


Fig 3.1: Underlying philosophical assumptions (Flick, 2009)

All research has a basic set of beliefs or orientations around these underlining assumptions that will help inform a piece of research, interpretive philosophies fit with this research and will be discussed and justified to put into a professional context.

3.1.1 INTERPRETIVISM AND THE INTERPRETIVISTS

The ontological position of interpretivism is relativism. Relativism is the view that reality is subjective and differs from person to person (Guba & Lincoln, 1994, p.110). Interpretive researchers believe that the reality consists of people's subjective experiences of the external world; thus, they may adopt an inter-subjective epistemology and the ontological belief that reality is socially constructed (Blanche et al., 2006). This paradigm places observation and interpretation at its heart with the aim of collecting information about events through observation. As events take place attempts are made to interpret and make meaning by drawing inferences or by judging the match between the information and some abstract pattern (Mcneil and Chapman, 2005). Interpretivism attempts to understand phenomena through the meanings that people have within a context or setting. The paradigm puts the analysis in context and is primarily concerned with understanding the

world as it is from subjective experiences of individuals and aims to explain the subjective meanings that lie behind social action.

Interpretive researchers start out with the assumption that access to reality (given or socially constructed) is only through social constructions such as language, consciousness and shared meanings (Myers, 2008). The philosophical base of interpretive research has many examples of methodology include, case studies (in-depth study of events or processes over a prolonged period), phenomenology (the study of direct experience without allowing the interference of existing preconceptions), hermeneutics (deriving hidden meaning from language), and ethnography (the study of cultural groups over a prolonged period).

3.1.2 Interpretivism In Professional Practice

The students drive the research and the researcher uses the interprevist paradigm to observe experiences as the construct mobile tests put into a context on the module. The interpretive paradigm is concerned with understanding the world as it is from subjective experiences of individuals (Mcneil and Chapman, 2005; Blanche et al., 2006). The interprevist uses meaning (versus measurement) oriented methodologies for example; focus groups, interviews or participant observation. The meaning based methods assess the subjective relationship between the researcher and subjects, in this case the students. This research requires observational methods which will take place in context in a social phenomena i.e., lab, natural, quasi or field settings. This requires a level of interpretivism specifically empirical interpretivism whereby interpretions of social influences and their actions support the philosophy and methods needed. Interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments (Myers, 2008). Interpretivism provides a level of flexibility allowing the observation of student experiences and actions a particularly common activity in social science and educational research.

The context of a mobile test that takes place in a natural setting is very different to traditional lab conditions with so many influences on the tester and the user of the mobile device (Johnson, 1998; Lindroth et al., 2001; Kjeldskov et al., 2004; Lee & Grice, 2004; Oulasvirta & Nyyssonen, 2009; De-Sa & Carrico, 2011). These influences are what interpretivists coin multiple realities, which “cannot exist outside social contexts that create them, realities vary in nature and are time context bound” (Pickard 2012: p7). The realities within this research are determined by student interpretation of mobile test design within natural context.

Investigating these experiences embedded in the context of a Bachelor degree course “is time and context bound” to the module where mobile tests take place.

The course structure and the delivery of the module provide observable events, timescales and settings, Darke et al., explain, that “to gain a deep understanding of the phenomena being investigated and acknowledge their own subjectivity as part of this process” (1998: p276). In normal circumstances the researcher (as a lecturer) would not be present at a mobile field test so being present provides a deeper understanding of the phenomena (i.e., user mobility, influence of social and physical contexts as participants interact with their applications). Focusing on what Mcneil and Chapman (2005) explain, as “how the real world is interpreted by people who inhabit it” is appealing, interpretivists attempt to observe multiple viewpoints. In the case of this research, it is from the student perspective as they interpret and apply mobile tests, these realities would not normally be observed. Interpretivists advocate interaction with research participants to generate outputs in contrast to the positivist who test hypotheses. Considering and observing the core stages the in test design from inception as lab pilots to the field will give the researcher a deep insight into the phenomena and how this been interpreted and applied. To help to contexulise these mobile testing events and how these are interpreted, the research will also seek to finding *meaning,* meaning of events as they happen in context.

3.2 RESEARCH APPROACHES

3.2.1 QUALITATIVE APPROACH

To study human behaviour in context the human is the most appropriate instrument (Pickard, 2012). Applying a qualitative methodology will support the investigation of context rich test situations qualitative methodology encourages observation, feedback and reflections as the design of mobile tests are applied. Identifying suitable data capture and collection methods to evaluate human behaviour will produce data, and theories will emerge. Qualitative methods help to evaluate a student's interpretation which justifies the sociological perspectives from which social life can be studied (Goffman, 1959) in this case the way mobile tests are applied. Guba and Lincoln (1994) support this mode of inquiry stating "human behaviour, unlike that of physical objects, cannot be understood without reference to the meaning of purposes attached by human factors to their activities". Observing student behaviour as they orchestrate mobile tests supports the investigation, using the researcher and student as a human instrument generates data informing the research aim. Planning and designing of qualitative research is not set in stone, Lincoln and Guba (1985) "play by ear" as the design evolves. Pickard (2012) explains qualitative research "needs to cascade, roll and emerge". The design of qualitative research in this case is not a measuring tool producing performance figures but understanding how students use many experimental approaches to think about it mobile tests and how they feel about it (Adams et al., 2008).

In summary, interpretivists help to explore realities assuming the explicit and inferred knowledge of the researcher and the social construction of the research environment (Pickard, 2012). It provides a context where observations and evaluations can take place, which will support the aim from the students' perspective and the researcher's perspective. Applying this approach will support the meaning, purpose and feeling behind students' ability to plan, design and execute mobile tests.

3.2.2 QUANTITATIVE METHODOLOGY

Quantitative research sits in the experimental research methodology usually involving truth-seeking utilising deductive approaches within the design (Gray, 2013). The intention of quantitative methods and the production of results are objective to prove or disprove something. This research has the potential to gather, use and interpret quantitative data this could be performance related (i.e., screen recordings of the test performance and data relating to the test context). Maxwell J. (2010*)* explains that "the use of numbers is a legitimate and valuable strategy for qualitative researchers when it is used as a complement

to an overall process orientation to the research […] it does have some potential dangers and should be used with a clear awareness of these". (p.481)

This research has the potential to explore and capture quantitative data and the influence on user interaction. The researcher does however take on board Maxell's warnings, the emphasis of this research is about human engagement, design and evaluation of observable events of mobile test frameworks. A quantitative methodology will gather a lot of data, so adding quantitate data (i.e., key strokes, timescales, errors and goals) would create a level of complexity hampering the primary aim of this stay. This is something to consider for future research, for example evaluating correlations between the test setting (social and physical) and the outputs from what was applied in the field test via the screen recordings.

3.3 RESEARCH STRATEGIES

Interpretivists explore realities in the case of this research the realities of students as they design and apply mobile tests that support experimental practice. This section will detail methods, which fit the interpretivist paradigm and support the needs of this research. This section will build upon these principles presenting a platform for this research. A discussion of methods will support the research strategy putting it into context inform possible mobile test frameworks.

3.3.1 SYSTEMATIC REVIEW OF LITERATURE: REVIEW OF HIB AND HCI MODELS

The systematic review is a way of reinterpreting and reshaping existing qualitative findings (McClean & Shaw, 2005). The procedure evaluates research practices proposing new ways and interpretations by identifying key concepts from studies and translating them into one another (Noblit and Hare, 1988; Finlayson and Downe, 2013). The literature review explored broad themes around information needs (driver for interaction), contexts (changing spatial environments) and mobility (movement of a user with a device). The review acknowledged two important theoretical models Wilson's (1997) HIB model, Kistoffersen, and Ljungberg (1999) Mobile Informatics Model. The visualisation (Fig. 2.4) maps the influence and potential importance of these models triggering the need for deeper exploration. The literature review provided a broad philosophical overview to the subject but this required a more detailed systematic review keeping this focused to the studies aim.

The researcher will interpret information by purposively selecting studies and then systematically evaluating them for methodological similarities. The search and evaluation of

qualitative findings and methodological practice within a range of research papers is a popular approach (Noblit et al. 1999; Finlayson and Downe; 2013), gathering data from a range of sources like keyword analysis of data from; observations, focus groups and one-to-one interviews are covered in the search process. This type of approach “utilizes multiple empirical studies but, unlike meta-analysis, the sample is purposive rather than exhaustive because the purpose is interpretive explanation and not prediction" (Barnett-Page and Thomas, 2009). Finlayson and Downe’s (2013) final synthesis for example explored the views of women within 21 papers including data from 1,239 participants. The systematic rigor informed the research aim demonstrating how practices have shifted, adapted and shaped the research fields in question.

Reflecting upon past examples the search strategy begins by using the literature review map to purposively identify and select papers that have a direct reference to Wilson or Kistoffersen and Ljungberg. This interpretive exploration could be a reference to their work or research practice, which implies their model, may have supported and influenced their own research approach. Based upon these influences 22 papers with 396 comparative codes emerged which will build into a theory, which is grounded in data and can be applied to support learning and teaching.

3.3.2.1 APPLYING THE SYSTEMATIC REVIEW

The categories within the synthesis follow the pathway set by Wilson’s HIB model (i.e., starting within the context of need and looping to the use can processing. Common groupings within the models (i.e. environments, social and physical) help to assess common experimental practices informing and evaluating theory. Using these categories provide the guidance needed to ensure continuity within the review as the practices are evaluated between the research fields. Charmaz (2006) noted categories will emerge from the simultaneous involvement in data analysis. The categories formed in Table 3.1 will be used as reference points explored and searched within the research papers. It is anticipated that this will identify concepts from past studies and translating them into one another (Bartlett-Page and Harden, 2009), for example, the types of technologies used to capture data, the setting and the activities they want the user to do whilst in the field. Bartlett-Page and Harden (2009) aimed to push beyond the original data to a fresh interpretation of the phenomena under review. The idea of finding new ways of doing things based on past research continues to be hugely beneficial within qualitative research. Finlayson and Downe (2013), Ward et al., (1983) and Cambell et al. (2003) all talk about “going beyond” the

content suggesting that a systematic review involves some degree of conceptual innovation […] of concepts not found in the characterisation of parts and a means of creating the whole. The fusion of characteristics from HIB and Mobile HCI helps to identify theories which will build into new innovative methods and techniques to contextualise mobile usability testing.

Table 3.1: Proposed categories aiding deeper exploration via Systematic Review

Category	**Sub-category**	**Theoretical source**
Contextual need activities	Context of information need	Wilson (1997)
	Stress and cope	Wilson (1997)
Intervening Variables	Environmental/Spatial (Physical Contexts)	Kristoffersen and Ljungberg (1999)
	Environmental/Spatial (Social Contexts)	Savolainen (2009); Paay, J. and Kjeldskov, J. (2005)
	Psychological	Wilson (1997)
	Role and interrelated	Wilson (1997)
	Source Characteristics	Wilson (1997)
User Modality Factors	Wandering	Kristoffersen and Ljungberg (1999)
	Travelling	Kristoffersen and Ljungberg (1999)
	Visiting	Kristoffersen and Ljungberg (1999)
Application & Data Accessed	Technology	Kristoffersen and Ljungberg (1999)
	Data	Kristoffersen and Ljungberg (1999)
	Program	Kristoffersen and Ljungberg (1999)
Information Seeking & Use	Passive Attention	Wilson (1997)
	Passive Search	Wilson (1997)
	Active Search	Wilson (1997)
	Ongoing	Wilson (1997)
	Processing and Use	Wilson (1997)

3.3.2.2 SYNTHESIS CHALLENGES AND APPROACH

All research methods and practices have its advocates and detractors when generating qualitative data. Finlayson and Downe (2013) used these techniques to generate themes and a line-of-argument synthesis. Their intention was to generate new theoretical insights that could form the basis for hypothesis testing in the future. Sandelowski and Barroso (2002) and Finlayson and Downe (2013) both acknowledged that identifying what Cambell et al. (2003) calls as “key concepts” from the qualitative studies is very difficult. This interpretation of the data within these studies is difficult and the researcher needs a clear

and coherent strategy. Jessen and Allen (1996) identified several problems that might occur, these include; reliability of data retrieval, missing data, sampling bias, loss of information, glossing over detail, to name a few. There needs to be clear guidelines for dealing with issues involved in the application of meta-analytic procedures for qualitative accounts (p556, 1996).

3.3.2 ETHNOGRAPHY/AUTO-ETHNOGRAPHY

Ethnographic research has its origins in anthropological studies of non-western cultures in attempting to develop deeper understandings of unfamiliar civilisations (Ellis and Broucher, 1996). Ethnographic studies are characterised by researchers spending significant amounts of time in the field and, to some extent, immersing themselves into the environment they study. This method also offers the researcher "a way of seeing, and not the way" (Wolcott, 1999: p137).

Wolcott's interpretation is interesting and will challenge the researcher (as a lecturer) using and applying new ideas and ways of experimental testing practices. The systematic review will help the ethnographer focus and refine categories. The categories built around a mobile test framework provide key observational codes/themes like; context of need, modality and environments. Charmaz and Mitchell highlighted problems with deep immersion as an ethnographer seeing "data everywhere and nowhere, gathering everything and nothing" (2001: p161). In this case, data is "everywhere" however using the codes from the systematic review will guide and focus the observations supporting the interpretists mode of inquiry.

3.3.3.1 AUTO-ETHNOGRAPHY

Auto-ethnography places personal experience within social and cultural contexts and raises provocative questions about social agency and socio-cultural constraints (Reed-Danahay, D, 2009). Jupp (2006) calls it a form of self-narrative that places the self within a social context. Personal, professional and cultural experiences do contribute to this research. The researcher does have past experience within the testing field and has taught students on this module for a number of years. So using the "human as an instrument" (Pickard, 2012) is fundamental, utilising the experience of the researcher in this context adds value to the research strategy and applying the auto-ethnographic approach does eliminate the subject of bias (to some degree). Based upon the systematic review and experience the researcher

informs theoretical practices, which will inform professional context of the doctorate. As Ellis et al. (2011) explain, “Auto ethnographers recognise the innumerable ways in which personal experience influences the research process”.

As a method, the auto-ethnography has different forms and variations Table 3.2 summerises Ellis et al. (2011) grouping of ethnographic approaches. Each approach has a different emphasis, which places the researcher and their interaction with others (Bochner, 1997).

Table 3.2: Summary of auto-ethnographic methods (Ellis et al., (2011)

Auto-ethnography method	Description
Native ethnographers	Observer and work to construct their own personal and cultural stories.
Reflexive, dyadic interviews	Interview that focus on the interactivity produced meanings and emotional dynamics of the interview itself.
Narrative ethnographers	Narratives that refer to texts presented in the form of stories that incorporate the ethnographer’s experiences.
Reflexive ethnographers	Observes and documents ways a researcher changes as a result of doing field work.
Layered account	The account focuses on the authors experience alongside data, abstract analysis and relevant literature.
Interactive interviews	In-depth and intimate view of peoples experiences with emotionally charged and sensitive topics.
Community auto-ethnographies	A methods that uses personal experience of researchers-in-collaboration to illustrate how a community manifests particular
Co-constructed narratives	Narratives that illustrate the meanings of relational experiences, particularly how people collaboratively cope with the ambiguities, and contradictions of being friends, family and/or intimate partners.
Personal narratives	These are stories about authors view themselves as the phenomenon and write evocative narratives specifically focused on their academic, research and personal lives.

Using the types of narratives available the researcher’s emphasis is on observation and reflection around learning and test practice this aligns with **reflexive ethnography**. Reflexive ethnographies start from the ethnographer’s biography conducted and written up in a way that takes into account the researcher’s self-interaction with the object of study (Davies, 2008). As a lecturer, life-long learner and reflective practitioner the experimental design module (CM0673) is similar to a biography of professional practice. The module has emerged out of the researcher’s interests and the subject content is driven by the BSc. Computer Science degrees overall learning outcomes. Davies (2008) talks about reflexive ethnographies as something that means turning back on oneself, a process of self-reference. Observations will allow the researcher to evaluate “one’s-self” and assess how students’ have interpreted theoretical concepts to inform test design. This type of

ethnography allows the researcher to evaluate and challenge these theoretical concepts and reflect on testing practices based upon the evaluation of student fieldwork. These data gathering processes, systematically obtained through social research (Goulding, 1998, p51) and the data gathered from students' shape and evolve the concepts through interpretism.

3.3.3.2 ETHNOGRAPHIC CHALLENGES

The major advantage this method is the generation of large amounts of data in relatively short time. The major disadvantages are unknown biases and no guarantee of collected data being representative (Kjeldskov & Paay, 2012). Individuals often describe what they do in a way that is not accurate. This may be due to lack of awareness of understanding of what they are doing, or individuals may report more socially acceptable actions that their actual actions (Blomberg and Burrel, 2009). Sun and May (2013) also explain that real-world ethnographic studies have received relatively little attention within the HCI literature, and little specific effort has been spent on delivering solid design methodologies for mobile applications. This is where the professional doctorate has a purpose and goal contributing to the research body of knowledge. As a lecturer with this sample of students' the research creates "real-world" contexts for interpretation. As students tests as part of their own data gathering for the assignment, the data will be accurate (to a point), the real world context on the module creates a platform to evaluated and observe these theoretical concepts in action.

3.3.3 TRIANGULATING

Triangulation of methods aims to eliminate bias. The assumption that bias is inherent in any particular data source, investigator, and particularly method will be cancelled out when used in conjunction with other data sources, investigators, and methods (Mathison, 1988). The theoretical exploration based upon the literature review and systematic review present a range of theories and concepts informing test practice. The mobile test framework will allow the researcher to reflect on their own perceptions test methods but the students' interpretations.

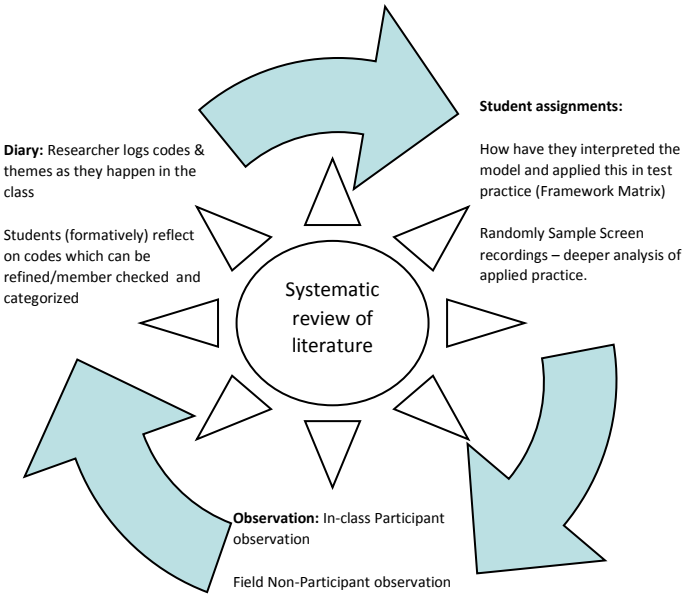


Fig 3.2: **Influence of the Systematic Review**

There are overwhelming positives to triangulate but there are disadvantages. A primary disadvantage is that it can be time-consuming (Thurmond, 2001). There is a 'possible disharmony based on investigator biases, conflicts because of theoretical frameworks, and lack of understanding about why triangulation strategies were used' (Thurmond, 2001, p. 256). This research, based upon a taught module within the faculty and part of the learning/teaching schedule requires the researcher (as the lecturer) to feedback and feed forward on progress prior to the field tests. The tacit knowledge from the lecturer, can, if used appropriately, provide a springboard to generate theory (Pickard, 2012), not an interference, bias or conflict.

Figure 3.4 displays an example methodological dualism presented at an iSchool conference. This example was part of a larger concept model demonstrating the ethnographer as an interprevist. The data captured triangulates with formative feedback and summative data showing how data works together supporting the evaluation. Triangulation helps in the reflection of testing practice (workshop exercises and discussion) and will help the researcher's discussion as part of the evaluation of the theoretical concepts informs the mobile test framework in practice.

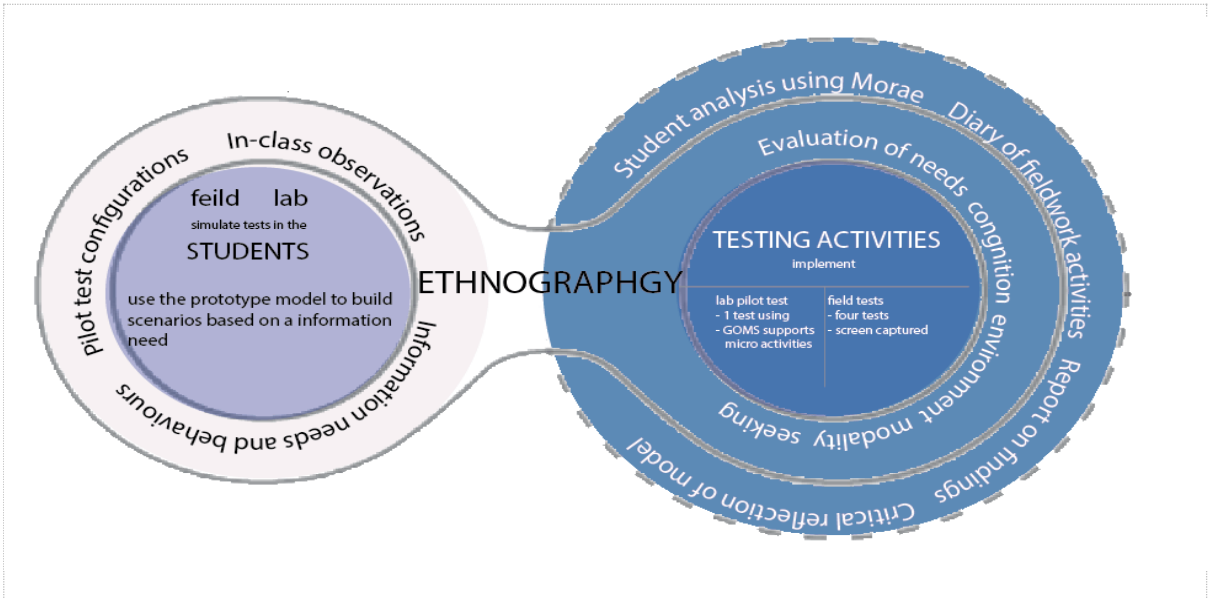


Figure 3.3: Ethnography - methodological dualism supporting Learning and Teaching.
Pointon (2014) Presented as the iSchool conference, Berlin 2014

3.3.4 SAMPLING

The sampling approach was based upon the pilot study which took place between September and December 2012. The researcher was able to gauge how long tests took by

looking at the workshop activities which were based around HIB and HCI models. Reflecting upon this it is envisaged that the researcher will be able to observe four students an hour. This is obviously dependent on the chosen context i.e. if they are travelling on the metro the researcher will not have the time to see the other student with the 2hr time scale. In these situations, a dialogue with the student and the research is needed so these contexts can be planned and scheduled.

Sampling is important to any research methodology as it enables representative testing of theory and limits the possibility of bias (Lewin, 2005, p.217). Sampling, within qualitative research is complex Coyne (1997) states that there are many variations of qualitative sampling described in the literature and much confusion and overlapping of types of sampling, particularly in the case of purposeful and theoretical sampling. The nature of this research is purposeful, students are studying the module and given clear guidance and repeated opportunities to decline any of the observations through the relevant university ethical procedures. Purposive sampling as Kumar points out is “based upon “your judgement as to who can provide the best information to achieve the objectives of your study” (2011, p207). Pickard (2012) highlights two approaches to purposive sampling; priori sampling and snowball sampling. The priori sampling sits with this research, the researcher wants to be able to use their judgements, there is going to be a timetable for the observations (Table 3.3) and judgements will have to be made on who attends and who do not attend the classes. The flexibility of this sampling technique is important – student are notoriously sporadic in attendance. The prior sampling technique will to structure the ethnography.

Table 3.3: Sample Timetable Framework

Week	Session One 9-11				Session Two 11-1				Notes.
Seven	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	Student need to move a test session
Eight	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	Students did not attend
Nine	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	Not prepared need alternative date
Ten	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	Declined observation
Eleven	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	
Twelve	0900-0920	0930-0950	1000-1020	1030-1050	1100-1120	1130-1150	1200-1220	1230-1300	

Sample Size: n=8 students evaluated over the 4hr period

3.4 TIME HORIZONS

The interpretivist paradigm supports numerous methodologies and analytical practices encouraging deep exploration of theory and practice, in this case evaluating experimental practices. Exploring mobile testing subjects goes deeper than the initial literature review aimed at new ways of applying “experimental design” within the module. O’Callaghan (1996) referred to in Goulding (1997) work describes this as an “interpretations made from given perspectives” and states that the “paradigm focuses on the search for meaning and understanding to build innovative theory and not universal laws” (1997, p53). The data from the systematic review and the ethnographic research will inform innovation supporting testing practice. Theories from this deep exploration will support mobile test practice and theories within this context will continually shape and research practice which will be disseminated to the wider research community. To contextualise the time horizon of this Charmaz (2006) identified components to summarise research process.

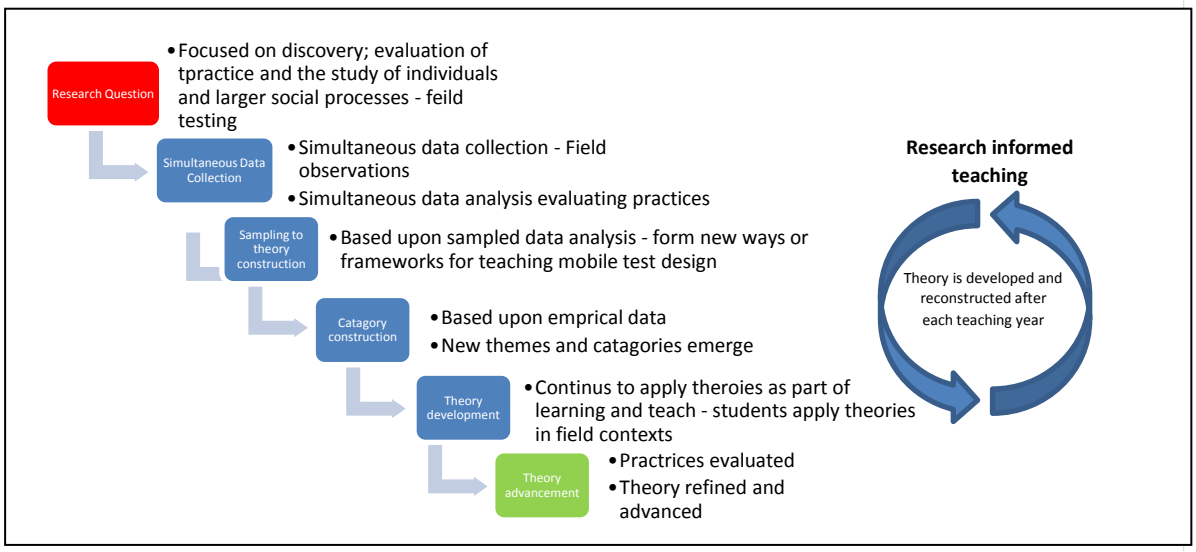


Fig 3.3: Time Horizon (based upon Charmaz (2006)

Using Charmaz’s (2006) principles the researcher has a strategy which will directly inform and improve testing practice, year-on-year. The principles go through what is essentially a set of iterative processes that building continually to improve initial theories (and practice). The simultaneous data collection and analysis evaluates test practices and how the academic field has modelled mobile tests providing theoretical interpretations from within HIB and Mobile HCI. The data collection and the knowledge gained will shape professional practice searching for new meanings innovative ways to shape testing practices.

3.5 DATA COLLECTION METHODS

This chapter has presented a philosophy, approaches and methods aligned with the philosophy. As the research puts methods into practice data collection tools and techniques need to be considered as part of the strategy. There are a range of data collection tools available to aid an interprevist's mode of inquiry and this section will evaluate the tools and techniques.

3.5.1 ETHNOGRAPHIC OBSERVATIONS

Observations are integral to any interprevist's approach that are, searching for and, exploring social situations to gain an understanding of meaning. Typically, data is gathered through observations and the phenomena studied are placed in a social and cultural context (Kjeldskov & Paay, 2012). The social and cultural contexts to this research study are important providing the researcher with data exploring how students have applied theories informed by the systematic review to support their own test practice. Maggs-Rapport (2000) applied observational techniques concentrating on the descriptions people give to their routine, daily lives, enabling the ethnographer to explore a number of views at the same time. To achieve the aim of searching for a mobile test framework the researcher requires a clear and grounded understanding of their social meanings behind tests planning and execution.

Mcneil & Chapman (2005) reviewed qualitative methods supporting social science research, observational methods proved to be the most effective (2005, p.92). Collecting data using observations requires systematic note taking and the recording of events, behaviours, and artefacts (objects) in the social setting (Marshall and Rossman, 2011 p139). Within social science research there are three broad ways in which observations have been applied, direct or non-participant observation, participant observation and complete or covert observation (Mcneil & Chapman, 2005; Robson, 2002).

This research blends observational techniques and uses them at two points within the module; ***in-class observations*** and ***field observations***. In-class, taking a participative approach aiming to gain an initial insight into the students interpretations that emerged for the researcher systematic review. The field observations are more non-participative and will evaluate how the students apply their mobile tests within the field context.

3.5.1.1 IN-CLASS OBSERVATIONS

Set within a teaching schedule (a formative setting) the researcher introduces theories formed from the systematic review. Students are set a range of practical exercises aimed at exploring test theories and concepts in practice. Test frameworks and models used and interpreted to test design and field preparation. The exercises match learning outcomes and students' apply theories and data is captured via participative observation help to gather feedback and feeding forward to the experimental field tests. The research set in-class/lab environment as Sun and May (2013) point out begins to test and simulate context richness within the lab through scenarios contributing to the realism this maintaining the benefits of the controlled setting before the field tests commence (Sun and May 2013; Kjeldskov, et al. 2004). Table 3.4 presents the session structure and splits into two distinct parts and the researcher's observational role can be seen at participative or non-participative.

Table 3.4: Formative Session Structure (three formative sessions follow the same a practical and reflective)

Breakdown	Time	Mode of inquiry	Activity
Part One	09:00-10:45	Participative	Topic theme introduced and workshop activities set around theme (context of information need, user behaviour, mobility and spatial environments). The researcher (as a lecturer) guides and supports students fielding questions about the model and how this could be applied to the activities and assignment Students work through the activities and the researcher notes in a diary points based upon the categories and themes from the model.
Break:	10:45-11:00	N/A	At the end of Part One there is a break and the researcher has the opportunity to group the points based upon the number of occurrences.
Part Two	11:00-13:00	Mixed between non and participative mode of inquiry	The students and researcher return and a focus group commences (in the guise of a seminar) and a discussion takes place where the points are member checked to help highlight the importance A final list is built up to see the importance, which will feed into the discussion of findings.

Sample Size: session one n=27, session two n=18 and session three n=18

Part One: The in-class observation is interactive and participative exploring students' approaches to test planning and development. The researcher and students' get involved with the activities, in this context the researcher is seen as a `loiterer' (Spradley, 1979) watching the interactions build-up individually as they communicate with one-another. The researcher wants to understand and quiz them about their interpretations as test scenarios

emerge extracting new codes that emerge which will be analysed to see some kind of vocabulary would emerge (Paay, J. & Kjeldskov, J., 2005).

Applying participative observation requires confidence and skill, Mcneil and Chapman (2005) talk about a “trusting rapport” with the participants (2005, p.96) being a challenge. The theories and data collection methods piloted in 2012 built around participative research. The aim of creating a trusted rapport with the students was important and students commented that this complemented the workshops design. This rapport grew throughout the module aiding confirming the approach worked. It was also anticipated that with this sample participative research helped planning as they received timely feedback feeding-forward into the assignment. The module outline also stated, “each week some class time is dedicated to development and planning of this project”. In essence students have plenty of time to pilot tests with their peers building up trust and confidence to guide their learning but not influencing decision making.

Part Two: Is less interactive in a practical sense but more of a seminar/group discussion. This type of approach is aligned with methods used within focus group design in that it’s a “form of group interview that capitalises on communication between research participants in order to generate data” (Kitzinger, 1995). The themes and new codes extracted in Part One are presented to the class and as a group a discussion takes place to rationalise and group creating a vocabulary to inform the research. The codes and themes are member checked which “is primarily used in qualitative inquiry methodology and is defined as a quality control process by which a researcher seeks to improve the accuracy, credibility and validity of what has been recorded during a research interview (Harper & Cole, 2012; Lincoln & Guba, 1985). Member checking reduces, validates and refines the themes, which help to clarify the findings from Part One. This helps to focus the research on the aim of study and as Fetterman (2010) discusses the success or failure of […] ethnography depends on the degree to which it rings true to the native and colleagues in the field. From the professional stance it is anticipated this approach will inform practice which will feed into analysis helping to cross checking the lab work against the actual field tests.

Table 3.5 displays the sessions, when they will take place and how they meet the modules learning outcomes. There are three planned sessions each following a consistent path i.e. an initial practical part and seminar which reflects on their practice.

Table 3.5: Formative Observation Schedule (Based upon the module workshops)

Week	Date	Session Title	**Learning Outcome:**
Week Four	Date: 16/10/2013 Time: 9am-1pm	Developing test plans (Introducing the Model)	Understand the context of information needs within a mobile context.
Week Five	Date: 23/10/2013 Time: 9am-1pm	Cognitive Modelling (Supporting HIB)	Model the context of needs using the theories to model and map out user pathways.
Week Six	Date: 30/10/2013 Time: 9am-1pm	Implementation (Piloting prior to field tests)	Pilot and record scenarios in lab conditions. Expert review and modelling user pathways.

Sample Size: session one n=27, session two n=18 and session three n=18

3.5.1.2 FIELD STUDY OBSERVATIONS

The field from the researcher's perspective is a non-participative mode of inquiry suiting this kind of ethnographic research. The field study aims to "explore the relationship between developing a descriptive understanding of human behaviour and designing artefacts which ostensibly support the activities described" (Blomberg et al., 1993). This field study explored how the students' behaviour has been influenced and supported by the test model developed as part of the synthesis.

This field observation was applied as a method to capture data in a non-obtrusive way. Cooper et al. (2004) explained that it offered a more objective and direct view of behaviour (p1, 2004). The mobile test framework is based around a number of theoretical concepts and observing these in practice will provide a more direct view than say interviews which may employ indirect mode of assessing information and information use (Cooper et al. 2004). The field studies are unobtrusive in many ways so the data collection does not impact on their experience as a learner. Planning observations around the module timetable makes sure observations are consistent, fair and timely with each student.

Table 6. Summative Observation Schedule (Based upon the module workshops)

Week	Session Title	Mode of inquiry	Data Capture
Week Seven	Running Field tests – Collecting Qualitative Data	Non-Participant observation	Structured scheduled observation over the 4 hour period
Week Eight	Running Field tests – Collecting Qualitative Data	Non-Participant observation	Structured scheduled observation over the 4 hour period

Week Nine	Running Field tests – Collecting Qualitative Data	Non-Participant observation	Structured scheduled observation over the 4 hour period
Week Ten	Running Field tests – Collecting Qualitative Data	Non-Participant observation	Structured scheduled observation over the 4 hour period
Week Eleven	Using the lab software to analyse tests	Non-Participant observation	Structured scheduled observation over the 4 hour period
Week Twelve	Using the lab software to analyse tests	Non-Participant observation	Structured scheduled observation over the 4 hour period

Sample Size: n=8 students evaluated over the 4hr period

3.5.2 DIARY

Diaries are self-reporting or recording instruments that examine ongoing experiences, offering the opportunity to investigate social, psychological, and physiological processes, within everyday situations (Bolger et al., 2002). These recordings can be anything from a simple record of activities (such as a schedule) to an explanation of those activities, to personal reflections on the meaning of those activities (Lazar et al, 2010). A fundamental benefit of the diary is that it permits the examination of reported events and experiences in their natural, spontaneous context, providing information complementary to that obtainable by more traditional designs (Riess, 1994 and Bolger et al., 2002) The diary methods allows the researcher to evaluate and reflect upon a whole range of experiences, like studying various human phenomena including personality processes (e.g., Bolger & Zuckerman 1995, Fabes & Eisenberg 1997, Rhodewalt et al. 1998)and physical symptoms. (e.g., Suls et al. 1994). These will all add value to the evaluation of the theories applied by the students.

In the case of this research the diary is used as the primary instrument to capture observable events in the lab and field. The diary is participant orientated, the researcher introduces the theories and using workshop time documents the students' interpretation of how these theories can be applied to support test their own development. The diary as a data collection instrument will support the researcher's reflections throughout this study acknowledging the theoretical sensitivity, which includes their intellectual, professional, and personal background that may affect the study (Birks & Mills, 2011). The researcher is basing this on a professional context so the reflective diary includes the professional and intellectual aspects which have been based upon the systematic review to support the student learning and help to evidence the research. This evidence is based upon the theories and innovative ways to demonstrate how this can support the students learning experience.

Lida et al. (2012) broadly split the diary as a data collection method into three categories:

- What are the average experiences of an individual, and how much do the experiences vary over time?
- Is there systematic (e.g., linear, exponential) change in experiences across days, and do such trajectories differ across persons?
- What processes underline a person's changes, and how do people differ in this process?

The diary aims to capture experiences and how these experiences evolve and change using the theories within lab and field contexts. The researcher wants to capture the moments when the scenario **starts**, how it **flows** and how it **concludes**. Collecting in-depth data within these contexts will help derive meaning from any one or several observation notes (Pickard, 2012). These notes will help the comparative nature of the research study. As this chapter has already discussed, the diary will be used in a participative mode within the lab based upon the focus group method a log of initial thoughts by the students are noted and then member checked helping the synthesis and focus the data. The diary will then be used in a non-participative observation and the researcher's diary will complement the auto-ethnography which will be help to triangulate the data collection. Within the ethnographic research the researcher needs to keep impartial and does not want to interfere with the field-testing conducted by the students. The structure of the diary will help to decipher meaning from several observational settings.

3.5.2.1 CAPTURING DATA IN-CLASS

Capturing the research activities within the class will enable the researcher to record students' initial thoughts. The dairy logs instances and these instances are based upon codes, which emerged from the systematic review using the codes based upon the model that will help compare meaning within the analysis.

3.5.2.2 CAPTURING DATA IN THE FIELD

The field diary is much more focused on the evaluation of the participants (students) and their use of the scenarios based upon the user model provided. At this point the students will have designed their tests scenarios and the researcher aims to evaluate how effective these scenarios are based upon the students understanding of the user model. Sociologists such as Dyson (1987) have championed the research diary as an important ethnographic resource in that it can give important insights in to the research process – this is exactly what the researcher diary aims to do, the research process is an evaluation of students' ability to

implement scenarios to aid the user testing the diary will help to capture this data within the field setting where the student will be conducting their tests.

Code	Code instruction
Event trigger – Context of need	What started the test, what was the need and how did the initial mobile interaction triggered?
Environment/context setting	Where is the test set? Does it match user needs? Is this realistic?
Modality factors	Walking, sitting, travelling
Seeking behaviour	What approach did they take (active)
Information seeking success	Did the user have any difficult
Date and Time of test	

Table 3.7: Research Dairy to aid field observations

3.5.3 PILOTING

Piloting for any research project is extremely important and enables the researcher benchmark the chosen methods against the studies aim. In this case establishing appropriateness, quality and accuracy of the procedures adopted to support the research questions (Kumar, 2011). The pilot study ran for twelve weeks starting 01/10/12 this gave the researcher time to reflect on methods and data collection in preparation for the ethnographic fieldwork which commenced September 2013.

The Pilot aimed to:

- check that the methods were suitable and not intrusive.
- check that the exercises meet the students experience and module learning outcomes.
- make sure trust would be built up between the researcher and the participants.
- see if the barrier between lecturer and student was there when an observation took place.

In September 2012 mobile test frameworks and core aspects of the systematic review (i.e., HIB and Mobile Informatics) were introduced to inform learning and teaching practices. At this point there were some key themes and features emerging from the grounded work around user context, information needs, environments and modality. These themes were firmly set within the researcher's vision and a core contributor to the aim of study and the outcomes of the module. With this in mind the researcher ran formative sessions over a three-week period where different aspects were used and applied. The researcher simulated participant observations so feedback could be gained on the students' ability to use these practices to support test design.

The feedback was interesting, an important point to note from the evaluation of the ethnography had synergies to past research practice, Cooper et al. (2004), for example, state that the ethnographic texts suggest that judgement is not bound by formal scientific rules, but rather that it is more experience and intuition (p. 5). As an academic with lesson plans and learning outcomes the intuition and experience helped to support observation practice within the ethnographic context. Piloting supported and reaffirmed the modules learning outcomes and based upon this experience and using the researcher's professional judgement a new supporting point was included in the assessment ***"Research and develop experiments based on Information Model provided".*** This came out of the pilot observations which makes it clear to the students that test cases (or scenarios) are informed by a mobile test model or framework, which improved support and contextualised assessments based upon the modules learning outcomes.

Another noteworthy point from the piloting exercise related to the research suitability and linked to the students' ability to critically think and develop mobile test based upon these models and frameworks - a core learning outcome. This point also relates to context and modality. The pilot highlighted a need for guidance on definitions of contexts which seemed too abstract and the researcher initially thought this could impact their mobile tests. The researcher was initially worried that the disparate nature of their context choices from the pilot study could have an impact on future summative work and research data, for example,

"Could the varied and wide ranging context and modalities make it difficult to identify themes and codes for the data analysis?" (student quote, 2012)

There was a worry that there are too many context options and micro-environments that impact on the mobile tests. One solution would be to narrow or prioritise options, which would help or maybe force students to develop tests based around one contextual factor and environment (i.e. wandering down Northumberland street before heading to University). These concerns can be traced back to earlier HCI studies, Beck et al. (2004) had a predefined route with potential obstacles which limited the environmental contexts. This is something the researcher did consider but felt was restrictive and limited the "contextual" nature of this research where physical environments play a big part in contextualising mobile tests. As the research evolved through the systematic review the use of information models in this case Wilson's model provided a framework of practice to support students' reducing confusion making the test process adaptive and structured which supported the test need and setting. Based upon this finding the workshop "***Using a module to improve testing agility"*** emerged which helped to shape the students understanding and supported the researchers formative observations sessions.

Trust factors are fundamental to any ethnographic research (Cooper et al, 2004; Mcneil and Chapman, 2005), trust is seen as a potential barrier between the students and the researcher. Students were initially wary about, as they put it, the lecturer ***"snooping over my work"*** but once the process was explained and the researcher got to the bottom of the main issue, ***"is this going to affect my mark?"*** they did not mind. This is a point that is taken very seriously and the assessment guidance included clearly ***"Please note. Matt will be out observing students between week 7-10 as part of the fieldwork for his Professional Doctorate. The class will be on but he might not be there in attendance each week. It is also worth noting that Matt will be observing you as a group between weeks 4 and 6, he will also observe you individually conducting your tests – this is NOT part of the assessment and Matt observing you has NO bearing on your assignment and mark!"***

The pilot also explored student data collection which was initially a diary which was going to be used from two perspectives, the students' and researcher's perspective. The student diary aimed to follow a systematic approach throughout the module (from weeks 3-12) each week students are encouraged to fill out a diary about their experiences and this would help to support their justifications within the final report. Students were encouraged to gather data reflecting on their practice and how the model supported their tests. This seemed like a good data collection mechanism but based upon the pilot students did not engage in capturing data (even though it was part of the assessment) and it was removed as a final data collection method. The researcher log/diary however did work and will support the researcher's attempts to capture attitudes and feelings toward the process. The diary helped to capture points about the model and how it is going to be applied.

3.6 DATA ANALYSIS AND RESEARCH PRESENTATION

The data gathered, synthesised and analysed will be constructed around Strauss' analytical approaches of structured comparative analysis (Strauss, 1987). The approach takes this research on a journey establishing themes (codes) and patterns through purposeful exploration of practice as student apply their mobile tests. The literature review identified two models to support the research and using the attributes from these models as comparative codes the systematic review will map these codes to discover how these have informed practice which will support the research aim and complement learning and teaching practice.

Data is collected at different points within this research life cycle, literature review, systematic review, formative session and summative (i.e., field studies and student work) are

all contributors. The data collected will critique and iterate around the same codes, the impact of the grounded model can be evaluated as a tool to support tests and improve student experiences of this practice. Basing codes on two established models a deeper grounded analysis of data gathered via the systematic review will shape practice and inform the two research communities. The data from the systematic review can be taken forward further using axial and selective coding (Strauss and Corbin, 1998) supporting the comparative nature of this investigation. The benefit of this type of method helps to handle large, complex data systematically, as it is generated in this research. The codes from the synthesis help to shape the model as a framework for teaching practice which is evaluated in action through the ethnography. Putting the model into practice within the class room will generate data based upon the models codes interpreting how students applied this within the formative sessions. The data from the formative sessions will provide richness in students' interpretations of the model and what the parts mean to them.

The analysis will lead to additional questions for subsequent research (Connelly, 2013). In the case of this research coded identified as part of the synthesis will be followed up within the formative and summative observations which are checked against the student work submitted. The researcher will observe and capture events in a diary which are based around the codes from the formative session as the study is ongoing (Montgomery & Bailey, 2007). The coded diary is a reflection on how the model is used by the student which is then compared against the summative work

In summary the research is following a pathway to interpretive qualitative analysis, one which is aiming to "comprehend and synthesize the phenomenon under study" (Morse, 1997 and Pickard 2012, p155). In this case to support mobile testing within context rich environments. The next part of Morse's four point to qualitative analysis "theorising and recontextulising" is addressed by the ethnography where the model is applied and evaluated to support teaching practice.

3.7 ETHICS

The ethical considerations to a research study should always prompt the researcher stance and mortality - does this research comply with ones beliefs and own code of ethical values? Audi (1998) believes that the moral justifications of a researcher are "grounded in the application of a principle to action which is judged in the light of information gained through perception or through some other apparently non-moral informational source". Audi's outlook is supportive and matches the researcher's point setting this as part of a Professional Doctorate the University has a mission and shared vision to become a ***"research rich and***

research focused institution" where research informs teaching. The researcher, as a lecturer, is attempting to apply newly researched theories to inform and practice providing richness and up-to-date skills to support (and hopefully improve) the student experience. Making these attempt pushes the knowledge of the researcher opening up new methods, development tools and applications to support mobile user tests.

These approaches do come with challenges to ethics. Hemmersley identifies four issues surrounding ethic where problems maybe encountered, "deception, privacy, consequences for others and for research" (1990: p132). The issues surrounding deception are common within observational methods and the researcher needs to keep an open and transparent dialogue with the students. Hammersley and Atkinson (2007) discuss the importance of "informed consent" arguing that the people studied by social researchers should be informed about the research in a comprehensive and accurate way, and should give their unconstrained consent (2007: p264). This research set out the observational methods to the students in the induction (week one) and gave them a consent form, the consent forms followed the University ethics policy in that ***"written consent must be obtained before any work can take place"***. Students were under no obligation to sign or be observed and it was reiterated that there was no way they could incur any penalty. Privacy and confidentiality is another salient point that does need discussion. This research is geared to informing professional practice, using students as the sample was pivotal and so was their privacy and confidentiality within the research process. This does come with challenges not on the scale of Laud Humphreys (1975) Tearoom Trade, anonymising a naturalistic observation of male homosexuality liaisons in public toilets. However, there are challenges relating to the way data is anonymous, Gomm (2008) mentions that researchers take care and use pseudonyms or code numbers to anonymise people in their research notes (2008: p379). So using these principles and to create "buy in" to the research the researcher earmarked the initial focus group which anonymised research participants. The aim of this researcher wanted to open this up to the students to empower them and make they feel part of the research process and it worked – pseudonyms won.

4. CHAPTER FOUR: SYSTEMATIC REVIEW

This research aims to search for a contextualised approach to testing methods within the mobile arena. The learning outcomes from the module identified codes as part of a research approach and based upon this Mobile HCI and HIB research supports professional practice. Two models emerged from the initial literature review, confirming the importance of Mobile HCI and HIB and their applicability to the research. Appendix C (Literature Map) provides evidence of how the researcher identified the two models. The methodology presented a range of methods fitting with an interpretist stance and the systematic review takes the research forward building theory from published research through linguistic analysis (metaphors) and theoretical concepts, which reveal connections.

This chapter discusses the reviews core finding, data from this exercise can be found in Appendix D (Systematic Review) and provides a complete breakdown of the metaphors and themes with evidence from the published work. An evaluation of these practices with supporting student “in-class” examples presents how the themes apply to possible testing practice. Figure 4.1-4.14 presents the examples aiming to contextualise mobile testing. Figure 4.15 pulls this together as a new model which will be applied as a framework to support teaching practice.

The review uses the broad codes from the literature (i.e., Context, HIB and Usability testing) but extends these codes to build themes based around the models. This aims to contextualise theory and informing practice, the codes are:

- Contextual Need Activity
- Application and Data Accessed
- Intervening Variables
- User Modality Factors
- Information Seeking & Processing Use

4.1 CONTEXTUAL NEED AND ACTIVITIES

People have a need to discover, search and access information everyday as they go about their lives (Wilson, 1977 and 1981; Savolainen, 2009), the ubiquitous nature of Smart technologies is making information access, to fulfill a user need even more mobile (Burford

and Park, 2014). A user's information need is seen as a natural starting point for the researcher and this presents the beginning of a pathway or journey for students.

4.1.1 CONTEXT OF INFORMATION NEEDS

Themes associated with the context of information need have helped to inform the synthesis identifying its importance. Synthesizing papers based upon metaphors "context" and "information need" the researcher has been able to group based upon information needs. An interesting point that keeps reappearing is the fact that the context of information needs does not happen in isolation, there are other factors involved for example a users' context or situation appreciating the space and environment influence the context of need. Savolainen (2005; 2009) called this "everyday life information searching" and space affects a users' ability to effectively search and will influence their approach. Table 4.1 presents a range of contexts and settings which help to show how past research has considered space within the research.

Table 4.1: Contexts - themes based upon Systematic Review

Context theme	Context setting	Systematic Review source
Office and industrial	Natural Setting	Johnson (2003) . Kristoffersen and Ljungberg's (1999) and later Wiberg (2005)Paay, J. and Kjeldskov, J. (2005); Wilson (1981)
Home	Natural Setting	Bouwman and Van De Wijngaert (2002), Rieh (2004), O'Case (2010) Church and Oliver (2011)
Academic	Controlled lab and campus setting	Kjeldskov & Stage, 2003; Beck, 2003; Barnard, 2007; Kane, 2007; Burnford and Park, 2012; Redondo et al., 2013
Simulated City streets or Campus	Semi controlled and semi natural	Nillson et al., 2001; Goodman, 2004; Oulasvirta, 2005; Kaikkonen, 2005; Chua et al., 2011; Teevan, 2011; Schmied et al., 2011; Hussain and Kutar, 2012
Virtual	Evaluation of everything and everywhere - assessment of user log files	Church, 2009; Church and Oliver, 2011

4.1.1.1 INDUSTRIAL CONTEXTS

Johnson (2003) investigated what he defines as the three senses of context: situation, contingency and frameworks, Johnson applied to two case studies one being the information needs and uses within a large organizational context. This study evaluated the senses of context of information on teams and their ability to seek and share information, evaluating information use within complex multi-disciplinary teams highlighting how contexts influence seeking behaviour. Kristoffersen and Ljungberg (1999) and later Wiberg (2005) set out information needs within computer-supported collaborative work environments (CSCW)

within the field, research evolved to their mobile informatics framework. Their frameworks evaluated contexts around collaborative mobile use to support industries, like telecoms. The information needs focused on critical tasks which supported maintenance of telecommunication networks for example, using a portable device whilst up a telegraph pole.

4.1.1.2 CONTEXTS AT HOME

Bouwman and Van De Wijngaert (2002), Rieh (2004), O'Case (2010) Church and Oliver (2011) all set their research within the home evaluating the context of information and use. Bouwman and Van De Wijngaert (2002) compared information needs within two contexts one being at home, activities centered on information needs to support communication and seeking approaches (i.e. finding a telephone number or passing travel details to a family member). Their study gave them an insight into how media is used in these contexts to support an information need. Rieh (2004) used Bouwman and Van De Wijngaert's home context suggesting that the context of "information use environment" centered at home, considering this as the primary "information gateway" to users (p. 796). The term "use environments" is an interesting point setting "home" as a context of setting where information work takes place. Rieh's user study analysed participants web logs supported with interviews which helped to define their behaviour i.e., information searches (recipes or parenting advice), geographic information to locate restaurant. Case (2010) assessed user behaviour at home using an auction site (E-Bay) to evaluate user ability to use, understand, evaluate information to make informed decisions about information in different parts of the auction site. Church and Oliver (2011) evaluated information needs, contexts and mobile use over a four-week period, their research identified the home as the most common place for user interaction with their mobile device (49.6%) to support an information need. This research was focused very much on the information use and not about needs but helped to firm up the home as a context of where user would interact with their Smartphone.

4.1.1.3 ACADEMIC CONTEXTS

The academic context received a lot of attention within the synthesis (Kjeldskov & Stage, 2003; Beck et al., 2003; Barnard et al., 2007; Kane et al., 2007; Burnford and Park, 2012; Redondo et al., 2013). The information needs focused on search and retrieval activities, for example locating and playing a piece of media within a catalogue (Kane et al., 2007). Kjeldskov & Stage, (2003) and Beck et al. (2003) both set initial activities within a laboratory switching to field settings comparing the values of the different environments. The

comparative research focused on identifying mobile usability problems and the ability to capture this data in the field. The research centered around the users' mobility whilst completing information based activities i.e., sending, receiving and managing mobile texts. Barnard et al., (2007) was not directly associated with information needs but a set of reading comprehension activities, again like the pervious example was concerned with motion and use of the device. Kane et al. (2007) set on campus and the information needs activities were based around the retrieval of music within a catalogue, activities required the participant to find tracks whilst moving around the campus. Burnford and Park (2012) set information tasks requiring students to interact on a tablet finding information via an application and the Moodle elp, the context and information used was evaluated via a Netnography. The main context of these activities was on campus and the assessment of log files triangulating the data with ethnographic observations.

4.1.1.4 CONTEXTS SIMULATED AND REAL WORLD

Real world contexts and task simulations were very common and informed the synthesis about research practice and data capture methods within the field. Nilsson et al. (2001); Goodman et al. (2004); Oulasvirta et al. (2005); Kaikkonen et al. (2005); Chua et al. (2011); Teevan (2011); Schmied et al. (2011); Hussain and Kutar (2012) set their research in a real world context. Test participants were set a range of activities to support and explore interaction and user behaviour in these contexts by; searching, accessing and gathering information. Simulations or enactments were applied bar one. Nilsson et al. (2001) used a real context (Swedish Car Rally) based around information needs, retrieval and aggregation of media. Users were provided with phones and required to pool multiple media sources to work out where to travel next on the race route, this information was gathered, used and shared within a group before setting off to the next destination. Oulasvirta et al. (2005) and Kaikkonen et al. (2005) conducted extensive field experiments within a number of different environments; the high street, a café and travelling up an escalator. Information tasks to support the information needs required a number of seeking activities, software downloads and management of information on the devices.

The use of GPS and maps on a mobile device to search and reenact a real information requests were within this simulated context Goodman (2004), Schmied et al. and Teevan et al. (2011), Church et al. (2009) and Hussain and Kutar (2012) set tasks around location based information. Searches focused on finding and navigating to certain locations like the Post Office, find a pizza place or coffee shop. Hussain and Kutar (2012) used location based information searches but used an alternative device other than the phone, the Tom-Tom

whilst driving. Chua et al. (2011) set their context of information need around weather information and their ability to check whist travelling on public transport.

4.1.1.5 VIRTUAL EVALUATION CONTEXTS

The virtual evaluation of contexts allowed large amounts of information and data to be gathered and evaluated (Church, 2009; Church and Oliver, 2011). These authors used log files to capture data and diaries to capture information over a four-week period.

The context of information needs is more than just the need its self, the context i.e. spatial situation needs to be addressed within the models from the outset. This does have strong connotation to the environmental element of the model however this sets the scene for the information based scenarios. Mapping out the range of contexts and how these have been applied to information needs research from the Mobile HIC and HIB perspective provides the researcher with a suitable breadth of knowledge of their application and how to apply this to teaching practice, based upon Timetable example this example emerged.

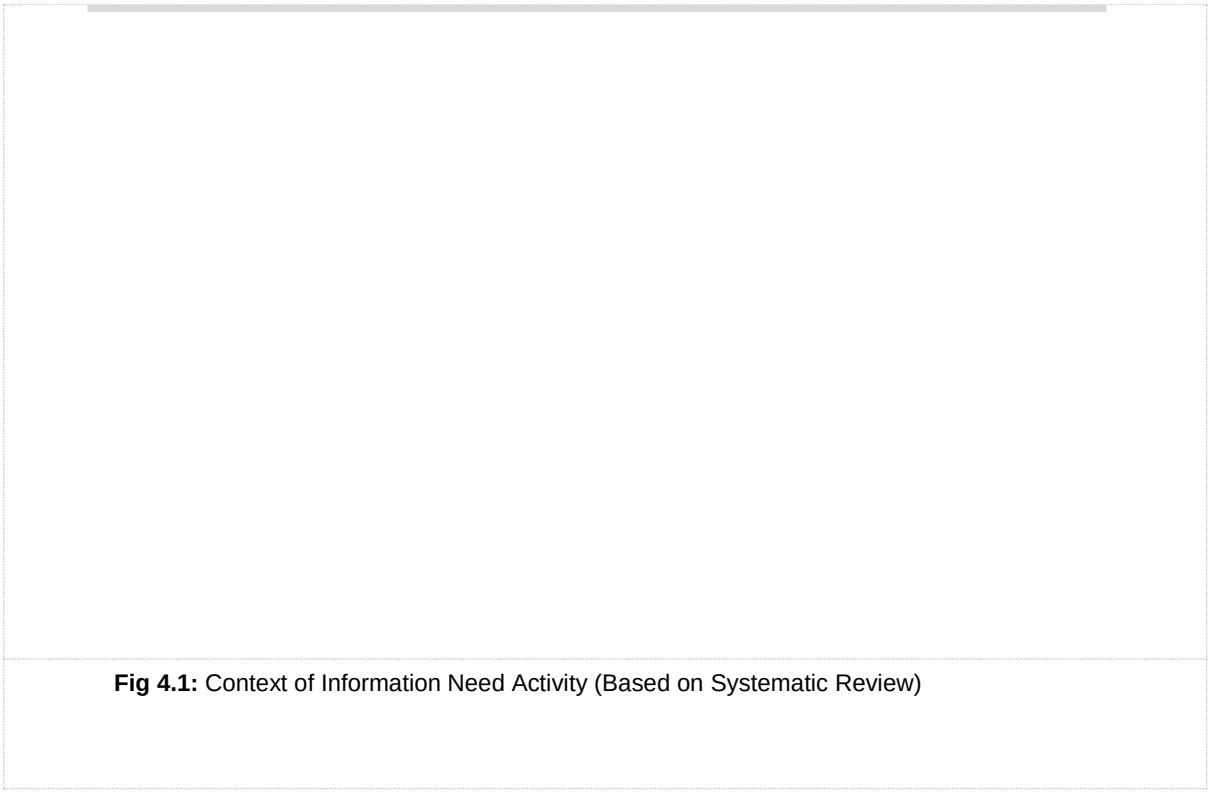


Fig 4.1: Context of Information Need Activity (Based on Systematic Review)

4.1.2 COPING AND STRESS THEORY

Coping defined by Folkman (1984) and Folkman & Lazarus (1980) as “a cognitive and behavioural effort to master, reduce, or tolerate the internal and/or external demands that are created by the stressful transaction”. The information behaviour model by Wilson (1981) stated that a user’s “individual need can be grouped by their cognitive and affective

information needs". This research formed the Human Information Behaviour Model which drew upon Johnson and Meischke (1991), their research of a cancer patient explained an "individuals need for cancer information can either consist of cognitive needs (obtaining factual information to prevent, detect, and/or treat) or affective needs (obtaining information which will aid in dealing with cancer emotionally)" (p10, 1997). So these types of needs create activations to cope with or relive stress in a situation.

Fig 4.2: Stress and Cope (Based on Systematic Review)

There are a number of behavioural effects that could potentially impact on their ability to fulfill a need. This could impact on the user's emotions, again Folkman (1984) used the term coping with other psychological attributes for example '**emotional focused coping'**. This echoes Troy et al. (2013) emotional regulation research where a user regulates emotions depending on the context. For example, users focusing on finding the factual information to fulfil the need and get to a place on time, this is potentially an emotionally charged context they don't want to let the other people down with miss-information (Nilsson et al., 2001; Church and Oliver, 2011). Bouwman and Van De Wijinaert (2002) and Chua et al. (2011) were not factual but more network issues impacting on emotions, the network cable was down and/or intermittent causing levels of personal frustration with the technologies.

The behavioural effects are not purely based upon a user's emotions and this could be a simple problem based activity Zuuren and Wolfs (1991) correlate this with '**problem focused coping'**. Within the context of this research problem based coping is seen as an information need or request to search and retrieve information activities. Kristoffersen and Ljungberg (1999) and Redondo et al. (2013) for example set problem based activities in

contexts that created cognitive actions to problem solve using a mobile device. Redondo et al. assessed a mobile VR application evaluating usability to support learning and teaching cognitive behaviors were evaluated to improve this as a potential learning tool. Kristoffersen and Ljungberg (1999) evaluated the engineer's ability to problem solve networking problems and their ability to cope (physicall) with the mobile device up a ladder.

4.1.2.1 DISSONANCE

As a user problem solves within a given context, physically, socially or digitally, their perceptions are challenged and dissonance can potentially happen. Cognitive dissonance is used to describe feelings of discomfort that results from the user holding two conflicting beliefs, simply stated as a theory about inconsistency (Cooper, 2007 p2). Consistency is something everyone strives for it provides structure and confidence in what happens in everyday situations. When there is a discrepancy between beliefs and behaviors, something must change in order to eliminate or reduce the dissonance. Case (2010) evaluated information behavior within eBay noting a lack of consistency and ambiguity of content creating dissonance where recommended changes in the why content is presented would help information need and a user's behaviour in this environment. Kristoffersen and Ljungberg (1999); Wiberg (2005) and Oulasvirta (2005) had multiple levels of user dissonance regarding the use of technology within natural environments. A user has this perception of using the device (i.e., sat in the office or at home), and in these examples this challenged in the field impacting on their ability to interact. To support the contextual factors considering dissonance aids critical thinking and appreciates user states; cognition or affective, coping or stress. Barnard et al. (2007) and Kane et al. (2007) created a platform to test people's cognition and perceptions of activities whilst moving, Barnard et al. (2007) created comprehension tests on a mobile phone altering lighting to test usability, Kane et al. (2007) changed modalities requiring the user to search a music catalogue. Both examples aim to challenge the user's beliefs and interactions whilst moving and potentially cognitive dissonance could appear.

These examples taken from the synthesis acknowledge levels cognitive dissonance. Dissonance can occur when a user's belief is challenged the psychological representations of an interface could be inconsistent with each another. More formally, this could be a set of cognitions which are inconsistent if one-cognition follows from the opposite of the other.

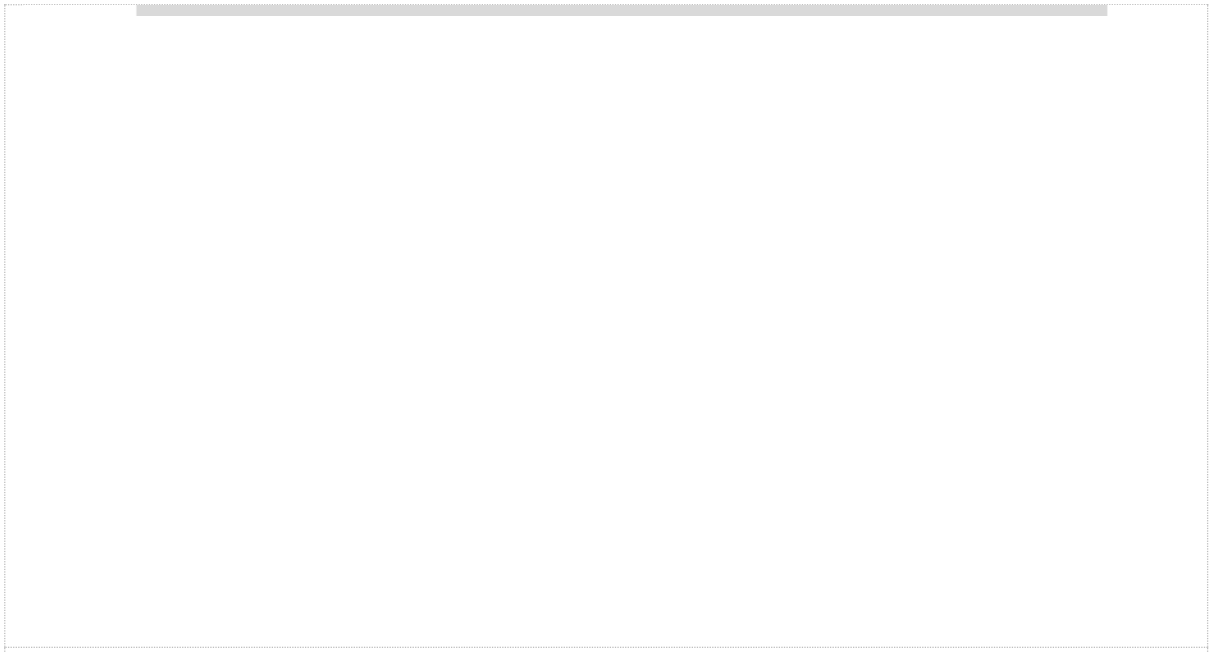


Fig 4.3: Stress and Cope – Dissonance (Based on Systematic Review)

4.2 ACTIVATION MECHANISM

The literature review acknowledged the exponential growth of Smart technologies, applications and the inordinate amount of data which shapes behaviour and communication (ThinkInsights, 2011; Noughton, 2012). Considering the technologies used will help to identify suitable Smartphones to support a mobile test strategy. As the research pointed out technology impacts on a users' interactions (i.e., Android vs. IOS vs. Window OS). Kristoffersen and Ljungberg (1999) split mobile technologies into three components; applications, data and programs. A typical configuration would be the; computing device (the application), programs installed on the device and data a user will need to work effectively. This technological grouping can be applied to modern mobile devices and applications. The application and program can influence decisions and the way in which the user interacts (Johnson, 1998) which will support the context of need. Table 4.2 presents the activations mechanism codes which relate to the technological choices made within the research papers and how the choices influenced the test participants' abilities.

Table 4.2: Activation Mechanisms

Research (by author)	**Application**	**Data**	**Program**	**Risk / Reward**	**Social Learning (efficacy)**
Kristoffersen & Ljungberg (1999)	Ericsson MC12	Order data and centralized info to maintain	DART Project running Windows CE	Finding order Inability to use device in field locations	Learning to use in challenging ergonomic conditions
Nilsson et al., (2001)	WAP Mobile	SMS, news, traffic and web info	Multi-channel Digital Radio, SMS app and web browser	Ability to find, aggregate and share info	Learning to use in the field – literally
Bouwman & Van De Wijngaert (2002)	Desktop PC	Train times	WWW Browser	Finding the best times & passing on the info	Learning the online timetable
Johnson (2003)	Work station	Varied depending on task	Email & web browser	Sharing correct info	Efficiency finding and sharing via email
Kjeldskov & Stage (2003) & Beck et al., (2003)	WAP Nokia 5511, 3310	SMS, EMS	Application for Compaq iPAQ	Getting right information whilst on the move. Inability to interact due to mobility	Ability to use device in a mobile setting
Rieh, S. Y. (2004).	Desktop PC	Search engine and site data	Web browser	Getting the correct results based upon search	Understanding and interpreting search results
Goodman et el., (2004)	Mobile device (PDA)	GPS data Information about physical objects i.e. post office, museum	Does not say	Ability to use data to get to destination. Inability to use application to find and extract location based data	Learning to use location based software to meet need
Oulasvirta et el., (2005)	Nokia 6600	Text input form Web search for information	Opera	Getting the right search results whilst on the move	Using the device in different environments which may challenge interaction
Kaikkonen et al., (2005)	Mobile phone	Web search, texting, downloads, open & closing apps, Sharing content & setting permission on the phone	Nokia and associated programs	Inability to complete activities whilst on the move	Using the device in different environments which may challenge interaction
Wiberg, M. (2005).	Mobile device	Error and network data	Does not say	Ability to find network information	Learning to use the device in these challenging contexts.
Barnard et al., (2007)	Palm m505 PDA	Reading comprehension Word search Motion lighting	Palm applications	N/A	N/A
Kane et al. (2008)	Tablet Sony UX2 ultra Mobile Windows XP	Accessing and finding music files within a playlist	Music Player at different sizes	Finding a song within a catalogue listing	Learning search process and the interaction whilst mobile
Church et al. (2009)	Own Smartphone	Travel data	Mobile Browser or App	Finding the right time	Learning the seeking process in a busy environment
Case (2010)	Desktop PC	Coin information	E-bay	Placing a bid and getting the bid accepted	Looking at options – overcoming the uncertainty
Schmied et al (2011)	Android, I-phone and Tom Tom	Map Location Navigation structures (evaluating optimal interface grid)	Google maps, Tom Tom Navigator, Google GPS	Ability to interact with both devices Unable to do both tasks at the same time	Ability to drive & complete even with fragmented attention

Chua et al. (2011)	Smartphone	Weather website	Mobile Browser	Ability to find the right weather updates	Learning to use the app in busy situations
Church & Oliver (2011)	Smartphone 4th generation	Social news feeds	Mobile browser	Ability to share information	Using the application in social situations
Teevan et al. (2011)	Mainly Windows phones	Finding location data	Location software i.e. Google maps	Extracting the right results	Learning to search effectively using this application in natural contexts
Hussain & Kutar (2012)	TomTom and CoPilot Live	Location data generated	SatNav application	Ability to program the right coordinates to travel	Learning to use the device on the move
Burnford and Park (2012).	In-class or on campus	Web and elp content	Tablet Browser (safari)	Using a variety of smart tools to interact with the eLP content	Uploading and interacting with context
Sun & May (2013)	Smartphone	Check Schedule, obtaining information, reviewing the progress, joining community & participating	Social app & site with DB about a sports event	Finding the right info	Learning about the application in semi natural environments
Redondo et al. (2013)	IOS and Android	3D Model, QR codes, web pages	Hand Held Augmented Reality (HHAR),	Capturing 3D data and interacting with eLP	Ability to use and understand the benefits to L & T

4.2.1 APPLICATION - DATA/PROGRAM

Using the definitions by Kristoffersen and Ljungberg (1999), the example below defines a:

- Smartphone is the application
- The user completes activities using a program (the mobile browser)
- The data is retrieved as search results (timetable information)

In some cases, an evaluation between different programs is required (i.e., websites or other programs on the Smartphone). Information is needed from the other programs to support the overall context of need, a number of sources of information will gathered which will require a number of applications open at the same time for example; timetable application, calendar application, online database, faculty website to name a few. Each one will activate and support the information need in question.

The technological definitions (application, program and data) have been identified as comparative codes. These codes support the evaluation of common practices which supports their inclusion. The subsections below evaluate past research based upon these definitions.

Example Timetable App (Application - Data/Program)

A student is passively browsing the BBC news site on their Smartphone. They receive an urgent message from a friend to help find a room for a class. The student has a decision to make regarding the context of need and how they support their friend, does the student:

- Close the browser and open the timetable application?
- Use the mobile browser, it's already open and seems a more efficient strategy than minimising and opening the timetable application?

Each strategy supports the context of need but as a tester we would like to evaluate the preferred route. This will help to plan evaluating their preferences and perceptions. Choosing to view the timetable via website instead of the timetable application does require a different interaction method. The variable would list:

Mobile Browser Strategy

- **Application:** Smartphone
- **Program:** Mobile Browser (Timetable website>moving to the timetable database)
- **Data:** Room information extracted (copied)
- **Data:** Information noted and emailed to friend

Mobile Application Strategy

- **Application:** Smartphone
- **Program:** Mobile Browser (Closed or minimized)
- **Program:** Timetable Application (Opened)
- **Data:** Room information extracted (copied)
- **Data:** Information noted and emailed to friend

Fig 4.4: Application and Data (Based on Systematic Review)

4.2.2 Application (The Device)

Tracing mobile test research technological applications (or device) tended to be a PDA (Goodman et al., 2004; Barnard et al., 2007) or mobile phone (Nilsson et al., 2001; Kjeldskov & Stage; and Beck et al., 2003). Research was based around changing modalities (walking, sitting or travelling), text entry and communication via SMS. Goodman et al. (2004) evaluated other technological capabilities analyzing GPS (Global Positioning System), however limited network coverage negatively impacted on field tests. Network problems were not just isolated to GPS, Nilsson et al. (2001) also noted media communication (which included streaming) hindered data capture but they concluded that this would improve with the new 3G network. Today's 4G networks is still challenging situational testing and considering network coverage is important. Test contexts maybe constrained due to network coverage (i.e., a test will struggle on a train, Wi-Fi is still intermittent and the test need to explore localized WI-FI hot-spots as an option to support test design).

The early network problems did not stop consumer demand. The popularity of the tablet PC increased and mobile research followed this growth, more people were using these technologies on the move (Kane et al. 2008; Church and Oliver, 2011). Modalities and changes in physical layouts (alternative resolutions) became even more popular research areas. Kane et al. (2008) used a Sony tablet to evaluate a media player and its layout whist walking, Church and Oliver (2011) wanted to investigate everyday interaction with mobiles studying behaviour by looking at log files.

Alongside the growth in tablets mobile networks were improving, the Smartphone generation was growing exponentially (Oulasvirta et al., 2005; Sun & May, 2013; Redondo et al., 2013; Hussain & Kutar, 2012; Schmied et al., 2011). These research papers used a variety of different Smartphone's and TomToms within different contexts, modalities and configurations evaluating user experiences based around different programs and data use and extraction.

4.2.3 Programs

Programs varied considerably. Early contextual testing used on board PDA programs (Barnard et al., 2007) and SMS (Nilsson et al., 2001; Kjeldskov & Stage, 2003; Kaikkonen at el., 2005). Kane et al., (2008) used the tablet and evaluated a common program (the music player) to support mobility testing within the field. As global communication networks improved Smart technologies had improved browsing capabilities to access the WWW. Mobile versions of the desktop web browser became key access points (Noughton, 2012). Reviewing device tests the mobile browser program is the primary access point to

information (Schmied et al., (2011); Hussain & Kutar, 2012; Redondo et al., 2013). Schmied et al., (2011) used a variety of software navigation tools (Navigon, TomTom navigator and Google Maps) on Android and IOS to support their research and evaluations of field tests.

4.2.4 DATA

Mobile data is seen as the output from a field test activity, this could be; **typing**, **searching** or **downloading**. This data was used as the primary source in evaluating the performance test. The active typing activity (Kjeldskov & Stage, 2003; Beck et al., 2003; Oulasvirta et al., 2005; Barnard et al., 2007; Sun & May, 2013;) tested data entry and the efficiency of this activity within different physical contexts. Hussain & Kutar, 2012 used the SatNav data, requiring user interaction to manage journeys and features on the device (i.e., altering distance measurements from miles to kilometers as they travelled).

Search or retrieval outputs were popular and nearly all the research evaluated this and applied some form of information search activity (Nilsson et al., 2001; Goodman at el., 2004; Kaikkonen at el., 2005; Kane et al., 2008; Schmied et al., 2011; Hussain & Kutar, 2012; Redondo et al., 2013; Sun & May, 2013). Kane et al. (2008) applied their searching activities within a music catalogue, Sun & May (2013) conducted search activities based around a sports event retrieving player information and match details in real-time. Schmied et al. (2011) conducted evaluations using a GPS navigation service to locate and order a specific pizza. Redondo et al. (2013) used GIS and geo-referencing aimed at supporting the students in collaborative experiments on an Architecture course. Hussain & Kutar (2012) also used navigational data tasks based around address searches using a TomTom.

The majority of papers within the synthesis had preloaded software, Kaikkonen at el. (2005) evaluated a range of mobile functions and one these required the user to download programs and media to the device.

A point that is worth noting from methodological perspective is that the research papers place on importance on comparing field and lab data generated. These testing practices were set as pilots (Kane et al., 2008) or used as a method to compare the effectiveness of lab and field approaches (Kjeldskov & Stage, 2003; Beck et al., 2003; Goodman et al., 2004; Kaikkonen at el., 2005; Sun & May, 2013;). Goodman et al. (2004) discussed the need to compare the results from one method with those from another i.e. field and lab. If the aim is to determine which of a set of possible alternatives (e.g., alternative interfaces) is best, then these alternatives can be compared against each other. Running tests in a controlled lab setting gathering “baseline data” provides a benchmark to compare interactions in the field data.

Example Timetable App (Application - Data/Program)
In reviewing the prototype model an activation mechanism is established, the differences occur in the application. The usability tester is able to apply this activation to build up a mental picture/profile of the user and his/her needs but also able to recognise the technological drivers.
A mobile test may require the evaluation of a number of applications that work with, and support the context of need. The test evaluates transition between applications (transitions could be challenges within different contexts). For example, the timetable information has been found and now the student needs to Tweet the information to his peers.
The variable would list:

Application: Timetable application > **Data:** Room information extracted (copied) > **Application**: Twitter > **Data:** Information pasted and tweeted

Fig 4.5: Data (Based on Systematic Review)

4.2.5 SOCIAL LEARNING THEORY (SELF EFFICACY)

The idea of personal mastery is central to the construct of self-efficacy (Wilson, 1997). Social learning theories are based upon notions of “stimulus response theory” coined by Rosenstock et al (1988). The idea of mastering has a great impact on the users’ self-esteem, something that Maslow splits into two areas of high and low self-esteem. From a higher point of view being able to repeat and complete the search to find the timetable and room becomes a permanent part of who the individual is with regard to their ability to use and interact with the device. This equates to a person's motivation that a given behaviour will lead to certain goals or eventual outcomes. The efficacy part of this model focuses on the expectation or conviction that a person successfully executes the task to produce the outcomes.

There is a clear link between self-efficacy and coping strategies and as Bandura (1977) points out in Wilson’s (1997) paper on HIB models ‘The strength of people's convictions in their own effectiveness is likely to affect whether they will even try to cope with given situations.' He goes on to note that feelings of self-efficacy will affect how long someone persists in an action and how much effort he or she puts into the action (p. 563).

Example Timetable App (Self Efficacy)

Relating this back to the timetable application there may be times when the given situation does result in the length of time someone will persist with the given activity being curtailed i.e. the bandwidth is appalling and they keep losing connection causing more frustration and stress.

Fig 4.7: Self Efficacy (Based on Systematic Review)

4.3 INTERVENING VARIABLES

HIB and HCI use theories from interrelated fields (i.e., psychology physiology, sociology, decision-making, engineering, design etc.) pointing out numerous significant determinants of information behavior (Niedźwiedzka, 2003). Cognitive needs being important as a user makes sense and creating order in the world around, or makes sense out of phenomena. These cognitive needs can be personal, role-related or of environmental variables which help the user make sense. Table 4.3 maps the intervening variables and how the practices have been interpreted from within the papers.

Table 4.3: Intervening Variables

Research (by author)	**Enviro /Spatial Contexts Physical**	**Enviro /Spatial Contexts Social**	**Psychological**	**Role / inter**	**Source char**
Kristoffersen & Ljungberg (1999)	Industrial setting: Different telecommunication locations	Work related Challenging and dangerous	Trained but the environments place demands i.e. not being able to place the device to do maintenance work	Individual activity to search for order info and support maintenance	Order data and maintenance documents
Nilsson et al., (2001)	Sporting event Camping at different geographic locations	A special stage of the rally with a social group in a forest	Proficient with technology	Groups sharing information as it comes through	Audio Website Text data (SMS)
Bouwman & Van De Wijngaert (2002)	Home office setting	Quiet personal space	Proficient with technology	Single activity	WWW information
Johnson (2003)	Office setting	Busy work environment	Mundane ritualistic office activities	Individual to group	Email content and attachments
Kjeldskov & Stage (2003) & Beck et al., (2003)	Recreate real-world situations. Simulated walking down the street	False lab setting people following and recording in the field	Challenging within these different contexts. User seen as proficient with mobiles	Individual activity	Game info

Rieh, S. Y. (2004).	Home setting	Quiet and relaxed setting	Professional users with varying technical abilities	Mainly single but some group activity (looking at houses)	Search data within a search engine.
Goodman et el., (2004)	In the street – different locations	Busy street environment	Wide age range does not mention technical competence	Individual set of activities. No specific activities set within the street	Location data
Oulasvirta et el., (2005)	Some real taxing tasks requiring planning and following route on device	Spatial awareness issues. Busy - walking while at the same time taking care of safety (avoiding collisions; e.g., being hit by a car)	Experienced using mobile phones. Taxing with some tasks required to be completed at speed whilst on the move	Individual activities	Web content or time dependent data like times
Kaikkonen et al., (2005)	Daily rush hour on the metro	A busy environment with cognitive distractions	Participants are briefed and get used to the handset	Individual activities	Multiple sources i.e. mobile software, images repository, SMS & Email.
Wiberg, M. (2005).	Telegraph pole and network router – for reboot	Industrial field setting outside	Trained professional with this mobile device	Individual activity	Network data and reboot acknowledgement
Barnard et al., (2007)	Mainly lab simulating the real world	Academic setting not true social setting. The change in lighting could have some connotation to this context	No screening or sample provided within paper – presume follow colleagues or students.	Single activity	Search result and reading information
Kane et al. (2008)	University Campus	Busy campus setting.	Due to the sample early adopters of mobile technology	Single activity	Music listing
Church et al. (2009)	Entries made out of their normal contexts	Every day activities. Busy or Quite.	Most comfortable with basic operations but some unsure about Mobile web searches	Does not say but looking at data it's a combination	Travel info – bus times, maps
Case (2010)	Home setting	Information sharing across communities via eBay	Competent E-bay user	Single activity but may share content	Information about coins
Schmied et al (2011)	Simulated work, leisure & travel - users cannot concentrate solely on mobile app they use	Lab setting simulating real world environments	Competent user	Single activity	Finding order Placing order Receive receipt
Chua et al. (2011)	Public transport – standing or sitting	Busy environment - passenger	In the main professionals and competent	Sole activity but may share	Weather data
Church & Oliver (2011)	Home setting	Quiet environment – sofa, kitchen	Competent Smartphone user	Sole activity checking feeds updating status	Feed info from social environment
Teevan et al. (2011)	Range of local locations evaluated. Tended to be outside not at home of work	Range of Social settings	Mostly early adopters at Microsoft so very competent	Mostly set around social and collaborative	Location based data sourced from log files
Hussain & Kutar (2012)	Car - driving to a given destination to program	Sat within a car reviewing the SAT-NAV with peers	Academic context proficient with technology	Collaborative with the driver of the car to navigate and input results	Location based data output/audio output

Burnford and Park (2012).	University campus	Individual and group activity App and information access required	Competent with elp/app/tablet	Individual activities and group	Apps, browser and elp
Sun & May (2013)	Sports stadium	Spectator at a game – simulated so quiet but would be noisy	Regular experience with personalizing phone settings	Single but shared info about athlete	Web data driven through prototype
Redondo et al. (2013)	Barcelona Campus	Educational environments working with computer-generated objects	Expert with tools and Smartphone	Shared activity to support learning	3d models used and applied

4.3.1 ENVIRONMENT OR SITUATIONAL BARRIERS

Environmental or spatial situations have considerable overlaps in HIB and HCI research. Contextualizing environments which include "space" where interactions place is important in test design. IB research explain the complexity due to "a lack of detailed studies on the nature of spatial factors as a contextual qualifier in information seeking" (Savolainen, 2006; Mervyn and Allen, 2012). Spatial research studies have leaned towards everyday-life information seeking based upon information selection and use, neglecting as Savolainen (2006) refers, to issues such as web searching in the home. Rieh (2004) notes that these natural environments have been excluded.

Spatial studies are broadly influenced by; macro-environments (Global setting uncontrollable factors, like the weather), micro-environments (Social and cultural setting - the people you interact with) and the individual (self-subject to all previous influences - ability, stress, coping. Modelling this is probably the most challenging for the student testers and one that has caused huge debate (i.e. Lab Vs Field Testing). Kristoffersen and Ljungburg's (1999) recognise similar environmental factors to Wilson, however they make this more authentic to the mobile user and users' physical situation, whereas Wilson associates this to time and cultural factors that impact on the environment making this less applied and more theoretical. Taking Kristoffersen and Ljungburg's perspective, environment is defined as the physical surrounding i.e. chairs, tables, power sockets etc. Taking the physical surrounding in to account there will be potential constraints within contextual environments.

The systematic review grouped mobile test situations into different physical and social environments these are based around; **urban** (busy street), **vehicle transportation** (public transport and private car), **university** campus, specific **event** (festival or sporting event) and **simulated** environment (predefined route within a corridor or car simulation). The busy

street environment was a common test environment. Evaluations took place on the move between destinations and experiments were based upon (wandering) the busy urban environments, in some cases on a predefined route (Goodman at el., 2004; Oulasvirta et al., 2005; Kallio & Kaikkonen, 2005; Kjeldskov & Stage; and Beck et al., 2003). Nilsson et al., 2001; Oulasvirta et al. (2005), Sun & May, (2013) used the environments to create situations that evolved into, who Oulasvirta et al. called “context-creating” activities. Oulasvirta et al. (2005) used a range of environments, café, bus station, escalator to name a few to describe environmental contexts and situations (both physically and socially), for example, café example requires the visitor to orient to the social (e.g., finding friends) and appreciate the spatial constraints (chairs and tables). Nilsson et al., (2001) and Sun & May (2013) set part of their experiments at busy sporting events assessing the social and physical constraints on mobile usability whilst searching for sporting information. Another common environmental context was the university campus, due to nature of the research aim, setting and sample the university campus met the research needs, Kane et al. (2008) and Barnard and Yi (2007) both set routes around a university campus to evaluate mobile user input and media searching. Redondo et al. (2013) used students on their construction course to test the augmented realities to support learning and teaching on a Smartphone. Kallio & Kaikkonen (2005) and Hussain & Kutar (2012) as we have seen set their environmental context within a vehicle. This set round the modality visiting the physical test environment was a car or train (Metro), both kept the social contexts light and not formal.

Finally, in some cases situations were falsified impacting on the real environmental parameters. Schmied et al. (2011) and Bernard et al. (2007) created environments that were not real but were effective in testing the impact on a particular user interaction in that situation. Schmied et al. (2011) used a car simulation to reproduce a mobile environment. Similar to other works associated with fragmented attention these environmental conditions are fit-for-purpose and do provide a suitable contextualise platform when evaluating creating spatial requirements. Bernard et al. (2007) sat participants performing tasks in different lighting conditions. They also set the lighting conditions for walking participants performing tasks walking around a 1-ft wide path that had been taped to a carpeted floor.

Example Timetable App (Physical Environment):
A student is travelling to University on an extremely busy train. Mobile computing conditions and ergonomics have change; the user was initially sitting but is now standing (they have given their desk-space to a family). The student is completing a group activity and is struggling to send an email. In this situation the student needs at least one hand to keep the iPad balanced, the other to type the email whilst holding on to the side of the carriage.

The test design needs to identify a practical combination of tasks and technologies to support the test simulation. For example, if the train is full and the ergonomics using an iPad is too difficult, so the email preparation is completed on a phone and sent view 4g not through the trains WI-FI connection.

Fig 4.8: Physical Environment (Based on Systematic Review)

4.3.2 PSYCHOLOGICAL (AND PHYSIOLOGICAL)

The psychological attribute is an extension of the emotional & problem-focused coping set out in the initial stress/coping theory section. Exploring psychological factors will help to build up a rich picture of the user. For example, the timetable test has identified stress factors in the initial usage this could create nervousness not knowing where or how to get to the class, making the student late for a class. All these factors have an emotional impact, affecting their ability to cope with the given information need. Within the information research field particularly research associated with information behavioral models, psychological factors have ties with emotions impacting on the ability to cope which might instill stress in certain contexts Kassulke, et al. (1993) call these emotional barriers which proved to be most significant in limiting access to health services.

Physiological characteristics like; hearing problems, cognitive characteristics such as the lack of medical knowledge and nervousness perhaps signifying emotional problems. These characteristics are ubiquitous with most computing devices related to situations and become even more of a challenge to the mobile user interacting with applications;

- Hearing: something that impacts upon a large portion of the UK population. In 2011 it was estimated that 10 million people have some form of hearing loss (Action on Hearing Loss, 2014) and this can have impacts on how people use multimedia based applications.
- Lack of knowledge: The user does not fully understand the application or the methods to effectively navigate to find the information. This has psychological implications such as dissonance and anxiety.
- Nervousness: A psychological and emotional factor that impacts on the user's ability to cope with the given information need and something that could be stressful (Grandey, 2000).

Example Timetable App (Psychological and Physiological characteristics):
A psychological influences are varied one might be to evaluation the ways in which the timetable information is searched and presented to the user. The emphasis of the test is on the Information Architecture.

For example, the student is using an Apple (IOS) phone to search and access a module on the timetable application. The test aims to evaluate the user appreciation and knowledge of image metaphors within this operating system (like the hamburger ≡) to see if this hides important signposts for the user.

Fig 4.9: Psychological and Physiological characteristics (Based on Systematic Review)

User barriers from a health information perspective were said to be, "a construct consisting of questions relating to an inability to make decisions about health and to take advantage of existing health services" (Kassulke et al., 1993 p61), and the precise nature of the barriers was not explained. The situation and interaction within these tests will vary considerably from context to context and person to person and "the ways in which people need, seek, and use information vary considerably from one context to another" (Burford & Park, 2014, p635). Appreciating psychological factors within a mobile test helps to appreciate the users condition adds values to the context (i.e., testing the test functionality on first year student and testing their knowledge against the new systems with a university and how they work

with their mobile devices). Psychological factor provides a platform to sample users based upon psychographic segments identifying suitable test participants.

4.3.3 ROLE-RELATED OR INTERPERSONAL

The need to belong or be accepted at a social level is an important need. If people of either gender feel safe and confident using a mobile application they will then feel confident in sharing and creating social groupings, demonstrating they can use the application within the given social and physical setting.

Example Timetable App (Role-related or interpersonal):
The student is completing a particular activity for his/her peer group. This social tier or level becomes the priority only after the physiological needs have been met i.e. they feel confident to complete the task whilst in the peer group.

From an interpersonal perspective this could also be, customizing timetable and scheduling events around the application. A characteristic of the realistic-pragmatic approach central to the concept of information pathways developed by Johnson et al (2003)

Fig 4.10: Role or Interrelated (Based on Systematic Review)

The level of competence is driven by the users' basic understanding of the application (and in some cases the actual Smart device). If this basic understanding is achieved, then cognitively their own ability will be enhanced improving self-efficacy. The user will feel a sense of achievement as they share their experiences within a social group. Improved understanding and acceptance as they interact will increase confidence in their ability and behaviour this "will form a particular individuals character and self-esteem" (Poston, 2009, p350). Considering the role (individual or group activity) will support the test design.

4.3.4 INFORMATION SOURCE CHARACTERISTICS

The lack of easily accessible sources may inhibit information-seeking altogether (Wilson, 1999). Accessible information relates to the information seeking process which potentially impacts on users' experience imposing a higher cognitive workload which can cost the enquirer and if they are prepared to pay the price (Case et al., 2005). Within a mobile test

there is a need to understand the potential cognitive inhibitors, these inhibitors could be the inability to access information due to cognitive disability. In this case there is a requirement gain support from other tools (i.e., assistive technologies) or other mobile applications or web services to support the need. Wilson refers to “communication channels” and reflects how user communicates will use information, passively to fulfill the need. In this research the source characteristics will support the tester modelling ergonomics as they plan the types of interactions required for example, key stroke, pinch, swipe etc.

Example Timetable App (Source Characteristics):
Based upon the cognitive model the interaction with the timetable application requires a combination of keystroke and swipes.
Keystrokes: 18
Swipes: 7

Please note. The Cognitive Model (GOMS) will map this in detail to aid comparisons. This variable is mapping the board interactions.

Fig 4.11: Source Characteristics (Based on Systematic Review)

4.4 USER MODALITY FACTORS

The literature review acknowledged the importance of modality and user interaction, particular the movement of a user. Almost all the papers within the meta-synthesis include some form of user mobility, which overlaps between Kristoffersen and Ljungberg’s (1999) wandering, travelling and visiting. Figure 4.4. attempts to match the movement of the test participant within these research papers to the modalities presented by Kristoffersen and Ljungberg’s perceptions of movement within an industrial setting. The discussion uses the themes from this data to contextualise approaches to support mobility and mobile testing.

Fig 4.4: User Modalities

Research (by author)	**Wandering**	**Travel**	**Visiting**
Kristoffersen & Ljungberg (1999)	Walk while using mobile computing device.	Travel between industrial sites in a vehicle	Moving around site on arrival - outside

Nilsson et al., (2001)	Sat and Walking - temporary context	In a Car - Travelling between events	N/A
Bouwman & Van De Wijngaert (2002)	N/A	N/A	At home but about to go to University
Johnson (2003)	N/A	N/A	Sat in the office for temporal time period
Kjeldskov & Stage (2003) & Beck et al., (2003)	Walking on a treadmill and walking outside	Simulation travel between destinations	N/A
Rieh, S. Y. (2004).	N/A	N/A	Does not fit with these variables but would be based around home life. So hear for a temporal period of time.
Goodman et el., (2004)	To find post office	No transport used	A colleague
Oulasvirta et el., (2005)	Walking through a busy street to a bus stop	Travelling on an escalator	Visit friends - Conversing in a café
Kaikkonen et al., (2005)	Walking between destinations	Travelling on metro - Office district in Helsinki	Visiting a friend in shopping center
Wiberg, M. (2005).	Walking between network locations	Schedule and travel to location	N/A
Barnard et al., (2007)	Walking a 1foot wide path around a room	Sitting, asks were perform with PDA flat on a table	N/A
Kane et al. (2008)	Walking down the corridor Set on predefined routes Walking outside set on campus	N/A	N/A
Church et al. (2009)	Travelling by various means	N/A	Travelling by various means
Case (2010)	N/A	N/A	At home – hard to distinguish with these variables
Schmied et al (2011)	N/A	Driving simulation travelling using Play Station.	N/A
Chua et al. (2011)	N/A	Public transport Bus/train	N/A
Church & Oliver (2011)	Walking Moving around the house	N/A	Sat at home – stationary
Teevan et al. (2011)	Range of Collaborative (agreeing on lunch and destination) Solely finding coffee shop	Pickup children	Meeting for lunch destination
Hussain & Kutar (2012)	N/A	Stationary sat in a car	Visiting different location - Sat in a car
Burnford and Park (2012).	Information related to their studies	Between classes	On the way to University
Sun & May (2013)	Simulated sports event. Sitting at the event	N/A	N/A
Redondo et al. (2013)	Walking and standing	N/A	N/A

4.4.1 WANDERING

The literature review defined wandering as an extensive local mobility within a building or local area (Kristoffersen and Ljungberg, 1999). Nilsson et al. (2001) set wandering within two physical contexts, a forest campfire and a music festival, which defined wandering within a "naturally occurring event" where people walked between social groups sharing information.

Their social settings are similar to Oulasvirta, A. et al. (2005) and Kallio & Kaikkonen (2005), their research conducted in “semi-naturalistic” settings applying to all three modalities. The wandering modality presented by Oulasvirta et al. (2005) used “*Conversing in a café”,* similar to the campfire setting in that a user moved within this local area to seek and share information. The café setting is not a motion of “wandering” per se but the fact they are in a local area/building fits with what Kristoffersen and Ljungberg define as the wandering modality. Their tasks do not require body movement except for movement as they sip the coffee, gesturing to support conversation, and being aware of the social setting and their personal space. Kallio & Kaikkonen applied wandering to the movement around a shopping centre tests focused on motion and the impact on device interaction. The data from this evaluation focused on movement within a shop for a set/temporal length of time before moving on. Similar to Oulasvirta, A. et al., (2005), Sun, X., & May, A. (2013) evaluated Smartphone interaction as the user personalised activities a spectator at a sports event. Their field studies applied the wandering modality, which sacrificed some experimental controls that a lab would offer in order to maximise the ecological validity of the experiment within a real context. Kjeldskov and Stage (2003) and Beck et al. (2003) used field context as they wandered (locally) between two destinations. This approach could be seen as travelling however most of this research based around a local environment assessing interaction and motion whilst walking with a devise. Kane et al. (2008) described two investigations, which explored the effects of walking on interaction, a clear wandering exercise set within the confines of the University campus evaluating the effects of walking on performance with soft buttons and music player when using a mobile device. Redondo et al. (2013) set within an educational environment (Barcelona Knowledge Campus - BKC), students used Mobile Learning (ML) practices visualizing experiments set in different locations. Students worked with the device for a temporal time-period before moving to the next location. The aim was so they can work with computer-generated objects (AR) as if they were real objects in a real environment, and in real time, set in a local area.

As we have already seen within the literature review, simulations have played an important part in mobile testing research. The simulation supports modality research. Mobile evaluations conducted by Barnard et al. (2007) simulated the wandering modality by assigning participants tasks to walk and perform tasks while walking around a 1-ft wide path taped to a carpeted floor. The path was a loop that wound around tables and chairs in the room, such that users could make multiple laps during a single task scenario. Hagen et al. (2005) state that simulations enable the controlled capture of comparable and measurable data, in varying degrees through established mechanisms such as observation and video recording to enable quantifiable data to be produced and compared (p6, 2005). Simulations

could complement the research as a mode to gather “baseline” data to compare against the field data.

4.4.2 TRAVELLING

Travelling is a user moving between destinations this could be by vehicle, as a passenger in a car or a commuter on a train or bus (Kristoffersen and Ljungberg, 1999). Nilsson et al. (2001) defined this as travelling to different destinations, which switches from traveling to wandering as they are in the local area (a campsite) for a temporal period watching the following stage of the car rally. Schmiedl et al. (2011) created a travel simulation re-enacting mobile situations whilst travelling in a car. This assessment evaluated users’ fragmented attention as they completed mobile tasks whilst driving a car simulation. Hussain, A., & Kutar, M. (2012) ran research experiments within a car to reviewing the usability of SatNav applications. Participants used the SatNav system as they planned visits to different destinations. The travelling modality was set as the car moved, the user was sat in a car completing location based tasks and sharing the information with the driver.

Kristoffersen and Ljungberg (1999) original coined these modalities and travelling is movement from one place to another in a vehicle. Oulasvirta, A. et al., (2005) and Kallio & Kaikkonen (2005) interpreted travelling on an escalator a modality which simulates motion similar to standing on a train or a bus. The escalator requires less motor control, although body posture must be monitored and the right hand is usually reserved for holding on (pp. 3, 2005)

4.4.3 VISITING

Visiting defined as “spending time in a place for a temporal period of time before moving” on to the next destination (Kristoffersen and Ljungberg, 1999). Visiting seeks to capture the mobility involved as the user spends time in a place basis before moving to another place (i.e. seating waiting for a meeting). Nilsson et al. (2001) termed “media convergence” as a platform to test the visiting modality, requiring participants to use mobiles (and other media) to find information. This information was sourced from these multiple media sources to help coordinate and communicate rendezvous points along the rally route. The rendezvous points were temporal where wandering would take place before moving (or visiting) the next destination. A more up-to-date version of Nilsson’s work was Hussain, A., & Kutar, M. (2012) applying visiting and travelling to predefined destinations using the SatNav. Goodman et al. (2004) created a set of tasks, which simulated a tourist visiting places (i.e., uncovering information about a particular building or tourist attraction, finding the nearest Post Office

and determining the location of work colleagues). Oulasvirta et al., (2005) and Kallio & Kaikkonen (2005) used modalities which all worked around the visit modality (i.e., visiting a friend in a café, travelling on a metro and moving to a shopping centre) these took place for a temporal timeframe. Oulasvirta, A. et al., (2005) set walking through a busy street to a destination and planning a route back within other cognitive demands by “walking while at the same time taking care of safety”.

Example Timetable App (Modality)

The student is sitting and then standing on the train travelling to University and moves to a different states and modality changes to (wandering) to the class.

Travelling: Going to university on the train from home for a lectures

Wandering: Moving between campus buildings from one lecture to the next

Fig 4.12: Modality (Based on Systematic Review)

Modality and levels of mobility in any given setting supports the identification of suitable contextual environments to support test design. The meta-synthesis has acknowledged that there could be multiple modalities within a test; this depends on the context set out within the environment variable. An awareness of these modality changes is important to establish context-aware tests, which will help evaluate applications, user interaction within different contexts (socially and physically).

4.5 INFORMATION SEEKING AND INFORMATION PROCESSING AND USE

Information needs has the potential to trigger a number of cognitive behaviours. Kristoffersen and Ljungburg’s in their Reference Model (1999) defined physical conditions like modality, travelling, walking and wandering and the environmental boundaries, which affect a user’s cognition. Wilson (1997) contextualised this as “intervening variables” which will influence information behaviour and will build into a picture of the user and their information needs.

The meta-synthesis evaluates seeking approaches contextualising information seeking and the influences on mobile interaction, codes taken from Wilson’s model will help articulate this behaviour. Wilson (1999) and Ellis’s (1983) behavioural model identify the “active search” as

the principle seeking mode. The synthesis presented in Figure 4.5. presents a ranges of seeking approaches and the discussion explores searching to see if “active” is the most prevalent. The synthesis’s also wants to establish if past research practices have combined seeking approaches (i.e., passive attention, passive search and ongoing) to create more than one search.

Table 4.5: Information Seeking & Processing and Use

Research (by author)	**Passive Attention**	**Passive Search**	**Active Search**	**Ongoing search**	**Use**
Kristoffersen & Ljungberg (1999)	N/A	N/A	Searching for order information	Iterative with maintenance work.	System info to support work. Updating tele communications network Updating order on database.
Nilsson et al., (2001)	N/A	Partly passive, intermittently on one or more media streams	Find info about race	Would need to keep checking for updates	Using SMS & radio info sharing with group to get to the new destination
Bouwman & Van De Wijngaert (2002)	N/A	N/A	Complete search and send information	N/A	Using Time info sharing with guardian
Johnson (2003)	N/A	N/A	Retrieving to aid work task	N/A	Communicating info via email
Kjeldskov & Stage (2003) & Beck et al., (2003)	N/A	N/A	Active searches within the game	Iterative and ongoing to progress through the game whilst moving	Information used to progress through the game simulation in the field
Rieh, S. Y. (2004).	N/A	N/A	Searching for info to support need i.e. checking conference schedule	Activities are in some cases iterative i.e. checking house prices	Use to inform decisions
Goodman et el., (2004)	N/A	N/A	Active to find location	Would be iterative to check location data	Use location data to navigate
Oulasvirta et el., (2005)	N/A	N/A	Finding item on a menu or time related sites about public services in region	Possible ongoing not clear	Use location data support search
Kaikkonen et al., (2005)	N/A	N/A	In finding and downloading the application, Searching for web info and sending SMS	Returning to application to take and share pictures.	Using info to support activities like searching for information & downloading software to the phone.
Wiberg, M. (2005).	N/A	N/A	Needing to locate and fix problem	Will need to return to reboot the network.	Use data to fix problem
Barnard et al., (2007)	N/A	N/A	Active to complete search and reading exercise.	Could be ongoing if the word has not been located.	Finding Word location
Kane et al. (2008)	N/A	N/A	Actively looking for a specific track	Possibly ongoing but not explicit. Seem to be simple active searches	Finding media within a library

Church et al. (2009)	N/A	N/A	Activity looking for travel information	N/A	Use travel & commuting information from apps Using social information to communicate this information
Case (2010)	N/A	Passively looking around the account holders	Making the move to bid for the coin	Returns regarding online feedback	Searching and aggregating options Sharing info and communicating via E-bay
Schmied et al (2011)	N/A	N/A	Activate to find and order custom pizza - actual payment excluded.	To check receipt	Receive and act upon data found
Chua et al. (2011)	N/A	N/A	Activity looking for weather info	Checking for changes in the weather outlook	Use Weather info to support decision
Church & Oliver (2011)	N/A	Passively looking at feeds not acting upon them	Keeping up to date with friends and family	Keep returning to check status and news updates	Check, use and update status
Teevan et al. (2011)	N/A	N/A	Very much active search based on log file analysis	Sometimes iterative searches so ongoing.	Use and evaluate location info
Hussain & Kutar (2012)	N/A	N/A	Need to set info to get to destination	Need to return and check Possibility of re-entering data	Use GPS data to inform decisions Use information to support the driver
Burnford and Park (2012).	N/A	Perusing the web with no real objective	Activity to do work	Returning to eLP content	Use App to access and share info
Sun & May (2013)	N/A	N/A	Active to find the information about the athlete	Returns to find out more detailed information about athletes	Use info to support knowledge about players
Redondo et al. (2013)	N/A	N/A	Extracting data and using the data with the modelling software	Returning back to Moodle to do more retrieval	Use to support learning activities Disseminate to peers as part of the work

4.5.1 SINGLE SEARCHES

Single searches were all based upon an active search and closely aligned with Zuuren and Wolfs (1991) ‘problem based coping’; searches required the test participant to locate a piece of information. Bouwman & Van De Wijngaert (2002) and Church et al. (2009) based this signal activity on how the participant searched for travel information and used the results to inform others - like a family member. This singularity to a search was similar to Kane et al. (2008) where participants’ actively searched a music catalogue relaying their findings back to the researcher. Kane et al. created tests but was not focused on information use but how the test participants interacted to support seeking which was used to evaluate the application design. Johnson (2003) evaluated information retrieval and how information found supported work activities, this was shared this information via email.

4.5.2 TWO SEARCHES

Seeking activities that used two searches appeared to be iterative or deemed ongoing. The searches were active but then refined or this was a new search at different points within the research. Kristoffersen, S. & F. Ljungberg (1999) and Wiberg, M. (2005) applied “Informatics Model” set in challenging industrial settings, these active searches located order information and seeking was ongoing due changes in modality. The engineer travelled and moved (wandered) between different locations looking for information. Kjeldskov & Stage (2003) & Beck et al., (2003) set seeking activities in an academic environment, based upon a game and searches were ongoing walking on a treadmill and then compared against the field. The comparative study assessed the importance of lab and field on the identification of usability issues. Barnard et al., (2007) created a range of comprehension tests where participants needed to search for keywords whilst walking, these active and ongoing searches were varied in environmental conditions (like lighting) to evaluate search performance.

Rieh, S. Y. (2004), Kaikkonen et al., (2005), Oulasvirta, A. et al., (2005), Chua et al. (2011), Case (2010) and Church et al. (2011) applied seeking activities which were natural, following what Savolainen (2006) called everyday information seeking. Kaikkonen et al., (2005), Oulasvirta, A. et al., (2005) and Chua et al. (2011) combined natural and simulated contexts evaluating interaction and searching on a mobile device. Kaikkonen et al. and Oulasvirta et al. required participants to activity seek for; software downloads, web information, finding and texting messages. Participants returned to the opening screen of the mobile interface and required to complete other test activities in an ongoing manner. Chua et al. applied specific searches based upon weather information, these ongoing searches checked for updates moving between different contexts. Church et al. (2011) combined natural seeking activities using social media, which assessed the pervasive use of social information (i.e., finding profile information and communicating information to others in their social groups).

Rieh, S. Y. (2004) and Case (2010) was not mobile but desktop activities. Rieh’s set at home searched for house prices and participants used the information in an ongoing and iterative manner evaluating the market. Case (2010) covered three seeking types where potential buyers on eBay pervasively look at information actively bidding and returning in a ongoing manner to make increased bids this information was used for future bids Case wanted to evaluate the information structures information presented in different areas within eBay influenced human information behaviour.

4.5.3 Three Searches

Nilsson et al., (2001) evaluated multiple information searches as participants made informed decisions, the mobile interactions were evaluated as different media sources were searched

and evaluated (i.e., web information and radio updates). Information searches were passive, active and ongoing collated then shared and disseminated to social groups. Burnford and Park (2012) natural the everyday use of an eLP on a mobile device the evaluated a variety of seeking approaches (i.e., passively looking at module content, actively looking for information and returning to repeat a search on a module). Redondo et al. (2013) used an eLP (Moodle) which hosted learning material; this research evaluated the instructions students used to support an augmented reality tool. Data from this AR application used on campus and an evaluation of students sort to see if they had benefited from this tool and the support offered on the eLP.

As part of the systematic review, the evaluation of seeking, types, styles and approaches builds into a picture of how seeking has supported research. Reflecting upon the practices provides an indication of the importance of information seeking within test design.

This leads to information processing (using the search results from the passive search, comprehend, analyse and synthesize the information) and information use (the information is now knowledge that the student can pass on to the group).

Example Timetable (App Seeking Options)

Active search: actively looking for the information about a room.

Passive attention: listening to rich media (like a tutor podcast) where there may be no information-seeking intended, but where information acquisition may take place nevertheless, for example this could include information about future guest lecturer slots or extra development sessions to support test design.

Passive search: this type of search does seem like a contradiction in terms, but signifies the possible occasions when one type of search (or other behaviour) results in the acquisition of information that happens to be relevant to the individual. Within the context of this research, a passive search could be triggered within social media. Students are passively searching and communicating with others and a post from another student could trigger a behavioural change that then moves from passive to active to support a search which prepares them for the next class.

Ongoing search: active searching has already established the basic approach and framework of ideas, beliefs or values, but where occasional continuing search is carried out to update or expand the approach. In consumer research, Bloch, *et al.,* (1986) define ongoing search as that which is independent on specific

purchase needs or decisions and that the motives are to build knowledge for future purchase decisions and simply to engage in a pleasurable activity.

Fig 4.13: Seeking Options (Based on Systematic Review)

Example Timetable App (Information Seeking Behaviour)
A students seeking behavior regarding the room within the Timetable Application is very much an Active Search. They need to find and communicate this information within a given timescale.

In the context of this research and the application of this model there are situations where the search could be ongoing or passive. An ongoing search might, be a student returning to the application to collate all the times and locations to transfer to their own personal calendar. A passive example could be planning activities where they are scheduling the week's activities around the timetable.

Fig 4.14: Seeking Behaviour (Based on Systematic Review)

4.6 SUMMARY - NEW FRAMEWORK DISCUSSION

The literature review identified two models within HIB and Mobile HIC, the systematic review has contextualised these models. The reviewed practices inform this research based around information behaviour and mobile testing research to inform practice, which formed examples (Fig 4.1 – Fig 4.14) examples that inform teaching and testing practice as working cases. The review of practices and the examples also helped to form a model, which takes aspects from HIB and Mobile HCI creating a "Hybrid field based testing model" (Fig 15).

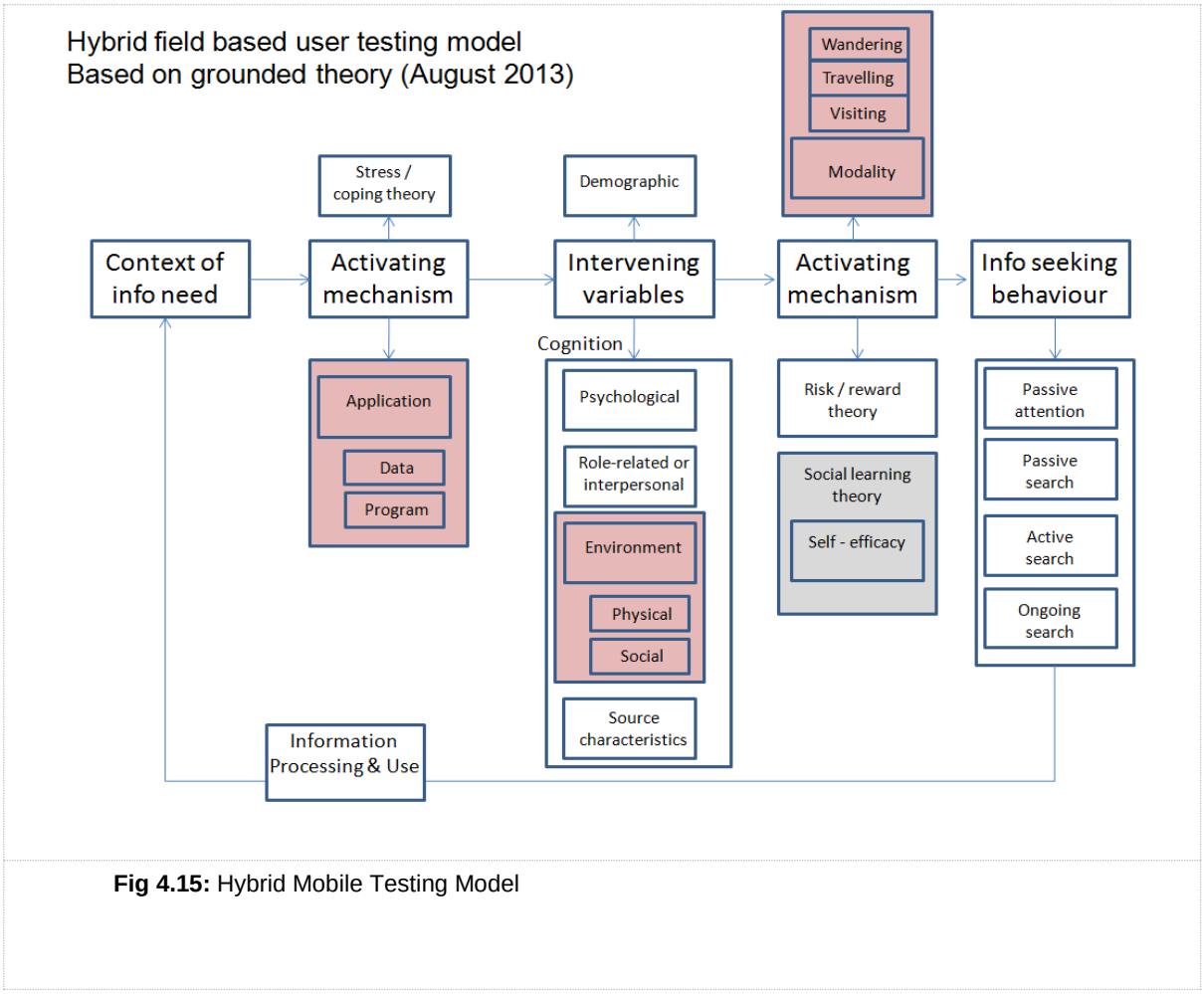


Fig 4.15: Hybrid Mobile Testing Model

The hybrid model is presented as an adaptive framework which will be used as an aid to the creation of mobile tests which will consider the wider implications i.e. contexts and situation where interaction will take place. The following discussion will summarize the model, the summary will acknowledge each component from the initial need to a seeking and use.

The Context of need is the trigger (or problem to solve) to the test, distinctions made among the variety of “needs” can be bewildering (Case, 2012). To help the setting and philosophy the researcher noticed that most information models (if not all) referred to Maslow’s Hierarchy of Needs to some degree (Ellis, 1993; Spink, 1997; Saracevic, 1997; Choo et al., 1999; Wilson, 1999). This has been a valuable focal point applying Maslow’s hierarchy – which is a key to Wilson’s models - helps “to layout the stages of need” (Poston, 2009, p349). Whilst this research it is not investigating basic needs for survival there is a resonance between a craving and possibly the urgency to find something i.e. finding a room quickly on campus using a timetable application. This “physical” craving can cause stress and create levels of in-security, a gap in their knowledge not knowing where the room is possibly and being late for the next class.

The review acknowledged the need to cope with a given situation and the situation might be stressful. These factors could influence a users' need and the immediacy of a need. Alongside this is their own perceptions of completing the need and with this in mind considering levels of dissonance can support a tests ability to user profile (i.e. evaluating user perceptions of the timetable application vs a "responsive" timetable website). The activity is very much a fact-finding exercise but could be stressful due to differences in design, function and layout of the content. This coupled with possible time constraints between classes, or asked to communicate the findings to a social group could affect their ability. Dissonance supports activation mechanisms and the intervening variables, which extend user cognition providing the user profile (i.e., motivations, demographics and environmental contexts).

The activation mechanisms identify the types of technologies, programs and data needed to support the test. Technological choices made will influence and impact on a user's cognitive state for example, a proficient Android user using a IOS phone for the first time will have design and ergonomic challenges to overcome, as well as possible dissonance. The decisions made regarding the type of application and data produced can and will trigger the coping and stresses in any situation. However, to map the activations and cognitive constraints the model considers "intervening variables" as a wider spectrum of constraints, which will support the user and context. Intervening variables help to map the wider user experience context the variables pull together user demographics, personal characteristics i.e. sight, physical cognition, disability (supporting web accessibility), selective exposure - consciously or unconsciously avoiding messages that are in conflict with our predispositions and environmental constraints (social and physical). Each variable builds the user profile helping to contextualise who, where and what influences the test.

Modalities by their nature have crossovers with the intervening variable "environments" and spatial considerations. Kakihara and Sørensen (2002) illustrated considerations as spatial, temporal, and contextual aspects of mobility to explain the relationship between mobility and human interaction. Spatial mobility means a shift from rigidly confined to moving freely. Temporal mobility means change from linear clock time to social time. Contextual mobility means a shift from locally conditioned to flexibly coordinated interaction. Spatial and mobility are aspects to human interaction will influence test design and the research applied by Kristoffersen and Ljungberg (1999) pull space and movement together. Applying these alongside the changing psychological and physiological constraints will support the contextualisation of a mobile test.

Within the framework scoping the user needs, environments and modalities support and contextualise test design. The final variable is the fulfillment of need (i.e., seeking, locating and retrieving the information), there is a clear cross over between what a user needs and how they seek. Shih et al. (2012) argue that information seeking is "the act of obtaining information from existing resources in both human and technological contexts" which helps to determine the user needs". Mobile application tests require a user need to acquire information (i.e., timetable application to find the room, which could have multiple technological contexts challenges within the spatial contexts). The synthesis identified evidence of all the searching approaches coined by Wilson's (1997) model. Even though the synthesis only found predominately active and ongoing searches, the researcher was intrigued to see how test could incorporate and apply passive elements within the model.

The researcher proposes this framework as an aid to supports the applied elements of the research. Using the timetable example provides a platform for evaluation of students' interpretations. The student assessment is a timetable case study, which will galvanize this model and help to present a new approach to user testing. Wilson (2005) noted that few researchers have proposed changes to his early model of human information behaviour. This research takes up that challenge in incorporating new insights into information needs, technology and behaviour. Table 4.2 pulls together all the examples from the synthesis to interpret how the codes can be modelled to support test planning. The table, depicted as a "matrix", is used to support learning and teaching students are encouraged to use matrix as part of the assignment. The matrices will support the analysis of results and discussion.

Table 4.2: Building a Field based test based upon the Systematic Review (New Framework)

	Stress/Coping theory There are time constraints so activation needs to be quick and completed in a set time – class starts in 10 minutes. The activity is deemed stressful the participant thinks they will be late for class and sharing this information could impact on their peers.		**Visiting** N/A	**Travelling** Train travel to University	**Wandering** Moving around on the train	
			Modality Participant is sitting and then standing on the train travelling to University and moves to a different stat and modality changes to (wandering) to the class.			
START **Context of information need**	**Activating mechanism** Cognitive activation causing stress Application activation to fulfil context of need	**Intervening variables :** Variables that build up into a understanding of who and where the test will task place	**Activating mechanism:** The activation of motion and moving with the device within the environment Activation to learn and gain gratification from the context of need		**Information seeking behaviour:** How do they do it? What strategy should they deploy? What do we expect in this field environment?	**END** **Information Processing & Use**
Context: Class is about to start and a number of students unsure where this is taking place. Context of need requires them to find the room and disseminate this information to peers. Information need/goal: Find and communicate the room location to peers. There are numerous pathways and methods to find the room using the timetable application. Possible methods to communicate this information could be by; text, use social media, email, phone call or a combination of the above.	**Application** Test evaluates the ability to search for timetable information and the user's ability to extract and share the information For example interacting with the timetable application to find information and then opens twitter tweeting information to peers.	**Demographic** Male 18	**Risk / reward theory** Reward: on time ability to send this information on the train. Risk: Missing class and not letting peers know the room		**Passive attention** (Not used)	Using the information to share with friends via Twitter.
		Psychological The student is using an Apple (IOS) phone to access the timetable application and want to review the user knowledge of mobile image metaphors like the hamburger.			**Passive search** (Not used)	
		Role/Interrelated Participant completes search on behalf of his/her peer group. This social tier or level becomes the priority only after the physiological needs have been met they feel confident to complete the task to find timetable information before sharing with peer group – pressure is on!	**Social learning theory**		**Active search** Very much an immediate reaction to find the room using the timetable application. Use application to search by module code and time, then share via twitter	
			Self – efficacy Relating this back to the timetable application there may be times when the given situation does result in the length of time someone will persist with the given activity i.e. the bandwidth is appalling and they keep losing connection causing more frustration and stress.			
		Environment: Where and who is around			**Ongoing search** This could be ongoing if they need to return to clarify which block i.e. Ellison room; A105, B105 or C105	
	Data Data: Room information (copied) Data: Information pasted & tweeted out	**Physical Environment** Struggles to send a tweet to his peers. Situation needs one hand to balance device the other to type email whilst holding side of carriage				
		Social Environment Rush hour on the train. Participant has to stand up to give his/her desk space up for a family.				
	Program Application: Timetable application Application: Twitter	**Source characteristics** Web information driven from the universities timetable database Twitter content – 140 char to express when and where the class takes place				

5. CHAPTER FIVE: STAGE 1 ANALYSIS OF RESULTS

This research aims to search for contextualised testing methods to support mobile testing in the field. The analysis of results will present results from formative sessions which took place within the semester and summative work submitted (matrices). These two data collection methods were acknowledged within the methodology as methods and modes of inquiry, which support the aim of study.

The results from the formative sessions will describe the students' interpretation of the prototype model as it informs the module. The formative results will provide an insight into the students' initial thoughts of the prototype model and how IB and Mobile HCI work together to create a contextualised mobile field-test. The results from this activity are based upon observations and discussion within the practical and seminar sessions. A narrative will support the data to provide meaning behind the sub-codes and instances gathered. The research from this data collection exercise collected 335 instances where codes from the model have been discussed (and member checked).

To provide a level of continuity across chapters within the thesis, results will be split using the themes which have been used to support the literature review and systematic review, these are:

- Contextual Need Activity
- Application and Data Accessed
- Intervening Variables
- User Modality Factors
- Information Seeking & Processing Use

The analysis of results will then present results from the summative work. The summative work will consist of a breakdown of the student matrices, these matrices were submitted as part of the assignment and were aimed at building field tests. The matrices will provide an insight into the students' interpretation of how they plan to conduct field tests and if they took onboard the feedback and discussion within the formative sessions.

5.1 FORMATIVE OBSERVATION RESULTS

Formative observations took place over a three-week period (16/10/2013 - 30/10/2013). In accordance with the Methodology (Chapter 3), the model introduced mobile testing to the

students and the researcher observed this within a controlled lab environment. Exercises set within the laboratory helped to collect a range of sub-codes based upon the model. The practical exercises can be found in Appendix F, after each practical session students discussed the model in a discussion (seminar). The researcher presented the sub-codes collected from the practical observation and this provided a discussion and codes could be member checked.

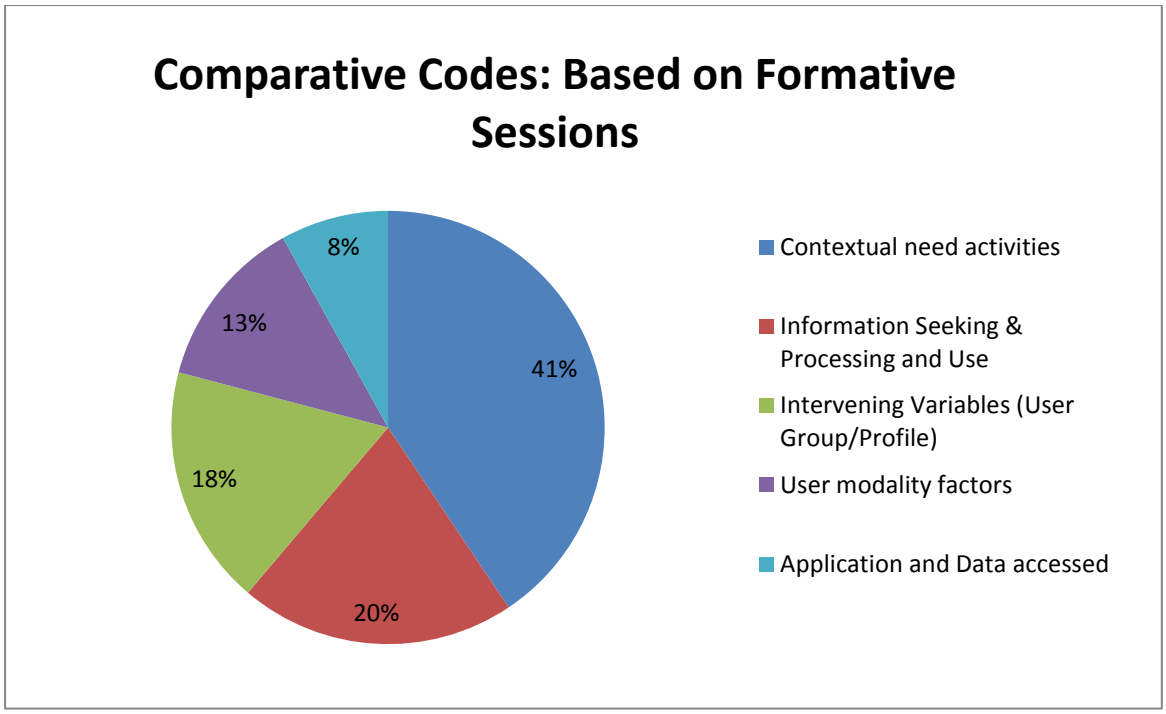


Figure 5.1: Comparative Codes: Based on Formative Sessions

In summary, 41% or 136 instances raised are based around Context of Information Needs. Students highlighted a need for; ***"clarification of needs and scenarios activities"***, ***"settling concerns about what a need or needs mean?"*** and ***"how to capture a need in the field?"***

In hindsight, this is not surprising the Context of Information Need Activity is pivotal and influences many other parts of the model, not getting this right will impact the tests ability to model user behaviour in a mobile context. For example, seeking cannot happen without establishing a clear context and the motivation behind the users need.

Information seeking, and how the test participant uses information, captured 69 instances (or 20% of the total). Students wanted to understand ***"how tests participants interact"*** with their application and "***what do they do"*** to fulfil the need? The Intervening Variable and Modality Factors collated 18% (60 instances) and 13% (43 instances) respectively. As students progressed and interpreted other variables to support their tests students focused

on environments ***"where can I test my application, the pub?"*** interestingly, students did not question or make a point of mentioning psychological aspects, like Wilson's components of efficacy, demographics' and source characteristics. The final code Application and Data Accesses at 8% (27 instances) appeared in the first and last formative session. This became more important as students prepared to test and needed to pilot the application. The central problem with this related to labelling or metaphors used the wording confused the students. Application related to the physical device and students confused this with the software program e.g. the timetable application.

5.1.1 CONTEXTUAL NEED ACTIVITY

This created a great deal of in-class discussion. The popularity of this code presented in Table 5.1. Split across the 3 sessions the table displays sub-codes relating the contextual need theme. To the right of the table the sub-codes have been member checked and presents the number of students who agreed of had issues with this sub-code. Out of the 335 instances recorded, 136 related to contextual needs. Presented at the end of each session is a sub total, the sub totals from each session help to demonstrate the magnitude over the three session, so in this case Context of Need Activities was consistently high as an issues in the three session starting with 56 recorded instances and ending with 61 recorded instances.

Table 5.1:Formative Session Sub-Categories - Context of Needs Activities

Formative Session	**Breakdown of the most popular instance (emerging sub code/categories)**	**n= Member Checked**
Session 1	Understanding context of need	18
Session 1	Scenario development based on need	11
Session 1	Stress/coping - placement	1
Session 1	Timescale of needs is too quick to solve	17
Session 1	**Occurrence Sub Total (Needs)**	56
Session 2	Too many needs within information scenario	16
Session 2	Confusion between needs and scenarios	12
Session 2	**Occurrence Sub Total (Needs)**	28
Session 3	Grouping elements of the model	18
Session 3	Need (initiation) How does we start the test	7
Session 3	Panic in capturing a need	10
Session 3	Need fitting with test strategy	17

Session 3	**Occurrence Sub Total (Needs)**	61
Total		136

The first formative session introduced the model. Students completed a range of activities aimed at initiating a test around an information need/or needs. This session focused on understanding what context of information need means within a mobile context, students explored the mobile context of information needs and how all the parts of the model fit and work together. This exploratory exercise created a wide and varied set of codes, as students understood the meaning behind context of information needs within the model. In the session the researcher coded 56 instances were coded for Contextual Need Activity.

The first formative session found that an "***understanding context of need***" and "***timescale of needs is too quick to solve***" were the most popular sub-codes capturing 18 and 17 instances. Reflecting upon the researcher's observational notes, these two sub-categories were interrelated and centred on student confidence, meaning that they did not fully understand what this meant and how a context of need and how it fits in a test strategy. Students' initial understanding of context of need activities was firmly associated with the applications functionality. Based upon this 18 (or 32.14%) of the 56 instances noted an issue relating to their own product and how it functions. This insecurity echoed from students agreeing that, ***"my app is limited"***. The assignment brief does clearly state that the applications build quality (and its overall functionality) was not being assessed it is based upon experimental methods adopted to conduct tests. These methods will gather data based around information needs, context (social and physical) and modalities. Using the assessment, the researcher explained that, ***"students need to think of the broader issues associated with context, for example how does motion challenge user interaction?"***

The second session helped to guide students' in collating information needs together into an "information rich" scenario based activity. A scenario would consist of a number of needs and/or demands making a contextual need activity. Students had difficulties with the concept of a scenario activity and the "***scenario development based on need"*** emerged creating 11 instances for discussion. Exploring this, it became apparent that students struggled with the concept of an information need evolving into an activity. Students' listed a number of demands and needs and struggled to contextualize these to form information driven activities. Contextualizing needs fed into the sub-code "***confusion between needs and scenarios"*** (12 instances) the students mindset and their interpretation was process-driven (i.e., go here>get this>find that>email to friend). The prescriptive approach based upon simple system demands did not have the depth or scope to build into a context of need

activity, hence the worry of ***"my app is limited"***. Students were encouraged to think a little more broadly about activities that support a users' experience. The difficulties with scenario activities also fed into the number of needs for a test students worried about having "***too many needs within an information scenario"*** (16 instances). As they modelled needs and interactions using the model the magnitude of the test started to take hold.

The second session modelled cognition mapping how test participant interact with the application (i.e., the operations or pinches/swipes, the goals and sub-goals to a demand/need and the different pathways a test could follow to complete the same need activity). Modelling cognition created uncertainty relating to the "***number of needs"*** required, 9 instances related to this point, as the researcher probed this point it became apparent that students were scoping out assessment details attempting to identify the minimum number of needs required to pass the module. Asking this question helped them work out ***"what was needed to pass the module?***", or the minimum needed to get a 2:1.

Contextual Need Activities became practical in the third session. The practical nature was due to their impending field tests, students begun to question data capture and ***"how needs fits into the overall test strategy?"*** As final preparation took place students pondered how things are going to be, notably ***"how are they going to start a test in the field***"? Students felt the lab comfortable and reassuring but what happens on the train or walking down the high street? They need to be prepared and the "***need fitting with a test strategy"*** (17 instances resonated with students). In the discussion, the need and fitting with the strategy related to planning and orchestrating the field tests. Students worried about tests activities as they ventured out into the field and need to feel self-assured that the test will meet the baseline goals set out. The researcher noted that the field data compared against the baseline data from the pilots test would support their experimental strategy. The level of anxiousness about the field tests was echoed with "***need (initiation) - how do we start the test?"*** (7 instances). The researcher tied this point back to contextualizing an information need if students have a clear context then the test will initialise and flow anywhere. Initiating a context of need fits with the last point raised "***panic in capturing a need****".* A point which reverberated across all qualitative fieldwork - the unknown. Students' worried about capturing field data especially things that cannot be seen. The researcher explained that this is something that faces all field tests, especially something of a qualitative nature like a need in the field. This about data capture and preparation making sure this is suitable for a field environment to get the most of the test.

5.1.2 INTERVENING VARIABLES (USER GROUP/PROFILE)

The main talking point focused on environmental contexts, 36 of the 51 instances directly referenced environments. As the tests established a context of need activity followed by seeking approaches, student's attention was on where these tests would take place, the spatial contexts. In summary, students found the thoughts of tests in environments outside unnerving, in that they had insecurities about testing applications with real users and this would take place in the field.

Table 5.2: Formative Session Sub-Categories – Intervening Variables

Formative Session	**Breakdown of the most popular instance (emerging sub categories)**	**Member Checked**
Session 1	Environmental configurations are not going to work	16
Session 1	Confusion of Source Characteristic placement in model	5
Session 1	Environmental perspective influencing stress & cope	20
Session 1	**Occurrence Sub Total (Intervening Variables)**	41
Session 2	Grouping elements of the model	4
Session 2	**Occurrence Sub Total (Intervening Variables)**	4
Session 3	Don't see the value in this element of the model	6
Session 3	**Occurrence Total (Intervening Variables)**	6
Total	**Intervening Variables (User Group/Profile)**	51

Table 5.2 presents a spread of codes where this variable was initially very high, session one highlights 41 out of 51 instances attached to the interning variable. Out of the 41, 16 instances evolved around their "***environmental configurations are not going to work***" and "***environmental perspective influencing stress and cope***" with 20 instances. It became clear that the configurations were around test logistics and how the students capture data in the field. The researcher attempted to contextualize this by explaining this is the "experimental" part of Experimental Design or Interactive Applications. Students need to explore and test a range of tools and methods, which are fit-for-purpose in the environment. The following example supported this discussion and decision-making.

"A student is travelling on a train form Darlington to Newcastle. The train is busy and the network is intermittent. In this environmental context the tester decides to use a screen reader to capture user interaction with the application and an interview will be conducted after the journey."

This example used two capturing methods the screen reader is not an intrusive piece of software and will not distract or add stress in this situation, if they used an external capturing tool (i.e. a Go-Pro fixed). The Go-Pro would be intrusive in this environment and will add unnecessary stress potentially affecting the test participant's cognitive abilities.

The second formative session created an unforeseen opportunity for the researcher. Students began to change the model to meet their needs –see the two examples in Appendix H. A discussion around *"**grouping elements of the model***" turned into moving parts of the model around. For example, students felt that once a context of need is set the test should consider the environment, one student said, ***"Naturally this takes place in an environmental context, at home on the metro or in my mate's car"***. Therefore, one part of the group they proposed moving the environment out of the intervening variables and putting this as an activation mechanism explaining that once the need is established the application is chosen in the environment.

As the students progressed to session 3 the comments were much more disingenuous and the researcher felt that students just did not want to go out and do this field test, a discussion around the values of field testing which create a problem as 6 students "**Don't see the value in this element of the model"**. This point raised by a small minority related to field testing with real users and the insecurities around their application.

5.1.3 User Modality Factors

Codes based around Modality did not appear in session two but were prevalent in session one and three. Students also provided their interpretation of modalities and where they fit, this can be seen in Appendix H – Model 2. This model was insightful and a group of students felt that the researcher's model should be split. One half was interpreted by the students as user requirements, or a user persona for the test and the other part was the test case or the seeking activity where the test participant is given an activity set by the user requirements.

Table 5.3: Formative Session Sub-Categories – User Modality Factors

Formative Session	Breakdown of the most popular instance (emerging sub categories)	Member Checked
Session 1	Changing states of modality	2
Session 1	Modality States - Confusion of a modality state	16
Session 1	**Occurrence Sub Total (Modality)**	34
Session 3	Sampling issues	9
Session 3	Too many configurations	16
Session 3	**Occurrence Total (Modality)**	9
Total	**User Modality Factors**	43

The wording of modality confused the student, "***confusion of a modality state***" noted down 16 instances, what constitutes wandering, visiting and travelling? Students interpreted visiting and travelling as the same modality and did not see the point. A suggestion was made to relabel to; walking, sitting and travelling (car, train or bike). This was interesting and the researcher explained the modality state is formed on past research and their interpretations and will shape new models in user behaviour and interaction.

Students also interpreted modality as something which is closely related to the environments, session one discussed the "***changing states in modality***" and students felt it will be hard to monitor and capture data whilst moving (i.e., the test participant is running to catch a bus). The researcher explained the importance of applying methods that are appropriate and fit-for-purpose in each setting and methods could change depending on the environment and modality. As students took these points on board session three notes ***"Too many configurations"*** which related to the changes in modality for walking, sitting travelling and their ability to capture and observe these changes. So students attempted to apply different user modality configurations but as the research will present in the analysis and discussion of field work students ***"played it safe"*** keeping to one or possibly two modalities.

5.1.4 Application and Data accessed

Students began to appreciate the importance of information as a driver for interaction. Based upon this a Smartphone – was a natural gateway to fulfil a need on the move. Formative

observations found that students appreciated the value of considering the Application and Data Accessed, and felt that it was important to acknowledge the technologies due to functional differences between devices and operating systems (i.e., Apple, Android and Microsoft).

Table 5.4: Formative Session Sub-Categories – Application and Data Accessed

Formative Session	Breakdown of the most popular instance (emerging sub categories)	Member Checked
Session 1	Cognition between phone & user (Application)	3
Session 1	External applications and source characteristics	5
Session 1	Networking	3
Session 1	**Occurrence Sub Total (Application and Data)**	**9**
Session 3	Confusion of application and program	16
Session 3	**Occurrence Total (Application and Data Accessed)**	16
Total	**Application and Data Accessed**	27

The first session discussed thoughts behind "***cognition between the phone and user***" and it transpired that their interpretation of cognition and the user was logistical. Some student wanted to include instructions on the phone to keep the participant informed of what to do keeping things ***"clear and accessible throughout would help test participant"***. They though that test participants would be able to refer back to the instructions, these instructions were included as notes on the phone. As the discussion progressed other students said, "***including instructions on a phone would distract"*** and would affect the realistic-ness of the test. Taking these points on board the researcher summerised by explaining the need to problem-solve a variety of methods to instruct and support the test participant whilst in the field. The points around hard-coded instructions like the notes would create a distraction and temptation. One possible suggestion by the group was a post-interview immediately after the test capturing data whilst it is fresh in the test participants mind.

The sub-code ***"External application and source characteristics"*** related to information on other applications and the need to gather this data to support the test strategy. Students explained that, ***"They are evaluating their application and not the usability of other external applications",*** a valid point. The researcher explained, ***"Users of Smartphones use a number of applications and their ability to move between applications is***

important. If a user leaves your timetable application and needs to return, how easy is if for them to orientate themselves? Having the ability to evaluate the overall experience will help to evaluate the context of need activity not the sole use of the timetable application". If the final session students felt the metaphors for Application and Data were confusing. Students interpreted application and program to mean something different i.e., the application relates to the Smartphone and the program related to the applications on the Smartphone.

5.1.5 INFORMATION SEEKING & PROCESSING AND USE

As students established a context of information need, every student moved straight to the seeking part of the model ignoring all the other elements of the model. Students moved back, in an iterative manor, to the other parts of the model once the context of need was clear and matched to a seeking strategy.

All students initially set out an active search in the class exercises (i.e., find a time, find and update something, find and delete something), no students considered ongoing, passive search or attention. Once students modelled their active searches, they realized that there are other possibilities, for example, an active search could be also something that was ongoing. Assessing the spread of codes in Table 5.5, seeking was very high with the first formative session noting 42 out 184 instances. As they modelled searches students reflected upon their initial searching strategy and in most cases added more detail, so again this was popular discussion point with 23 out 55 instances. As their search strategy became established discussion around the search tailed off noting 4 out of 96 instances.

Table 5.5: Formative Session Sub-Categories – Information Seeking Processing/Use

Formative Session	Breakdown of the most popular instance (emerging sub categories)	Member Checked
Session 1	Seeking approaches – needs clarity to the types of seeking	20
Session 1	Multiple seeking and searching needed for a test	20
Session 1	Passive Attention to Seeking Behaviour – what?	2
Session 1	**Occurrence Sub Total (Info Seek)**	42
Session 2	Breaking GOMS down to support Information Seeking	5
Session 2	Matching GOMS to scenario activity (Use)	10
Session 2	Choosing between GOMS elements (Use)	8
Session 2	**Occurrence Sub Total (Info Seek)**	23
	Worry about different seeking strategies - than expected	4

Session 3		
Session 3	**Occurrence Sub Total (Info Seek)**	4
Total	**Information Seeking & Processing and Use**	69

The introduction of the model exposed students to all the search components and it soon became apparent that context of information need activity and seeking were closely interlinked. This relationship between seeking and need created an air of confusion. Students found it difficult to separate these two parts of the model and they wanted to ***"clarity between a participants need for information, which then created a call to seek for that information"*** a point that created 20 instances and say these as the same thing. To help differentiate between these two very important elements the researcher discussed the possibility of multiple searches and asked the group to think about a range of seeking strategies, the following example was used.

> "A test participant passively looks for information on the web and a message appears in the form of a text message. The text is from another student asking for help about a module. So, this passive seeking activity turns active and now requires the student to find module information and rely to the text with a hyperlink to the friend."

This example establishes a context of need something that has a setting and environment and within this context there is a seeking activity, initially passive moving to active search. This example helped to support the sub-code *"**multiple seeking and searching"*** where 20 out of the 42 instances needed clarification regarding the number of seeking activities, which build into a contextual need activity. Examples like this opened up more questions especially around the way Wilson (1997) had worded searches, students were uncertain about the names used and what these meant in their research examples like this put seeking into a mobile context.

As the discussions evolved around a context of need having multiple searches students kept returning to the meaning behind the search notably, passive search and passive attention. All the students appreciated active and possible ongoing searchers however, "***seeking approaches***" kept reappearing 20 out of the 42 instances need more examples to contextualize the different seeking approach and how this fits within a mobile context. Each example returned to the point that seeking approaches build upon the contextual need activities.

In the second formative session, which modelled the searches all the students altered and refined their seeking practices. Modelling mapped out interaction and searches became more elaborate. Students began to realize that tests do not always consist of a single active search; test participants could take a number of pathways so ***"Breaking GOMS down to support seeking"*** acknowledged a level of uncertainty about the detail needed. Students needed to model all the possible seeking strategies, for example:

> "A contact search could use global navigation or a text link within the footer to retrieve the same information, but which is the preferred and most efficient pathway?"

Students need to model both pathways and compare the results. Students also highlighted "***Matching GOMS to the scenario activity***" where 10 out of the 23 students raised this for discussion. The researcher noted and used examples to articulate this by explain that:

1. Each scenario has a **goal**, a user goal (or context of need activity) and to fulfil this need,
2. **Operators** are available to accomplish the goal (the tap, swipe, page movement),
3. A test participant could follow a number of pathways to reach that goal - **methods** (or seeking approaches),
4. **Selection** rules dictate what happens when a user has chosen a method or pathway to follow.

This example clarified the GOMS which information the scenario activity and as the discussion defined clearly the difference between operators and selectors, which caused a lot of debate.

Finally, there was a discussion around ***"worrying about a seeking strategy that is different to what was expected"***, this point was turned into a real positive discussion that helped to galvanize the students field experiments. If a test participant does something unexpected this could open up new avenues for research and could influence the design and interaction of the application. The researcher concluded that this is a fundamental part of research which will inform practice and help support recommendations.

5.2 SUMMATIVE: STUDENT MATRICES

The summative results follow on from the formative results and supports Objective 5 helping to “evaluate data gathered to shape and evolve the model….” Observations are integral to any interprevists approach in searching and exploring the situations, which were set out theoretically in the methodology. The interpretivist mode of inquiry (based upon the model) investigates how the students apply this model to support mobile test design.

As part of the assessment students submitted a matrix, the researcher coded the matrices as evidence of practice in appendices I-L. The matrix supports the research in two ways; firstly, helps to present how the students have built tests around the model and secondly do their plans actually match the experiences in the field? The researcher will present these findings based around the themes.

The summative section consists of 21 student submitting their work. These form 21 individual case studies and this works out as 75 student matrices submitted for analysis. The breakdown for summative work follows the same approach using the themes and the researcher will present the findings from each theme.

5.2.1 CONTEXTUAL NEED ACTIVITY

Fig 5.2 presents the distribution of needs, there were a very high proportion of tests that directly referenced searching as part of the context of need (42 out of 75 matrices).

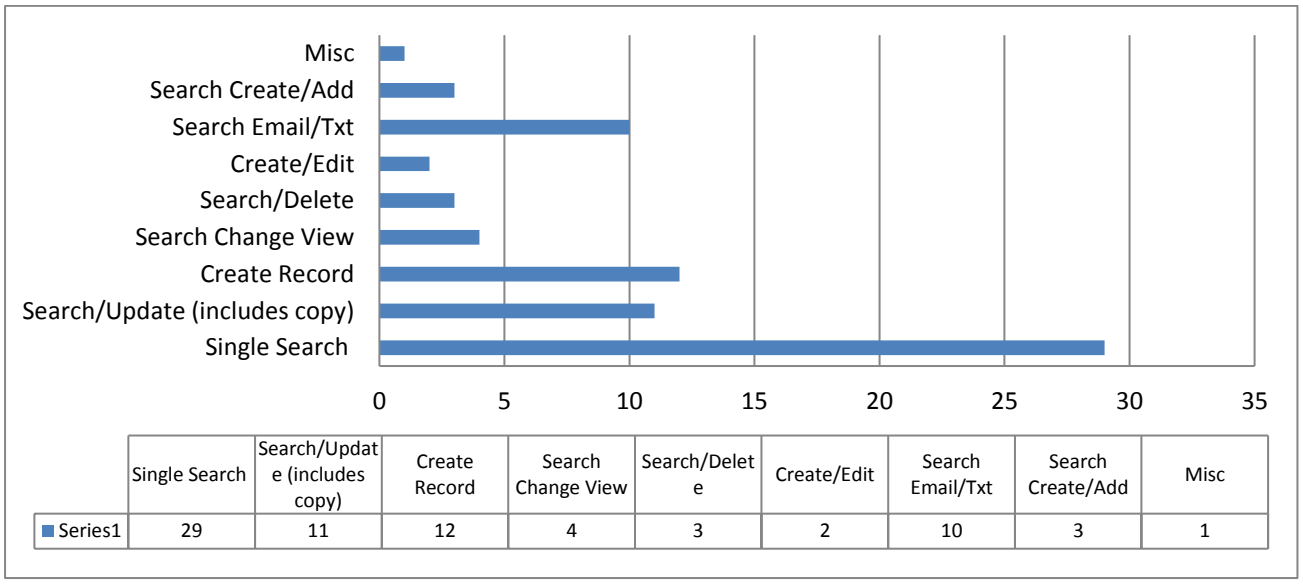


Fig 5.2: Distribution of Context of Need Activities

The formative sessions applied of a range of needs and/or demands based upon a mobile system building into a context of activities. As the researcher coded each matrix the column

multiple/sub need (Appendix I) presents the number of needs used to make each context of need activities. Based upon this 54% (41 out 75) were coded as “one need” activity, meaning these were all very simple and structured activities split in Fig 5.6.

Table 5.6: One Need activity applied to model Context of Need

Need Type	Summary of students interpretation of need in the model	Number
Single Search	Searching for Timetable information (room, exam and module) Searching for the updated details Searching for a specific room, calendar entry, contact or module information View timetable as a whole to schedule time with friends	12
Create Record	Creating a new recording adding new timetable information Adding an entry to the timetable allowing for assignment work Create a to-do item reminding them of room booking Creating a digital copy of a paper based timetable Add in holiday times and exam times	29

Evaluating each “One Need” activity a pattern emerged and it became apparent that students changed the context of need, modality and environments for each test. In doing so, creating four different tests, which affect the consistency of data collected – how can they compare four different data sets?

Record creation was a popular test activity, a high number of students’ matrices used record creation as a primary activity and test participants populated databases prior to searching. For example, following the need ***“creating record adding new timetable information”*** by the student with the pseudonym Hound the researcher can appreciate how this evaluated the test participant’s ability to create records. Hound’s other three tests evaluate the timetable functionality aimed at searching and viewing information, in this case searching for rooms already stored in the database. Another student Peter Parker changed modalities and environments applying signal searches for each test. Parker creates a test, which produces a consistent data set based around the search facility. These two examples use a One Need with different research outputs, Hound was able to test three core application functions; record creation, record search and viewing record information. Peter Parker on the other hand only evaluated one function - a calendar search.

By grouping matrices by the number of needs used the researcher begins to visualise that these matrices have the ability to add a real context to the need activities. Grouping has been defined where a context of need has more than one function or demand. The formative sessions noted that creating need activities/scenarios – which consist of multiple needs and/or demands - help to evaluate the application and users’ experience. Table 5.7 presented these with summary of the core combinations used within their experiment.

Table 5.7: Two Needs activities applied to model Context of Need

Need Type	Summary of students interpretation of need in the model	Number
Search and Update	Walking home and need details from phone Meeting with dissertation supervisor, need to change contact details Find and edit entries within timetable due to lecture changes Find and alter event by two hrs before film Search for a specific meeting and the change time Search and update event information Search and updating time (lecturer temporarily changed it) Searching for and Editing Timetable information entries Searching for specific lecture altering the view using a grid Finding and updating contact information	11
Search and Delete	Search and delete event Searching for and delete timetable entries Deleting contact entry on bus	3
Create and Edit	Creating new recorder and editing timetable entries	2
Search and Email	Search and share event information via email Add contact information and updating contact Search for tutor contact details and email them Searching for contact and emailing	10
Search and Create/Add	Search for available room and create event based on availability Search for and locate timetable information, input new Search for entry and then add location for a room	3

The creation of “Two Needs” which equated to 35% (or 26 out 75), this is where students applied more than one need within the matrices. There are clear variations in the students’ appreciation of needs when attempting to build the activities within the test. Single or One Need tests appear to be prescriptive, Table 5.7 presents Two Needs and these examples present clear differences of needs and types of needs, which aim to explore other activities within the application.

The Search and Update constructs a more purposeful test activity where a piece of information has been located and the test participant needs to do something with it i.e., update or edit a record. This example demonstrates that students are interpreting a wider possible range of activities (than just a search), which support a user needs relating to the application. The example “***find and edit entries within timetable due to lecture changes”*** creates a clear set of requirements, the context of need activity creates a setting that tests two core activities and is structured and understandable. Search and Email also creates a set of requirements applying two needs, which create a platform evaluating the flow between their timetable application and the phones email application. The examples ***“search and share event information via email”*** and ***“search for tutor contact details and email them”,*** both require a test participant to find a record or contact in the timetable application

and then extract the information, via the copy and paste command, to put into an email. The formative sessions emphasized that users interact with multiple applications to meet a context of need, appreciating the transitions and movements will help evaluate how their application works within others.

Table 5.8: Three Needs activities applied to model Context of Need

Need Type	Summary of students interpretation of need in the model	Number
Update, copy and search	Information received via txt with a new number, need to copy txt, search for the correct record and update the entry with the new information for the txt.	1
Search, Email and Add/update	Search for email address, email teacher and add homework to collect missed work Add and then edit entry, view the updates and share via email to friends.	5
Search, update and view in grid	Search for existing entry in the database, change the rooms number to reflect a change, view the entry in the grid format	1

Out of the 75 matrices, only 9% (7 matrices) applied a context of need activity with more than two needs. These activities pulled together different activities, functions and applications to create a setting that feels real and encapsulates the challenges faced by the test participant. The student Magina created a test that required the participants ***"to receive a txt to their phone"*** and only on receiving the text information can the test start. This information calls them to action and a search task takes place to update the records. Santiargo and Tony Stark pulled together seeking activities and edits, which also required communication via email. Finally, Santiargo created another test where the test participant needed to search and edit a record but added a viewing option (similar to Hound) where the test participant needed to view their timetable and rotate (to landscape) evaluating the timetable's visibility.

STRESS AND COPING

Stress and cope is seen as a behavioral effort to master, reduce, or tolerate the internal and/or external demands that are created by the stressful context setting grouped by the cognitive and affective information needs. 'Cognitive' in this context meaning that the test participant obtains factual information which will improve organisation and planning. Affective in this context meaning a user need for information to deal with emotional needs of the activity at hand (i.e., being late for class). Based upon these two psychological states Table 5.9 presents the students interpretation in their plans which is based upon the type of context of need activity.

Table 5.9: Stress and Cope - Cognitive and Affective

Stress and Cope Type	Summary of students interpretation of need in the model	Number
Cognitive	A test participants' cognitive behaviour to add, search and create information for; timetable/ module information, email address, homework etc.	17 (23%)
Affective	Indicators of stress or coping; major or minor stress in competing activity, assignment due in a week, intermittent network coverage, updating information in time, time limitations – class about to start.	
	Add and then edit entry, view the updates and share via email to friends.	42 (56%)
Void	Null entry or misinterpreted entry	16 (21%)

i. Cognitive

The matrices which exhibited cognitive behaviors were closely related to how they set out the context of need and seeking behavior for the test. Within this context the matrix was used to the cognition which entered, updated and searched for information.

Bear Grylls and Magina developed a context that required an information search within the timetable where the cognition needed to, Bear applied ***"enter correct info"*** and Magina "***inputting the correct number".*** Trevor Mac applied cognition where the ***"user must add a planned holiday"*** this requiring a level of management to reflected planned holidays within the application. Wolf applied ***"ability to complete update"*** aimed to evaluate that the participant is able to cope and update the information with the application.

Santiargo created an identical copy of the context of need and pasted this into this which ***"added a new entry, edit an entry, view timetable, email timetable"*** it is seen as an action and not a cognitive behavior. The same applied to Santiargo's other cognitive element "Edit the colour of the entry, view in grid mode" again an action not a cognitive component.

Creating and editing was one cognition but the other was the search and cognitive behavour was presented around finding records or information relating to module. Bo, Sherlock, Trevor Mac and Magina all applied the cognition to find the right information, Bo ***"Get the right info and sending to friend",*** Sherlock ***"Listing information relating to event"***, ***"Updating in time"*** and Trevor Mac ***"Find existing contact to update"***. Magina "Find existing contact to update" and "Inputting the correct number". In summary these all relate to a test participant being able to cope within a given cognitive behavioral challenge, there is no affective or stressful connotations with the context of need activity.

ii. Affective

The affective presumes a level of stress on the participant and this has been articulated within the matrix. This has been presented in two ways; one where the matrix directly uses the terms stress and cope, the second method used word to amply the stress of the test situation (i.e., ASAP, time limits and impending due dates).

Based upon the data from the matrices affective test measures can be interpreted as the following; time pressures, miss-information and technical constraints. Time pressure was a popular activity to simulate affective behaviours, Peter Parker, Fat Mike, John-117, Chambers and Hound all used time as a pressure within the test. Test set a time limit on the activity to see if this affected the test participants' ability to complete the test, Peter Parker Magina list this as ***"unable to find the information in time"*** and ***"Can't find contact, can't send email"*** which was acknowledging that a time will be set within the test. Fat-Mike was less descriptive with his four tests as ***"finding the room in time",*** which does insinuate a time limit will be imposed on the participant. John-117 used an affective stress measure as **"having to add multiple entries"**, **"Not know when the event is?"** and ***"time limitation to find info before next lecture".*** This has a range of stress put upon the participant and time pressures contributing to the test activities of multiple entries within the application. Hound attempted to simulate major and minor stresses, which required the test participant to ***"attempt to complete at speed".*** Finally, Chambers applied ***"limited time to message tutor before class"***, which required the participant to ***"finds detail before break is over".*** Each one of these tests has attempted to apply a time limit to complement the real world activities.

Miss information was applied by Bo and Wolf, Bo applied ***"stress of receiving info needed to be stored",*** which can be interpreted as a need to be organised and using the application to fulfil this need. Bo also include ***"not having correct info"*** this would have stressful connotations in that not have the right information will cause anxiety and inability to full fil the context of information need. Wolf applied ***"stress: timetable in app is out of date",*** this could be interpreted in two ways; the application need updating and is not work efficiently or the information within the application is out-of-date and needs updating – this needs clarifying. Giuma was the only student to include technical constraints which could and will cause stress whilst interacting in this case the participant ***"needs to catch the lecture ASAP"*** and "WWW interrupts process" something that does happen a lot especially on public transport.

Within the context of this research the affective measurement is clear, this are pressures with make the test stressful or there are no pressures and the participant is coping within the

given test situation. So coping created a more relaxed test situation. Sherlock created a cope to mean ***"successfully shared event with staff"*** which is more of a process and use of information not a coping mechanism. Giuma created an interpreted this as ***"cope - shopping at home"*** where there are relaxed browsing the internet. Tony Stark could have stress connotation but the ***"need to notify teacher so work can be collected"*** which he applied in four matrices is a coping mechanism to keep the lecturer informed so the participant can collect work. Wolf used coping in the matrix as ***"helping to understand what it is all about"*** Finally, Roberts used cope to support the context and environment setting this as ***"non-pressured environment".***

Out of all the matrices there were three students whom either left the coping and stress as BLANK (Rudd, Boyton and Chadijiouraniou) or in Pouchy's case misinterpreted the meaning of stress and cope in this context and used it as an aid to support the test case i.e. "Stress wearing head cam". This is something planned in the overall strategy not in the understand of application usability.

5.2.2 Activation Mechanism

The technological definitions defined in the Systemtic Review, which is based upon the work by Kristoffersen, and Ljungberg (1999), defined a mobile computing device (the Smartphone) as the "application", the activities are completed on a "program" (the timetable, calendar, email or mobile browser). Finally, "data" is the retrieved as results from a search, an update or a record added to the database.

i. Application:

Within the context of a test defining the application is a simple but one that is important. There are, for example, very different interaction styles between the Android and Apple operating systems, which will affect a user's interaction. The entire cohort used an Android-based phone; this was out of accessibility due to the number of Android phones available on the module. Also in 2013, Google Play store included more screen recording features to support data capture.

ii. Programs:

Programs describe the types and combinations of applications (mobile apps) needed to fulfil the test activities. Based upon this, 77% (or 58 matrixes) used a Single Application (i.e., Timetable App, Calendar App etc.) with their matrices and 17% (13 matrices) applied more than one program to support this part of the test strategy. Reflecting upon the spread of

instances for students using more than one program does appear to be small especially when the emphasis in the formative sessions was to integrate different applications to support the holistic view of mobile interaction.

Cross checking the programs listed by the student and their contexts of need activities, students have not applied the all the programs to support the test and in most cases just included the main application (i.e., Timetable App). A clear example of this can be found with an "Update and Email" in this case they test plan needs two programs to support this test – the timetable application and the email application. In the case of Santiargo, the context of need activity requires an "***add, then edit entry, view the update and share with email***" and matrix for program lists "***Timetable app***". Timetable App is only part of the test requirements, Santiargo needs to acknowledge an email application, the test flows between these two applications and the test participant and for completeness the email application needs to be present.

Finally, 6% (4 instances) labelled as void and in these cases the matrices are labelled incorrectly (i.e., ***"Exam creation confirmed"*** and ***"Location creation is successful"***). These examples demonstrate a level of confusion between data and program, exam creation is not a program by the data presented back to the test participant, simple to the creation of a successful location. There were also synergies to other parts of the model relating to the information use and would have been better placed in the Processing and Use part of the model.

iii. Data:

Data appears in different locations as the data is, identified, search, used and processed within the model. Data could appear setting the context of information need activities as part of the need or system demand, data drives the search process and data is processed and used to fulfil the user's information need. The Systematic Review noted a range of data types using within the research fields i.e. music files, SMS information, GPS data, timetable information, browsed information and general textual information types entered into applications on the device. Labeling the possible datatypes within the model will support test requirements and of what needs to be evaluated? Fig 5.3 presents the distribution of data types within the matrices.

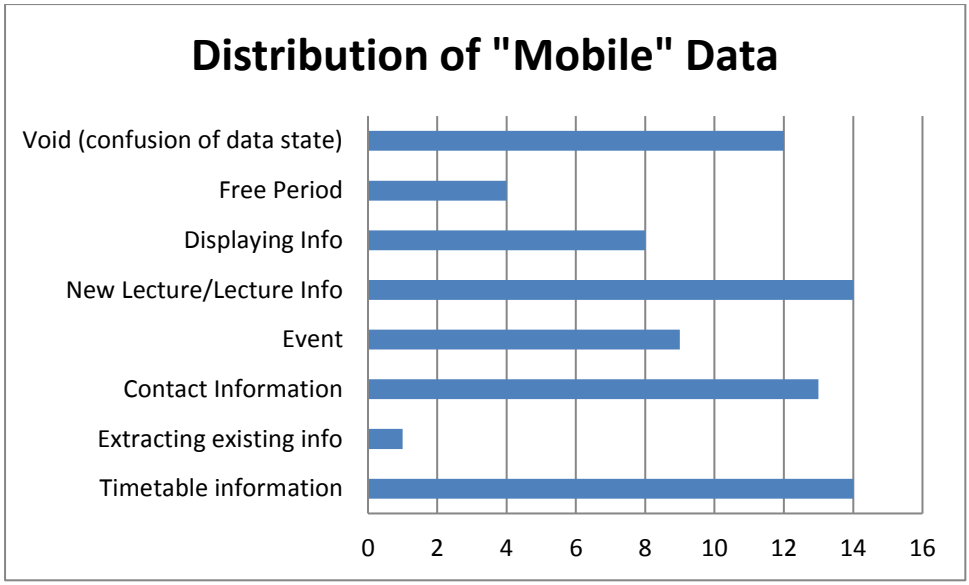


Fig 5.3: Distribution of "Mobile" Data

Students presented a wide range of data types the most popular data instances were ***"Timetable Information"*** and ***"New Lecture information"*** both with 14 instances (17%).

The student Bear Grylls labeled data as "***timetable entry information"*** this example appreciates the data within this context of need as an entry made into the timetable application (i.e. this could be interpreted as characters, numbers etc..). Tony Stark labeled the data as **"*email, lesson and homework information"***, Tony's data is information driven and is based upon sharing homework and highlights how the information flows between other areas of the model. Tony's matrix demonstrates:

- The context of information need has informed the data as a context, which ***"searches for email address, email teacher and add homework to collect missed work".*** Provides a wider scope, which is contextualized further within other parts of the model.
- The seeking behavior where the data is searched for and the test participant ***"locates lecturer info outside of the application".***
- This data is then used and process by ***"processing the change in lesson time, use and gathering of the lecturer's email address"*** fulfilling the need and drawing a close to the test.

  Each one of these elements demonstrates the information flowing through the model.

The datatype "***displaying Information***", a popular type but is a unclear and ambiguous within the matrices, a matrix needs the actual data (i.e., date, time, timetable information etc.). For example, Hound labelled "displayed information" but what information does Hound mean? Hound's context of need is labelled as ***"searching for specific lecture altering the***

view using a grid" and seeking ***"successful timetable entry or retrieval of information"*** help to contextualize the data type should be lecture code, time and room. Using these as datatypes will provide cohesive flow within the matrix so the test appreciated the data needed for the search and the data presented after the retrieval process.

Data types coded as void were 16%, void cases demonstrated a level of confusion. Students were not interpreting data within the model and in some cases a datum was used as an opportunity to action something (i.e., adding and updating information). These actions are more pertinent in the contextual need activity or and information processing and not data. The student Pouchy misinterpreted the meaning using data as a way to instruct and support the tester within the test i.e., ***"document given to participant"***, ***"verbally instructed"*** and ***"info provided verbally"***. This type of labelling is supporting the test process but not the types of data gathered to support the overall context of need.

5.2.3 INTERVENING VARIABLES

Intervening variables consist of a number of elements supporting user behaviour, setting out demographics and creating a setting (socially and physically) where information behaviour can be scrutinised. For the purposes of this analysis and the scope of this research, results will concentrate on students' interpretations of the social and physical environments within the students' matrixes. A discussion in Chapter 6 will acknowledge the influence of the other intervening variables to support environmental contexts within tests. This section splits into two parts, physical and social environments.

PHYSICAL ENVIRONMENTS

Physical contexts consider the architecture and institutions, and within these physical contexts study the objects within a space, for example, evaluating a Smartphone user navigating around tables, chairs, doors within a University campus. The results will be synthesised presenting how the students labelled these within their matrices.

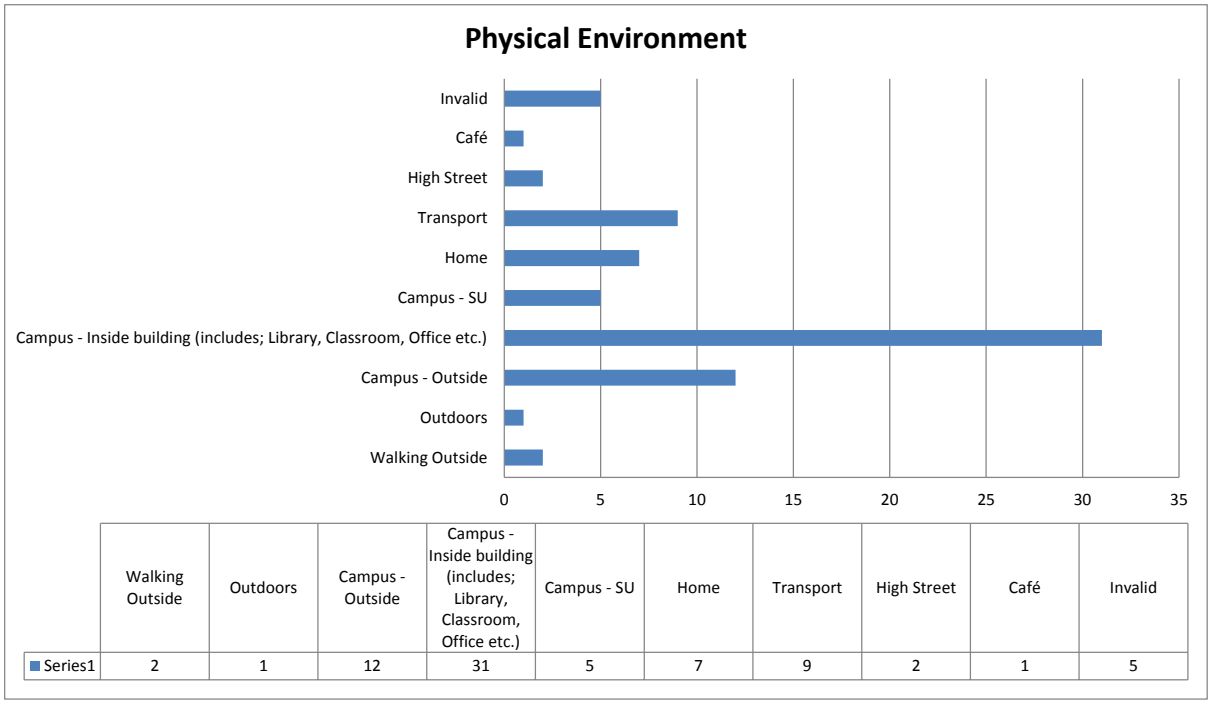


Figure 5.4: Overall Distribution of Physical Environments

The most popular physical environment broadly defined in the matrices and labelled as a Campus (Inside) setting. A popular environment and one justified by the students as ***"a place where the test participant of their timetable application would interact"***, in an every-day setting to find classrooms. Out of the 31 matrices, 12 labelled this as simply Campus "Inside" with no other description to support this setting. Whilst campus inside acknowledges the architectural setting the description lacks detail to contextualize the physical setting (i.e., seminar room, lab, office or canteen). Campus inside does not present a clear account of physical placement or location of the test participant. However, the other 19 instances do add a description adding to campus inside, Table 5.10 presents the distribution of physical contexts set inside the University Campus.

Table 5.10: Physical Environments - Campus Inside

Need Type	Summary of students interpretation Campus Inside	Number
Campus (Inside)	Poorly labelled with the only acknowledgement that this was set in side a campus building	12
Lab/Classroom	Students provided a setting which is set with a teaching environment	9
Corridor	A true setting, students are interacting with the application before and after a class	3
	Acknowledged that test participant was inside and has to contend with doors and other physical objects like chairs and tables	4

Inside with obstacles		
Office Building	Used to denote waiting for an appointment with tutor	2
Library and quite room in a building	Working in a quite space	1
Total		31

i. Campus Inside

The classroom/lab (9 instances) was noted by the researcher in the observations were settings used more out convenience and not relevance, ***"students felt they had more control and this did seem like an extension of the lab/pilot tests"***. Trevor Mac attempted to contextualise the lab setting further, which considered other physical objects, like the desktop PC and desk physical objects which could obstruct or distract a test participant thus helping to inform the physical setting of the test.

The "corridor" applied 3 times added a different dimension to campus inside and probably created a different modality, the participant is stood still or walking. Peter Parker and Tony Stark applied this setting and Peter contextualised this with stood still with peers as the social setting. Tony considered other physical objects like; a table, chairs and other students around, the test participant needed to navigate and walk round people and opening doors. The corridor examples have similar connotations with "Insides with obstacles" students set this physical environment in a room including physical objects like; PC's, desks, chairs and other people. Rudd used these physical objects but listed these within the Social Environment part of the model. Rudd however considered ***"physical objects - Computers, chairs, desks"***. Snow White was a little less descriptive labelling the environment as ***"campus - inside (Obstacles in the way in building)***". These examples both begin to contextualise the physical setting for the test.

The office building, which was applied by Chambers and Trevor Mac attempted to differentiate the classroom setting and corridor environment. They achieved this by labelling office environment to denote tutor's office. There are distinct connotation differences and potentially have different environmental and social constraints on the test participant (i.e. the lab/classroom is socially different and the office may have added stress factors - booking to see the tutor about the assessment for example).

ii. Campus Outside

Students' interpretation of "Campus Outside" with 12 instances and "Outside and Walking Outside" with 2 instances were very similar. In a comparable way to the Campus "Inside" both applied limited descriptions to contextualise the setting. Pouchy and Sherlock were the only matrices where an attempt an attempt was made to contextualise this setting both matrices positioned tests ***"outside walking over the campus bridge"***.

Transport: The transport setting was a little more adventurous applied within 9 matrices. Students interpretation of this environment made an attempt contextualise and include other physical objects. For example, Santiargo, Magina, Boyton and Chambers introduced a modality to this physical setting (i.e., sat on the bus, standing up moving and constantly shifting). Each of these applied connotations to create a feeling of movement within the physical setting - perhaps better suited within the Modality part of the model. Boyton and Chambers set on a bus applied a modality ***"constantly moving and shifting"***, which suggests that they are travelling which is something that would happen on a bus. Tony Stark's matrix was the only one that contextualised the physical context further by including ***"uncomfortable cramped seating"***, which again happens when travelling on a busy bus or metro at rush hour for example.

Fat Mike, Giuma and Trevor Mac applied transport as Metro, train or Bus ***"On public transport"***. This does create a setting but lacks contextual detail and developing further including other physical objects would help the context. Finally, Peter Parker created a ***"Car simulation"*** which involved pushing a student around a room on a chair with wheels. The test does enable Peter Parker to simulate motion in a car but this is more suited to a pilot test not an actual field test.

Home: Rudd and Bear Gyrlls labelled this as "Home" which lacks contextual detail to the physical setting. The remaining matrices applied additional context to the home environment. Tony Stark, Roberts and Sherlock set this environment with the Television as a distraction, the Television is a poplar physical object, which can distract and divert attention and influencing interaction. Roberts also set the home environment as a ***"communal environment"***, like the Halls Residence applying other social interferences within the environment. Sherlock and Pouchy set home front of the PC, similar to a lab and the TV examples.

High Street: Santiago and Boyton created tests on the High Street. Santiargo's ***"walking outside"*** and Boyton's ***"outside busy street"***. Both examples create a physical setting but lacks extra context needed, which considers other physical objects of; people, cars (parked), bins, lampposts etc.

Café: A physical environment simulated within the formative sessions but only applied by one student. Giuma used this physical environment in a social group to as a single search to find a contact.

Void: This was mainly one student Bo. Bo applied social constraints to the physical environment, for example **"noisy"** and ***"use unsmooth conditions"*** whilst these contribute to a physical setting, the physical context needs elaboration to help contextualise the test setting, location and objects.

SOCIAL ENVIRONMENTS

The social environment was set as single "alone" or a group activity. Single "Alone" meaning that the test participant was interacting with the application on his or her own. Group are activities where students fulfil the need as a group (i.e., with their peers or family). Both single and group will have varying levels of influence on the test participant from the social environment around them. The distribution in Fig 5.5 presents the distribution the narrative presents the students interpretation of these within their test plans.

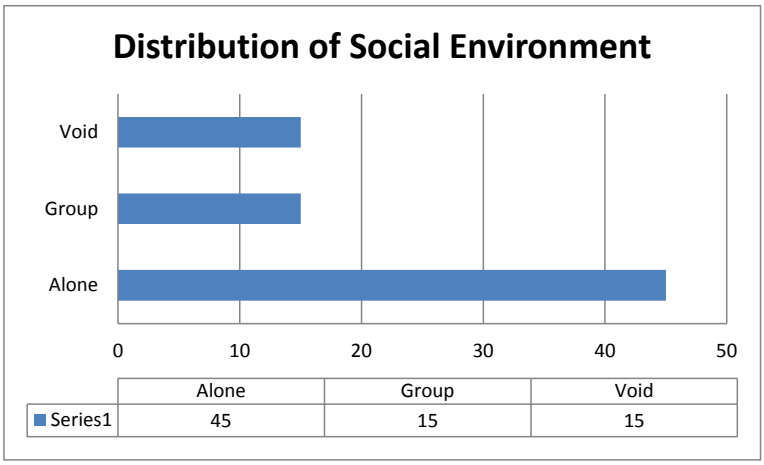


Figure 5.5: Distribution of Social Environments

There we a number of variations of how Single "Alone" was applied, Table 5.11 presents an overview of these interpretations. It is worth noting that as this data was coded two sub-themes emerged from a physical and psychological perspective. The first, an extension of the physical environment, aimed at contextualising the environment further, for example a ***"busy crowded"*** corridor or classroom. The social influence from psychological perspective influenced the test participant to ***"distraction"*** for example major or minor distractions set within the test evaluating user interaction, this was not from the television but people around them possibly fragmenting their attention whilst using the application.

Table 5.11: Social Environments - Alone

Social Type	Summary of students interpretation Social Setting	Number

Walking	Walking alone whilst interacting	3
Busy and Noisy	Extension of the physical setting, busy corridor, class room, student union etc.	16
Alone	Poorly labelled with the only acknowledgement that this was set alone	1
Quiet Setting	Extension of physical setting alone at; home, library, classroom - no people around	15
Distraction	A major, minor, significant or no distractions on the test participant	7
Misc. Alone	Extension of need in social setting i.e. alone view contact information, alone working	3
Total		45

The social type “Busy and Noisy” and “Quite setting” was the most popular using these as social settings helped to contextualize the physical environment, which complemented location of the test.

Busy and Noisy: Trevor Mac, Fat Mike, Santiargo and Tony Stark used transport as the physical environment, which by their nature are noisy and very busy places. Trevor Mac required the test participants to be ***“sitting down on a moving bus”,*** the social environment being alone and it being a *“**very noisy and disruptive**”* setting. Santiargio’s specified a ***“crowded and noisy”*** bus. Tony Stark added another dimension to the social setting by applying ***“Alone (Busy unknown travellers, lots of noise (people & vehicle)”.*** Each one of these examples helped to contextualise the physical environment from a social perspective.

Bear Grylls, Pouchy and Wolf identified the Students Union and again by the nature of this environment and is a ***“busy, crowded and noisy”*** social environments. Each matrix had the test participant ***“alone in the SU***”, Bear aimed to set the test in a ***“busy environment with lots of background noise”*** Wolf and Ray Mears aimed to set their tests making sure the environment was ***“busy crowded and noisy”***. Ray Mears, Fat Mike and Sherlock aimed to set the tests outside at **“busy times – between classes”.**

Ray and Fat Mike were not specific with their social settings where as Sherlock aimed to set the test on a bridge connecting two parts of the campus, which does get ***“very busy and congested between classes”***. Finally, Tony Stark created an alternative social setting at home, where the test participant is using the application but set in the ***“family in same room creating noise***”. Each one of these examples attempts to create a real life social context and consider the “everyday” social interactions to the physical environment. Considering these social factors, all have the potential of influencing a users’ interaction that may distract and fragment attention of the test participant.

Quiet Setting: A quiet social environment is static and relativity easy to recreate, whereas, a busy and noisy environments are varied and unpredictable depending of the time and the number of people for example, student conducting the test cannot always guarantee that the bus is full and camped. Roberts, Fat Mike, Pouchy, Snow white and Trevor Mac created a quiet social setting inside a building (i.e., a lab or teaching space). Trevor Mac's matrix did contextualise this with in the physical setting as ***"sitting at office desk"*** supported socially as ***"alone - quiet setting"***. Tony Stark created a matrix ***"outside of the lab"*** in the corridor aiming to conduct this test moving when the campus corridors are "quiet". Tony's test aims to evaluate the application whilst the test participant navigates physical objects, for example opening doors but not contending with people as well. Bear Grylls and Pouchy created tests, set at home environment in a bedroom ***"seated at their desk in bedroom"***, an environment for ***"quiet study"***. Santiargo and Ray Mears created test matrixes set outside and the test participant is alone - there are ***"people around but is not disruptive or noisy"***.

i. Distractions

Interpreting physical and social spaces creates a setting however, some students included possible distractions. The interpretation of distraction is another person, or persons physically distracting the test participant – this could be asking a question or interrupting them as they interact. Distractions have the potential to connected other parts of the model, notably stress, coping and psychological effects. Creating a distraction provides the tester with something additional to measure, for example, does a distraction like someone talking to the participant impact on interaction?

Out of the 45 matrices, 7 matrices planned some form of distraction within the tests. Hound labelled tests with ***"Major Distractions - Loud and busy bar"*** and ***"Major Distractions - Busy Corridors"***. Hound interpreted distractions as people talking to the participant, which can be potentially measures that affect user interaction. Tony stark and Snow White on the other hand labelled the test to be set ***"Alone Quiet setting (No Distractions)"*** and ***"Alone - No social distractions"*** both ensuring that there are no influences or possible distractions on the participant.

ii. Group Activity

The creation of test matrices involving peers as a group to fulfil the need. In these examples peers to help orchestrate the test and 15 matrices were group activities. Giuma set in a café created a social setting with friends attempting to fulfil an activity need whilst ***"conversing with friends"***. Group activities within a study/learning environment were the most popular with Tony Stark, Santiargo, Magina, Boyton and Peter Parker all applied this to their social setting. Tony Stark aimed to create a familiar classroom environment where a ***"group of***

friends and teachers discuss work". Santiargo and Boyton Group created a group activity and the students are ***"working on computers whilst socialising"*** and ***"talking with friends"***. Magina set the test in the Lab but just had ***"class mates around"***. Finally, Peter Parker created group activities in the classroom and corridor with ***"friends present"***.

There were two group matrices set outside, Roberts Campus test explaining that the test is a ***"Group (Busy Crowded and noisy)"*** test environment and Santiargo created the test on the "High Street (Newcastle High Street - Walking outside on)" and ***"Group - Friends walking alongside holding a conversation"***.

Snow White and Roberts recreated the communal space and the social influences were ***"watching TV, People trying to make conversation"*** and ***"watching TV in communal space"***, both group activities are ***"loud with people talking"***.

Finally, Boyton and Peter Parker created group activities on the ***"Bus, standing up and moving - Surrounded by a group of friends"*** and Car Simulator, the researcher is unsure how the car simulator will work as a group activity. The tester is pushing the test participant around on a car so it will be extremely difficult to create a group activity in this situation.

5.2.4 User Modality Factors

User Modality splits over three different states; visiting, travelling and wandering. Out of 75 matrices, 72 were matrices included one of the three states of modality. Examples used in the formative sessions encouraged students to reflect upon the different modality states. A test participant could start "Travelling" to University and then "Wandering" within a University building to find a room and move to another.

However, from the outset only one student (Fat Mike) considered more than one modality state. Fat Mike did confuse the different parts of the model i.e. the visiting state was set as a physical environment. Mike stated visiting as "Campus", strictly speaking the modality visiting is where they spend time in a place for a temporal period of before moving. Based upon this, the test participant is seated in a lab or room on campus and then walking (wandering) between classes.

Table 5.12: Visiting Modality State

Modality Type	Summary of students interpretation of the Visiting Modality State	Number

Sat	At the Student Union, At Home, At a Desk, in Seminar Environment	16
Stationary	Stood still, Stationary, Stood Outside the Classroom	5
Walking	In a Building (Pandon Building)	1
Void	Set as an environment i.e. Library, Campus, University Building, Short Meeting	14
Total		32

i. Visiting

A state defined by "spending time in a place for a temporal period of time before moving" on to the next destination (Kristoffersen and Ljungberg, 1999). A large number 14/36 did not interpret visiting modality correctly and used visiting as an extension of the physical environment (i.e., campus, library and home). The visiting state needs to depict the test participant in a sat down or walking state at these physical locations. On the flipside to this 16/36 did set this state correctly and depicted a visiting (sat or sitting) state, for example, Bear Grylls, Snow White, Tony Start and Sherlock set one of their tests at home seated. Students also set this at University campus (i.e., lab, SU and classroom), Bear Grylls set another test sat in the Students Union, Tony Stark was as in a seminar environment, Giuma set the participant ***"sat on a table in a Café"***. Finally, Boyton designed two modality states that were both "sat" both on Campus but altered the social setting from quite too busy. Magina uses a lab setting contextualized by ***"staying and seated"*** to present the modality feeling. Tony applied ***"sat in a seminar environment".*** The use of physical environments as part of the modality was also used by Hound ***"SU with friends"***, this does not depict the actual state of the user (i.e., sat or stationary) but the matrix does provide an overall context that the test participant is in the SU for a temporal time period with friends and using the application.

The other noteworthy state was a ***"stationary setting or stood still"***, Hound, Trevor Mac and John-117 used this state within visiting. Hound also applied the physical environment library with "stationary" to suggest that the test participant is hanging around the library, perhaps waiting for friends and using the timetable application. Trevor Mac used stationary as the test participant is ***"sat at an office desk"***. John-117 applied "stood still" in two of the matrices both in a campus environment inside.

The final example used within the visiting modality was used by Giuma ***"walking in Pandon"***, this state is interpreted as a way to present the setting of being there for a temporal time period, however "wandering" was used for this state i.e. local mobility within a building or local area.

ii. Travelling

Defined as “going from one place to another in a vehicle, this could be a commuter on a train, car or bus” (Kristoffersen and Ljungberg, 1999). Out of the 17 instances 9 applied this correctly 6 were not labelled correctly and should have been placed in the visiting or wandering state. Guima used “***sitting”***, Fat Mike used ***“stationary”*** and in these test contexts they fit with “visiting” to denote the test participant visiting the actual destination. Wolf labelled the travelling state ***“on campus moving between rooms”***, strictly speaking this is a wandering state not travelling where there is local mobility between rooms onsite.

Table 5.13: Travelling Modality State

Social Type	Summary of students interpretation of the Visiting Modality State	Number
Train	Sitting on a Metro	1
Car	Passenger in a car or car simulation	2
Bus	Sitting on a Bus	5
Alternative	Walking home	1
Void		6
Total		17

Students continued to feel the need to include the physical space where this modality is applied (i.e., sitting on the bus, sitting on the metro) Magina applied ***“sitting on Metro”*** searching for information to send via email. Bo and Peter Parker applied the travelling state as ***“passenger in a car***” Bo evaluated the searching activities whilst in a car. Peter Parker simulated travel and created motion whilst pushing a student about the corridor on a chair with wheels. Sanitargo, Trevor Mac, Boyton and Chambers used the bus to travel in or go home from University. Santiargo set the test participant on a ***“seated on a moving bus”,*** Trevor Mac’s test modality was ***“sat on the bus” travelling into University and*** Chambers set the test ***“sat heading home on the bus”.*** Boyton applied ***“sat – travelling on a bus”*** and a group of friends surrounded the test participant. Finally, Chambers applied ***“walking home”***, which is not a vehicle but is a form of travelling that was not acknowledged by the research but is defiantly going from one place to another and is a valid state.

iii. Wandering

Wandering is seen as an extensive local mobility within a building or local area (Kristoffersen and Ljungberg, 1999). The spread of instances for wandering was 23/72 students appreciated this state and in the main labelled this correctly. The idea of local mobility within a building or local area fitted with a student timetable. Out of the 23, 2 were incorrect i.e. on campus and sat in busy building is not seen as “extensive” mobility.

Bear Grylls and Fat Mike labelled this as ***“walking”***, reviewing the rest of the model this modality state fits with the context of need activities and environments presented. Bear uses wandering for two matrices set in side a campus building, the test participant completes a search activity moving on their own and the other activity with peers.

Fat Mike and Boyton set the modality within a shopping environment moving between shops a modality and environmental setting used in the formative sessions. The remaining students all based on campus moving between buildings and classrooms which fits with the “local mobility” wandering from local destinations on campus.

5.2.5 Information Seeking, Processing and Use

Information seeking is split across the test matrix has the potential to combine a number of different searches depending on the Context of Need Activity. Student exhibited some insight interpretations and labelling however, there was confusion regarding the meaning and how seeking applies to seeking behaviour.

This section will present the result. Fig 5.6 summarises the search distribution, 89 different searches in total and active searches being the most popular.

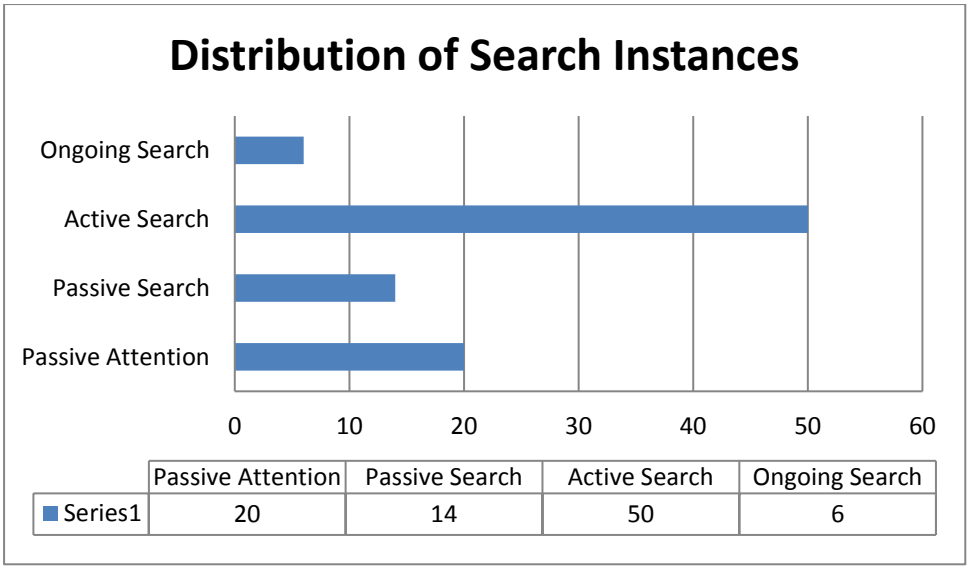


Figure 5.6: Distribution of Search Instances

i. Passive Attention

There was confusion with passive attention based upon the 89 searches 20 matrices included Passive Attention. Bear Grylls applied ***"walking and given information"***, this is not passive attention and is a test instruction used within the experiment – similar to teachers notes. Fat Mike used what appears to be an information processing and use statement; ***"timetable successfully entered"*** this has no passive connotation and is a result of the information need in the form of a system response. Wolf also used a process and use statement where the test participant is ***"editing the information to reflect the changes"*** and ***"entering information into the application"*** again these are actions resulting from the test participant finding the place where this information is stored not searched.

Hound partly appreciates the ideas around passive behaviour, ***"looking and planning class"*** and ***"looking and planning with friends"*** both imply that the test participant is looking but not actually actively doing anything to constitute a search. However, Hound's interpretation could be Passive Searching by implying "looking" and this is seen as a search to find information in preparation for the class, while this is in-active it is still a search, a Passive Search. Roberts also interpreted this in a similar way by ***"passively looking to see what free time is available"*** again this could be seen as a passive search there is no direct call to action and activeness to search for a time.

Tony Stark introduced physical factors to the passive behaviour whereby the environmental space is considered but do not influence the search. For example, "***paying attention to***

external factors such as doors and objects" and ***"attention on external factors such as people around and motion of vehicle"***, Tony's interpretation does not have any not passive connotation to look at information but attempts to explain that the physical environment around the test participant has the potential to influence the search. Chambers introduced a modality factor (wandering) within passive attention by ***"trying to watch where you are walking"*** and then pulled in a stress factor where the test participant was ***"trying not to miss bus stop"*** this is passive attention within a physical environment where physical objects influence the test but not their search behaviour.

There are misunderstandings to passive attention only 5 out of 20 fit with the context of the timetable application. Even the instances that align with Passive Attention there are some questions about the placement whether it is a Passive Attention or Passive Search.

i. Passive Search

Passive Searching is somewhat "inactive" the search has the potential to turn active if external events trigger a behavioural change in the test participant. A behavioural change may happen if the participant reads information which may or may not trigger a more active need to search (i.e., note about a module about a timetable event) or an external trigger outside the application (i.e., text from a friend or incoming Facebook message).

Bear Grylls applied ***"search for information whilst with friends"*** a passive search which could be something that is not relevant to a timetable request but could turn into an active if the test participant sees a something that needs attention i.e. noticing that an entry is incomplete in the database which requires an active search and a update.

Tony Stark used Passive Search requiring the test participant to ***"locate lesson information in app"***. Reflecting upon the whole test plan in the current state this type of search is more relevant to the active search. Tony requires the participant to locate lesson information which feeds into a need to actively contact the lecturer based upon finding this information so their behaviour and cognition is active not passive.

Rudd confuses searching and processing within the matrix, Rudd labels passive search, as ***"application will recall the event for the user"*** the recall is a system process where the participant is presented the information. The participant then makes a decision to act upon this information in an ongoing search and makes a decision to use this information ending the search and fulfilling the need. John-117 also applies a system process where the system is ***"altered to the event"*** this system action happens once the test participant does something like create an event and returns to check. Boyton's matrix did not include a

definitive end and required the test participant to ***"casually try to find data, no time limit"***, an interesting approach and one which will allow for a deeper exploration of the application without pressure.

ii. Active Search

The most popular activity, students connected with this type of search there were 50 instances of active searches. To support their interpretation Table 5.14 synthesised the raw data presenting active search themes to support the narrative.

Active searches have a strong correlation with the Context of Need Activities so to help the narrative the results are presented with references made back to the Context of Needs showing the synergies between the two core IB elements within the model.

Table 5.14: Active Search Themes

Active Search Type	**Summary of students interpretation of Active Search** **(n)= time used in the test**	**Total**
Search to Edit	Browsing timetable, looking for the correct entry to change (1)	3
	To update app and to get sorted for exam (1)	
	Find and Edit (1)	
	Room identification (3)	
	Looking for contact Information (2)	
	Looking for contact Information (1)	
	Need to find the event (1)	
	Need to find information before next lecture (1)	
Searching to View/Find	Identifying record in DB (1)	
	Information needs to be found as quickly as possible (1)	
	Viewing to find module info (1)	
	Viewing their timetable, searching for a free slot (2)	
	Looking for the corresponding slot matching the free time period (1)	
	To find right information (1)	
	Active to get tickets and details of the film times (1)	
	Active to find the data as quick as possible (1)	
	Actively to ensure there is a record of the exams and assessments (1)	
	Focusing on tutor giving info (1)	
	Searching for correct contact information (1)	
	Finding in time (3)	
	Actively competing to ensure they have a record of if available at all times (1)	
	Locating lecturer info outside of the application (4)	28
Search to Create and Add	Searching for entry information (1)	
	Identification and add record (2)	
	Found location and input event (1)	
	For where to input data and a pdf (1)	12

	Located and added to-do (1)	
	To find location and add information (1)	
	Need to find timetable to be able to enter it (1)	
	Creating timetable entry (2)	
	Adding and setting alerts for holiday (1)	
Search to Remove	Actively searching and deleting (1)	
Search to Share	Finding and sharing (1)	
	Active to input and send information (1)	
	Active to find and send contact (1)	4
Misc.	Maybe if the user struggles (3)	3
Active Search Total:		50

Search to Edit: Ray Mears, Roberts, Trevor Mac and Magina applied an active search requiring the test participant to use their application to search and edit a piece of information. Ray's applied searches to ***"browse timetable, looking for the correct entry to change"*** and ***"view their timetable, searching for a free slot"*** contextualised by the context of need requiring a ***"search and update of time (lecturer temporarily changed it)"*** and ***"looking for the corresponding slot matching the free time period"***. Both need an active search and an edit to reflect changes in test participants plans. Roberts applied a similar approach and the search ***"activity is completed to ensure records are up-to-date"***, the database updates reflecting the context ***"finding and editing entries within timetable due to lecture changes".*** Ray Mears and Roberts applied a context of need created by an event where the lecturer altered a class location and time the test participant is required to cope with this change making sure they do not attend the class at the wrong time and place. Trevor Mac required the test participant to simulate an edit activity ***"to update app and to get sorted for exam"***, a similar pathway to Ray's search and edit. Trevor Mac required a search and edit for an examination time change the test participant needs to manage and keep on top of the records within the application. Finally, Magina applied ***"find and edit"*** this example did not offer much of an explanation to the search, cross checking this against the context of need it became clear that this was active search and well considered. Magina set out a context where ***"information is received via text with a new number, need to copy>search>update entry"*** the test participant needed to apply a search coupled with a range of other applications to find and move information to meet the need activity.

Search to View/Find: Fat Mike applied active searches one of which ***"room identification"*** needed more guidance and support, the context presented as ***"searching for a specific room".*** Fat Mike's examples are very direct and simple extracting data. Giuma applied a simplistic approach that required the test participant to, "***look for contact information***", ***"look for timetable information"*** and ***"identifying record in DB"***. These simple active searches lacked support from the context of need in Giuma's case ***"searching for….***

contact, room or timetable". Pouchy, Peter Parker, Hound John-117 and Trevor Mac all used simple active searches to view and find records these example do not explore the wide context of need to evaluate their application.

Ray Mears and Boyton built upon their context applying an extension of a search to make the activity stressful for the test participant. Mears applied ***"information needs to be found as quickly as possible"***, this was based around the Context of Need Activity ***"searching for room and time when next lecture will take place"*** and Boyton an ***"active to find the data as quick as possible"*** with a supporting context of need to ***"search for classes at a particular time, find all details"***. Mears and Boyton have interpreted the context and appreciate the nature of the search activity, emphasising stress and coping supported other possible cognitive and psychological challenges within the model.

Search to Delete: Chambers was the only student to formally include an activity which ***"actively searched and deleted"*** a record and the test participant needed to ***"delete contact entry on bus".*** The search and delete activity did not appear to be a significant in the students' matrices, which surprised the researcher. The researcher imagined that a search and delete activity was core. This type of activity would have also helped to improve the students who included very simple searches which would explore the application improving their test strategies.

Search to Create: Hound and John-117 coupled this active search with an information process, the test participant searches for a place within the application to create an entry. Hounds "***identifying and adding a record***" is based upon context ***"creating a new recording adding new timetable information".*** This activity required the test participant to navigate the application from the home screen and accessing the record management area to create new timetable entries. John-117 required the test participant to ***"find timetable entry to be able to enter"*** a new record based upon the context ***"creating new records and editing timetable entries"***. Part of this active search follows a similar path to Hounds the test participant needs to navigate from the home screen to find the timetable management area and add new records. Snow White set a context of need activity to ***"search for available room and create event based on availability",*** based upon this the active search presented that the participant ***"found location and input event"***. Using "found location" means the activity is already complete and this is a process and use, the test participant is inputting the event based upon the location information found from the active search.

Snow White and Trevor Mac required the test participant in locate a piece of information relating to a timetable event. Snow Whites test requires the participant to move between

applications to add the information to a ***"to-do list***". Trevor Mac also requires the participant to move between applications ***"adding and setting alerts for holiday"*** which requires the test participant to move out of the timetable application to the phones calendar application to set the alert.

Search to Share: Students felt that sharing information was important in the context of their application tests. Testing information sharing also helps to evaluate the transition between applications. Sherlock set a search to ***"find and share"*** information and based upon the context of need to ***"search and share event information via email",*** this test has the ability to evaluate interaction between the timetable and email application. Magina applied an active search which ***"inputs and sends information"*** and "***active to find and send contact"*** information, both require interaction with other mobile applications. The Context of Need Activity set by Magina required information to be sent by text and passed on to a friend using an email distribution list. Finally, Tony Stark applied ***"locating lecturer info outside of the application"***, initially this was not clear however assessing the test matrix Tony's activity is based around the test participant's actively looking for contact information based upon the Lectures webpage then using this information within their application.

Misc:

Bo applied the active search ***"maybe if the user struggles"***, in this context, Bo insinuates that the test participant will use the active search option and this is triggered if other searches do not succeed. As an active search, this does seem to be a little confusing.

iii. Ongoing Search

Bo included ***"entering info and referring back to it***" this does have connotations to ongoing searching and applied the context ***"finding and updating contact information",*** this is similar to search and created but the main difference is that Bo's test participant needs to return back to the information to reflect upon the entry***.*** Bo has used "updating" which is seen as an ongoing activity. Sherlock applied ***"updating and possibility returning to do more"*** this does have a clear ongoing part to the search and the context of need is based around a ***"search and update event information".*** These examples are ongoing and help to contextualize the search activity within the matrix need. Rudd and Wolf put ongoing searching in the wrong place within the model. Rudd also needs to split this ongoing activity into two parts currently; ***"active to delete and manage existing events"*** are two activities, firstly the need to ***"actively delete events"*** actively searches for event and deletes them from the application, the second activity requires the test participant to ***"manage existing events"*** in the ongoing search. Separating helps to simplify the test flow and the researcher gets a better idea of the order of events within the model. Wolf on the

other-hand has ***"Looking up module information and research"*** in the context of this test the activity is very much active.

5.2.5.1 INFORMATION PROCESSING AND USE

The model aims to support test development to appreciate; user behavior, contexts in which a user finds themselves (spatial/environment), how interaction with technology takes place and finally how the information is used. The latter is where the test attempts to appreciate what the user does with the information retrieved from the mobile application and how the student can conduct a test which will capture search results. In the same way Context of Information Needs and a seeking need to be present to make a test workable so does the Information Processing and Use. For any activity there needs to be some form of system response and the user needs to do something with that information.

With this in mind out of the 75 matrices 5 matrices were left blank and in these cases the search activities included a form or process and use (i.e., Snow White "BLANK"). To interpret the data a narrative will summarise the students' interpretation of processing and use, there may be a need to refer back to the needs and seeking approaches to help appreciate their understanding within their own test matrices. To start Bear Grylls applied ***"success; entering, viewing, deleting and viewing webpage"*** this interpretation attempts to explain all areas of a test result. This should ideally be contextualised to each individual test to help understand the output from the test (i.e., success in entering and updating information or the search has been successful and the record deleted). Tony Stark, Ray Mears, Chambers and Trevor Mac on the other hand do contextualise the process and use, Tony applies "***processing the change in lesson time. Use and gathering of the lecturer's email address".*** Tony takes the search results and explains that the activity has been a success and the time has been changed which does end the loop in the behavioural cycle from information need to information process and use. Ray Mears also creates a context that informs and concludes the process by a ***"free period of time to complete assignment work has been found"*** and ***"new module entry has been created to represent assignment work and the slot has been represented within the update",*** these examples pull together the search and needs to finish the test with a system response. Chambers applies an approach that repeats the context and search activates by ***"information that is retrieved is used to edit current contact for supervisor and update with new info, Information is deleted, no more use for the information"*** and ***"once information is retrieved from app the information will be processed and used to make the call to GP."*** Chambers does contextualise the process very well providing depth in detail of what the test participant does with the information and where they need to go next

in the behavioural loop. Finally, Trevor Mac applied ***"adding the information helps manage their time provides access point to other resources"*** interprets the use which helps manage their time and also supportive with additional resources which could potentially help the participant with other activities. This can also be seen by another process and use by Trevor Mac where the participant is ***"organising personal information with suitable alerts"*** another set of processes to manage time and keep the participant informed via alerts.

Bo created a range of different tests for each participant and the outputs varied for each test. For example, Bo's tests used contexts of needs, which were based around finding, searching and displaying, each context was processed by ***"contact successfully added", "information changed"*** and ***"contact displayed"***. Simple outputs but did follow a pathway which was conclude with a systems response to the test participant. This simplistic approach can be echoed by Fat Mike, Peter Parker and Sherlock, they end the process by the participant ***"viewing, viewing and updating, viewing and sharing"*** information.

Magina, Rudd, Hound, Boyton and John 117 build in narrative that attempts to pull together the context and search, Magina applied ***"successful edit stored on DB"***, ***"added information and sent the TXT"*** and ***"find friend details send information"*** informs the test in that an update has taken place but also pulls together the context of need by the process being success or the information have been sent. Rudd and Hound do the same by the ***"event viewed by the users"*** and ***"event is found and changed",*** Hound applies ***"as the room to upload and views event"*** and ***"user has code and searches retrieving class information"*** thus fulfilling the context of need. Boyton applies a similar process and use strategy to Rudd and Hound, using ***"correct lesson is found at the scheduled time and data collected"***, ***"exam is successfully created for the correct time and named mobile applications"*** and ***"new lesson is created for the correct subject"***, these three examples feed from the context of need where by the information needs to be created and then searched to support the test participant. Finally, John-117 applies ***"processing timetable to enter it into the app"*** where by the test participant needs to ***"use notification to ensure attendance at event".*** This pulls the test together by a notification supporting the user needs ensuring attendance.

Pouchy, Wolf and Santiargo attempt to apply a physical cognition or action to finish the process, for example Pouchy applies ***"timetable app will now contain the new entry, viewing information and in different views (grid/table)"***, the test participant needs to add entries and then change the view to landscape to test the table in the alterative view. Wolf's is slightly different and requires to participant to reflect upon their action and compare the

results against the paper copy i.e. ***"view app timetable - now look the same as paper copy"***. Santiargo similar to Pouchy in that the process applies ***"new entry is successfully added and amended - the grid mode is successfully found and the email is sent successfully".*** These tests are attempting to check information in a different view on the phone to complete the test.

Finally, it is worth noting Giuma, the matrices Giuma submitted applied a process and use which ***"used extracted information to aid next task"*** and ***"edited contacts and sending FB response"***. These are both appropriate uses and are workable but FB (Facebook) is not included in the context to need, making assumptions about Facebook at this late stage in the model will not work and needs to be set out from the outset. The context of need is based around finding information and then sharing it via social media.

5.3 CONCLUSION

To summarize the analysis of results, the analysis has presented data from the fieldwork with a narrative of how students interpreted the prototype model. These interpretations set out the students' initial discovery of HIB and Mobile HCI based around; information needs, mobility and environmental contexts which informed the prototype model.

In summary, the analysis highlighted a clear need to test planning. Students built their tests around a context of need but they need to practice and work through each test prior to the field tests. The data clearly show levels of insecurity and confusion when it came to the implementation of the tests. This would help their strategy and also help them initiate the tests in the field.

As students worked through the model there did appear to be duplication of states as they interpreted the model i.e. the use of environmental statements appeared in the context of need, modalities and environments. Also searches appeared within the context and the seeking sections within the model. Students also felt levels of insecurity when capturing needs and modality's and as students modelled their tests using GOMS they felt that there were ***"too many needs within information scenario"*** and ***"too many (modality) configurations"*** so trimmed the tests back so this did not cause any problems. This is something that should addressed in the piloting stages within the lab, time was given to this activity so they can assess alternatives and not just take them out of the test completely which made tests simple and structure not fully exploring the applications features. These are some of the key talking points which will be taken further and discussed in the next chapter.

To fully appreciate the students' interpretations of the model, which is geared to support mobile tests as a way to "contextualise field testing", the analysis of results will be elaborated in the discussion.

6. CHAPTER SIX: STAGE 2 ANALYSIS WITH DISCUSSION

Chapter 5 (Stage 1 Analysis) presented data from the formative sessions and student the matrices. The data gathered and presented in this chapter display how students' interpreted the model and how they approached tests which considered context and practice based upon the model formed as part of the Systematic Review.

Chapter 6 (Stage 2 of the analysis) aims to summarise key findings from Chapter 5 and triangulate findings based upon a deeper analysis based upon a student sample. This deeper analysis supports Objective 5 evaluating data gathered shaping professional practice through an interpretivist mode of enquiry based upon student interactionism. This analysis is based upon a random sample of five students' (i.e., Bo, Pouchy, Hound, Tony Stark, Ray Mears and Bear Grylls) providing insights into field practice. Chapter 6 will call upon visuals from the experiments noting events based upon their student screen recordings and complemented with observation notes taken by. This discussion triangulates the findings using the Systematic Review and the initial literature review presenting the researched theories in practice.

Discussing these results, especially the student sample, interprets students interaction with the test model, by evaluating these interactions the investigation will appreciate the influence of context (social, physical, mobility and psychological) on IB and user interaction. Ultimately interpreting how context-aware testing complements professional practice, this discussion supports aspects of objectives 1, 2, 3 and 4 set out in the introduction.

To keep this discussion consistent and structured the chapter uses headings and references used within the Systematic Review and will address objectives based upon the findings which will aid the conclusion of this research.

Themes include;

- Contextual Need Activity
- Application and Data Accessed
- Intervening Variables
- User Modality Factors
- Information Seeking & Processing Use

6.1 CONTEXTUAL NEED ACTIVITY

A context of information need is based around the need to inform a belief or question something (Wilson, 1997; Chowdury, 2012). So, have students been able to apply a range of "information" needs to support activities when formulising a question or explore a belief? Exploring these activities will help to evaluate how students interpreted the researchers practice and the model to support test planning and development.

Based upon the analysis of results two discussion points emerged, as students attempted to design these contextual need activities:

1. Planning tests.
2. Starting (or initiating) a test.

6.1.1 TEST PLANNING

A context of need activity supports test planning aimed at addressing test initiation. The context also recognises the wider influences of information behaviour in the field whereby other elements (i.e., modality, physical and social environments) support and add contextual detail. Reflecting upon the data (Chapter 5) and activities based around planning a mobile field test became an area of concern to the students. Students appeared to be very process and time driven making the test detached from the overall context of need i.e., ***"timescale of needs"***, or how the length of time to complete a test. These factors worried students' which correlated to other finding relating to ***"timescale of needs is too quick to solve", "number of needs", "too many needs"*** and ***"panic in capturing a need".*** These points demonstrate that students had not appreciated the wider social and physical aspects to data capture which influence data collection whereby they either do not collect enough data or gather too much data. Quotes like, ***"my needs are too vague and the test will last seconds!"*** were commonplace. The researcher explained as they ***"plan you need to be patient and follow each part of the model"*** the model opens up to other areas that influence the context of need activity and add complexity, which will add depth test activity (i.e., alternative seeking activities, active ongoing or combinations, interaction challenges in difference social and physical environments). Kristofferson and Ljungberg's (1999) and later Wiberg (2005) set out field tests within a Computer Supported Work Environment (CSCW). These examples presented test contexts which were set in challenging environments where even the simplest of tasks create interaction and information retrieval difficulties problems (i.e., updating a database on a mobile computing device half way up a telegraph pole). The

task may be very simple in a laboratory setting but the data gained from interaction in this environment was insightful in how different contexts and modalities challenge interaction. CSCW's are common, users access information anywhere and everywhere. Salvolaien's (2006, 2009) ***"everyday"*** contexts to information behaviour demonstrate how important it is in understanding user needs when information is searched and extracted from mobile applications in everyday situations.

It was explained that, ***"you need to consider the entire model and the philosophy around mobile testing in the field will surface"***. Students' plans in early formative sessions were too surface (assignment driven) and an appreciation of other factors to a context of need facilitates a test strategy, examples by Kristofferson and Ljungberg's (1999) and Wiberg (2005) articulated this in practice. The struggles with "Contextual" and "Activities" as terms to identify information needs was problematic, ***"scenario development based on need"***, ***"too many needs within information scenario"*** and ***"confusion between needs and scenarios".*** Their ability to list a range of needs was acceptable however putting this together into a context of need activity proved challenging. Context and Activity demonstrates a need for clarification as a concept which evolves into the overall a context of need, (or scenario, a term used as a bridging term between a "test case" and "context of information need"). A piloting exercise was recommended which, ***"cross-reference needs against what you are trying to achieve i.e. are these making a suitable scenario and will they be workable within the field to create baseline data so you can compare field results"***.

A context of need activity will have a number of needs and demands attached, prior to a field test some form of simulation test (or pilot test) is important. Shneiderman & Plaisant (2005 p145) noted the importance, which enabled a "user complete a representative set of tasks in a representative environment". Piloting helps to evaluate these representative tasks pulling together as a context of need activity an exercise which was encouraged throughout the module. Time was allotted to piloting activities as a method to support planning and eventual test practices, past research recommended piloting as an integral part of experimental design (i.e., Goodman et al., 2004; Kaikkonen at el., 2005; Sun & May, 2013). Piloting experiments allowed time for refinements, but was also applied as "baseline data" to compare any field results.

6.1.2 STARTING AND INITIATING TESTS

The formative sessions used philosophies around context of need activities to form a mobile application test – the starting point to an information need. Initially, this research reflected upon the researcher's teaching experiences as a usability tester. A core observation was making a test feel real even if this was simulated so, ***"how do I start my test?"*** was echoed year-on-year in workshops. To justify the researcher's anecdotal evidence, the literature review revealed "information drives a user to interact with a system on a mobile computing device" (Johnson, 1998).

The observed struggles to interpret contextual need activities which required discussion particularly at the beginning, noted that from the 325 instances from the formative sessions 135 connected starting of initiating a test. The Systematic Review and literature review revealed information needs and the contextual activities as subjective starting points, "information acquired to satisfy a need or change in uncertainty" (Burnkrant, 1976; Wilson, 1997; Maity et al., 2014*).* Case (2012) calls information needs "bewildering" and students connected with this bewilderment ***"need (initiation), how do we start the test"*** and ***"need fitting with test strategy"*** emerged from formative sessions. The aim was to support students in acknowledging the broader context to a test strategy noting, ***"if students have a clear context then the test will initialise and flow anywhere"***. The other external contextual influences on interaction will be supported as the test evolves adding further to the context of need activity.

The continual confusion within the formative sessions around the "context" factors to a need i.e., ***"understanding context of need"*** and ***"timescale of needs"*** were popular 35 instances out of a total of 56 for an entire session were noted by the researcher. These insecurities echoed the researcher's notes, ***"my app is limited"***, just because the application was simple does not necessarily hamper the context of need and explores more than just the application in question but the wider context of where this interaction takes place. The module stated, ***"other applications and information sources could support application tests"*** reflecting on this point would make a test more contextualised and realistic. Mobile phone users very rarely use an application in isolation and flick between applications to support their needs. Nilsson et al.'s (2002) ***"media convergence"*** evaluated multiple information sources which supported the users' objective.

A contextualised need activity could follow and collate information from a number of sources (i.e., website content>emailing>tweeting content) to support a test. Media convergences influence a context of need, Reih (2004) calls this the ***"information gateway"***. These different gateways are ***"information types"*** based upon Dervin (1977) and O'Case (2012), the tester needs to ***"make it clear (or elucidate) the information"*** making sense prior to

dissemination to the test participant. Applying this school of thought helps to clarify and build examples, which support tests and the students understanding of information needs in this context.

As students modelled mobile interactions (i.e., GOMS) they discovered that a test participant could follow one or more pathways to fulfill the same information need, furthering ideas around “contextual” need activities. There are different pathways, retrieval methods and applications which fulfill a user’s need, for example, extracting timetable information from a mobile application whereby the information is copied, pasted and tweeted. This type of pathway has similar connotations to Ellis (1989) ideas around “chaining”, information relates to one-another and needs to be following to complete the overall need activity, which is similar to a citation trawl which cross examines theories and their influence.

6.1.3 Context Of Need In Practice (Student Sample)

Using these two themes (test planning and test initiation) and reflecting upon the student sample (i.e., Bo, Pouchy, Hound, Tony Stark, Ray Mears and Bear Grylls) the researcher can evaluate how context of need was applied to their test practices. Using data from the sample provides a deeper insight into these themes which can be cross examined against test practice via the screen recording and videos submitted as part of the assessment.

6.1.3.1 PLANNING TEST

As test plans take shape the activities within the matrices attempt to form, as Johnson (2003) interprets the “situation” to set the context of need. Tony Starks ***“meeting with dissertation supervisor and need contact details”,*** creates a situation which sets out a context and from this matrix the researcher can visualise the contextual situation which unfolds and evolves as Tony adds detail to the other parts of the matrix. Bo planned an activity, which applies CSCW characteristics within the context based around a ***“job interview”***. Bo’s activity requires ***“contact information, interview date and the timetable to plan the interview around classes”,*** a contextual situation which feels real and collaborative using the application not too dissimilar to Kristoffersen and Ljungberg (1999) and Wiberg (2005). They use CSCW uses information to support their maintenance activities Bo uses the information to share and coordinate the interview dates.

Pouchy and Ray split the context of needs into multiple matrixes creating micro-needs, Pouchy’s ends up with four frameworks for each scenario (i.e., a matrix for update, add, search and delete timetable records). The assessment submission for this work increases

and so does the complexity but it does help the flow of the test. The tests ran very smoothly feedback noted that it ***"provided a good directional aid to the flow of the test"*** the breakup of needs helped choreographing field tests. Relating this back to test practice this does lack consistency in verifying the application usability, Rubin and Chisnel (2008) state, "the user test evaluates the pathways taken and verifies that there is an improvement". If this is the case, Pouchy and Ray Mears will struggle to verify the application and activities which produce four inconsistent data sets. This lack of consistent data will make it difficult to identify interaction challenges in different test contexts. Pouchy and Ray Mears' method to test design contradicts the promotion of "ease-of-use during the design process" (Nielsen, 2012).

6.1.3.2 IMPLEMENTATION OF THE CONTEXT OF NEED ACTIVITY

Conducting a simulation as a controlled capture of comparable and measurable data or an enactment will help (Hagen et al., 1995), an approach adopted by the students as a piloting exercise. Piloting took place in the form of a simulation. Schmiedl et al., (2011) explain that simulations should be "an addition to conventional laboratory tests". The pilot in this context aims to collect data which is compared against the field, observing the pilot studies was an opportunity to evaluate how students applied elements of the model (i.e., test initiation and simulate any mobility factors). Students' recorded laboratory tests aimed at providing baseline data, Shneiderman & Plaisant (2005) interpreted this approach as "experimental methods which include measurements of; task performance, time performance, errors, key strokes or logging and click-stream analysis". This data is used to benchmark against field evaluations as a "way of playing with data in embodied ways" (Roto et al., 2004).

Figure 6.1: Bear Grylls Laboratory Pilot

The student sample found that they conducted a pilot by recording themselves running through activities as a way of "playing with the data". The pilot tests helped to shape and inform decisions on what needs to be prioritized with their application which meets the need of the experiment. Ideally in these test conditions using the experimenter in this laboratory test is not suitable, the experimenter understands the application and this prior knowledge will distort the results. In experimental design practice this is a flawed approach however it

still captures something to compare which provides an improved understanding of how the test will run in the field helping to eliminate “fears of tests becoming irrelevant” (Lindroth et al., 2001).

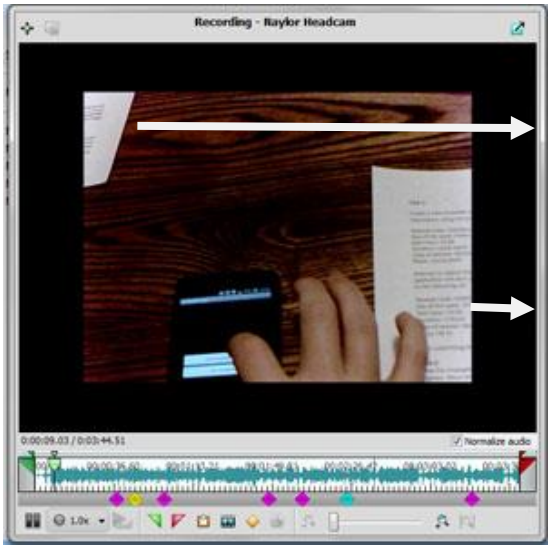
Initiating tests correctly is pivotal and was a contentious issue with 17 of the 18 students agreeing with ***“How does my model fit with the testing strategy?”***. Tony Stark, Bear Grylls and Bo submitted the Screen Recording and no other tools, like the head camera to show how the user interacts with the application in the environment. This single screen recording makes it is difficult to gauge the wider contexts i.e. the physical and social states of the test.

Figure 6.2: Tony Starks - Test initiation

However, their report narrative helps present physical and social settings, Tony Stark’s Methodology included a test plan (Appendix N – Tony Starks Methodology) presents pre-test arrangements with a test the route and an introduction to “***explain the task process and what was expected”***. Tony’s approach sets a context which appreciates test initiation from an information context and wider physical/social situation.

Experimenter confidence did appear to hamper tests, Bo, Bear Grylls and Tony Stark have notes against test initiation highlighting where they ***“interfered with the participant as they were conducting the test”***. The test setting and tasks seem complicated where they kept interrupting and reminding the participant of the task, these examples included all the task activities which articulated within a single briefing – very hard for the participant’s memory load. Using Tony Stark as an example, researcher did note that Tony provided ***“too much information to brief user, caused the tests to stop start, too many factors to consider at once”*** which it did.

Pouchy and Hound initiated tests in a similar way to Tony Stark using pre-test instructions. The researcher is able to appreciate the wider environmental context within these recordings, tests are initiated and orchestrated using a paper guide the participant follows and type instructions.

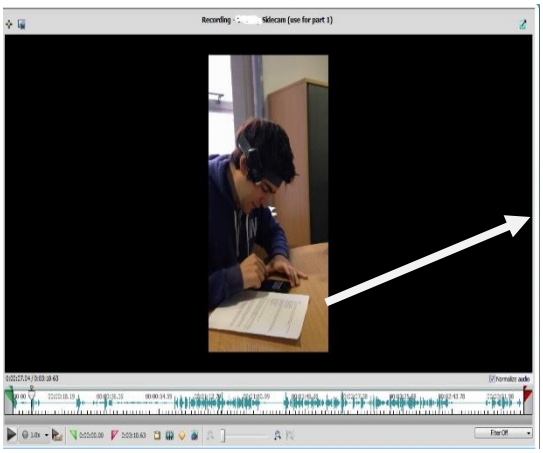


Pouchy's notes are read out and this does interfere with the participant.

Participant also follows prescriptive instruction which lacks in realism.

Figure 6.3: Pouchy - Participant and Tester Guide

Pouchy initiates this test by reading out the instructions. To start this works and the test flows however using instructions in this way impacts on the test authenticity – the approach feels a little false and not real. The proximity of Pouchy also influences and in some cases interferes with the test participant. This interference resonates with previous research and findings, Pouchy needs to simulate and choreograph tests to stop any interference. There is a significant memory load for the test participants and this memory overload impacts on their ability to remember and the test becomes regimented and restricted as Pouchy guides and interferes with the test participant.



Hound has notes to inform the participant of the records needed for the experiment

Figure 6.4: Hound – Record creation with instruction

Hounds test ***"Create Records"*** uses a predefined list of records which are entered into his database. These instructions simulate something that would potentially occur (i.e., a paper copy of a timetable which is uploaded to the calendar). Pouchy, on the other hand uses, paper instructions throughout each test activity. Hound uses instructions once to populate

the database, the remaining three experiments focus on data extraction and information searches as the test participant move around campus – a more realistic set of experimental activities.

6.1.4 ACTIVATION MECHANISM

Programs describe the type software and possible combinations - on the mobile device – which are required to fulfil the activities. Stage 1 of the analysis noted that 77% (or 58 matrixes) interpreted the program as a Single Application (i.e., Timetable App, Calendar App etc.) and 17% (13 matrices) applied more than one program to support activities as part of the test strategy. This spread of instances did not match what was actually presented when the researcher evaluated the matrices, there appeared to be a discord between the program entry and the rest of the test matrix. In many test cases students implied that there was more than one application used to support the entire test. The formatives sessions highlighted that a test participant will potentially interact with more than one program, highlighting a ***"need to extend and include external applications to support the sources of information within the test"***. External programs (i.e., email, Twitter, text application, calendar etc.) will be used and needed by the test participant, they will act upon information transferring and sharing information between programs. Bettman (1978) discusses that information acquisition and search strategies are supported by internal searches and external searching, in this case tests will explore and evaluate information transition between programs. The convergence of information and media defined by Nilsen et al., (2002) helps to identify and collect information from different media sources to support the information need activities.

To cross-examine this against the student sample, examples of "media convergence", even though not formally listed were present but not acknowledged within the program part of the matrix. Tony Stark was the only student to make reference to another program other than the timetable i.e. ***"email and timetable".*** However, Hound, Pouchy and Bear Gryll's list the program as ***"timetable app"***. Using Hounds matrix, Hound evaluated the user interaction between two application environments requiring the test participant to find a building and room using his timetable application switching to Google Maps locating the building on campus. Hounds experiment has similar connotations to Case (2012), Hound was trying to find the same building using two applications, Case evaluated information presented in parts of eBay evaluating information presentation and its impact on user behaviour in understanding the bidding process. Hound made no mention of Google with the matrix and this only became clear viewing the recordings to see interaction with Google to find a campus location.

The lack of detail within the matrices also applied to Bo. Bo labels risk with ***"getting correct info, editing and retrieving",*** the word "getting" implies that the test participant has to receive information. This information was via a phone conversation and a number is noted on paper prior to adding data to the application. This conversation needs to be acknowledged within the matrix to help inform the test strategy.

So why did students not formally list the other programs, even when these will impact on the search for information to fulfil the need? Observations within the formative sessions noted a level of confusion relating to the "Application" and "Program". These metaphoric terms used within past research apply to ***"mobile computing devices"*** and are dated, they meant something different back in 1999 - Smartphones and "Apps" did not exist. Students work highlighted this confusion, for example, students labelled the Application and Program as the same thing, for example:

A student example:

- Application: Mobile App (which is a generic term meaning program on the device)
- Program: Timetable App (a more specific software program on the device)

In fact, the matrix should represent application and program as:

- Application: **Smartphone or tablet** (Apple or Android)
- Program: **Email>Twitter>Timetable application**

Students did feedback about the metaphor problems ***"they mean the same thing to us so it's recommended the labels should be Device, Application and Data/Information"***. A significant point that will shapes the model informing the output form the research.

In summary, to investigate the influence of context on user needs, behaviour and interaction the auto-ethnography provided a methodological platform supporting Objective 4, whereby the observational techniques and the data gathered identify topics or areas of interest. The planning and initiating of application experiments became a significant point from the data gathered based around student confidence. Findings clearly knowledge time and preparation issues as students plan and prepare experiments within the lab, Pouchy is a clear example by leaving instructions for the participant to follow. This example clearly demonstrates a lack of preparation and understanding regarding real mobile contexts – user would not carry instructions with them, this would not happen in a real life setting. Extra planning and orchestrating time would increase confidence and improve contextual challenges within their test strategies supporting data capture. These problems correlate with observation notes identifying a number of points where the model supported and/or hindered tests supporting Objective 2. An example of this in action relates to the models outdated metaphors causing

confusion, these metaphors need updating to reflect the “smart” generation.

6.3 INTERVENING VARIABLES

Within IB, Wilson (1981) identified areas relating to an individual’s situation, these include personal, social and role-related, and environmental. Over the course of time, Wilson’s models revealed a number of subsets. Chowdhury (2009) draws attention to the fact that in “today’s information environment, all the intervening variables identified in Wilson’s model may be significantly influenced by the digital characteristics of a user”. This part of the discussion aims to establish these “characteristics” in a mobile context by interpreting students’ understanding of the model focusing on intervening variables, which contextualise field experiments.

6.3.1 STRESS & COPING VS. INTERVENING VARIABLES

There are a number of psychological factors impacting user behavior attempts are made to fulfil an information need. Stress and cope along with interviewing variables introduce psychological factors within IB which are contextualised as “risk and reward” factors within the activation mechanism. Based upon this, students attempted to interpret psychological influences as a “cognitive and behavioral efforts to master, reduce, or tolerate the internal and/or external demands” (Folkman & Lazarus, 1980; Folkman, 1984). A process or set of influences where a test participant is put in a coping state to find something or a stressful state where the activity is done in a challenging physical environment or there is a timeframe to complete activities.

To get a deeper insight of students’ interpretations of these psychological components, Table 6.1 presents interpretations which will be discussed related to past theories.

Table 6.1: Psychological factors (Summative sample)

Student	Stress and Cope	Risk	Reward	Cognitive/Affective
Bo	Getting the right information and sending to a friend	Getting correct info and retrieving	Added and displayed	Affective
Bear Grylls	Entering correct info	Enter wrong information	Entering correct info	Cognitive
Hound	Major stress planning in advance	Blank	Successful timetable entry or retrieval of information	Affective

Pouchy	Stress wearing the head cam	No real risk	Reward view on grid	NULL
Ray Mears	Assignment due in a week	May not be available when friends are free	Blank	Affective
Tony Stark	Need to notify teacher so work can be collected	Work completed with penalty	Ensures teacher is aware of absence	Affective

Johnson and Meischke (1991) defined psychological factors as cognitive, requiring a need to "obtain factual information" and affective as "obtaining information which will aid in dealing with this emotionally". Bo's matrix plans to obtain information to pass onto a friend, Hound and Ray Mears interpret affective as a way to be more organised and gather information together to help the test participant plan. Bear Grylls set factors cognitive as the test participant obtains information and cognitively enters information into the timetable application. Bear Grylls example could improve the psychological representation by using the term ***"causally"*** entering information which would present a lower stress level (or coping) which complements the seeking activities i.e., casually looking for something would be deemed passive eventually turning active or ongoing depending on the context of information need.

The students interpreted "rewards" as something achieved as part of the information processing and use part of the model. A reward is something that the participant achieves as they obtain information, Tony Stark interpreted reward as ***"information to make the teacher aware"*** this has levels emotional regulation something that Troy et al., (2013) applied and Starks experiment simulates a context whereby the participant regulates emotions making sure the teacher informed of their absence. Hound and Bo interpret reward by explaining how information is processed, presented and achievements presented as information is successfully ***"entered, retrieved and added"***, a cognitive achievement within the timetable application with a success response from the system.

6.3.2 Environmental and Spatial Contexts

Environments and spatial contexts applied as working examples within the Systematic Review are important elements within this investigation. Spatial situations and subsequent environments are difficult to model (Savolainen, 2006) influencing how the context of need and seeking approaches are formed. Initial observations noted ***"students struggling to reenact social and physical environments"***, which can only truly be depicted in "real world" contexts around application use, user modality and set in physical spaces. Kjeldskov (2012) noted these challenges in his research "Is it worth the hassle?" Theories used to

support students aimed to contextualise this from a Mobile HCI the perspective (notably Kristoffersen and Ljungburg, 1999 and Kjeldskov, J., & Stage, J; 2004) and HIB (Wilson, 1997) intervening variables which was influenced by environments helped to describe a user's information behavior.

6.3.2.1 ENVIRONMENT PHYSICAL

Physical contexts need to state both architectural and institutional terms (Agre, 2001). The analysis discovered that the most common "physical" context was the University Campus, which is not a surprise. Experiments are based around a student's experience with their timetable application and large portion of their time would be spent using this around campus (i.e., moving between classes).

Matrices struggled to contextualise physical settings and tended to be a vague representation of the environment ***"inside building and outside building"*** were common providing a general setting but lacked detail. Applying additional detail to the matrix would help to create a consistent test protocol especially if this test was repeated, which could be the case if the test design was conducted as part of a team effort. Possible improvements could have been ***"outside the campus library", "outside crossing the footbridge"*** or **"inside (open access lab for general use)"**. Just adding extra context informing social aspects support the test and informs the modalities. These types of reenactments are similar to research papers investigated as part of the Systematic Review. Kjeldskov and Stage, 2003; Beck et al., 2003; Goodman et el., 2004; Oulasvirta et el., 2005; Kaikkonen et el., 2005; Kane et al., 2008; Burnford and Park, 2012 created and defined physical environments to support the research design (i.e. the academic building or around the campus) which provided a clear setting to the research.

The student sample noted that modalities and social environments supported physical setting of their tests. Bear Grylls designed tests on campus participants needed to ***"walk, sit in a busy Students Union"*** Bear also applied ***"be at home in a quite social setting"***. These examples complemented the physical setting by using "busy" and "quite" contextualise overall environment situation. Ideally, these attributes would be preferred within the social environment and modality within the model. Physical elements within Bear's study would benefit from using other physical objects (i.e., chairs and tables) to support this setting, the test strategy appreciates that the participant is sat at a table or at the bar on a barstool. Hound applies a physical setting ***"outside walking over the campus bridge",*** an appropriate approach contextualised further within social environment with ***"major and minor distractions".*** This type of physical setting also introduces levels of stress depicted

within the matrix. Tony Stark created “context-creating” activity an approach coined by Oulasvirta et al., (2005). The test strategy considers physical “obstacles” within a building and public transport (i.e., table’s chairs, metro poles and doors). Oulasvirta et al., (2005) acknowledged context-aware obstacles to interaction and Tony Stark applied this approach to inform test practice.

Bo confused physical settings interpretation this as, ***“considers noise, unsmooth conditions and noise”.*** This interpretation would influence physical environments but Bo needs to take a holistic approach by applying physical elements to contextualise space environment. Bo does include elements in modality section (i.e. “***basement peak time”)*** to provide a setting but modalities needs to relate to the movement of the test participant in this physical setting.

6.3.2.2 ENVIRONMENTAL (SOCIAL)

Social settings can have an effect on user interaction within the physical setting, for example people talking or in Hounds case ***“distracting”*** the test participant as they interact with the application. Social settings defined in the literature were set as one of two extremes; Kristoffersen and Ljungburg (1999) set as ***“challenging and dangerous”*** environments relating to telecommunications maintenance work. The other being a ***“personal”*** and ***“group spaces”*** (Wilson, 1997; Bouwman & Van De Wijngaert, 2002) and these spaces are in a ***“relaxed or quiet setting”*** (Rieh, S. Y., 2004) and a ***“busy setting”*** (Church et al., 2011; Oulasvirta et al., 2005; Kaikkonen et al., 2005).

Figure 6.5: Hound using a Side Camera

Stage One of the analysis noted that students interpreted and applied combinations of these approaches, which presented a level of detail to support physical environments. Social settings changed between ‘busy and quiet’, ‘alone or group’ dynamic. These were not listed in isolation, for example, there are instances where a test would be set within a group dynamic which was also set in quiet and busy, loud environments (i.e. Students Union). Paay, and Kjeldskov, (2004) state that an “understanding of the interplay between tests and the situations a user finds themselves” support field-testing. Stage 1 found that a range of social settings used a number of combinations; working alone, alone in a quite setting or alone on a busy metro etc.

Hound presented social environments as ***"Major Distractions – Loud and Busy Bar"*** and ***Major Distractions – Busy Corridor"*** and this complements test strategy supporting the physical environment. Tony Stark's ***"Alone (Busy unknown travellers, lots of noise (people & vehicle)"*** also supports the physical environment from a social perspective. Bear Gyrlls interprets the environment ***"Home"*** with the social ***"relaxed or quiet setting"*** an approach applied Rieh (2004) to investigate information seeking approaches. Ray Mears uses the social setting **"crowed and busy"** similar to the example by Oulasvirta et al., (2005) evaluating mobile interaction within a busy cafe.

6.3.2.3 TEST RECORDINGS

Stage One of the analysis interpreted the student matrices, Stage Two adds substance to the discussion exploring how social settings have been applied, in action. Evaluating recordings provides insights into the choices made (socially and physically). Figure 6.6 is an example of Hounds, creating a recording that demonstrates interplay between the physical and social environments. Donath (1996) and McCullough, (2004) state the tester of mobile application needs to "understand better the physical and social context of the user's situated social interactions", the use of these capturing supported Hound's interpretation presenting the interplay as the participant interacts with the device.

Figure 6.6: Hound – Head Camera

Hound and Pouchy used multiple cameras aimed at capturing the physical and social environments, this approach was ben attempted by past research students and used as example in class (notably; Oulasvirta et al., 2005; Kaikkonen et al., 2005 and Paay, J; Kjeldskov, J (2013). Tony Stark, Bo and Bear Grylls used screen recording capturing (only), this hampered their abilities to capture social interaction. These students did not capture the interplay between the physical and social environment. Hound and Pouchy on the other hand used a number of different capturing methods. Past research struggled to capture data accurately within the field and there was interference with the participant (Kjeldskov, 2004; Oulasvirta et al., 2005; Kaikkonen et al., 2005). Screen recording in 2013/14 was relatively new data capture method on a mobile phone and coupled with traditional research methods is a powerful tool recording and evaluating interactions.

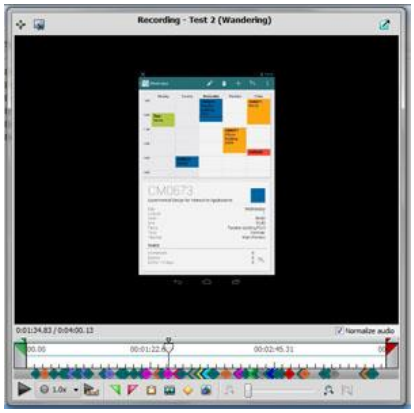


Figure 6.7: Tony Stark – Screen Recording

Figure 6.8: Bo – Screen Recording

Distractions, which can be social or physical, will influence user cognitive workload as they device interact with a mobile application. The literature review knowledge environmental challenges can affect a participant fragmented their attention and will also influence the way a tester attempts to capture this real world data. This discussion established that students clearly appreciate applications (like their timetable application) would be used in a variety of different settings. Their own timetable application provided clear setting to run experiments and these contexts will have varying levels of stresses on a participant. Students appreciated context as an important requirement and needs careful planning within the experiment. The formative sessions did create a platform to share context experience but as they attempted to apply this within the field they become reticent, however the evidence within the analysis does pull together this issues around contexts (personal, social and physical) supporting Objective 2 and 3. The model has clearly supported students in their appreciation of context aware tests and their appreciation filtered into the field tests whereby the experimental context fitted with the applications purpose.

5.4 USER MODALITY FACTORS

Life styles have become increasingly mobile in the sense that the speed of transportation and hence geographical reach within a given time span is dramatically augmented by modern technologies (Kakihara and Sørensen, 2002). The literature review and the Systematic Review explored modalities and the influence of work by Kristoffersen and Ljungberg (1999), which have been implied and interpreted to inform past research.

Stage One of the analysis discovered a range of points associated with modalities and students' interpretation to inform mobile tests. Based upon the results the discussion will focus on three core areas:

- Disconnect of modality states
- Capturing modalities
- Applying modalities (a worked example)
- Summative work (student sample applying modalities)

6.3.1 DISCONNECTION OF MODALITIES

The movement of a test participant will influence the way they use a mobile device (Oulasvirta et al., 2005; Kallio & Kaikkonen, 2005). Observations noted that the concept of modality challenged students, ***"help, I have too many configurations within my draft model! The user is wandering, sitting and visiting"***. The Systematic Review applied Kristoffersen and Ljungberg (1991) interpretation of modalities, which had a clearly defined industrial setting (i.e., a network engineer moving between sites using a mobile device or an engineer working up a ladder). Other researchers adopted Kristoffersen and Ljungberg's model for day-to-day mobile interaction noting complexities (Oulasvirta et al., 2005; Kallio & Kaikkonen, 2005). These studies highlighted complexities running tests with several different contexts within changing user modalities concluding the need that tests require careful planning and orchestrating before venturing into the wild. Kristoffersen and Ljungberg (1999) point out that a modality state is "one of those words that are virtually impossible to define in a meaningful way". These types of complexities can be seen in students' interpretations and concerns around test configurations formative sessions observed that the ***"pilot sessions help to prepare for different modalities, in the early stages it's best to have too many working through each configuration working out most popular to the test participant in that environment"***. A test participant could be a passenger in the car (travelling) and then the state changes as they get out of the car walking to University (wandering). Students need to get the balance right by not making the test too simple and unrealistic or too complex making what Lindroth et al., (2001) by environment and modalities making the test impossible and "irrelevant".

6.4.2 APPLYING A MODALITY STATE

The modality concept continued to challenge students' ***"I'm confused between the different states of modality",*** designing modality states considering the transient nature of

mobile use between is challenging especially when originator to the concept had a clear industrial setting. With this in mind the researcher developed a working example adapting Kristoffersen and Ljungberg's work. The Train Booking Example (See Appendix P) aimed at supporting understanding, interpretation and application of modality states within a mobile test. This example used modality states where the user; **visits** (a client), **travels** (by train to the meeting) and **wanders** (planning the homeward journey). This level of confusion within modality states is nothing new especially between the visiting and travelling state. Kjeldskov and Stage (2004) did say that Kristoffersen and Ljungberg's framework is not particularly helpful, which contradicts Oulasvirta et al., (2005) praise of the model. However, as the sessions applied this working example students appreciated the modality process and the logic of how these different modality states support context-aware experiments.

Reflecting upon the analysis in Stage One context of needs and modalities were very simple even though the formative sessions explored multiple modalities. Students needed to be more adventurous, expanding modalities into their field test activities; the visiting modality was the most popular set on Campus. There was confusion in how states were applied i.e. visiting state ***"short meeting"*** and ***"stood still"*** do not really make any sense, this should be ***"standing outside for a short period of time waiting for a short meeting"***. Students also confused modalities using environmental elements i.e. visiting university, visiting library or visiting a lab, these should represent some form of movement

6.3.3 Capturing Modalities

As students interpreted modality concepts within their experiments a common point emerged around capturing modality states, which were seen as problematic, ***"still do not know how the test will capture the different modalities?"*** Capturing data, as with any research method needs planning (Oulasvirta et al., 2005; Kallio & Kaikkonen, 2005; Pickard, 2007) piloting research helps preparation firming up a research strategy. Within a mobile context a number of research studies used the laboratory to help prepare the field tests (Kejeldskov and Stage 2003; Hussain & Kutar, 2012; Schmied et al., 2011; Kaikkonen et al., 2005).

Conducting simulated field tests is an important consideration, the literature review identified a range of approaches and examples of practice within the Systematic Review. The review formed test case examples based upon the model this helped students appreciate and interpret contextual issues, which included modalities within their experiments.

Piloting and simulation activities informed the module supporting experimental practice and recommended to help prepare tests evaluating data captured methods ensuring that the methods were fit-for-purpose in a specific context.

Figure 6.9: Hound Wandering (Walking)

Capturing a participant's movement as device interaction takes place is challenging and something that has hindered past research. Kejeldskov and Stage (2003) evaluated these highly dynamic contexts explaining that capturing useful field data has challenged user testing research as they attempt to reproduce environmental conditions (Kejeldskov, 2013; Schmied et al., 2011; Hussain & Kutar, 2012). Modality states are pivotal in understanding mobile interaction in context, appreciating the impact modalities have and been able to capture this is extremely important in the experiments success.

6.4.4 Modality in Practice (Student Sample)

Chapter Five highlighted confusion in students interpretation between modality states and environmental contexts, this appeared in a number of the matrices submitted. Student interpreted a modality state as a set of environments or space (i.e., at home, in home environment) and to truly set a modality in these circumstances the student needs set this as ***"sat"*** at home. In this case the experimental design appreciates the sitting modality state set within the environment ***"home"***.

Tony Stark did make this connection within his experiments, Tony used the same information need and changed the modality state, social and physical contexts***.*** Applying a consistent information need kept continuity in the experiment ensuring that the data collection was consistent resulting in a coherent analysis. Tony also distinguished between modality and environments. Bo portrayed a suitable range of modalities within his matrices realizing that a modality can change as a participant interacts and works through the experiment. Bo's matrixes attempted something quite ambitious regarding modality, the participant moved from the confines of the University to travelling as a passenger around Newcastle and then being in a shopping centre. Bo's work displays similarities to Oulasvirta et al., (2005) research whereby experiments are set in multiple locations moving between one and another. Bo attempts to model "everyday life" expressed as something that will happen as the user moves and searches for information (Dervin, 1993); Salvolainen, 1995). The researcher's observations of Bo noted that the experiments complexity regarding

modality was unable to follow the entire study – time did not permit this - so a snapshot of the University test is evaluated.

Comparing Bo's longitudinal study to the rest of the sample, students' experiments lacked depth regarding modality and motion, Hound, Bear and Pouchy apply travelling. The travelling state going from one place to another in a vehicle, this could be a commuter on a train, car or bus (Kristoffersen and Ljungberg, 1999). Hound set modality as ***"Walking Outside"*** on campus, which is actually a local modality "wandering", not travelling. The screen recordings submitted set experimented locally between University buildings (i.e., moving from one building to another) as the participant wanders between destinations and loiters outside the classroom. Bear Grylls and Tony Stark applied the modality wandering around the University, which is the correct state. Tony keeps modalities simple applying wandering in the same building the test participant waits outside a classroom whilst interacting with the application.

Figure 6.10: Pouchy Wandering (Sitting)

In summary, modality factors within this discussion support Objective 3 by interpreting students' interactions via the screen and video recordings conducting experiments within the field. Evaluating the student sample triangulated between the formative results and the practice examples within the Systematic Review provides a deep understanding of the use of modality within the model. This discussion can see the merits of the state of modality but there were issues associated with each modality state - Travelling, Wandering and Visiting - originally set by Kristoffersen and Ljungberg (1999).

Based upon the discussion there is an apparent dissonance between the states of modality. The model based upon a set of field industrial contexts confused students interpretations of wandering, visiting and travelling within their own experimental practice. Whilst modalities really helped within the lab to enable student to think more holistically about device interaction. This investigation needs to refine the state of modality to contextualise the everyday uses of smartphones.

6.5 INFORMATION SEEKING & PROCESSING AND USE

Information needs support communication and seeking approaches (Van De Wijngaert, 2002), something which Stage One of the analysis acknowledged. Students demonstrated a close connection whereby seeking approaches and context of need were aligned and in some cases were repeated in both areas of their matrixes. This part of the discussion presents key findings from Stage One in an attempt to form this distinction which will evaluate interpretations based upon work submitted. The student sample will add substance to the findings and this discussion will build into tangible approaches informing the conclusion.

6.5.1 Need and Seeking Approach – The Same Thing?

Information seeking fulfills an information need (Case, 2012), students built seeking around an; information need, environmental setting and alternative modality states (i.e., are they walking between campus buildings). Experimental seeking activities were based upon looking at seeking to discover, seeking to check or seeking to form an opinion (Chew, 1994). The ideas around discovery and opinions appeared to be important within tests and seeking helped to evaluate mobile applications. Stage One discovered difficulties in separating the need and seeking approach students required ***"clarity between a participants need for information, which then created a call to seek for information"***. Case (2012) agrees with this a "information need is often described simply and somewhat circularly as a cause of information seeking" (2012, p80). To differentiate between a need and seeking approach, the researcher pointed to ideas around multiple searches explaining, ***"that these search strategies are depicted within the seeking part of the model, the context of need defines the overall or holistic information need"***. The holistic nature of a need pulls together the overall context of the situation where the seeking activity will take place within the application.

6.5.2 Seeking Definitions

Types of seeking caused levels of confusion, this confusion pointed out as types of seeking approaches which needed calcification for example, in one session 20 out of the 42 instances were highlighted displaying a disconnect of misunderstanding between seeking types notably, passive attention and passive search. The Systematic Review provided practical examples to support interpretation aimed at elevating concerns around the seeking type, form example:

> ***"The test participant is passively browsing (searching) the BBC news site and receiving an urgent text message from a friend for help which calls them to***

action and actively search to support them to find information via Blackboard for a class"

"The test participant is listening to a lecture podcast on a podcast, the lecturer announces something additional reading which calls them to actively search for the link within the podcast"

Figure 6.12: Systematic Review - example of seeking practice

The examples aimed to invoke a number of decisions (or calls to action) relating to an unexpected need for information. The BBC example applies what Lerbinos (1990) explains "can take place when a person has knowledge stored that precipitates an interest", the interest is a need to help a friend, they know where to look for the information to support their friend. The podcast example uses concepts similar to Shih et al., (2012) whereby the technological context is based upon the podcasting environment and the seeking behaviour obtains information from information sources within the podcast, which requires other technological resources to fulfil the need. Using examples like the BBC and Podcast create a platform showing how seeking states work together within a test activity, each example has a "call to action" moving between seeking states (passive attention or passive search) to another (active search) supporting the information need. It is also worth noting that as users spend more time on their mobile devices, which is increasing user year-on-year (Ofcom, 2013; Google, 2011), their behaviour with this technology is changing. Information retrieval is less active and their behavior is more passive, for example, browsing the news feed within Facebook is classic example user passively looking at streams of information but not acting upon the sources.

6.5.3 Seeking In Practice (A review of Student Sample)

Seeking in practice will use the student sample evaluating their interpretations using these theories to inform seeking within mobile test practice. The literature review identified seeking approaches within Wilson's (1997) model, these approached were put into practice via the Systematic Review using theoretical seeking behaviours (Johnson, 1968; Belkin et al., 1982; Ellis et al., 1993, Dervin, 1997 and Case, 2012). The literature review split seeking into four categories; seek answers, reduce uncertainty, make sense and spectrum of motivation (Dervin, 1997; Case, 2012). Ellis et al. (1993) added logic to seeking and a structure based around a "Behavioural Model", using these principles the discussion will evaluated the students' interpretations within a mobile context.

Hound applied passive behaviour by ***"looking and planning class"*** and ***"looking and planning with friends"*** these examples use Johnson's (1968) "visceral" interpretation, the user is not seeking for answers but Hound implies "looking" as a passive act where the participant is searching but is not actively extracting data. In this example, the test participant is not actually doing anything with the search results. The conscious and formulised approach to Johnson's seeking would be instigated if, for example, Hounds planning activity needed an update, which could be triggered by a friend. Bear Grylls applied a similar approach ***"search for information whilst with friends",*** which Bear defined as passive. The test participant is not required to act upon any information with the database. Both examples could become an active search if, for example, one of their friends makes the search a conscious one to find information to support a request that they might make.

Tony Stark's interpretation is not directed at a search to seek answers but "make sense" of the surroundings where a search could take place. Tony's interpretation of passive attention appreciated the spatial awareness of the test participant (i.e., "***paying attention to external factors such as doors and objects"*** and ***"attention on external factors such as people around and motion of vehicle").*** This example is attempting to evaluate the test participant's ability to search, but interprets passive, as a mode to make sense of the physical environment where this search takes place. Tony attempts to contextualise physical environments further influencing the user search, Savolainen (1995) and Dervin (1993) explain seeking takes place in the "everyday world". The test participant using Tony's timetable application on campus has to make sense of the surroundings as they complete the search. Tony Stark also applied passive searching ***"locating lesson information in app"*** this was a more formulised search for answers and this approach is better placed as an active search not passive. As the participant constructs a search to locate information the participant knows what they are looking so is actively (not passively) contacting the lecturer based upon this information.

Active and ongoing searches tend to apply seeking which will "seek answers", "reduce uncertainty" and "make sense" (Dervin, 1997; Case, 2012). Ray Mears used active searches to ***"search and update of time (lecturer temporarily changed it)"*** this approach implies a seeking behaviour similar to Ellis et al., (1993) behavioural model. Ray's test participant browses the database extracting data to make changes because of a time change for a lecture. This example also exhibits levels of "uncertainty as a motivation for information seeking" (Shannon and Weaver, 1949), they want to avoid incorrect information making them late or miss a scheduled class. Ray's searching activity also has connotations with the "spectrum of motivations"; the spectrum of motivations has objective and subjective

meanings this is objective to find information and update the database. Ray's second active search ***"looking for the corresponding slot matching the free time period"*** is a search another objective search to support the test participant managing their time within the timetable application.

Tony Stark's ***"locating lecturer info outside of the application"*** is an attempt to make sense and reduce uncertainty of the context. Reflecting Belkin et al.'s "ASK" concept the test participant does not have the lecturers contact and their availability. They are "faced with a level of uncertainty and attempt to address this by consulting information" (Belkin et al., 1982). This uncertainty is solved by actively looking for this information outside the application by accessing lecturer's webpage, extracting this via a copy and paste to insert into the timetable application.

Bo's ongoing search activity applies a chain of events, which information is ***"entered and referring back to***" the search uses with Johnson's making sense using this as a "framework to reduce uncertainty" (Artandi, 1973). Referring back to the information in an iterative manner is a way to check the information. This was a walking activity, so it confirmed and reduced the uncertainty of mistakes happening within this modality. These behavioral events add a structure to the experiment simulating a real world event the participant needs to browser the timetable database, edit the information and then monitor that this information is correct.

In summary, information seeking and information needs are extremely hard to separate and have strong connotations to one-another, there is clear evidence of this in the students' experiments and work submitted. Case (2012) explained that one cannot work or even be evaluated without the other, information needs requires some form a seeking strategy. The synergy between seeking and needs observed found that in many cases students confused the holistic nature of information needs, which may have more than one seeking behaviour. If at all possible, a context of need sets the background and activities within the mobile experiment and may have a range of seeking approaches (passive, active and/or ongoing). Capturing students' seeking interpretations has significantly helped to shape this investigation of IB in practice, recognising the adaptive nature of IB in a mobile context. The discussion informs professional practice where the model needs to respond to these observations (supporting Objective 4) and helps to evaluate and shape practice via an interprevist approach (Objective 5).

6.6 CHAPTER SUMMARY - ANAYSIS (STAGE TWO) AND DISCSSUSION

Stage Two of the analysis identified significant points from analysis of matrices (in Stage One) and contextualised these matrices through discussion. Stage Two channeled this discussion whereby the student sample provided vivid examples of interpretation and how the model was applied to experimental practice. The discussion used findings from both analysis (stage one and two) in an attempt to interpret these significant points referring back to theories which inform new test practices. At the end of each section within the discussion a summary pulled together findings demonstrating how this investigation begins to address objectives set out in Chapter One.

6.6.1 Student Informed Model

Spatial contexts (social and physical) were clearly at the forefront of students' thoughts as they attempted to interpret the meaning behind intervening variables. The analysis noted, "***environmental configurations are not going to work***" and "***environmental perspective influencing stress and cope***" as two of the most popular instances highlighting a level uncertainty. Spatial conditions are quite complicated; there is a lack of detailed studies on the nature of spatial factors as a contextual qualifier (Savolainen, 2006). However, students were encouraged to deconstruct the model, which they did, and presented some vivid interpretations. Figure 6.12 presents one of their outputs which makes a clear contribution to this research.

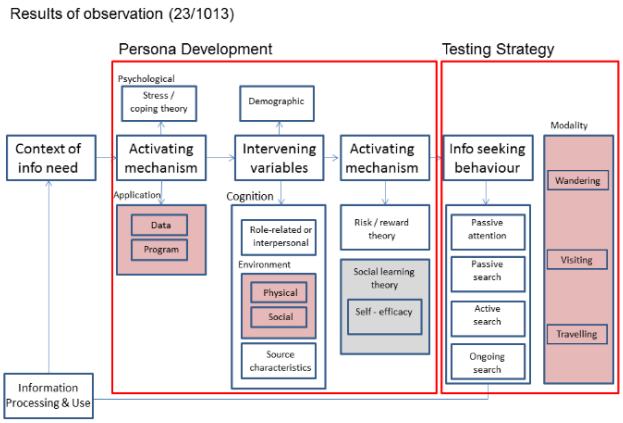


Figure 6.12: Students interpretation of the model

The variables grouped within this model to set out a ***"persona",*** or sample with a setting for the test, the persona presents what Chowdhury (2012) calls the "electronic user" within a mobile context with "personal characteristics" by Wilson (1981). Using these two user characteristics builds into what Tan et al. (2009) calls "a range of activities in a scenario-based environment" the scenario is based upon a user interacting with a mobile application in a physical setting.

In the second formative session, a number of students had been less receptive about using the model to support field-testing. This minority did not want to venture outside the lab, so the point ***"don't see the value of this element with in the model"*** appeared. In response,

the researcher created a group activity where students discussed the influence of environments (social and physical), and the impact different environmental situations will have on test participants. The discussions created a context of need (i.e., information or data) and based upon a need students felt that psychological demands were influenced by the physical and social environments. These influences will affect how the test participant copes with the activity (i.e., stress factors searching for information standing on a busy train). Their interpretation of psychological demands and environments are similar to what Folkman (1984) states as a "stress element which is the relationship between the person and the environment". Relating Folkman's work to the students' discussion the relationship would be between the applications and the test participant's ability to use the application to fulfill the need in the environment. As students worked through the influence of social and physical environments, a test persona emerged which grouped the stress and coping and the applications with the other intervening variables.

The grouping as a persona created a test setting and students agreed that based upon this persona a seeking approach will take place. As the test participant searches students felt that the test participant would move in the environment, so based upon the environment set a range of modalities (wandering, travelling or visiting) would be applied. The students' interpretation was influenced by Kristoffersen and Ljungburg (1999) examples (i.e., the engineer up a ladder using the device). The model built by the students was interesting which spontaneously yielded results that were not expected but help appreciate their interpretations.

This new model (Figure 6.12) clear demonstrates how students interpreted the model (supporting objective 5) and will make a significant contribution to Objective 6 which will inform a new testing model that synthesizes theory and practice to inform future mobiles tests. These points to will pulled together and address within the conclusion.

6.6.2 Cognitive and Affective

The cognitive and affective states defined within a test help to depict the possible psychological states a participant may display whilst interacting with information on a mobile device. Reflecting upon the Systematic Review, past studies within the Mobile HCI field have not considered stress and coping in this way to support mobile experiments. As students considered affective states they were able to build a clearer understanding of the test

participants, and how this state could influence interaction as they search for information on the mobile application. This point has two benefits for a mobile test which will inform a new model;

1. It is an important point with any context-aware test that the participants “personal state of mind” will influence interaction within context.
2. The psychological state of the user helps in screening and sampling participants for a mobile test within a particular context.

Both points will help to plan a mobile test which will make a significant contribution to a new model supporting Objective 6

6.2.3 Modality States and Data Capture

Modality states are pivotal in understanding how a user interacts as they move. The test design also needs to have the flexibility to capture these events as the user moved. The data capture and flexibility will drive the holistic nature of the context of need. The findings from the analysis and the Systematic Review noted that students should have a range of modality states and these can be used depending on the context of need activity under study.

Capturing data within a field context has been challenging and many research projects past and present have acknowledged this challenge that it is difficult to capture these real events as the participant move. This research attempted to blend new screen recording technologies which were relatively new in 2013/14 as a data capture method, coupled with traditional research methods to create a range of tool which have been (and continue to be) powerful recording tools evaluating “on the move” interactions.

The Stage One and Two of the analysis found that there were some significant issues impacting on the models effectiveness. The main point to take from this related to the confusion between modality and environment. There are closely connected i.e. a participant changes his/her modality in an environment, so students repeated this in both parts of the model. A point with will need to be addressed in the conclusion to support the new model.

6.2.4 Information seeking

The analysis of formative sessions found that all students initially set out an active search in the class exercises (i.e., find a time, find and update something, find and delete something). A significant finding from the research found that no students considered ongoing, passive

search or attention within the formative sessions. The analysis of matrices backed this point up, students connected with this type of search with 50 instances of active searches. Past research highlighted the importance of seeking and that the range of seeking behaviours are important in approaching the holistic nature of IB.

The seeking approaches used and applied by the sample are in affect attempting to "Sense-Make" of given context and this aims to evaluate the information need, behaviour and situational context. Dervin's (1993) "Sense Making Theory" helps to inform what the students interpreted where the context, interaction and seeking takes place is "central to the transfer of information seeking research and demonstrates that people strive towards a holistic view of their world" (p376, 2012). This holistic viewpoint attempts to contextualise something which Wilson's (1981) IB research explains will support users within the given situation creating a realness to the situation and the potential challenges faced.

These findings will help to professional practice as the researcher presents examples of ISB to students within a mobile context reforming the examples used within the Systematic Review and will help to address Objectives 3 and 6.

7. CHAPTER SEVEN: CONCLUSION

The Professional Doctorate within Information Science (ProfDocIS) aims to bring about a new way of contextualising Smartphone testing using models adapted within HIB and HCI. The study investigated a group of students' and their understanding of a prototype test model to support test planning, designing and executing their own application tests. This conclusion will pull together the main research findings and present a new model that synthesises HIB and HCI practices to support testing within natural/real contexts. The conclusion will also include a subsection which will reflect upon practice and highlight key contributions to knowledge and finally present future research.

The conclusion will begin by reflecting upon the aims and objectives of the research, which are based upon individual student cases as they studied the module "Experimental design for interactive interfaces". As part of the professional doctorate the conclusion will refer back to learning outcomes from the module as a way of supporting the aims and objectives of this research to show how this inform professional practice.

This research aimed to ***"investigate the influence of context on user behavior and interaction to provide a new approach to support user testing",*** the literature investigated broad themes and based upon this "information" and "information needs" was

seen as a driving force to interaction with a system on a mobile computing device (Johnson, 1998). As a user interacts in this way contextual factors to information and information seeking "characterised by the situation of a place, person or physical or computational object" (Chua et al., 2011) were also seen as important factors. Barnard et al., (2007) and (Kane et al., 2008) identified situational impairments triggered by contextual factors impacted on a user's ability to seek for information on a mobile device. These contextual factors to information needs and mobile interaction appeared to be extremely important like the "taming of an unruly beast" (Dervin, 2003) which will influence any user evaluation as a tester attempts to evaluate their mobile application. Exploring context and influences upon interaction two theoretical models complemented the aim of this research; Wilson's (1997) HIB model and Mobile Informatics Model by Kistoffersen and Ljungberg (1999). These models also supported the Experimental Designs module learning outcomes (i.e., ***"Demonstrate an understanding of the theory and principles of user behavior and interactive design"*** and ***"Examine models of user behavior within different social settings"***) these models inform HIB and HCI with context as a commonality where environments are considered as a user interacts with information and technology to meet their own information needs.

The Systematic Review attempted to contextualise this and put into practice which helped in "***Developing a grounded prototype model that supports the learning and teaching strategy by helping guide students Smartphone application tests",*** the synthesis formed a prototype test model which explored practices and created practical examples to support teaching practices on the Experimental Design module. To synthesise practice the research pulled together these two researcher fields which resulted in a prototype model that underpinned teaching practice informing and creating a platform to support the objective ***"Apply the model to test a mobile applications functionality set within a range of contexts – lab and field"***.

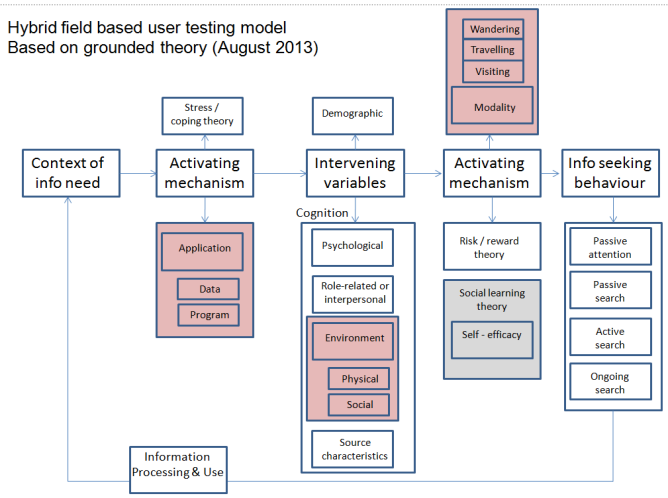


Fig 8.1: Hybrid Mobile Testing Model

7.1 RESPONDING TO THE RESEARCH AIMS AND OBJECTIVES

Responding to the aims and objectives of this research will highlight contributions made to theory and practice. The research was based upon two aims the first ***"investigated the influence of context (social, physical, mobility and psychological) on user behaviour and interaction to provide a new approach to support user testing".*** This aim had supporting objectives, each objective will be discussed and evidence of theory and practice used to conclude the doctorate.

7.1.1 OBJECTIVE 1: INVESTIGATE HIB AND HCI VIA A LITERATURE REVIEW EVALUATING THE INFLUENCE OF A USER'S CONTEXT TO INFORM EXPERIMENTAL PRACTICES.

The literature review revealed that a holistic view to information supported HIB research (Wilson's, 1981; 1997; 1999). This holistic use of information in context coined by Wilson (1981) created connections between IB and mobile interaction (HCI) driving people to use mobile computing devices (Johnson, 1998) to meet their own information needs.

Investigating IB and mobile interaction literature identified a Mobile Informatics Model (Kristoffersen & Ljungberg, 1999), the model supported HIB in a mobile context. Thus creating a theoretical platform whereby principles within both fields complemented a context-aware mobile test. The context of information need and the place where interaction takes place became important components and this widened to "everyday seeking" where the person, place and situation is taken into account (Savolainen, 2009), further contextualising

experimental design. Hepworth (2004), Oulasvirta et al., (2005; 2009) and Kane et al., (2008) understood that identifying the person, his/her social environment and his/her interaction with information create situational impairments on interaction and IB.

The literature concluded that the context, environment and information activities are important in developing mobile experimental practices. The academic theories and practices needed further exploration to inform test practice within a teaching context and a Systematic Review of literature took place aided professional practice by building working examples based around these themes which evolved into a new framework (the prototype model). The framework could then be applied to support application tests.

7.1.2 Objective 2: Develop a prototype test model that supports testing practice, the practices focus upon a user's context helping to guide application tests.

The three research themes within the literature identified gaps in knowledge, knowledge that will support the applied nature of the doctorate to develop test case examples. This required a deeper exploration aiding professional and experimental practice supporting the modules learning outcomes. The systematic review of literature formed examples building into a framework of practice (prototype model) supporting test case design.

The literature discovered field tests to be very specific, process driven activates not holistic where the person and their environment (personal, social and physical) support the context of an experiment. Previous experiments did not appreciate everyday information needs creating this gap in knowledge where the systematic review created test case examples informing professional practice for this research based upon user behavior and mobile interaction. For example, Goodman (2004) and Kane et al. (2008) tested a users' ability to find geographic information and searching a music catalogue. In both cases there was no real appreciation of the holistic nature to why this is important other than the users' interaction, so factors like user; information needs, environment (personal, social and physical), stress, coping and seeking strategies were not considered. These factors support test case design creating a profile of user experience with a mobile context.

The literature review highlighted the contribution of the Mobile Informatics Model (Kristoffersen & Ljungberg, 1999) and the HIB model (Wilson, 1997), both used environmental contexts. These models also brought other characteristics to support the holistic view pulling together IB (information needs and seeking), device interaction and

social/physical influences to the interaction with information in context. The models created a platform for experimental practice where the information, behaviour and situation became pivotal in the test design process. The examples built around this framework evolved into a working model which considered HIB and HCI both important themes on the module supporting the learning outcomes.

7.1.3 Objective 3: Apply the model to test a mobile applications set within a range of contexts – laboratory and field.

This doctorate required testing to be academically rigorous making user behaviour and experimental practice fundamental from both a theoretical and practical perspective. The literature highlighted capturing mobile behaviour (especially in natural contexts) as problematic continuing challenging the academic community (Wilson, 1981; Belkin and Vickery, 1985; Kejeldskov and Stage, 2003; Beck et al. 2003; Case, 2012). There has been considerable debate over whether interactions with mobile systems should be investigated in the field or in the more traditional laboratory environment (Sun and May, 2013). The literature review explored experimental methods and tools presented in Table 2 (Mobile field study and test apparatus). This critical review informed experimental practice by example and the prototype model pulled together IB, environments and mobility practice.

Students simulated tests within the laboratory evaluating experimental practice using the tools and theories practice from the critical literature review. These simulated laboratory tests created baseline data and students benchmarked this data against the field data. The researcher observed students' interactions as they adopted and applied experimental methods. These observations evaluated the model in practice as part of the ethnographic process, data from this ethnographic exercise enabled the researcher to reflect on how the students applied the model using experimental methods supported in a lab and field context.

The second aim required a detailed assessment of the model to "***To propose a new model which can be applied academically and professionally to support testing opportunities in a mobile context."*** Observations identified a range of interpretations of the model in practice, these interpretations are based upon the ethnographic work proposed a new model (, the researcher set 3 objectives to reflect, evaluate and create a revised model based upon the research. The objectives be discussed which will form a research output and contribution.

7.1.4 Objective 4: Use auto-ethnographic means to reflect and inform professional practice by observing students' understanding of the prototype test model

The measurement of observable events, in this case event around a student's interpretation of theoretical models to construct mobile tests. This was important within this investigation to understand the effectiveness of the model within a mobile test context. Evaluating the social phenomena (i.e., lab, natural, quasi or field settings) as the model was applied required a level of empirical interpretivism. The Auto-ethnography aided the interprevist approach placing the researcher's own personal experience as a lecturer within the social and physical contexts of a test. This approach observed and evaluated students experience in their understanding and application of the model. The evaluation of practice raised provocative questions about social agency and socio-cultural constraints (Reed-Danahay, D, 2009) a point, which will be followed up in Objective 5. The self-narrative, which was captured formatively and summatively gathered data and placed the researcher firmly within the social context of the student studying the module. These personal, professional and cultural experiences as a lecturer and researcher provided an excellent self-reflection tool to contribute to the research design, research strategy and data collection. A significant point to note from this exercise was the continuous evaluation of the researcher's past and current experiences of mobile testing. This self-reflectiveness created a platform for a longitudinal study whereby the model has been through a number of iterations from 2013-2017. Feedback from the students has continued to support the process of self-reflection something which underpins the *auto* in auto-ethnography.

7.1.4 Objective 5: Evaluate data gathered to shape and evolve professional practice through an interpretivist mode of enquiry based upon student interactionism

The data presented as part of this research produced some extremely vivid examples of practice based upon students' interpretation as theories and experiments were applied within the laboratory and field settings. The analysis of qualitative data and discussion coded around the model (i.e., contextual need activity, application and data accessed, intervening variables, user modality factors and information seeking, processing and use) identified some significant points. The points will be summarised below concluding how this research has formed a new model informing test practice:

- **Contextual of Need Activities:** Attempted to provide a holistic view of mobile testing which considered the information need activities within a particular context. The Systematic Review presented this as a starting point for a mobile test (i.e., academic setting, industrial setting, home setting). Reflecting upon the prototype model and how this was applied, students did not establish a holistic viewpoint and kept it focused on the need activities specific to the application processes. For example, Tony Starks ***"meeting with dissertation supervisor and need contact details"***, very much an activity which prepares activities for a meeting but does not provide the contextual detail or a setting to the test, from a holistic point of view this would have been the supervisor's office. The holistic judgements by the students also created a level of duplication within their models, for example, if context is a place then this is also set out in the environmental part of the model. The environment section of the model does include the physical spaces to depict a test setting but also includes possible physical objects within the space (i.e., table, chairs, computers etc.). There is an argument to make the environmental part of the model more specific to physical objects within the test and the context of need activity present the overall physical setting. Separating this would make the context of need activity more explicit to the physical environment, like a buildings or spaces outside. Separating these elements would also stop ***"confusion between needs and scenarios"*** and ***"confusion with the term Context in Context of information need and the physical environment (context)"***, points which were highlighted in the formative and summative work. The researcher recommends a change to the model, the current Context of Need Activity relabeled to Test Context (Activities and Test Situation). This uses Johnson's (2003) own interpretation of user "situations", the test activities are then set in real situations which also complement Savolainen's (2005; 2009) "everyday life information searching" which describe physical spaces and how space potentially affects the information need activities and search strategies within the model.

  Making the context and situational space explicit to the physical space will also influence other areas of the model i.e., Environmental (Social and Physical) changed to "Environmental Objects "and "Social Environment". Both of these changes provide a clear distinction and places the emphasis on the activities and the situation where this takes place. This will also provide a distinction between the seeking activities and the need as the test activity explains what the test participant is attempting to achieve "holistically", the seeking activities contextualise this further to provide detail to the search whether passive, active and/or ongoing.

- **User Activation (Application, Program and Data):** Formative sessions highlighted levels of confusion with the terms; application, data, program, and students labelled the application and program with the same meaning. Formative discussions also highlighted interpretation problems with the taught ideas around Nilssen's (2002) media convergences whereby a test participant will interact with multiple applications aimed at meeting the context of need activity. Hound, Pouchy and Bear list the program as ***"mobile application"***, however their matrices and test plans noted that there was more than one application required within the test (i.e., email, google and text). This vagueness did not really explain how the data flowed between the applications as the user interacts on the device.

  Based upon the findings from the analysis and discussion the application needs to apply terms (metaphors) that clearly apply to smart computing devices, the test model presents:

  - Device: Smartphone (Apple or Android)
  - Application: Email>Twitter>Timetable application
  - Data: date, times and rooms

  Using the term 'device' makes a clear distinction, the test will define the type of phone, the applications required to meet the context of need and the data which will be used to support the seeking strategy.

- **User Profile (Activations Mechanism and Intervening Valuables):** As students' interpreted these two areas of the model there was a desire to group them together this can be seen by their interpretations as they design a new model within a formative workshop - see Appendix H. The analysis also noted, "***environmental perspective influencing stress and cope"*** and instances from the formative sessions set stress and cope as a direct influence on the social environment. For example, a busy shopping center will have a direct influence on the way they feel as they interact with the application to meet their need. Cross examining these points against the matrices submitted the research reaffirms this need to group (i.e., ***"non-pressured environment"*** and ***"cope - shopping at home"***). These examples mention environments which create levels of stress on the test participant. This also continues within the psychological aspect within the intervening variables (i.e., Hound ***"major stress attempting to complete at speed",*** Giuma ***"need to catch the lecture ASAP"***, Wolf ***"stress: timetable in app is out of date"***, ***"coping: helping***

to understand what it is all about"), these points applied within their models demonstrate a connection between stress and coping, social environments and psychological factors all grouped together.

The Systematic Review identified social environments as ***"personal"*** and ***"group spaces"*** (Wilson, 1997; Bouwman & Van De Wijngaert, 2002), ***"relaxed or quiet setting"*** (Rieh, S. Y., 2004) or ***"busy settings"*** (Church et al., 2011; Oulasvirta et al., 2005; Kaikkonen et el., 2005). Students created social settings but also included stress and coping connotations. Tony Stark's ***"alone (busy unknown travellers, lots of noise (people & vehicle)"***, a setting which supports the physical environment but includes levels of noise and people which creates a stressful social situation. Bear Gyrlls applied ***"relaxed or quiet setting"*** presenting a different psychological influence where the test participant is coping within the situation. These examples and others from the analysis present is clear evidence that grouping Intervening Variables and Activation Mechanisms creating a persona or profile of the test participant creates a setting where social spaces can create and will influence the way a user will feel as they interact within the space.

Finally, the analysis also noted that students did not really apply social learning theories within their matrices. If they did attempt this it was used as an extension of the context of need or a seeking strategy which explained the feelings if the search activity was successful, or not. Using these findings, grouping learning theory with the psychological factors highlight the possible achievements as they accomplish a test. It is recommended that the new model will label this within the persona as participants "learning experience".

- **Modalities:** There was a discovery or crossover between some of the social and physical environmental elements and modalities (i.e., Santiargo ***"seated on a moving bus",*** Tony Stark ***"sat in a seminar environment"*** and Hound ***"SU with friends"***). These examples present a connection between the environment and modality or movement of the test participant, again creating a level of duplication within the test model. It is recommended creating a new 'physical objects' element within the user persona applying Oulasvirta et al. (2005) 'context-creating' activities, where a range of environmental objects also inform the test situation. This will complement physical environments within test situation, defining the physical objects

the test can contextualise and appreciate the types of social surroundings. Physcial Objects will complement user modalities within the model, for example:

- sat (modality)
- table (physical object)
- seminar room (physical environment)

These examples fit with Kristoffersen & Ljungberg's (1999) ideas of being somewhere for a temporal period of time creating a need within a test to explain where they are in this physical space and what they are doing i.e. sitting at a desk working at home.

The other point that emerged from the data related to the students' ability to differentiate between Kristoffersen & Ljungberg's visiting, wandering and travelling, a point acknowledged data found within the formative and summative areas. The research (and researcher) appreciates the value of these modalities and how they apply to industrial contexts of a telecoms engineer for example. However, to help students interpret their tests the new model needs to contextualise this to everyday modalities i.e., walking or running (outside), walking (inside) traveling (in car up public transport). These new elements help support the context creating exercise of everyday use within the test model.

- **Information Seeking:** Information seeking within a mobile context had the potential to combine a number seeking types depending on the context of need activity. Based upon the summative work it was disappointing that students applied very simple seeking practices based around a single search. Students also found it difficult to separate a context of need and the seeking approaches within their test plans something that Case (2012) agrees with that a "need drives the search they are kind of mutually conclusive". It was pointed out that ***"the context sets out the holistic setting of the test participant which may have seeking attributes within in the setting"***. The context sets the situation the information seeking presents the types of seeking needed to meet the need (i.e., is it ongoing or a quick active search for information).

  There was confusion regarding the meaning and how seeking applies to seeking behaviour, mainly around the passive attention and passive search. For example, Bear Grylls ***"search for information whilst with friends",*** defined as passive

attention in that the test participant is not required to act upon any information with the database. However, this is an active search and the user is not passively looking around the timetable or other application on the phone, this was one of a number of examples in the analysis. Based upon this, students' did not use the "passive" seeking in the correct manner an activity that is even more prevalent in today's mobile phone users. A user's behaviour has become passive, they passively interact with information and media with no real agenda or intent, so passiveness in the context of a mobile test is important as will be kept within the model.

7.1.6 Objective 6: Presenting a new Mobile Information Behaviour

Synthesizes theory and practice to support mobile testing within different situational contexts.

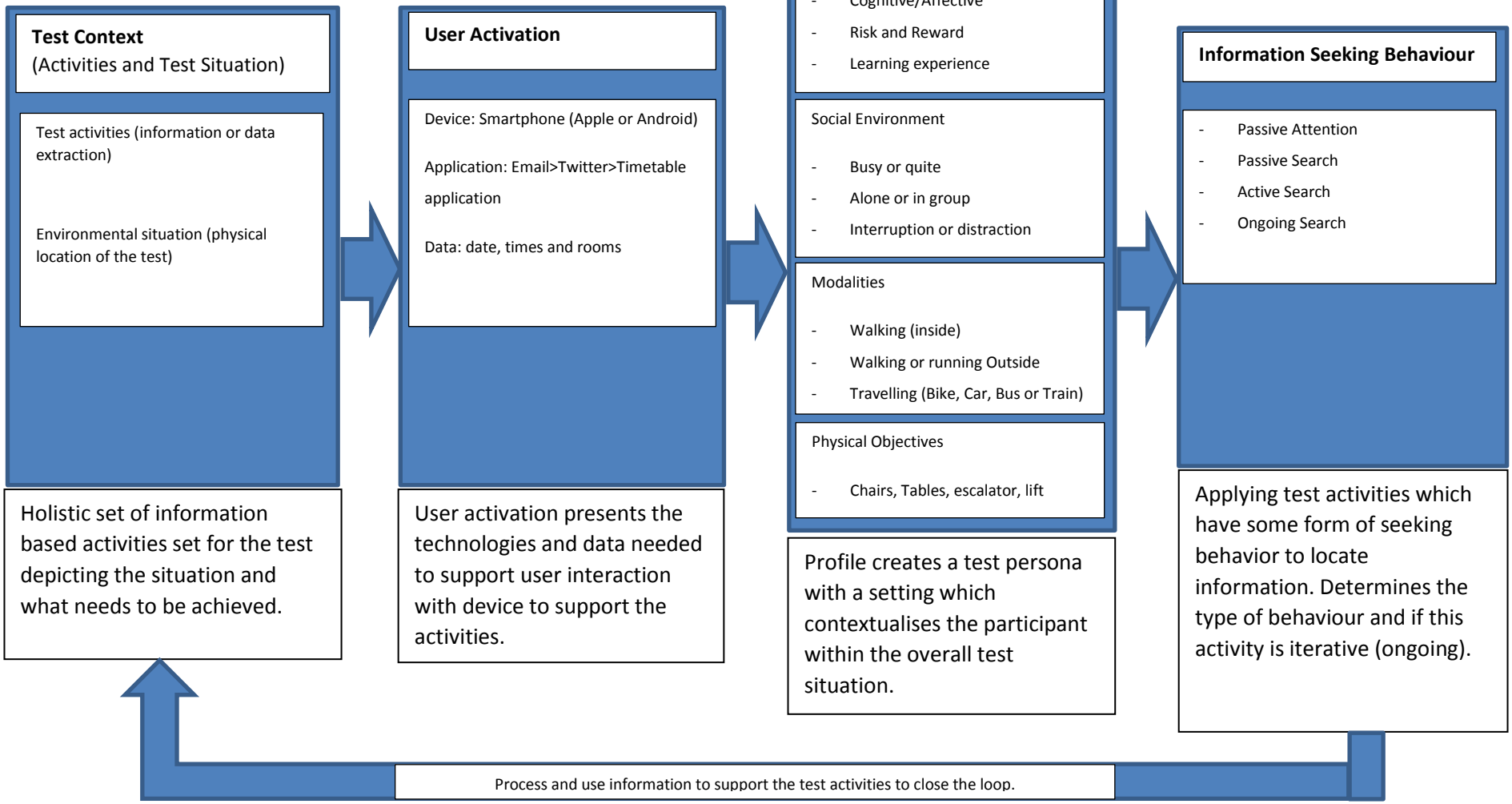


Figure 7.1: New Mobile Information Behaviour Model

7.4 REFLECTION, CONTRIBUTION AND FUTURE RESEARCH

The research process, whist a challenge as a full time academic, helped improve skills and personal interests in HCI and HIB from a mobile/smartphone perspective. The process supported the student experience, modules learning and teaching strategy. This was also an opportunity to apply new methods, practices and apply skills as information professional. This research experience opened up new opportunities, which will help to inform the reflection, contribution and future research. This section will bullet and explain the key opportunities.

- **Systematic Review of practice:** This approach helped the researcher in a number of ways, it helped to identify tools, research methods and methodological approaches to support experimental practice. These approaches make three clear contributions to the academic field:

    1. Systematic Review formed a deep attachment to the HIB and HCI fields supporting the evaluation of practice and theory. The synthesis was used as a way of following and presenting practice which formed a rich data set which identified challenges and opportunities with the area supporting this research, which can aid further research into mobile testing practices.

    2. Modelling mobile tests makes a clear attempt to apply theories (one practice and one theoretical) within HIB and HCI, considering information needs, spatial (context) factors, technological use and mobility as a way to understand a user's information activities. Previous IB and HCI research has appreciated a users' behaviour and interaction for example, seeking for information using desktop information system (Wilson, 1997). This research aims to contextualise and consider the wider influences to information use from a HIB perspective and how IB is now a key factor in a user experience as users interact with smart technologies to meet their information needs.

    3. From a learning pedagogy the research combined focus group exercises and practical work creating an interesting blend to inform learning and teaching through discussion. The user centred design (UCD) approach to data collection via class feedback created a collaborative environment, ideas were shared and discussed to inform students interpretation of the testing model.

This informed the research (i.e. Appendix F) as students reshaped the model based upon initial interpretations, something which has continued in class.

- **Capital Expenditure:** Throughout the research the researcher put forward a number of funding bids to shape HIB and Mobile HCI area within the department. On the back of a number of successful bids, in 2015 a new UX Laboratory was built. The laboratory (Figure 7.1.) was designed around research conducted from this thesis, the labs flexible space can be configured to conduct mobility testing (i.e., setting predefined routes and using a treadmill).

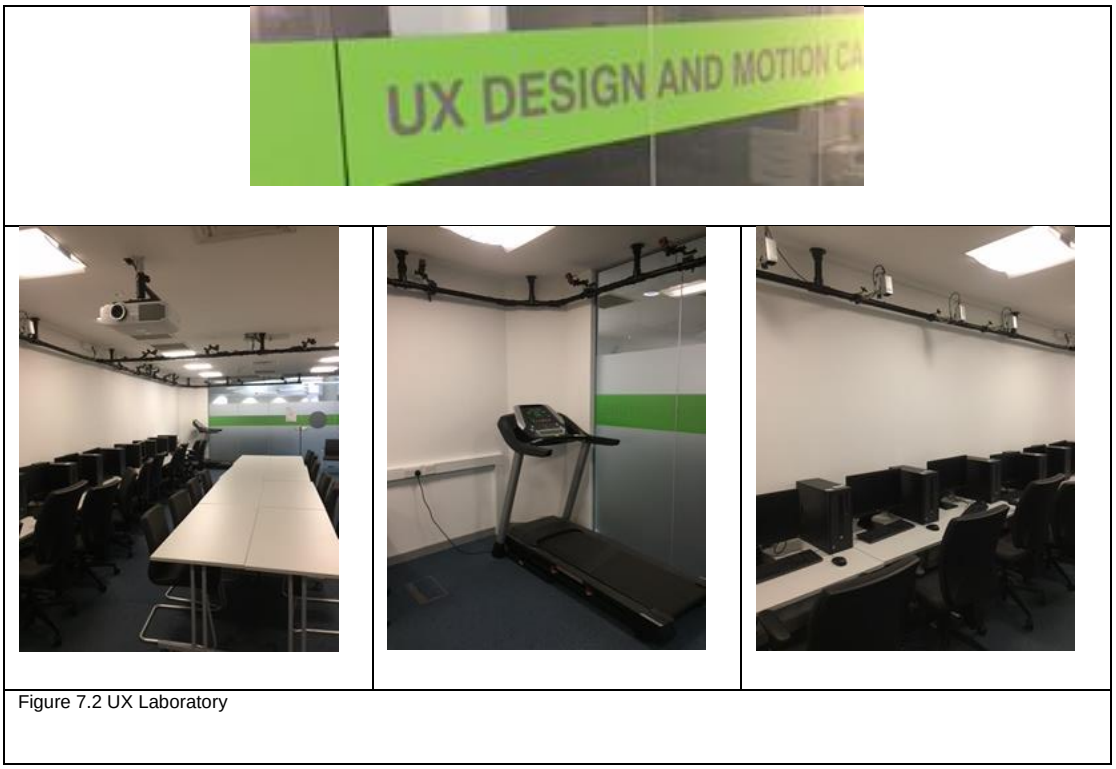


Figure 7.2 UX Laboratory

- **Academic Research:** The lab has created new research opportunities and the researcher is working with colleagues to push this mobile and mobility research, in this case using Information Retrieval theories and practice. The abstract below has been accepted to CHIIR2017 (Human Information Interaction and Retrieval)

"Perceptions of the effect of fragmented attention on mobile web search tasks"
This research was a laboratory experiment with both phone and tablet devices with the aim of evaluating common mobile situations that cause; fragmented attention, impact search performance and impact on user perception. To do this the distraction level was varied by simulating 3 everyday situations: walking quickly (on a treadmill), navigating a pre-defined route and a sitting still (which was used as the baseline

condition). The results showed that different experimental conditions had a number of different effects on the participants' perceptions of their own search performance, how hurried they felt and how engaged they were in the tasks.

- **Data Presentation and Analysis:** To support data collection and analysis of field results the researcher has worked on other test enhancements. For example, the testers ability to sync, analyse and present data based upon multiple capturing technologies (i.e., screen recorder, Go-Pro and handheld cameras). The Systematic Review and student test presentation found a lack of support when it came to the analysis and presentation of results. There needed to be a method to merge and sync data helping the interpretation of field results. The researcher liaised with the IT team and used a new application (Adobe Premier) was identified to support the merger of field data (Figure 7.2). A bespoke plugin was designed and implemented enabling students to code findings on a timeline and export data to Excel or SPSS for analysis via XML. This is seen a valuable tool which will inform future research.

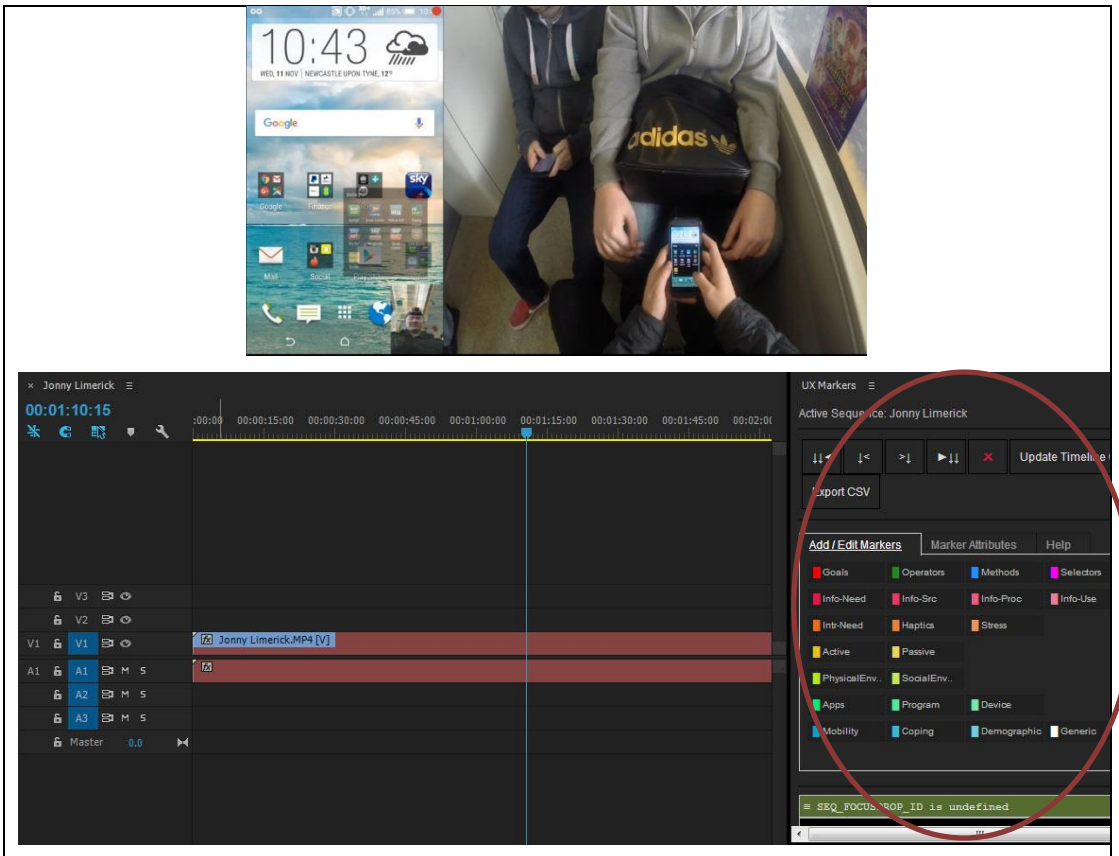


Figure 7.3 Adobe Premiere and API Plugin

Industrial connections: The UX laboratory has created regional interest, the UX and testing departments at Sage and Accenture are keen to collaborate on research around mobile testing within their respected fields. The researcher is looking at the possibility of a Knowledge Transfer Partnership (KPT) with Sage in 2017.

The researcher is supervising a number of final year student projects. One student is currently working for Nissan he is part of a UX team that has built a mobile stock-control application. The application needs to be field tested on the production line at Nissan and the student is using the test model to support mobile test case development within this industrial setting. The team at Nissan aim to evaluate the usability within this context considering potential spatial and mobility issues around user interaction as they complete tasks on the production line. Data will be gathered and evaluated using the Adobe Premiere Suite.

Finally, the researcher is working with a local company OnCLu (social gaming tool). OnClu allows people to play quizzes, score points and win prizes, but OnClu also encourages people to make quizzes and communicate through quizzes. One area of research which stemmed from a meeting with Onclu was a better understanding of interactions as user played the game outside. Based upon initial requirements gathered the researcher introduced test model as a platform to support mobile evaluations in the field. This has evolved into a final year Web Design and Development project to;

"investigate and identify user interactions and behavior when playing online games. A gamification case study will be developed to evaluate the interaction and behavior of students, when participating in an online game designed to engage new students during fresher's week at Northumbria University".

The project requires the student to build a game using Onclu simulating tests with students based upon different geographic locations within the University. The test model will be used as a platform to build test cases for Onclu, which will be recorded and analysed using Adobe Premiere.

Total word count: 70468

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APPENDIX A: TOUCH-LEVEL MODEL (TLM) OPERATORS (RICE AND LARTIGUE, 2014)

	Retained Operators **[From the KLM Model (Card, Moran and Newell, 1980)]**
K	**Keystroke / Button Press.** A button press on a purely virtual keyboard.[1]
H	**Homing.** The act of positioning fingers or the hand over various parts of the interface in preparation for touchscreen operations.[2]
M	**Mental Act**. The mental preparation needed to perform another action.
R(*t*)	**Response Time**. The time spent waiting on the interface to system or to respond
	New Operators
X	**Distraction.** A multiplicative operator that adds time to other operators. It models the distractions that naturally take place in real-world usage of a mobile device.
G	**Gesture**. The time needed to physically form specialized gestures with one or multiple fingers.
P	**Pinch.** A 2+ finger gesture commonly used to zoom out.
Z	Zoom. A 2+ finger gesture commonly used to zoom in
I	**Initial Act**. The action or actions necessary to prepare the system for use (e.g. unlocking device, tapping an icon, entering a password).
T	**Tap**. Tapping some area of the screen to effect a change or initiate an action.
S	**Swipe**. A 1+ finger gesture in which a finger or fingers are placed on the screen and subsequently moved in a single direction for a specified amount of time
L(*d*)	**Tilt**. The tilting — or full rotation of — the entire device d degrees (or radians).
O(*d*)	**Rotate**. A 2+ finger gesture in which fingers are placed on the screen and then rotated ***d*** degrees (or radians) about a central axis
D	**Drag**. A 1+ finger gesture in which fingers are placed on the screen and then moved — usually in a straight line — to another location. Often used for scrolling of content or moving an interface item from one location to another

Touch-Level Model (TLM) Operators (Rice and Lartigue, 2014)

APPENDIX B: SAMPLE SCENARIO AND TEST PLAN
(Rubin and Chisnel, 2008)

Tasks

Participants start from one of three starting points: All participants will use www.H.com to book a hotel room (up to the point of entering a credit card number or just before completing the rewards reservation) in a major U.S. city that has multiple H properties. Within that task, participants will select a hotel and room based on a combination of price and amenities. Each group will start at a different point:

Group 1	Start at H.com
Group 2	Start at non-branded search from Google (example: premium San Francisco hotel 4 star hotel).
Group 3	Start from a branded search from Google (example: H Hotel Atlanta)

Let the participants start where they would normally start: Because you'll select participants for different combinations of characteristics, expect that different types of participants are motivated to do different things. Briefly interview the participant at the beginning of the session to get some impression of how the particular participant approaches booking travel arrangements–especially accommodations–and let them perform the task within their own context. This way, in addition to getting a feeling for the overall usability of www.H.com, you can also identify usage patterns that could be further investigated in follow-on research. Finally, you will also get a better understanding of the traveler's thought processes and how H.com fits into that traveler's life.

Methodology

This usability study will be somewhat exploratory but will also gather assessment data about the effectiveness of www.H.com. Participants will fall into three groups by the starting point they use to perform the main task, which is to reserve a room. We will collect data about error and success rates as well as qualitative data about participants' experiences using the site.

We will use a between-subjects design

In this between-subjects study, each participant will work through one task path (in a within-subjects study, each participant would try all paths in counterbalanced order). I will conduct up to 30 individual 45-minute usability study sessions. Each participant will perform one of three major task "paths" using www.H.com. I'll use 15 minutes of each session to explain the session to the participant, review basic background information with the participant, and then conduct a post-test debriefing interview. During the middle 30 minutes of the session, participants will work to reserve a room at an H property in a major U.S. city.

Session outline and timing

The test sessions will be 45 minutes long. I will use 15 minutes of each session for pre-test introductions and post-test debriefing interviews. The sessions will take place at Shugoll Research in Bethesda.

Pre-test arrangements

Have the participant:

- Review and sign nondisclosures and recording permissions.
- Fill out a background questionnaire (with the same questions as the screener).

Introduction to the session (2 minutes)

Discuss:

- Participant's experience with usability studies and focus groups.
- Importance of their involvement in the study.
- Moderator's role.
- Room configuration, recording systems, observers, etc.
- The protocol for the rest of the session.
- Thinking aloud.

Background interview (3 minutes)

Discuss the participant's:

- Experiences booking their own travel.
- Reasons for booking their own travel.

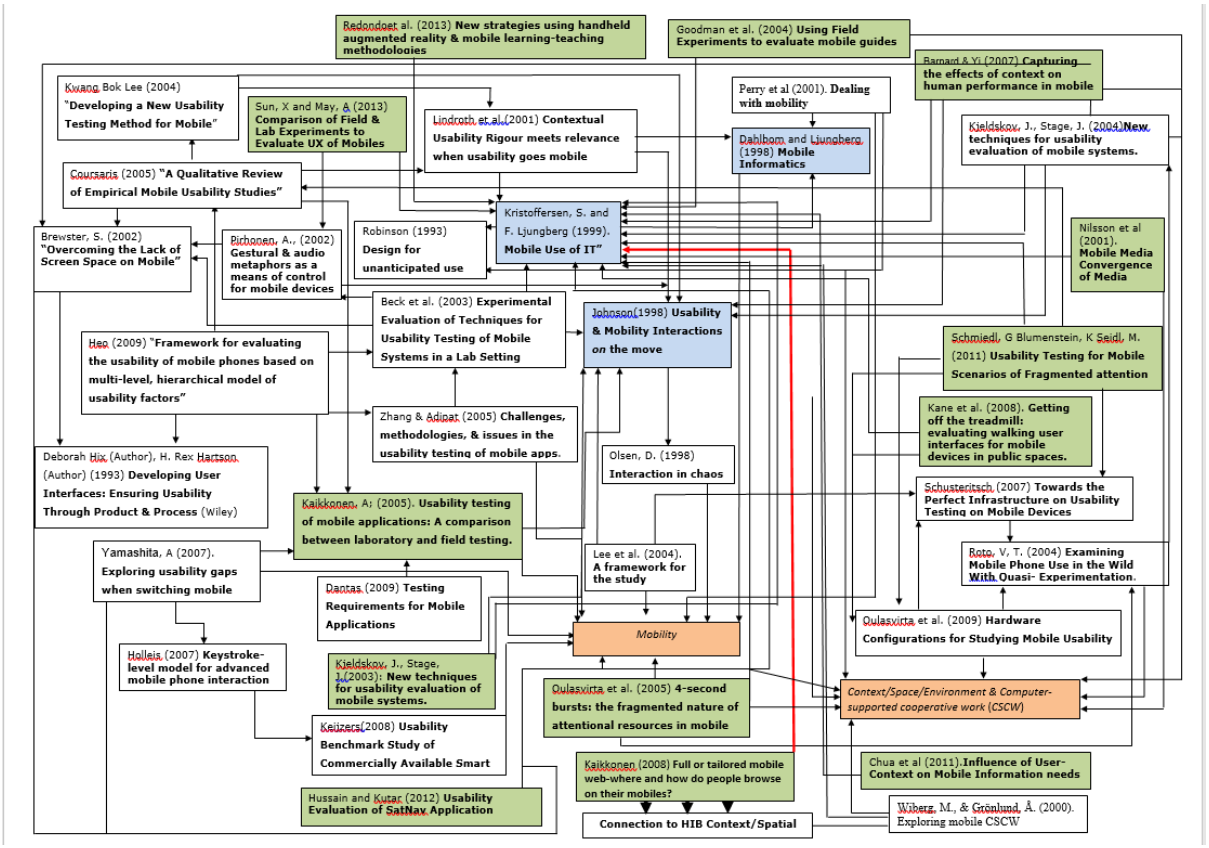
Tasks (30 minutes)

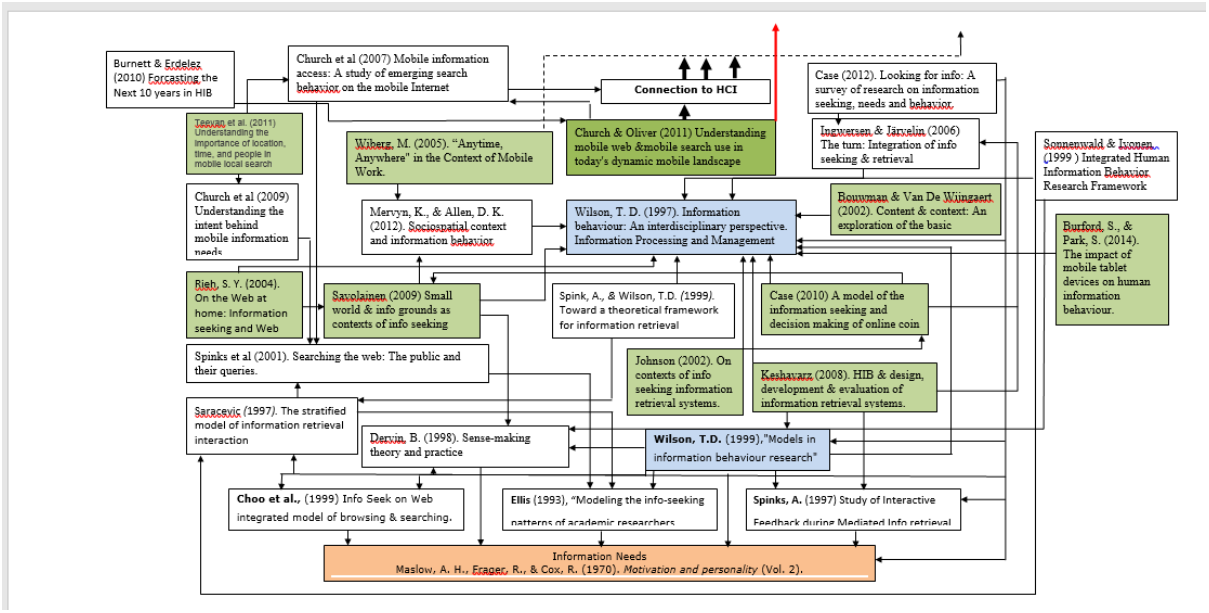
Participants will start at one of three points to reserve a room at an H hotel in a major U.S. city where H has multiple properties.

Post-test debriefing (10 minutes)

- Ask broad questions to collect preference and other qualitative data.
- Follow up on any particular problems that came up for the participant.

APPENDIX C: LITERATURE MAP





APPENDIX D: SYSTEMATIC REVIEW

Comparative codes supporting themes and metaphors: Identifies in-text and descriptive themes based upon the impact and use of contexts within HIB and Mobile HCI (in the main practical examples have been unpicked from the papers to support the emerging themes).

Paper	Contextual need activities		Intervening Variables					User modality factors			Activation Mechanisms					Information Seeking & Processing and Use				
	Context of Information need	Cope & Stress	Enviro /Spatial Contexts Physical	Enviro /Spatial Contexts Social	Psychological	Role / inter	Source char	Wandering	Travel	Visiting	App	Data	Progra m	Risk Reward	Social Learn (efficacy)	Passive Attention	Passive Search	Active Search	Ongoing search	Use
Kristoffersen & Ljungberg (1999)	Industrial Context: Order information to support installations & Maintenance of telecoms	Stress: One-handed problems with information access	Industrial setting: Different telecommun ication locations	Work related Challenging and dangerous	Trained but the environments place demands i.e. not being able to place the device to do maintenance work	Individual activity to search for order info and support maintenan ce	Order data and mainten ance docume nts	Walk while using mobile computing device.	Travel between industrial sites in a vehicle	Moving around site on arrival - outside	Ericsso n MC12	Order data and centralized info to maintain	DART Project running Window s CE	Finding order Inability to use device in field locations	Learning to use in challengin g ergonomic conditions	N/A	N/A	Searching for order information	Iterative with maintenance work.	System info to support work. Updating tele communicatio ns network Updating order on database
Nilsson et al., (2001)	Social Group Context: Need based upon a number of media streams i.e. radio, web, other people	Cope: Gathering info to move to next destination. Sharing the info with the social group	Sporting event Camping at different geographic locations	A special stage of the rally with a social group in a forest	Proficient with technology	Groups sharing informatio n as it comes through	Audio Website Text data (SMS)	Sat and Walking - temporary context	In a Car - Travelling between events	N/A	WAP Mobile	SMS, news, traffic and web info	Multi-channel Digital Radio, SMS app and web browser	Ability to find, aggregat e and share info	Learning to use in the field – literally	N/A	Partly passive, intermitt ently on one or more media streams	Find info about race	Would need to keep checking for updates	Using SMS & radio info sharing with group to get to the new destination
Bouwman & Van De Wingaert (2002)	Academic context: Grandmother wants to know when the train is?	Stressful due to intermittent network - cable down	Home office setting	Quiet personal space	Proficient with technology	Single activity	WWW informat ion	N/A	N/A	At home but about to go to University	Desktop PC	Train times	WWW Browser	Finding the best times & passing on the info	Learning the online timetable	N/A	N/A	Complete search and send information	N/A	Using Time info sharing with guardian
Johnson (2003)	Organisational or office context: Tasks within a large organisation	Cope: finding information to share with group	Office setting	Busy work environment	Mundane ritualistic office activities	Individual to group	Email content and attachm ents	N/A	N/A	Sat in the office for temporal time period	Work station	Varied depending on task	Email & web browser	Sharing correct info	Efficiency finding and sharing via email	N/A	N/A	Retrieving to aid work task	N/A	Communicatin g info via email
Kjeldskov & Stage (2003) & Beck et al., (2003)	Academic context: Game activity possibility of embedded info needs with the game to progress	Altering speeds on route could impact on task success and ability to interact	Recreate real-world situations. Simulated walking down the street	False lab setting people following and recording in the field	Challenging within these different contexts. User seen as proficient with mobiles	Individual activity	Game info	Walking on a treadmill and walking outside	Simulatio n travel between destinatio ns	N/A	WAP Nokia 5511, 3310	SMS, EMS	Applicati on for Compaq iPAQ	Getting right informati on whilst on the move. Inability to interact due to mobility	Ability to use device in a mobile setting	N/A	N/A	Active searches within the game	Iterative and ongoing to progress through the game whilst moving	Information used to progress through the game simulation in the field
Rieh, S. Y. (2004).	Natural contexts: Searching for information at home	Stress: Parental advice on parenting Cope: Checking house price and stocks	Home setting	Quiet and relaxed setting	Professional users with varying technical abilities	Mainly single but some group activity (looking at houses)	Search data within a search engine.	N/A	N/A	Does not fit with these variables but would be based around home life. So hear for a temporal period of time	Desktop PC	Search engine and site data	Web browser	Getting the correct results based upon search	Understan ding and interpretin g search results	N/A	N/A	Searching for info to support need i.e. checking conference schedule	Activities are in some cases iterative i.e. checking house prices	Use to inform decisions
Goodman et el.,	Academic context: Finding	Coping with the task no real stress a	In the street – different locations	Busy Street environment	Wide age range does not mention	Individual set of activities.	Location data	To find post office	No transport used	A colleague	Mobile device (PDA)	GPS data Informatio n about	Does not say	Ability to use data to get to	Learning to use location	N/A	N/A	Active to find location	Would be iterative to check	Use location data to navigate

(2004)	Geographic information i.e. the Post Office	simulated activity to evaluate interaction in the field			technical competence	No specific activities set within the street						physical objects i.e. post office, museum		destination. Inability to use application to find and extract location based data	based software to meet need				location data	
Oulasvirta et el., (2005)	Simulated Natural contexts: Information needs based upon web searches – reporting experience back to the experimenter	Multiple cognitive demands on participants. Each demand impacted by the environmental context	Some real taxing tasks requiring planning and following route on device	Spatial awareness issues. Busy - walking while at the same time taking care of safety (avoiding collisions; e.g., being hit by a car)	Experienced using mobile phones. Taxing with some tasks required to be completed at speed whilst on the move	Individual activities	Web content or time dependent data like times	Walking through a busy street to a bus stop	Travelling on an escalator	Visit friends - Conversing in a café	Nokia 6600	Text input form Web search for information	Opera	Getting the right search results whilst on the move	Using the device in different environments which may challenge interaction	N/A	N/A	Finding item on a menu or time related sites about public services in region	Possible ongoing not clear	Use location data support search
Kaikkonen et al., (2005)	Simulated Natural contexts: Finding information to support software download	Field environments i.e. busy streets create stress and coping factors	Daily rush hour on the metro	A busy environment with cognitive distractions	Participants are briefed and get used to the handset	Individual activities	Multiple sources i.e. mobile software, images repository, SMS & Email.	Walking between destinations	Travelling on metro - Office district in Helsinki	Visiting a friend in shopping center	Mobile phone	Web search, texting, downloads, open & closing apps, Sharing content & setting permission on the phone	Nokia and associated programs	Inability to complete activities whilst on the move	Using the device in different environments which may challenge interaction	N/A	N/A	In finding and downloading the application, Searching for web info and sending SMS	Returning to application to take and share pictures.	Using info to support activities like searching for information & downloading software to the phone.
Wiberg, M. (2005).	Industrial Context: Locating network problems, checking updates and rebooting network	Time factor issue, coping and have to reboot at night. Stressful due to device interaction in unusual or unfamiliar setting i.e. up a ladder	Telegraph pole and network router – for reboot	Industrial field setting outside	Trained professional with this mobile device	Individual activity	Network data and reboot acknowledgement	Walking between network locations	Schedule and travel to location	N/A	Mobile device	Error and network data	Does not say	Ability to find network information	Learning to use the device in these challenging contexts.	N/A	N/A	Needing to locate and fix problem	Will need to return to reboot the network.	Use data to fix problem
Barnard et al., (2007)	Academic context: Reading comprehension and word search task	Altering the task type, motion & lighting causing different coping strategies	Mainly lab simulating the real world	Academic setting not true social setting. The change in lighting could have some connotation to this context	No screening or sample provided within paper – presume follow colleagues or students.	Single activity	Search result and reading information	Walking a 1foot wide path around a room	Sitting, asks were perform with PDA flat on a table	N/A	Palm m505 PDA	Reading comprehension Word search Motion lighting	Palm applications	N/A	N/A	N/A	N/A	Active to complete search and reading exercise.	Could be ongoing if the word has not been located.	Finding Word location
Kane et al. (2008)	Academic context: Situational impairments on Info need/retrieval, Finding information from a media catalogue	Cope: Changing modality impact on interaction. Assessment of enviro attentional & physical factors on user	University Campus	Busy campus setting.	Due to the sample early adopters of mobile technology	Single activity	Music listing	Walking down the corridor Set on predefined routes Walking outside set on campus	N/A	N/A	Tablet Sony UX2 ultra Mobile Windows XP	Accessing and finding music files within a playlist	Music Player at different sizes	Finding a song within a catalogue listing	Learning search process and the interaction whilst mobile	N/A	N/A	Actively looking for a specific track	Possibly ongoing but not explicit. Seem to be simple active searches	Finding media within a library
Church et al. (2009)	Virtual setting: Captured a range of needs from users. Research found Geographic –	Coping in main. Participants noted things in a diary	Entries made out of their normal contexts	Every day activities. Busy or Quite.	Most comfortable with basic operations but some unsure about Mobile web searches	Does not say but looking at data it's a combination	Travel info – bus times, maps	Travelling by various means	N/A	Travelling by various means	Own Smartphone	Travel data	Mobile Browser or App	Finding the right time	Learning the seeking process in a busy environment	N/A	N/A	Activity looking for travel information	N/A	Use travel & commuting information from apps Using social information to

	local information as the most popular use																		communicate this information
Case (2010)	Natural contexts: Information gathering to decide on the purchase of a coin	Ambiguous information makes process stressful	Home setting	Information sharing across communities via eBay	Competent E-bay user	Single activity but may share content	Information about coins	N/A	N/A	At home – hard to distinguish with these variables	Desktop PC	Coin information	E-bay	Placing a bid and getting the bid accepted	Looking at options – overcoming the uncertainty	N/A	Passively looking around the account holders	Making the move to bid for the coin	Returns regarding online feedback	Searching and aggregating options Sharing info and communicating via E-bay
Schmied et al (2011)	Simulated Natural contexts: Find and order a pizza	To cope with simulated activity	Simulated work, leisure & travel - users cannot concentrate solely on mobile app they use	Lab setting simulating real world environments	Competent user	Single activity	Finding order Placing order Receive receipt	N/A	Driving simulation travelling using Play Station.	N/A	Android, I-phone and Tom Tom	Map Location Navigation structures (evaluating optimal interface grid)	Google maps, Tom Tom Navigator, Google GPS	Ability to interact with both devices Unable to do both tasks at the same time	Ability to drive & complete even with fragmented attention	N/A	N/A	Activate to find and order custom pizza - actual payment excluded.	To check receipt	Receive and act upon data found
Chua et al. (2011)	Simulated Natural contexts: Weather information for an outdoor activity	Coping to find weather information. Stressful - due to intermittent network connection	Public transport – standing or sitting	Busy environment - passenger	In the main professionals and competent	Sole activity but may share	Weather data	N/A	Public transport Bus/train	N/A	Smartphone	Weather website	Mobile Browser	Ability to find the right weather updates	Learning to use the app in busy situations	N/A	N/A	Activity looking for weather info	Checking for changes in the weather outlook	Use Weather info to support decision
Church & Oliver (2011)	Virtual Setting: Information Awareness, looking for FB information (most popular)	Check information in a hurry, mainly coping in a given situation	Home setting	Quiet environment – sofa, kitchen	Competent Smartphone user	Sole activity checking feeds updating status	Feed info from social environment	Walking Moving around the house	N/A	Sat at home – stationary	Smartphone 4th generation	Social news feeds	Mobile browser	Ability to share information	Using the application in social situations	N/A	Passively looking at feeds not acting upon them	Keeping up to date with friends and family	Keep returning to check status and news updates	Check, use and update status
Teevan et al. (2011)	Simulated Natural contexts: Location Searching	Find location in a time period Searching to coffee	Range of local locations evaluated. Tended to be outside not at home of work	Range of Social settings	Mostly early adopters at Microsoft so very competent	Mostly set around social and collaborative	Location based data sourced from log files	Range of Collaborative (agreeing on lunch and destination) Solely finding coffee shop	Pickup children	Meeting for lunch destination	Mainly Windows phones	Finding location data	Location software i.e. Google maps	Extracting the right results	Learning to search effectively using this application in natural contexts	N/A	N/A	Very much active search based on log file analysis	Sometimes iterative searches so ongoing.	Use and evaluate location info
Hussain & Kutar (2012)	Simulated Natural contexts: Finding and setting geographic locations with a Sat/nav	Cope: no real stress factors set Coping with the given situation	Car - driving to a given destination to program	Sat within a car reviewing the SAT-NAV with peers	Academic context proficient with technology	Collaborative with the driver of the car to navigate and input results	Location based data output/audio output	N/A	Stationary sat in a car	Visiting different location - Sat in a car	TomTom and CoPilot Live	Location data generated	Sat/nav application	Ability to program the right coordinates to travel	Learning to use the device on the move	N/A	N/A	Need to set info to get to destination	Need to return and check Possibility of re-entering data	Use GPS data to inform decisions Use information to support the driver
Bumford and Park (2012)	Academic context: Finding information via app and elp (Moodle)	Cope: student working on module	University campus	Individual and group activity App and information access required	Competent with elp/app/tablet	Individual activities and group	Apps, browser and elp	Information related to their studies	Between classes	On the way to University	In-class or on campus	Web and elp content	Tablet Browser (safari)	Using a variety of smart tools to interact with the eLP content	Uploading and interacting with context	N/A	Perusing the web with no real objective	Activity to do work	Returning to eLP content	Use App to access and share info
Sun & May (2013)	Simulated field event in a lab: Obtaining athlete information	Cope: simulated setting but had to cope in a given time	Sports stadium	Spectator at a game – simulated so quiet but would be noisy	Regular experience with personalizing phone settings	Single but shared info about athlete	Web data driven through prototype	Simulated sports event. Sitting at the event	N/A	N/A	Smartphone	Check Schedule, obtaining information, reviewing the progress, joining community & participatin	Social app & site with DB about a sports event	Finding the right info	Learning about the application in semi natural environments	N/A	N/A	Active to find the information about the athlete	Returns to find out more detailed information about athletes	Use info to support knowledge about players

Redondo et al. (2013)	Academic context: Use content from Moodle to then model urban landscapes	Student activity: Coping with the technology	Barcelona Campus	Educational environments working with computer-generated objects	Expert with tools and Smartphone	Shared activity to support learning	3d models used and applied	Walking and standing	N/A	N/A	IOS and Android	g 3D Model, QR codes, web pages	Hand Held Augmented Reality (HHAR).	Capturing 3D data and interacting with eLP	Ability to use and understand the benefits to L & T	N/A	N/A	Extracting data and using the data with the modelling software	Returning back to Moodle to do more retrieval	Use to support learning activities Disseminate to peers as part of the work
Mobile HCI/ HCI/Co-operative working/Mobile Computing Journals																			
Information Science/Media and Society/Information Networking Journal																			

APPENDIX E: RESEARCHERS CODED DIARY SUMMARY

Test No	Code Name	Initiated	Contextual Need Activities	Environment		Risk/Reward	User Modality Factors	Info Seeking Process & Use	Supported
				Contextual	Physical				
1	Bear Grylls	Yes	Add, view and delete	Real/True	Lab Setting	Not Considered	Stationary	Active and ongoing	Yes but prompts
3	Bear Grylls	Yes	Create and update	Not realistic	Wandering	Not Considered	Wandering	Active and ongoing	Yes but prescriptive
1	Bo	Yes	Contact Update	Not realistic	Lab Setting	Considered	Stationary	Active and ongoing	Yes but prompts
2	Bo	Yes	Searching	Real/True	Corridor	Considered	Wandering	Active	Yes but prescriptive
3	Bo	Yes	Add and Facebook	Real/True	Lab Setting	Not Considered	Stationary	Active and ongoing	Yes but prescriptive
2	Fat Mike	Yes	Creating, Searching & updating	Not realistic	Wandering	Not Considered	Wandering	Active and ongoing	Yes clear
3	Hound	Yes	Updating	Real/True	Basement test	Not Considered	Stationary	Active	Yes but prescriptive
3	Hound	Yes	Update and Deleting	Real/True	Lab Setting	Not Considered	Stationary	Active, ongoing and Passive	Yes but prompts
2	Hound	Yes	Update and Deleting	Real/True	Walking between buildings	Considered	Wandering	Active, ongoing and Passive	Yes clear
1	Null	No	Update/Mange app data	Real/True	Basement test	Not Considered	Wandering	Active and ongoing	No a little ad hoc
1	Peter Parker	No	Updating	Real/True	Corridor	Not Considered	Wandering	Active and ongoing	No a little ad hoc
3	Peter Parker	Yes	Creating and updating	Real/True	Lab Setting	Not Considered	Stationary	Active and ongoing	Yes clear
2	Pouchy	Yes	Creating and Searching	Real/True	Wandering Visiting	Not Considered	Wandering and visiting	Active and ongoing	Yes clear
3	Pouchy	Yes	Update and Deleting	Real/True	Lab Setting	Considered	Stationary	Active, ongoing and Passive	Yes but prompts
2	Ray Mears	Yes	Updating	Real/True	Basement test	Considered	Stationary	Active	Yes but prompts
1	Santiago	Yes	Searching	Real/True	Basement test	Not Considered	Stationary	Active	Not clear
3	Santiago	Yes	Creating and updating	Real/True	Sitting in a meeting room	Not Considered	Stationary	Active, ongoing and Passive	Yes clear
1	Sherlock	No	Creating and Searching	Not realistic	Wandering Visiting	Considered	Wandering	Active and ongoing	Yes but prompts
3	Snow White	No	Creating	Not realistic	Class setting	Not Considered	Stationary	Active	No a little ad hoc
1	The Wolf	Yes	Creating	Real/True	Wandering Uni	Not Considered	Wandering and visiting	Active and ongoing	Yes clear

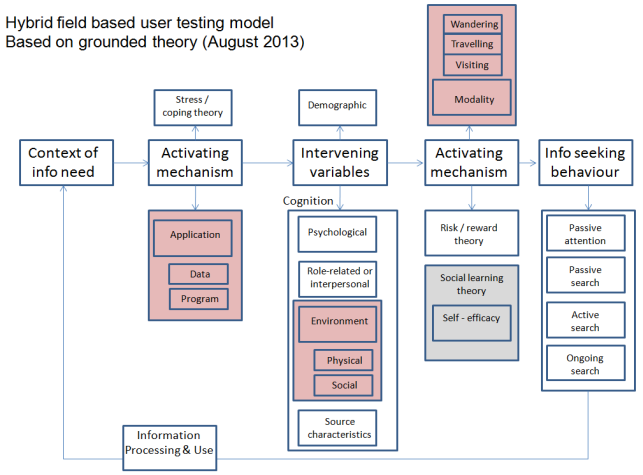
1	Tony Stark	Yes	Updating	Real/True	Corridor	Not Considered	Wandering	Active and ongoing	Yes clear
4	Tony Stark	Yes	Creating	Not realistic	Simulation	Considered	Travelling	Active, ongoing and Passive	Yes clear
3	Trevor Mac	No	Create	Not realistic	Walking between buildings	Not Considered	Wandering	Active	Yes clear
2	Trevor Mac	Yes	Updating	Real/True	Sat at desk	Not Considered	Stationary	Active and ongoing	Yes but prescriptive

Cognitive Demands					
Mental	**Temporal**	**Performance**	**Effort**	**Frustration**	**Notes**
Low to Medium	Medium	Near Perfect	Low	High	
Low	Low	Near Perfect	Low	Low	Other modalities could have improved the realistic nature of the test
High	Medium	Near Perfect	Medium	Medium	More depth to help evaluate needs and user interaction - prescriptive and short
High	Medium	Perfect	Medium	Medium	tried to influence the test
High	Medium	Failure	Medium to High	High	Nice using other 3rd party techs, again a lot to take in for the user
Low	Medium	Middling	High	High	Good clear guidance tasks were too prescriptive impacting on performance evaluation
Low to Medium	Medium	Perfect	Low	Medium	Worked well with clear instruction, professionally done but does influence the user
Low	Low	Perfect	Low to Medium	Low to Medium	Provided a range of seeking methods to support the test, good range of data captured
High	Low to Medium	Middling	Medium	Medium	
Medium to High	Medium	Middling to Failure	Medium to High	Medium to High	Struggled to set the needs into action for the user, piloting needed to support the field test flow
Medium to High	Medium	Middling to Failure	Medium to High	Medium	Poor execution that needs piloting needs more explanation to help user, assessment of needs was good but poor execution hard to capture cognition
Medium to High	Medium	Near Failure	Meduim	Medium	Guidance needed throughout need to test beforehand
Medium to High	Medium	Near Perfect	Meduim	Medium	Some sub-tests disjointed Excellent test approach
High	Low	Middling	Medium	High	Inputting retrieving and updating is a great way to simulate a real test. Prompting was required
High	Low to Medium	Failure	Medium to High	High	User required constant guidance, tests do help the evaluation of seeking approaches

Medium	High	Failure	Medium	Medium	More depth to help evaluate needs and user interaction - prescriptive and short
High	Low to Medium	Near Failure	Medium to High	High	A good range of tasks that are set correctly that are challenging to help the app evaluation
Medium to High	Medium	Middling	Low	Low	Too much information to brief user, caused the tests to stop start, too many factors to consider at once.
Low	Medium	Near Failure	Medium to Low	High	Flowed well but the environment and setting seemed false and staged, the simulations don't really help the scenario, initiations was hard due to emailed instructions - check beforehand!
Low to Medium	Low to Medium	Perfect	Medium to High	Medium	Good clear guidance, tests are a little long and hard to keep user engaged with tasks, user a range of modalities to support
High	Medium	Near Perfect	Medium	Medium	Too much information to brief user, caused the tests to stop start, too many factors to consider at once.
Medium to High	Medium	Near Failure	Medium	Medium	Simulated due to WIFI issues on metro
Low	Low	Near Perfect	Low	Low	Too simple need to test due to Wi-Fi problems, false environment
Low	Medium	Perfect	Low	Low	Again too simple

Finalising Test Cases “supporting context agility”

Today’s smart technologies give a person the ability to do almost everything that they would normally do on a desktop PC. This has been the case for the last few years, however even back in the late nineties HCI researchers like Olsen (1998) noted that a person ‘will use a variety of computing devises because they serve their **information needs** in a variety of situations’. The information being the operative word, this seen as driver in how a person will use and interact with technology. To effectively design and test mobile applications that are useful, there needs to be an appreciation of the many situations a user might be in considering the different configurations and environments. This is where a model/framework can help.



In the seminars you have seen how information needs impacts on a user and device interaction. Now we are going to model the information needs. Modeling can help test preparation which is often ‘described as a **framework** for thinking about a problem…they are statements, often in the form of diagrams, that attempt to describe an information-seeking activity, the causes and consequences of that activity’ [Wilson, 1999 p.250]. Using these principles, we are going model user behaviour to finish the test cases.

References:

- Pointon, M. (2014). Searching for an Agile Approach to Methods and Methodology in the Mobile Arena. In iConference 2014 Proceedings (p. 998 - 1001). doi:10.9776/14341
- Wilson, T. D. (1999). Models in information behaviour research. *Journal of Documentation* **55**(3): 249-270.

Activity (finalising test cases): Using the Information Needs research with Geoff and Matt’s research using Kristoffersen and Ljungberg Mobile Informatics Model add these to the matrix on the next page. Once you have completed this consider the new elements below. These elements contextualize the test acknowledging the wider implications on the user and their behavior in the field. Applying this will create a repeated study which will alter modalities and environments supporting the experimental work.

The final elements to a mobile test case are the;

- Intervening Variables:
  - Demographics – test segment (male 18-24)
  - Psychological – builds upon cope/stress factors this is more about their knowledge and understanding of the application
  - Role and interpersonal (group or single activity)
  - Environment (use last week's work to populate this section)

- Activating Mechanism
  - **Self-efficacy:** measure of the belief in one's own ability to complete tasks and reach goals (i.e. older people may find it challenging)
  - **Reward** i.e. if this is a comparison site getting the best deal, not being late, successful bet/transaction.

- Seeking Behaviour
  - **Active search:** a search most commonly thought of in the an individual actively seeks out information to support outcome
  - **Ongoing search:** where active searching has already established the basic framework of ideas, beliefs, values, or whatever. i.e. you have found the train ticket you now go back to check deal and most suitable time
  - **Passive attention:** Such as looking at websites or streaming radio/watching TV, there is no seeking intended but information acquisition may take place nevertheless
  - **Passive search:** Seems like a contradiction in terms, signifies occasions when one type of search (or other behaviour) results in the acquisition of information that happens to be **relevant** to the individual

- Processing and Use
  - The information behaviour, **what are they going process**? Is it iterative? Do you need to keep going back?
  - Note down how the use and what they do with the information?

	Stress/Coping theory			Visiting	Travelling	Wandering	
				Modality			
Context of information need	**Activating mechanism**		**Intervening variables : Cognition**	**Activating mechanism:**		Info seeking behaviour	Information Processing & Use
	Technology		Demographic	Risk / reward theory		Passive attention	
	Data	Program	Psychological	Social learning theory			
			Role/Inter	Self – efficacy		Passive search	
			Environment – Physical			Active search	
			Environment – Social				
			Source characteristics			Ongoing search	

APPENDIX G: OBSERVATIONAL DATA – GROUPED BY WORKSHOP SESSION

Develop Test Plans -	**Introducing the Mobile Information Model**			
Date Captured - 16/10/2013				
Comparative Code (Sub-Cat)	**Breakdown of most popular instances**	**Member Checked**	% of 184	**% of sub total**
Contextual need activities	Understanding context of need	18		32.14%
	Scenario development based on need	11		19.64%
	Number of Needs for a test	9		16.07%
	Stress/coping - placement	1		1.79%
	Timescale of needs is too quick to solve	17		30.36%
	Occurrence Sub Total (Needs)	56	30.43%	100.00%
Information Seeking & Processing and Use	Seeking approaches	20		47.62%
	Multiple seeking and searching	20		47.62%
	Passive Attention to Seeking Behaviour – what?	2		4.76%
	Occurrence Sub Total (Info Seek)	42	22.83%	100.00%
Intervening Variables	Environmental configurations are not going to work	16		39.02%
	Environmental perspective influencing stress & cope	20		48.78%
	Confusion of Source Characteristic placement in model	5		12.20%
	Occurrence Sub Total (Inter Var)	41	22.29%	100.00%
User modality factors	Too many configurations	16		47.06%
	Changing states of modality	2		5.88%
	Modality States - Confusion of a modality state	16		47.06%
	Occurrence Sub Total (Modality)	34	18.47%	100.00%

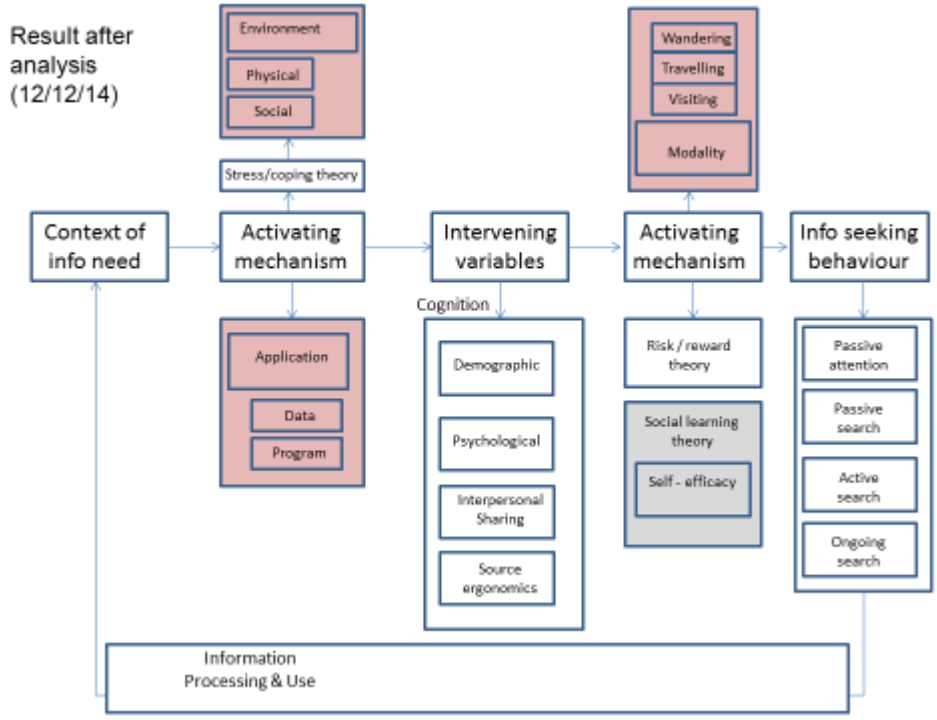
Application and Data accessed	Cognition between phone & user (Application)	3		27.27%
	External applications and source characteristics	5		45.46%
	Networking	3		27.27%
	Occurrence Sub Total (Application)	11	5.98%	100.00%
	Total Session Occurrence	184	100.00%	

Cognitive modelling: Supporting user behaviour research			% of 55	% of sub total
Date Captured - 23/10/2013				
Intervening Variables (User Group/Profile)	Grouping elements of the model	4		
	Occurrence Sub Total (Intervening Var)	4	7%	100%
Contextual need activities	Too many needs within information scenario	16		57%
	Confusion between needs and scenarios	12		43%
	Occurrence Sub Total (Needs)	28	51%	100%
Information Seeking & Processing and Use	Breaking GOMS down to support info seeking	5		22%
	Matching GOMS to scenario (Use)	10		43%
	Choosing between GOMS elements (Use)	8		35%
	Occurrence Sub Total (Process and Use)	23	42%	100%
	Total Session Occurrence	55	100%	

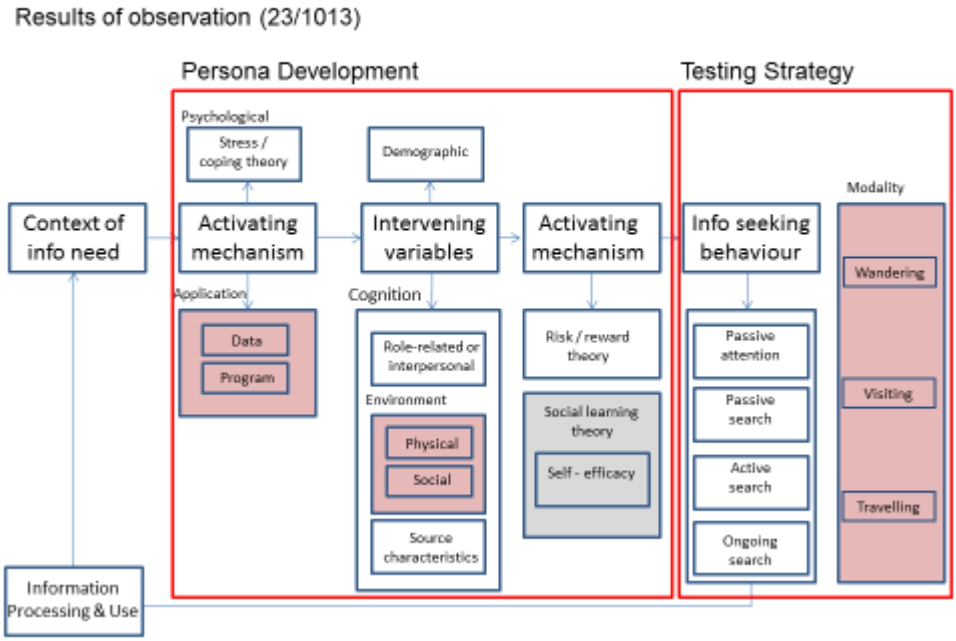
Implementing the model to support piloting			% of 96	% of sub total
Date Captured - 30/10/2013				
Contextual need activities	Grouping elements of the model	18		29.50%
	Need (initiation) How does we start the test	7		11.50%
	Getting the right users to test	9		15.00%
	Panic in capturing a need	10		16.00%
	Need fitting with test strategy	17		28.00%
	Occurrence Total (Needs)	61	58.56%	100.00%
Information Seeking & Processing and Use	Worry about different seeking strategies - than expected	4		
	Occurrence Total (Process and Use)	4		100.00%
User modality factors	Sampling issues	9		
	Occurrence Total (Modality)	9	8.64	100.00%
Application and Data accessed	Confusion of application and program	16		
	Occurrence Total (Application)	16	15.36	100.00%
Intervening Variables (User Group/Profile)	Don't see the value in this element of the model	6		
	Occurrence Total (Intervening Var)	6	5.76	100.00%
	Total Session Occurrence	96		

APPENDIX H: STUDENTS INTERPRETATION OF THE MODEL

Model One



Model Two



APPENDIX I: SUMMATIVE – CONTEXT OF NEED ACTIVITIES

Name	Test No.	Need type	Need/Sub Needs	Context of Need
Bear Grylls	1	Single Search	1	Searching for Timetable information
Bear Grylls	2	Single Search	1	Searching for Timetable information
Bear Grylls	2	Single Search	1	Searching for Timetable information
Bear Grylls	4	Single Search	1	Searching for Timetable information
Bo	1	Search/Update	2	Finding and updating contact information
Bo	2	Single Search	1	Searching for the updated details
Bo	3	Single Search	1	Displaying new information added
Fat Mike	1	Create Record	2	Creating a new recording and adding new timetable information
Fat Mike	2	Single Search	1	Searching for a specific room
Fat Mike	3	Single Search	1	Searching for a specific room
Fat Mike	4	Single Search	1	Searching for a specific room
Hound	1	Create Record	2	Creating a new recording and adding new timetable information
Hound	2	Single Search/View change	2	Searching for specific lecture altering the view using a grid
Hound	3	Single Search/View change	2	Searching for specific lecture altering the view using a grid
Hound	4	Single Search/View change	2	Searching for specific lecture altering the view using a grid
Giuma	1	Single Search	2	Searching for specific lecture altering the view using a grid
Giuma	2	Search/Update	2	Searching for and Editing Timetable information
Giuma	3	Single Search	1	Search for room location
Peter Parker	1	Single Search	1	Searching for contact
Peter Parker	2	Single Search	1	Searching for contact
Peter Parker	3	Single Search	1	Searching for contact
Pouchy	1	Search/Update	2	Search for and locate timetable information, input new entries
Pouchy	2	Single Search	1	Searching for and viewing workshop session
Pouchy	3	Single Search	1	Searching for module information
Pouchy	4	Search/Delete	2	Searching for and delete timetable entries
Ray Mears	1	Search/Update	1	Updating time (lecturer temporarily changed it)
Ray Mears	2	Single Search	1	Searching for and locating a period of free time for assignment work
Ray Mears	3	Create Record	1	Adding an entry to the timetable allowing for assignment work
Santiargo	1	Single Search	1	Searching for room and time when next lecture will take place
Santiargo	2	Search/Update/Email	3	Add and then edit entry, view the update and share with email
Santiargo	3	Misc.	2	Change colour of existing entry in grid timetable, check update.
Santiargo	4	Search/Update	3	Search for existing entry, change room number, view in grid mode.
Sherlock	1	Single Search	1	Search for a specific event information
Sherlock	2	Search/Update	2	Updating event information
Sherlock	3	Search/Email	2	Search and share event information via email
Snow White	1	Search/Create	2	Search for available room and create event based on availability
Snow White	2	Single Search	1	Opening the mobile browser to search for supporting PDF on the WWW

Snow White	3	Create Record	1	Create a to-do item reminding them of room booking
Snow White	4	Search/Update	2	Search for a specific meeting and the change time
Wolf	1	Create Record	1	Creating a digital copy of a paper based timetable
Wolf	2	Search/Update	2	Timetable change requires an update to entry
Wolf	3	Single Search	1	New module in a new room need to look up module information
Wolf	4	Single Search	1	Looking up info on a new module to support learning preparation
Tony Stark	1	Search/Email/Add	3	Search for email address, email teacher and add homework to collect missed work
Tony Stark	2	Search/Email/Add	3	Search for email address, email teacher and add homework to collect missed work
Tony Stark	3	Search/Email/Add	3	Search for email address, email teacher and add homework to collect missed work
Tony Stark	4	Search/Email/Add	3	Search for email address, email teacher and add homework to collect missed work
Trevor Mac	1	Single Search	1	Search for room location
Trevor Mac	2	Create Record	1	Add an Exam - User needs to input exam details.
Trevor Mac	3	Create Record	1	Add in holiday times
Trevor Mac	4	Single Search	1	Search for a room & lecturer information for a lecture
Magina	1	Update/Copy/Search	3	Information received via text with a new number, need to copy>search>update entry
Magina	2	Create Record/Text	2	Adding contact information to app then confirm via mobile text
Magina	3	Search/Email	2	Searching for contact and emailing
Rudd	1	Create Record	1	Adding a reminder for cinema times
Rudd	2	Single Search	1	Search for event reminder for cinema times
Rudd	3	Search/Update	1	Altering event by two hrs before film
Rudd	4	Search/Delete	2	Search and delete event
Roberts	1	Create Record	1	Add new timetable records for the new semester
Roberts	2	Display	1	View timetable as a whole to schedule time with friends
Roberts	3	Search/Update	1	Editing entries within timetable due to lecture changes
Roberts	4	Create Record	1	Adding exam and assessment details for specific class
Boyton	1	Single Search	1	Search for classes at particular time, find all details
Boyton	2	Create Record	1	Create an exam for Mobile Application on the app at a particular time
Boyton	3	Create Record	1	Create a new lesson for particular subject using app
Boyton	4	Search/Add	2	Search for entry and then add location for a room
Chadijiouraniou	1	Create/Edit	3	Add contact information and updating contact
Chambers	1	Search/Email	2	Search for tutor contact details and email them
Chambers	2	Search/Update	2	Meeting with dissertation supervisor, need to change contact details
Chambers	3	Search/Delete	2	Deleting contact entry on bus
Chambers	4	Search/Update	2	Walking home and need details from phone
John-117	1	Create/Edit	2	Adding and editing timetable entries
John-117	2	Single Search	1	Searching for specific calendar entry (future event) finding location information
John-117	3	Create Record	1	Setting reminders for events in the form of notification and emails
John-117	4	Single Search	1	Searching for a module code to identify lecture time and any attached lecture slides

APPENDIX J: SUMMATIVE – INFORMATION SEEKING

Name	Passive Attention	Passive Search	Active Search	Ongoing Search
Bear Grylls	Walking and given information			
Bear Grylls			Searching for entry information	
Bear Grylls		Search for information whilst with friends		
Bear Grylls			Searching for entry information	
Bo	No Passive expected	Maybe with search or menu bar	Maybe if the user struggles	Entering info and referring back to it
Bo	No Passive expected	Maybe with search or menu bar	Maybe if the user struggles	Entering info and referring back to it
Bo	No Passive expected	Maybe with search or menu bar	Maybe if the user struggles	Entering info and referring back to it
Fat Mike	Timetable successfully entered			
Fat Mike			Room identification	
Fat Mike			Room identification	
Fat Mike			Room identification	
Hound			Identification and add record	
Hound	Looking and planning class			
Hound	Looking and planning with friends			
Hound				
Giuma			Identifying record in DB	
Giuma			Identifying record in DB	
Giuma		Looking for location		
Peter Parker			Finding in time	
Peter Parker			Finding in time	
Peter Parker			Finding in time	
Pouchy			Creating timetable entry	
Pouchy	View timetable			
Pouchy			Viewing to find module info	
Pouchy		Delete entries		
Ray Mears			Browsing timetable, looking for the correct entry to change	
Ray Mears			Viewing their timetable, searching for a free slot	
Ray Mears			Looking for the corresponding slot matching the free time period	
Santiargo			Information needs to be found as quickly as possible.	
Santiargo	Tasks are completed in a timescale which suits the participant			
Santiargo	Tasks are completed in a timescale which suits the participant			
Santiargo	Tasks are completed in a timescale which suits the participant			
Sherlock	Viewing event			

Sherlock				Updating and possibility returning to do more
Sherlock			Finding and sharing	
Snow White			Found location and input event	
Snow White			For where to input data and a pdf	
Snow White			Located and added to-do	
Snow White				
Wolf	Entering information into the application			
Wolf	Editing the information to reflect the changes			
Wolf			Looking up module and repeating on BB	
Wolf				Looking up module information and researcher
Tony Stark		Locating lesson information in app	Locating lecturer info outside of the application	
Tony Stark	Paying attention to external factors such as doors and objects	Locating lesson information in app	Locating lecturer info outside of the application	
Tony Stark		Locating lesson information in app	Locating lecturer info outside of the application	
Tony Stark	Attention on external factors such as people around and motion of vehicle	Locating lesson information in app	Locating lecturer info outside of the application	
Trevor Mac			To find location and add information	
Trevor Mac			To update app and to get sorted for exam	
Trevor Mac			Adding and setting alerts for holiday	
Trevor Mac			To find right information	
Magina			Find and edit	
Magina			Active to input and send information	
Magina			Active to find and send contact	
Rudd			Active to get tickets and details of the film times	
Rudd		Application will recall the event for the user		
Rudd	Application will recall event			
Rudd				Active to delete and manage existing events
Roberts			Actively competing to ensure they have a record of if available at all times	
Roberts	Passively looking to see what free time is available			
Roberts			Actively completing, ensure records are up-to-date	
Roberts			Actively to ensure there is a record of the exams and assessments	
Boyton			Active to find the data as quick as possible	
Boyton		Casually try to find data, no time limit		
Boyton		Casually try to find data, no time limit		

Boyton			Active to find data a quick as possible due to environment	
Chadijiouraniou				
Chambers			Focusing on tutor giving info	
Chambers			Attention on supervisor	
Chambers	Try not to miss bus stop		Actively searching and deleting	
Chambers	Trying to watch where you are walking		Searching for correct contact information	
John-117			Need to find timetable to be able to enter it	
John-117			Need to find the event	
John-117		Altered to the event		
John-117			Need to find information before next lecture	

APPENDIX K: SUMMATIVE – PROCESSING AND USE

Name	Information Processing and Use	
Bear Grylls	Success; entering, viewing, deleting and viewing webpage	
Bear Grylls	Success; entering, viewing, deleting and viewing webpage	
Bear Grylls	Success; entering, viewing, deleting and viewing webpage	
Bear Grylls	Success; entering, viewing, deleting and viewing webpage	
Bo	Contact successfully added	
Bo	Information changed	
Bo	Contact displayed	
Fat Mike	Update database	
Fat Mike	Room displayed	
Fat Mike	Room displayed	
Fat Mike	Room displayed	
Hound	As the room to upload and views event	
Hound	User has code and searches retrieving class information	
Hound	User has code and searches retrieving class information	
Hound	User has code and searches retrieving class information	
Giuma	Using extracted information to aid next task	
Giuma	Editing contacts and sending FB response	
Giuma	Finding location on map - retrieving in preparation to send	
Peter Parker	Extracting the contact details for the database	
Peter Parker	Extracting the contact details for the database	
Peter Parker	Extracting the contact details for the database	
Pouchy	Timetable app will now contain the new entry	
Pouchy	Viewing information and in different views (Grid/table)	
Pouchy	Finds webpage with more module information	
Pouchy	Participant is able to delete entries	
Ray Mears	The relevant lesson in the timetable has been updated to feature the new value.	
Ray Mears	Free period of time to complete assignment work has been found	
Ray Mears	New module entry has been created to represent assignment work and the slot has been represented within the update	
Santiargo	The next lecture is found and room number identified	
Santiargo	new entry is successfully added and amended. The grid mode is successfully found and the email is sent successfully.	
Santiargo	Colour of the entry is successfully changed and the grid mode is viewed to confirm the change.	
Santiargo	Existing entry successfully found room number edited. Grid mode is also found room number change confirmed.	
Sherlock	Viewing event	
Sherlock	Viewing and updating the right event	
Sherlock	Viewing event and sharing event	
Snow White	BLANK	
Snow White	BLANK	
Snow White	BLANK	
Snow White		
Wolf	App timetable now look the same as paper copy	

Wolf	The timetable is now reflecting the session change	
Wolf	Looking module information and location	
Wolf	Looking module information and looking on BB/WWW to find out more.	
Tony Stark	Processing the change in lesson time. Use and gathering of the lecturers email address	
Tony Stark	Processing the change in lesson time. Use and gathering of the lecturers email address	
Tony Stark	Processing the change in lesson time. Use and gathering of the lecturers email address	
Tony Stark	Processing the change in lesson time. Use and gathering of the lecturers email address	
Trevor Mac	Adding the information helps manage their time provides access point to other resources	
Trevor Mac	Having all the exam information and dates stored	
Trevor Mac	Organising personal information with suitable alerts	
Trevor Mac	Retrieving information in a timely fashion	
Magina	Successful edit stored on DB	
Magina	Added information and sent the TXT	
Magina	Find friend details send information	
Rudd	Confirmation of storage and booking of film	
Rudd	Event viewed by the users	
Rudd	Event is found and changed	
Rudd	Film seen and event is deleted	
Roberts	Timetable is complete for their schedule	
Roberts	Timetable info has been read and processed, user is aware of times	
Roberts	Acknowledged as up-to-date and correct	
Roberts	Details noted correctly enabling the user to plan and prepare for both	
Boyton	Correct lesson is found at the scheduled time and data collected	
Boyton	Exam is successfully created for the correct time and named Mobile Applications	
Boyton	New lesson is created for the correct subject	
Boyton	Locate successfully added and correct	
Chadijiouraniou		
Chambers	Enter information into contact+ application to store tutors contact information for use at later date	
Chambers	Information that is retrieved is used to edit current contact for supervisor and update with new info	
Chambers	Information is deleted, no more use for the information	
Chambers	Once information is retrieved from app the information will be processed and used to make the call to GP.	
John-117	Processing timetable to enter it into the app	
John-117	Finding the event information	
John-117	Use notification to ensue attendance at event	
John-117	Being prepared for next lecture by knowing what will be covered	

APPENDIX L: SUMMATIVE – APPLICATION AND DATA

Application	Data	Program
Mobile app	Timetable information	Timetable app
Mobile app	Timetable information	Timetable app
Mobile app	Timetable information	Timetable app
Mobile app	Timetable information	Timetable app
Mobile app	New contact	Phone App
Mobile app	Extracting old info	Phone App
Mobile app	Displaying contact info	Phone App
Mobile app	Timetable information	Timetable app
Mobile app	Next lecture	Timetable app
Mobile app	Next lecture	Timetable app
Mobile app	Next lecture	Timetable app
Mobile app	Displaying lecture info	Timetable app
Mobile app	Displaying information	Timetable app
Mobile app	Displaying information	Timetable app
Mobile app	Displaying information	Timetable app
Mobile app	Contact information	Phone App
Mobile app	Contact information	Phone App
Mobile app	Contact information	Phone App
Mobile app	Staff contact detail	Timetable app
Mobile app	Staff contact detail	Timetable app
Mobile app	Staff contact detail	Timetable app
Mobile app	document given to participant	Timetable app
Mobile app	info provided verbally	Timetable app
Mobile app	verbally instructed	Timetable app
Mobile app	verbally instructed	Timetable app
Mobile app	An updated timetable entry	Timetable app
Mobile app	A free period of time	Timetable app
Mobile app	A new entry for assignment work	Timetable app
Android Application	Lecture time and location	Timetable app
Android Application	Added, updated and email confirmation	Timetable app
Android Application	Entry updated confirmation	Timetable app
Android Application	Room change confirmation	Timetable app
Android Application	Event	Google Calendar
Android Application	Event	Google Calendar
Android Application	Event	Google Calendar
Mobile app	Name, date time of event	Calendar app
Mobile app	Name, date time of event	Calendar app
Mobile app	Name, date time of event	Calendar app
Mobile app	Name, date time of event	Calendar app
Android Application	Timetable information	Timetable app
Android Application	Timetable information	Timetable app
Android Application	Timetable information	Timetable app

Android Application	Timetable information	Timetable app
Mobile app	Email address, Lesson info, homework info	Email client and Timetable app
Mobile app	Email address, Lesson info, homework info	Email client and Timetable app
Mobile app	Email address, Lesson info, homework info	Email client and Timetable app
Mobile app	Email address, Lesson info, homework info	Email client and Timetable app
Android Application	Timetable information	Timetable app
Android Application	Timetable information	Timetable app
Android Application	Timetable information	Timetable app
Android Application	Timetable information	Timetable app
Android Application	Display contact and new number	Contact/Calendar app
Android Application	Name and contact	Contact/Calendar app
Android Application	Contact and location	Contact/Calendar app
Android Application	Film title, date and start time	Calendar App / To-do list
Android Application	Film title, date and start time	Calendar App
Android Application	Film title, date and start time	Calendar App
Android Application	Film title, date and start time	Calendar App / To-do list
Android Application	A complete timetable of their schedule	Timetable app
Android Application	Day and time of classes	Timetable app
Android Application	New lecture entries	Timetable app
Android Application		Timetable app
Android App	Scheduled lesson time	Lesson details returned
Android App	Exam details	Exam creation confirmed
Android App	Lesson details and time	Lesson created and confirmed
Android App	Location details - room number, name	Location creation is successful
Android App	Contacts information	Contact app
Android App	Contact information	Contacts + timetable app
Android App	Contact information	Contacts + timetable app
Android App	Contact information	Contacts + timetable app
Android App	Contact information	Contacts + timetable app
Android App	Timetable information	Calendar app
Android App	Event Information	Mobile calendar app
Android App	Information on event	Mobile calendar app
Android App	Lecture slides	Mobile calendar app

APPENDIX M: RESEARCHER OBSERVATION FRAMEWORK AND EXAMPLE FINDING

INSTRUCTION: Capturing the information need and the events in the non-participative field test						
Date:	4/12/2013		**Test number**			
Scenario name:	Hand		**1**	**2**	**3**	**4**
Student code:	Pardon Bridge					
Initiating: did it start well?	**Yes/No**	**Notes:** Excellent well prepared & rehearsed Context appropriate but start of tasks				
Capturing cognition:	**Achieved/not achieved**	**Notes:** The dual screen & head cam helped				
Environmental setting:	**Where is this set?** Bridge & other building on campus	**Does this match the information user and is this realistic?** Yes, the ocean through of the town so the bridge was busy				
Factors are fit for purpose within field test?	**Environment** Yes. Out side on bridge Good capturing technology to capture context	**Modality** Wandering & Visiting Does this match matter?				
	Information Seeking Clear & challenging interfacing between system					
From observing has the model ~~to~~ helped to supported the test?	**Yes/No** Reducing the distance would help	**Notes:** Created a clear setting with lots of tasks to create a rounded test strategy				
Supporting notes: Using head cam. A very well constructed test that has found some already results to support the test development The problem with this was the number of tasks & the ~~test~~ detail this required alot of workload of the tester impacting on realism						

More than one application used ie trackable interfaces with google maps - is this planning in the nature?

INSTRUCTION: Capturing the information need and the events in the non-participative field test

Date:	27/11/2013	**Test number**	
Scenario name:	[illegible] - [illegible] update	(1) circled / 2 / 3 / 4	
Student code:	Bear Grylls		
Initiating: did it start well?	Yes (circled)/No	**Notes:** Detailed briefing but there could be help i.e. from the participants perspective	
Capturing cognition:	Achieved/not achieved	**Notes:** But did interfere with participant	
Environmental setting:	**Where is this set?** [illegible] corridor	**Does this match the information user and is this realistic?** Yes	
Factors are fit for purpose within field test?	**Environment** Yes	**Modality** Could have used more modality to help them	
	Information Seeking Clear but were too prescriptive. Maybe using more external resources would help = Debriefing & ongoing		
From observing has the model ~~to~~ helped to supported the test?	Yes (circled)/No	**Notes:**	

Supporting notes:

Good questions to help gather qualitative data

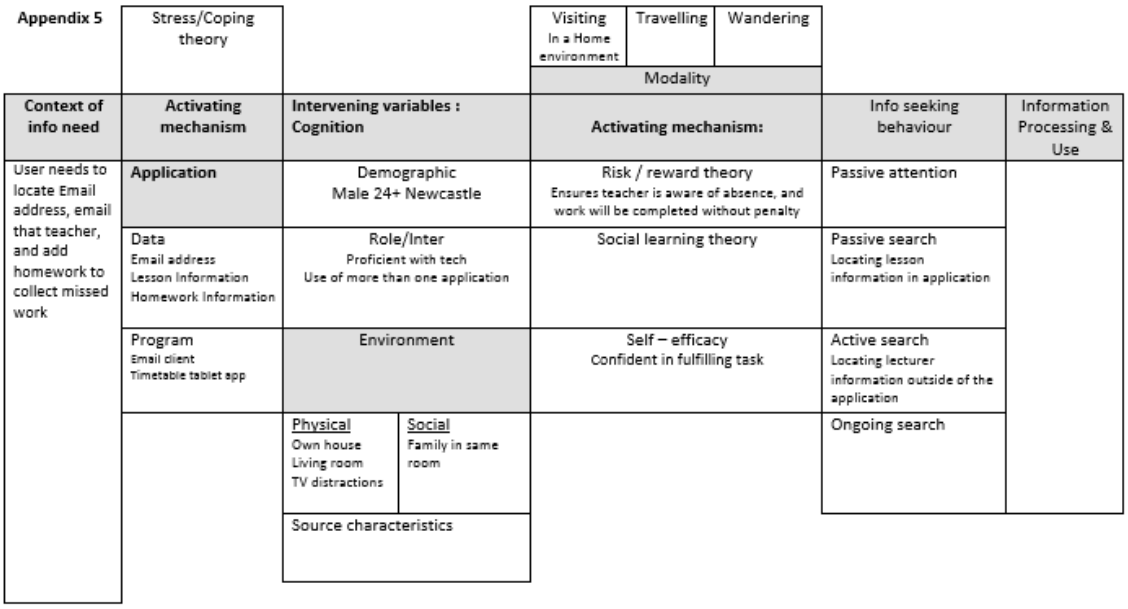
Thing shows good potential but does need to be tested before hand the context setting was too much for the participant so Bear kept interfering this ended up too prescriptive

APPENDIX N – TONY STARKS METHODOLOGY

Section of the Method and Test Design to show Tonys appreciation of user modalities

“The application was tested by the user under the three different types of modality, (Visiting, Wandering and Travelling) specified by Kristofferson and Ljunberg(1999) and would be compared to the pilot test conducted by the expert reviewer and the other users.
When constructing the scenarios there were initially five individual tasks. One larger scenario was then implemented using three of the tasks from the initial scenarios each with their own information need. This allowed for the other aspects of the modelled to be as accurately as possible without the user filled in, for example determining the environmental and social factors to coexist with the given modality. “

“The scenarios were ran within a school/university setting, and due to hardware limitations this meant the locations had to be within wireless internet range, this mean to all three environments had to be taken place in the same building.
Visiting was achieved by remaining stationary within the university environment.
Wandering was achieved by navigating quiet corridors during lesson periods.
Travelling was the modality which in the end had to be simulated as travelling by car/bus would not have the internet capabilities required. This led to courses being set throughout university corridors and class rooms while being pushed gaining the required social factors of both little and a significant amount of background noise and motion.”



Appendix P: Working Example

Test Application: Trainline.com		Test Situation: Walking to the train station		
1. Test Context	2. User Activation	3. User Profile	4. Seeking Behaviour	5. Process & Use
Test Activities	Device:	Psychological	Active Search	Closing the loop
• Train information (Monday 8:45 London > Newcastle). • Searching (quickly) for a ticket price at that time. • Texting a college of travel arrangements. • Searching for possible trains home round 16:30.	• Android phone • Test Requirements - Screen Recorder and audio output) - Go-Pro (Chest-Plate). - Diary to observe activities.	• A proficient user of the application. • Cognitive activity to find and share the information. • Stress full – have a time limit (2 minutes) to book and get the train on time. • Reward completed in time. • Risk miss the train and not able to share information.	• Looking, searching and extracting data to complete the activity.	• Train information is found and shared. • Ticket is purchased (to point of sale).
			Ongoing Search	
			• Once completed initial active search participant is looking for training the homeward journey.	
Environmental situation	Application:	Social Environment	Passive Search	
• Outside their house travelling to the station. • Running late, need to process transaction and share train information with a colleague.	• Trainline Application. • Android text application.	• Busy street with lots of people wandering around – people are talking and it aloud setting. • Many distractions	Passive by nature – participant is looking for information but not acting upon the search information.	
		Physical Objects		
		• Obstacles: People, pushchair, bikes and cars.		
	Data:	Modalities	Passive Attention	
	• Train ticket costs. • Train times.	• Walking at speed.	N/A	