Supporting NGO Intermediation with Internet Systems: Comparing Mobile and Web Examples for Reaching Low Income Urban Youth of Cape Town

By
FREDERICK WILHELM MEISSNER

Supervised By
PROFESSOR EDWIN BLAKE

Dissertation presented for the degree of Master of Science in the Department of Computer Science
University of Cape Town

January 2014

ABSTRACT

Intermediaries are necessary to overcome challenges of Internet use for many users in the developing world. However the need for co-presence with intermediaries can be inconvenient for beneficiaries, and the process is time consuming for intermediaries. We work with an NGO programme called Link which wanted to expose high school students from low income urban communities of Cape Town to Internet career guidance content, but did not have the staff power for regular in-person meetings with all of the students they wanted to reach.

We present Internet-supported intermediation, in which intermediaries create a source of content that is tailored to beneficiaries and is accessible using the most appropriate Internet technologies for the context. We discuss the use of two technologies, the web as accessed by conventional computers (preferred by the NGO), and the mobile Internet accessed through low end feature phones. In the target demographic the mobile Internet is very popular for entertainment, especially because of low cost for communication via instant messaging, but the web is more frequently used for tasks outside of entertainment.

Using an Action Research approach we implement two Internet systems to support Link intermediation, one a conventional website and the other a text interface suitable for access through mobile instant messaging. We evaluate the systems to determine whether they increase the impact of Link intermediation, and compare the usage of each to determine relative adoption of the technologies for a task outside of entertainment.

Students demonstrated capable but slow website use in controlled evaluations, but almost no use occurred outside of our presence. Most students were experienced mobile Internet users, and some began unsolicited use of the mobile system and demonstrated it to their peers. In eight months of simultaneous deployment website users demonstrated minimal engagement, while mobile system users made repeated visits at all hours of the day from varied locations such as homes spread across the city. Students' most frequent use of computers took place at venues where many users competed, and they prioritised other activities over the website during that access. Mobile use could take place when these restrictions did not apply.

The mobile system demonstrated the benefit of Internet support for intermediation: the number of students who viewed career guidance content through it no longer affected the Link team's effort, while students no longer had to travel to a single meeting place to access content. The consistent higher use of the mobile system than the website shows that the mobile Internet is suitable for non-entertainment use cases by low income urban youth.

CONTENT PUBLISHED ELSEWHERE

Some ideas and content from this dissertation have been published in academic venues.

Short papers:

F. Meissner and E. Blake, "Understanding culturally distant end-users through intermediary-derived personas," in Proceedings of the South African Institute of Computer Scientists and Information Technologists (SAICSIT) Conference, Cape Town, 2011, pp. 314–317.

F. Meissner and E. Blake, "Consequences of Software Design Decisions for Low-Income Communities: A Case Study," in Proceedings of the Southern African Telecommunications Networks and Applications Conference (SATNAC), 2011.

Full paper:

F. Meissner and E. Blake, "Availability4D: Refining the Link between Availability and Adoption in Marginalised Communities," in Human-Computer Interaction–INTERACT 2013, Cape Town, 2013, vol. 1, pp. 762–779.

GLOSSARY

- **Action Research (AR)** – research framework in which researchers and non-researcher partners collaboratively pursue research objectives and benefit to non-researcher partners in a cyclical fashion. Used in this project to frame our research and collaboration.
- **Afrikaans** – first language of most residents of Lavender Hill and Manenberg
- **Apartheid** – System of racial discrimination enacted as legislation in South Africa between 1948 and 1994
- **beneficiary** – Recipient of assistance in intermediation, in some way unable to make full use of technology without the help of an intermediary; also used to refer in general to high school students with whom Link
- **Content Management System (CMS)** – interface that allows non-technical users to maintain content in a database, typically for a website.
- **conventional web** – web access through desktop computers, unoptimised for mobile devices
- **EDGE** – pre-3G wireless network protocol with a peak bandwidth of 236 kb/s. Some devices owned by participants in this project support EDGE, but almost none support faster 3G connections.
- **entry** – unit of information used to describe Link content. Each course, bursary, etc. exposed by the Link website or LinkChat is stored as an entry.
- **entry detail page** – page of the Link website which exposes the full content of an entry
- **ExpressionEngine (EE)** – PHP content management system which underpins the Link website and LinkChat mobile system
- **feature phone** – a low end Internet capable mobile phone typically offering camera and Bluetooth features, but not touchscreen or fast 3G Internet connection
- **Generation Mobile** – Related study of Internet adoption by low income urban youth in Cape Town
- **GPRS** – wireless network protocol with peak bandwidth of 80 kb/s. Devices owned by participants in this study were more likely to support GPRS than faster Internet connections
- **homework club** – weekly event organised by the Link programme at a church in Mowbray, where the author acted as a tutor for high school students who were later recruited as participants in this study
- **high school** – grades 8 through 12 in the South African schooling system
- **ICT4D** – Information and Communication Technology for Development
- **instant messaging (IM)** – class of text message service which takes place over the Internet, typically offered without charge apart from data costs
- **intermediary** – actor who assists a person (the beneficiary) who is unable to use technology by using it on their behalf, or by providing access
- **Java ME** – Framework of libraries for the Java programming language which allows simple graphical applications to be built for low end mobile devices
- **Lavender Hill** – Low income area of Cape Town where the Link team built a relationship with a church group, where usability studies were conducted

- **life orientiation teacher** – A school teacher responsible for teaching life orientation subject which covers personal well-being, citizenship education, recreation and physical activity, and career choices
- **Link coordinator** – The lead staff member of the Link team
- **Link content** – Content produced or collated by the Link team, including tertiary education courses, bursaries, and job adverts
- **Link programme** – Poverty alleviation programme at The Warehouse NGO on which we collaborated
- **Link staff member** – staff member of the Link team
- **Link team** – Part-time staff members of The Warehouse NGO who worked on the Link programme, and with whom we collaborated
- **Link website** – Website designed in collaboration with the Link team and built by the author in order to disseminate Link content
- **LinkChat** – Mobile system which exposed Link content over instant messaging, built by the author
- **M4Lit** – Related study in which a 21 chapter short story was exposed over instant messaging
- **Manenberg** – Low income area of Cape Town where the Link team built a relationship with a church group, where usability studies were conducted
- **missed call** – Cost saving practice of communicating meaning by a number of rings in a voice call which is ended before the recipient answers
- **Mowbray** – Area of Cape Town where homework club meetings took place, at which usability studies, demonstrations, and interviews were held
- **MXit** – Popular South African mobile instant messaging service
- **MXit Lifestyle, Inc.** – Corporate owners of the MXit service
- **please call me** – Message which conveys to the recipient that a specified number wishes the recipient to call. Free service offered by cellular operators.
- **secondary intermediary** – Our term for actors such as church groups, libraries and schools who intermediate between our systems and students. We distinguish between these and the Link team, who intermediate between the Internet and students with the help of our systems.
- **SMS** – 140 character text message service offered by cellular operators which costs around 0.06 USD.
- **The Warehouse** – NGO focused on poverty alleviation in Cape Town which established the Link programme
- **township** – Informal settlement characterised by deprivation and poor infrastructure, in South Africa normally inhabited by race groups who were excluded from formal residential areas during Apartheid years
- **USSD** – Operator controlled technology typically used to allow text menu transactions to take place using numerical input
- **Ward** – Area which demarcates local government responsibilities, also used for elections and census counts. The City of Cape Town is divided into 111 wards.
- **Xhosa** – South African language and people group – roughly one million people in Cape Town

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1 INTRODUCTION

In this dissertation we investigate questions related to two topics of relevance to computer science in the developing world, where solutions must be found to obstacles to technology use that have not been considered elsewhere.

The first is *Internet-supported intermediation*: the use of the Internet to publish content tailored to developing world content consumers who struggle to use un-tailored content, on systems which are designed to be accessible within the infrastructure limitations faced by those consumers. The content is prepared by *intermediaries* (helpers) who would normally help *beneficiaries* (consumers of content) in person. Internet-supported intermediation and its benefits are described in more detail in Section 1.4.

Second, we compare adoption of the mobile Internet and conventional web for use outside of entertainment by teenagers from low income communities of urban Cape Town. They have minimal access to the conventional Internet, but many use the mobile Internet for entertainment. The mobile Internet as it is used by this demographic and our interest in it is introduced in Section 1.5.

To answer these questions we designed and evaluated two systems in collaboration with an NGO programme that ran career guidance workshops with high school students in some of Cape Town's poorest areas. They used our systems to provide information more regularly than they could run workshops. One was a conventional website, and the other a text interface accessible over the mobile Internet.

1.1 ICT4D and Technology Use Difficulties in the Developing World

This project falls under the sub-discipline of ICT for Development[1], which investigates ICT use in the developing world. Heeks describes the origin of the field as the coincidence of international development and the introduction of the Internet [1]. Goal 8F of the Millennium Development Goals [2] formalises the relationship between technology and development: "… make available benefits of new technologies, especially information and communications". The basis of Goal 8F is the observation that technology has benefited the developed world more than the developing world [2].

[1] The starting point for the choice of sub-discipline is our position at the University of Cape Town's Research Centre in ICT4D [91]. We are aware that the name "ICT for Development" opens it to criticisms of the sort that Dourish and Mainwaring call the "logic of lack": history may be reduced to a simplistic path on which the goal is for developing nations to resemble developed nations in all aspects; context can be erased while solutions are found for problems that researchers imagine rather than real needs; power is exerted in the name of universalising knowledge [92]. However, these issues are being examined by the field, without a definitive move away from the name. For instance, the title of Heeks' paper which suggests "per-" and "para-poor" work starts with "ICT4D 2.0", an implicit acceptance of the name even while recognising the need for change [1]. We continue in this tradition, heeding the warnings that the field already offers about top-down solutions, and embracing methods that privilege the perspectives of those who will ultimately use the systems designed. Sections 1.1 - 1.3 especially focus on this aim.

The obstacles to technology use in the developing world run deeper than simple lack. For instance, one third of more than 60 telecentres (shared facilities that offer access to desktop computers and the Internet, in areas where other access is minimal) in South Africa investigated by Benjamin were not operational at all four years after the start of the programme, despite external funding for purchase and installation. Benjamin found a variety of reasons why this was so: theft, technical problems, managerial weakness, financial problems, community conflict, fire, and wrongful repossession of equipment [3].

Other work which summarises difficulties identified over multiple projects includes:

- Brewer *et al.* categorise developing world technology use difficulties they encountered in eight countries as either technical (*e.g.* equipment failure), environmental (*e.g.* transport of equipment) or cultural (local communities responding to interventions in unanticipated ways) [4]
- Ali and Bailur identifies five dimensions of sustainability in the ICT4D literature: financial, social, institutional, technological, and environmental [5].
- The now-defunct[2] Bridges.org NGO compiled a list of twelve "Real Access Criteria", which can be understood as common areas of difficulty for ICT4D projects. They are: physical access, appropriateness, affordability, human capacity and training, locally relevant content, integration to daily life, socio-cultural factors, trust in technology, local economics, macroeconomics, and public support and political will

The holistic effort necessary to overcome these issues is summarised in Heeks' concept of "ICT4D 2.0", which "designs around the poor's specific resources, capacities and demands" [1]. Top down projects have failed to apply this: for instance, Benjamin discusses a centralised equipment replacement approach as being a hindrance to the effective maintenance of telecentres he investigated. On the other hand, telecentres which achieved financial sustainability were those where management developed new services unanticipated by the funding agency, based on an understanding of local needs [3]. Successful technology implementation is therefore dependent on successful understanding of specific user groups.

1.2 Difficulties of Design in ICT4D

There is a risk that even when successfully deployed, ICT4D projects might not address users' real goals. Methods such as user-centred design (UCD) attempt to increase the attention paid to user goals. However, UCD techniques are difficult to adopt in developing world contexts. Many of the same issues which plagued adoption of technology designed for a different context also affect the relationship between users and designers from different contexts.

There may be difficulty in physical access to users due to geographical distance [8] or safety concerns [9]. When in the same location, language may not be the same and cultural misunderstandings may occur [8]. Even once co-presence and communication are ensured, users who are not familiar with technology will not know what it is capable of and may have difficulty understanding designs and providing feedback [9, 10]. They may also be reluctant to express criticism of the work of researchers whom they perceive as powerful outsiders [9].

[2] Unfortunately all trace of the Bridges.org NGO has been removed from the web, but record of their framework exists in other academic work, for instance [6] and [7].

As a solution to these difficulties, Marsden *et al.* recommend working with "human access points". These are people who understand the target community but also have sufficient knowledge of technology to provide useful feedback to designers [11]. The NGO programme with whom we partnered played the human access point role on our project. They are introduced in Section 1.6.

1.3 Action Research Framework

In this project we used action research (AR) as a framework to guide our research. Action research attempts to benefit participants (our Link programme partners are introduced in Section 1.6) while simultaneously contributing to knowledge. Hearn *et al.* [12] cite Reason and Bradbury's "comprehensive definition" of Action Research:

> *"a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes... It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions of pressing concern to people, and more generally the flourishing of individual persons and their communities."*

AR is particularly appropriate to the field of ICT4D, in which participants' severe resource constraints make even small expenses (for instance due to travel) and opportunity cost of working with a researcher hard to replenish. AR prioritises the needs of participants ("…pursuit of practical solutions of pressing concern to people," from the definition above), even when those needs are outside of a researcher's theoretical interests. Hayes makes this case regarding the benefits of AR to the subset of the related field of Human Computer Interaction that shows "significant interest in doing research that has inherent value to society": "this view privileges local knowledge… all involved are co-investigators of, co-participants in, and co-subjects of both the change and evaluation activities of the project" [90]. AR thus ensures return on the resources that participants dedicate to the research process.

1.3.1 Themes

In AR, researchers begin a project with *research themes* that are based on theory and the researcher's interests [13]. Our research themes are introduced in Sections 1.4 and 1.5. Actual investigation is shaped by the application of research themes to participant goals. We discuss their application in Sections 1.6.2 and 1.6.3, and list the research questions that result in Section 1.7.

1.3.2 Cycles

Another important characteristic of AR projects is that they are iterative. Because AR has as its subject organisations or communities of people, and "people change over time" [57], it cannot be performed solely through laboratory style experiments which vary only one element and keep others constant [58]. Knowledge is instead generated through understanding the effects of change in a particular context. However, a contribution to knowledge beyond a single context is still important to AR [59]. What is lost by not being able to isolate effects is made up for through iteration in cycles. Lessons learned from action and reflection are fed back into the process of inquiry and examined in subsequent cycles – in this way, applicability to other contexts, or "recoverability" [13] is obtained. This also allows participants who are not technology experts (as

in the case of our partner NGO) to become accustomed to the possibilities of technology and make useful suggestions in later cycles.

In this project we used Susman and Evered's five step AR cycle (Figure 1, reproduced from [58]) for each iteration:

- **Diagnosing:** theory, a researcher's interests, and lessons learned from previous projects and cycles are applied to the problems faced by the organisation or community
- **Planning:** possible solutions to the problem are discussed
- **Action:** an action is performed
- **Evaluation:** the effects of the action taken are evaluated
- **Specifying Learning:** findings related to the action, the organisation, and theory are identified. These are used as input to the diagnosis step of the following cycle.

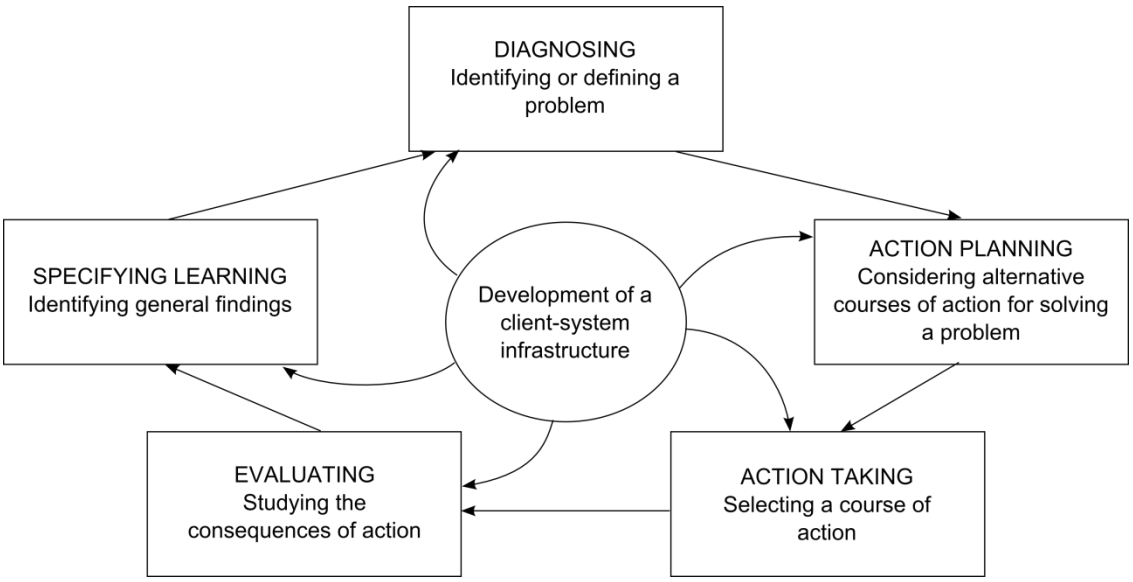

Figure 1 Susman and Evered's five stages of an action research process, redrawn from [58]. Each cycle of our project followed the five phases of diagnosing, planning, action, evaluation and specifying learning. This dissertation is organised accordingly.

This project consisted of six action research cycles (Chapters 3 to 8), each shaped by the aims of the NGO programme in reaching target communities (see Section 1.6) and our research themes. Multiple methods – including usability evaluation, system logging and semi-structured interviews – across different cycles helped us to triangulate [60] the effects of actions. Methods were chosen based on both data gathering needs and the values of the Link team (such as minimising the impact of our research on participants' time). Justification for each method is documented in the individual cycles.

1.4 Research Theme One: Internet-Supported Intermediation

Our first research theme is how to support developing world intermediation using Internet technologies. This theme is explained with reference to direct Internet access, and intermediated access which results from difficulty.

1.4.1 Direct Internet Access

The Internet offers benefits to both consumers and producers of content. Users who can find and use sources properly can meet their own information needs whenever and wherever they have access. Authors can create content without being concerned by how many users access it.

However, in our developing world context, many users lack skills and resources necessary to make good use of the Internet. They may struggle with synthesis of multiple sources, possess insufficient literacy or digital skills [14], or face barriers to access such as insufficient infrastructure or the lack of a suitable device [1]. Some users may not even know that there is useful information available on the Internet [15]. These possibilities are represented in Figure 2.

1.4.2 Intermediated Internet Access

Developing world community members frequently enable technology use for others who are unable to operate it entirely on their own. This process is called intermediation [16]. Figure 3 represents how beneficiaries who are prevented from accessing the Internet may receive the assistance of an intermediary who does have sufficient access and skills.

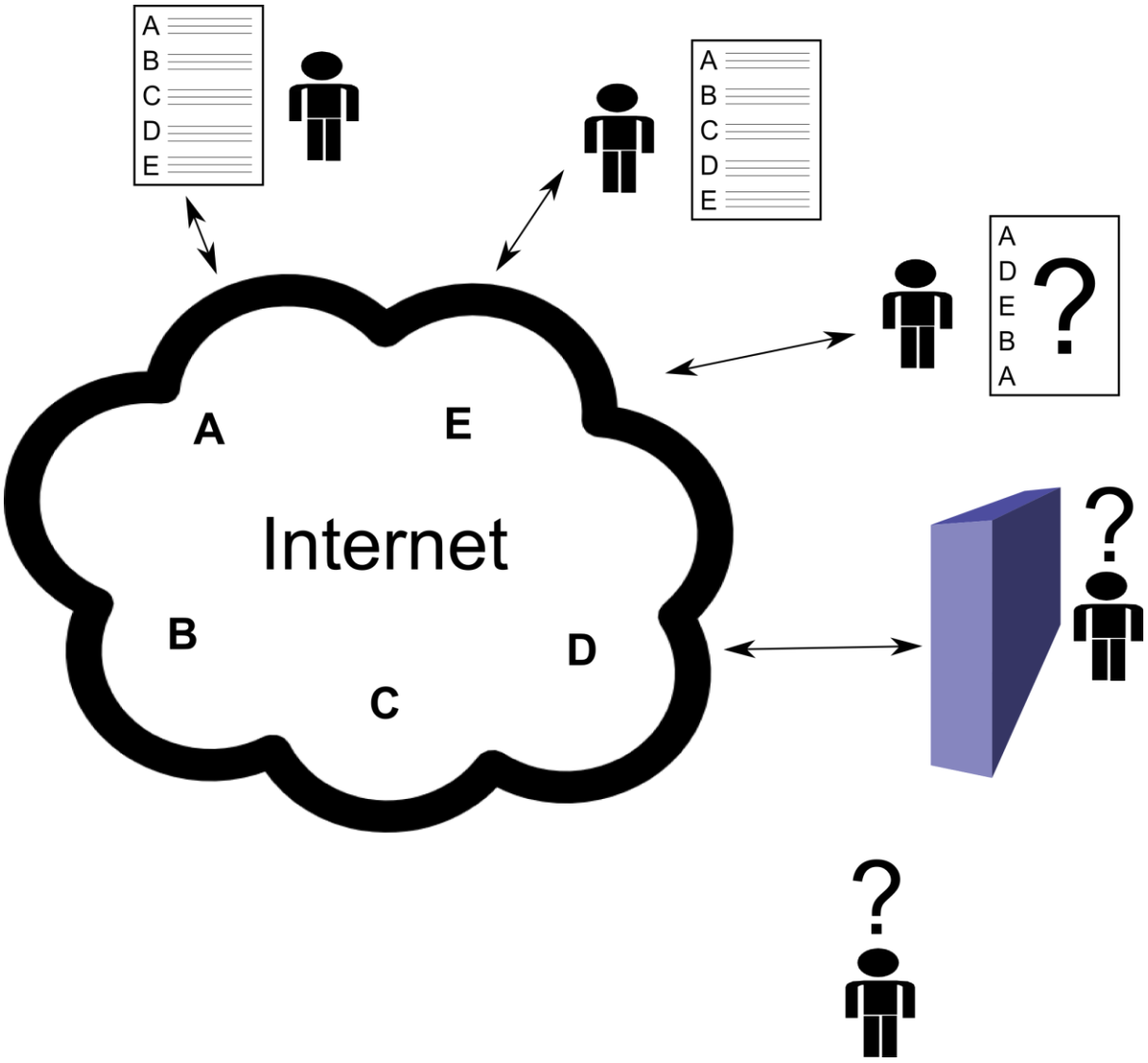

Figure 2 The Internet is not necessarily useful to developing world users. Information must be synthesised from multiple sources (represented as letters), which is not a skill all users possess, and a lack of resources or infrastructure may form access barriers, while others may not even be aware that suitable information exists.

Sambasivan *et al.* investigated intermediation in Indian slums and found factors that drove people to seek help rather than access technology directly [16]. We reproduce their list here, together with examples from their work:

- Fear of the technology: an older woman reported that dialling a phone number was something she would ask younger people to do for her, offering a perception of her generation as technologically illiterate by way of explanation
- Lack of textual literacy, numeracy, or digital operation skills: an alarm clock owner could only read the time on their alarm clock, but not set it
- Habits of dependency: beneficiaries turned to their existing relationships for help with technology. A woman whose finances were handled by her son also relied on him for help operating her mobile phone
- Cost of ownership: interviewees had minimal income and little left over after paying for basic necessities
- Access constraints: societal, geographical, or financial constraints affected technology access. For instance, women were less likely to have access to a mobile phone because their husbands would take the household's only mobile phone with them to work.

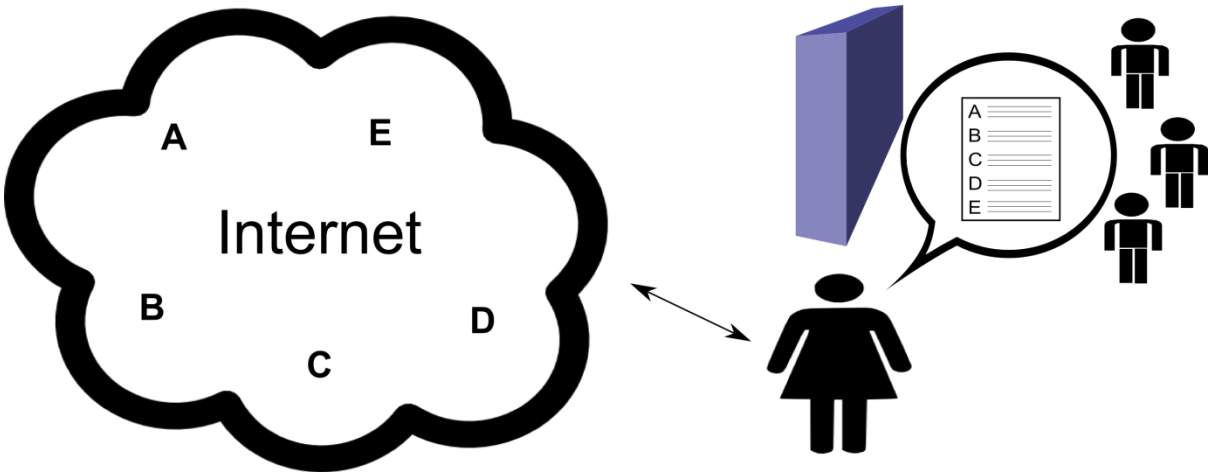

Figure 3 Intermediation compensates for difficulties of Internet use, but decreases convenience for beneficiaries, and increases effort for publishers. The example in this diagram is of a helpful intermediary (large figure) obtaining the information beneficiaries (small figures) are interested in from the Internet, and communicating it to them verbally.

A feature of intermediated interactions is that they require the co-presence of intermediaries and beneficiaries [16]. This removes some of the convenience which is associated with direct Internet access. Further, content authors must consider that each consumer who needs intermediation will require someone's help. It will be in the interest of authors to ensure that a suitable intermediary does exist, because without them no access will take place. There is therefore a burden per user on authors who hope to reach this type of user.

1.4.3 Supporting Intermediaries with Internet Systems

In Figure 4, the intermediary has created an Internet source which can act as a proxy intermediary to beneficiaries. Content that is tailored to the needs of users is exposed using

appropriate technology: slow Internet connections, low-end hardware, and so on. This is different from the original sources, which are not created with specific user groups in mind.

The advantage over intermediated access is that Intermediary and beneficiary no longer need to be co-present, restoring the convenience of the direct access for beneficiaries. The intermediary effort is no longer a function of the number of users who need help.

Intermediaries are not necessarily well positioned to create Internet systems. In this project we designed and evaluated systems an intermediary group used to publish content without having to be aware of the technical details of Internet technologies.

Of course, the need for intermediation remains for developing world users who have no means to access the Internet at all. In this case, beneficiaries may find a greater number of appropriate intermediaries: where before help with content and with access was necessary, now intermediaries who have access but not knowledge about the content may also be of use. Such intermediaries are discussed in Section 1.6.2.

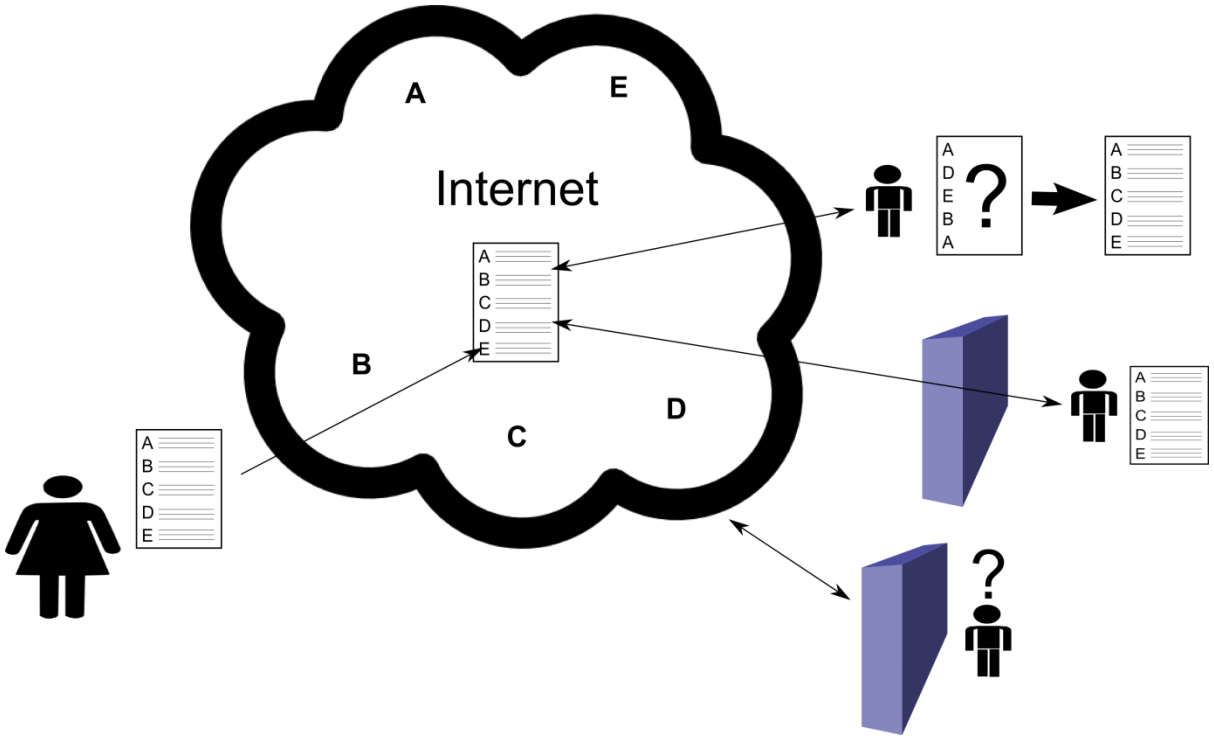

Figure 4 Intermediation can be supported by Internet systems, where some Internet access is possible.The intermediary (large figure) has created a source on the Internet with content and technology tailored to beneficiaries (small figures). The possibility of access outside of the beneficiary's presence increases convenience for beneficiaries and reduces effort per beneficiary for intermediaries.

1.5 Research Theme Two: Mobile Internet in Urban South Africa

High rates of mobile phone ownership (126 per 100 inhabitants [17]) and the high cost of competing communication technologies such as SMS and voice [18] have created favourable conditions for the mobile Internet in urban South Africa. In low income communities, many teenagers have adopted the technology for entertainment (discussed further in Sections 2.5 and 2.6).

In the absence of easy desktop computer access (PC ownership stands at 19.5 per 100 households [17]), their Internet experience is through low end "feature phone" devices. They offer a small screen, slow Internet connection, and input only via twelve button numbered keypad. An example is shown in Figure 5. The difference in input, output, and connectivity have made services different from those associated with conventional computers and smartphones popular. The canonical example is the MXit mobile instant messaging (IM) service, which claims 9 million active (60 million total) user accounts [19]. Mobile IM particularly benefits from cost comparisons: a 160 character SMS costs USD 0.1 while a thousand characters of text transferred over the Internet costs USD 0.0002.

Our initial research interest was in whether mobile Internet services in a domain outside entertainment – but taking advantage of existing patterns of ownership and spending on mobile connectivity – would be adopted by low income urban youth. Some studies report that tasks such as research for school homework are more strongly associated by teenagers with conventional computers [20], [21], and Smyth *et al.* find that entertainment is stronger motivation for overcoming technology difficulties than other developmental content [22]. We planned to investigate whether mobile Internet use was subject to rigid preference for entertainment, or just that these teenagers had not encountered content and services which were specifically designed for it.

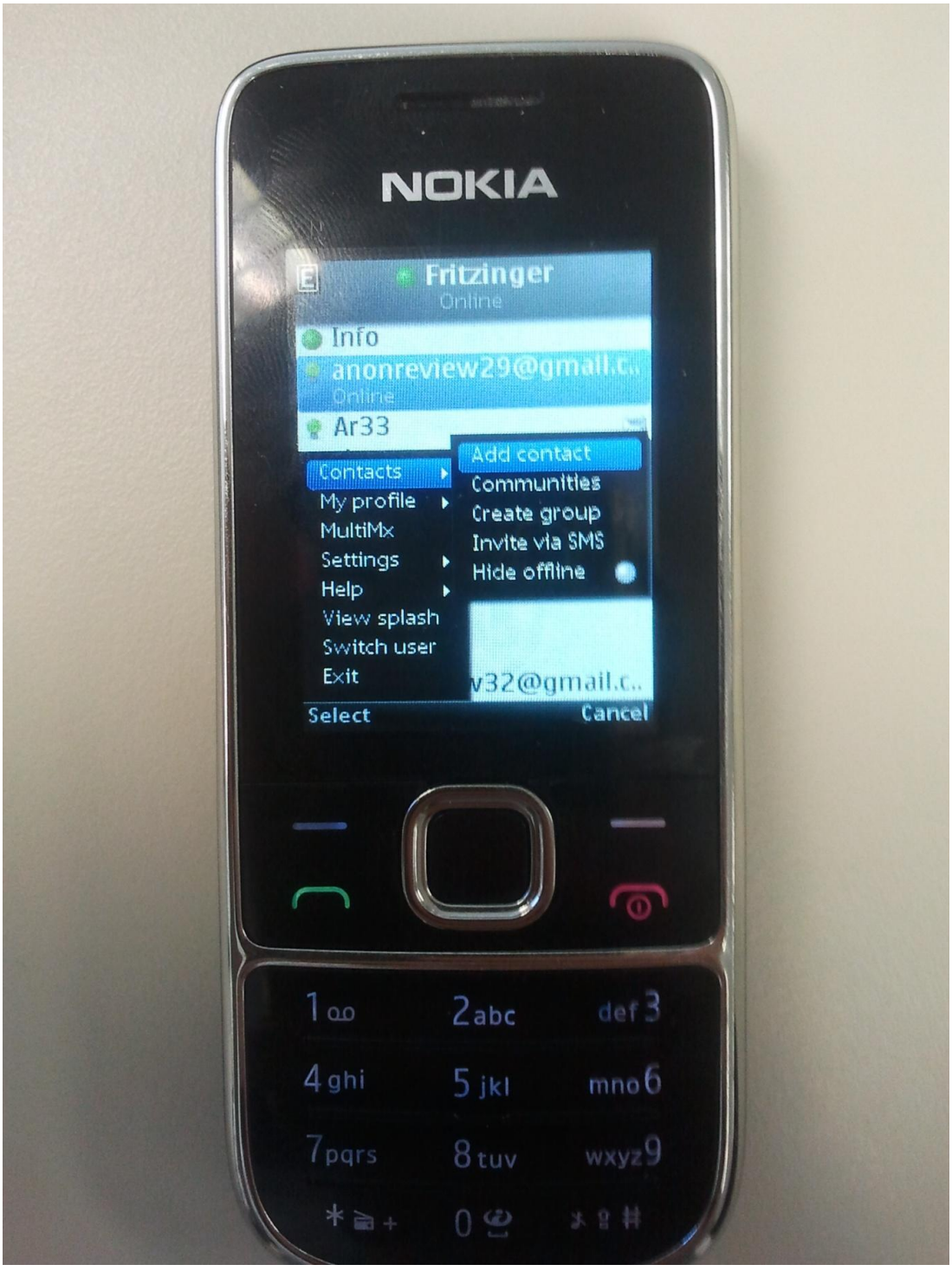

Figure 5 Typical feature phone used by low income teenagers for mobile Internet access, the Nokia 2700 classic. It offers slow Internet connectivity, small screen, and numbered keypad for input. This device is running the MXit instant messaging client. MXit is popular in low income urban communities because Internet instant messages are orders of magnitudes cheaper than SMS.

We return to this theme in Section 1.6.3 when we discuss how the theme applies to this project.

1.6 Link Programme at The Warehouse NGO

The Warehouse NGO [23] operates a number of poverty alleviation programmes in Cape Town. We collaborated with one of these programmes, called Link, which ran workshops with high

school students from low income communities to prepare them for tertiary education or the job market.

Link programme staff (hereafter referred to as the "Link team") gave us access to users (their beneficiaries) and provided design insight. Their insight helped us avoid the problematic top-down approach that we have identified in Section 1.2.

The students with whom the Link team worked were normally members of church youth groups (churches being a particular focus of The Warehouse NGO). Workshops were normally hosted at church venues.

1.6.1 Intermediation between Students and Internet

We discussed in Section 1.4 how developing world users face difficulties using the Internet and that intermediation may emerge as a result. This phenomenon had emerged in the Link team's relationship with students, who were unable to access and apply information that was available on the web:

> *"We went back to Khayelitsha and to Gugulethu [informal settlements in Cape Town] and we ran a 'helpdesk' where we brought the computers, we brought application forms, we brought information about universities so that they could actually apply... but we didn't have enough capacity. There was me and [redacted] with one computer, and no printer. So we really had to think ahead about what information we needed to take with us, to make copies, and then actually sit with the kids and help them fill out the forms... these kids had had no career counselling ever. They didn't know what a bursary was."* – Link coordinator

> *"Finding content is very overwhelming... because, when you go onto any other websites you have to mine for the information that you're looking for, and nine out of ten times I think what kids look at ends in a dead end, and then you don't have time to explore dead ends. Somebody needs to do the work to make sure that of the two things you look at, they are two relevant things."* – Link coordinator

The Link team's assistance was necessary for Internet content to become useful, but intermediation on a regular basis to the number of students they hoped to reach was beyond their staff capacity.

1.6.2 Application of Internet-Supported Intermediation theme

The Link team hypothesised a website that could address the disparity between students' need to engage with Internet content and the available capacity from staff members. Frequently updated content (job openings which would fill, for instance) would be on the site, while workshops could run at a sustainable pace. The site would be easier to use than pre-existing Internet sources because it would be tailored to students.

This website would realise the concept of Internet-supported intermediation which we introduced in Section 1.4.3. Career guidance information could be published with a single action, and many students could access it as often as necessary without extra effort on the part of the programme staff.

The Link team had considered that access would require a computer and Internet connection, which would be an obstacle. They had identified s*econdary intermediaries* – our term – who could address this. Ideally, partner churches would invest in sufficient technology to give students access from church premises. There was also the possibility of access to shared computer and Internet infrastructure, for instance at public libraries [24]. These groups would act as intermediaries of our systems rather than the broader Internet, as they did not have the same subject knowledge as the Link team.

1.6.3 Application of Mobile Internet theme

We believed that our mobile Internet research theme (see Section 1.5) could be usefully applied to the benefit of the Link programme. Their beneficiaries were in the low income urban youth demographic with whom we knew the mobile Internet was popular, and the career guidance domain was suitable for an investigation of non-entertainment content.

However, when we suggested a mobile Internet system to the Link team they were hesitant. Limited experience of the mobile Internet left them unsure of its suitability to the task. They were aware that mobile phones were popular, but believed them inferior to conventional computers for reading, and were concerned that mobile data costs might be high. They were also confident that between church partners and public venues the necessary infrastructure for access to a website did exist.

To proceed with a mobile system regardless of the Link team's perspective would be contrary to the democratic nature of action research, and to advice in the ICT4D literature about technology interventions being more successful where they complement an existing developmental effort [25, 26].

Compromise provided us with opportunity to assist the Link team and pursue our research theme. We would develop both the proposed website and a mobile system, and the Link team would allow us to test both with their beneficiaries. The website was their top priority, and hence this became the focus of our first action research cycles (Chapters 3 through 5). We anticipated that some design and back-end work would be reusable when we moved to a mobile system.

1.7 Research Questions

Our research questions arise at the intersection between research themes and the Link team's plans. They are as follows:

1. Can we increase the impact of Link team intermediation, and reduce the inconvenience for student beneficiaries, if we provide a system that implements Internet-supported intermediation? If not, what prevents the new information source from being used?

Impact of intermediation is measured in terms of number of interactions between students and the system, repeat access to content, and exposure to multiple original sources through our system.

Convenience for students can be measured in terms of the hours and venues at which they access it. The five factors driving beneficiaries to seek intermediary assistance (fear, skill, cost, dependency, access constraints) identified by Sambasivan *et al.* in Indian slums [16] are used to reflect on cases when intermediation support is not successful.

2. Is there a difference in adoption between mobile Internet and conventional web technologies when both are available to low income urban youth as options for accessing content outside of the domain of entertainment?

Adoption is measured in terms of number of users and number of interactions on two equivalent systems, one a conventional website, and the other optimised for the mobile Internet.

The output of this research will contribute to the understanding of the ability of technology to support intermediaries and connect them to more beneficiaries. It will also provide recoverability [13] regarding the applicability of desktop and mobile Internet technologies for small NGO programmes like the Link team.

1.8 Outline

In Chapter 2 we cover topics which are necessary to understand the rest of this dissertation. Research question one leads us to consider intermediation in other developing world projects. We then describe the context in which we operated, where and how we interacted with participants, and the level of Internet access available amongst their demographic, according to other studies also performed in urban South Africa. We also discuss other developing world studies comparing one or more mobile systems.

The six cycles of our action research approach are documented next, one per chapter. They are structured as per the five step action research cycle we used (outlined in Section 1.3.2). Of special importance is the specify learning phase of each cycle, which informs the following chapter and the ultimate findings of this dissertation.

In Cycle One (Chapter 3) we met the Link team and their beneficiaries for the first time. We designed the first version of the Link website in collaboration with the Link team. In order to test the site's potential for intermediation support we performed a usability evaluation with a small group of students from two church groups (the church groups are introduced in Section 2.2.3). The evaluation revealed usability obstacles that would prevent intermediation.

In Cycle Two (discussed in Chapter 4) we reacted to the usability difficulties identified Cycle One by making changes to the Link website. Evaluation showed improvement: Where users had difficulties they were slowed but (for the most part) not prevented from completing tasks, and we found evidence of improving skill as the evaluation proceeded.

In Cycle Three (Chapter 5) we made the website accessible over the Internet. Unfortunately, system logging recorded minimal engagement. Three causes were possible: the Link team might have overestimated the beneficiaries' desire for their content, students might not be aware of it, or students had difficulties accessing the website.

In Cycle Four (Chapter 6) we learned that communication to students had broken down, and few were aware of the website's existence. While the Link team investigated, we created a mobile Internet intermediation support system. We performed a usability evaluation with a small group, who all demonstrated the ability to operate it. However, feedback ranged between enthusiasm and unwillingness to use it.

In Cycle Five (a) (Chapter 7) we began a comparative, controlled evaluation of the two systems. Controlled evaluations proved inappropriate when system logging began to record significant unsolicited use of our mobile system, and we ended the cycle early.

In Cycle Five (b) (Chapter 8) we advertised both systems to a single group. System logging over eight months' parallel deployment enabled us to answer both research questions. We demonstrated benefits of Internet supported intermediation for both students and the Link team. Mobile use accounts for almost all evidence of Internet-supported intermediation. Qualitative feedback revealed that computer access through secondary intermediaries required significant effort, but that mobile phones were personally carried, or borrowed from peers and family. The latter allowed Internet-supported intermediation to take place in times and places where other activities did not take precedence.

In the conclusion (Chapter 9) of this dissertation we draw together the findings from each cycle and reflect further on our two research questions. We also reflect on method, summarise the contributions which we make to research from this study, and discuss future work.

1.8.1 Project Timeline

Figure 6 shows approximate dates for significant events in the project. Action research ran from September 2010 until the end of October 2012. Cycles Five (a) and Five (b) overlap because the data considered in the latter was gathering at the same time as the events of Cycle Five (a).

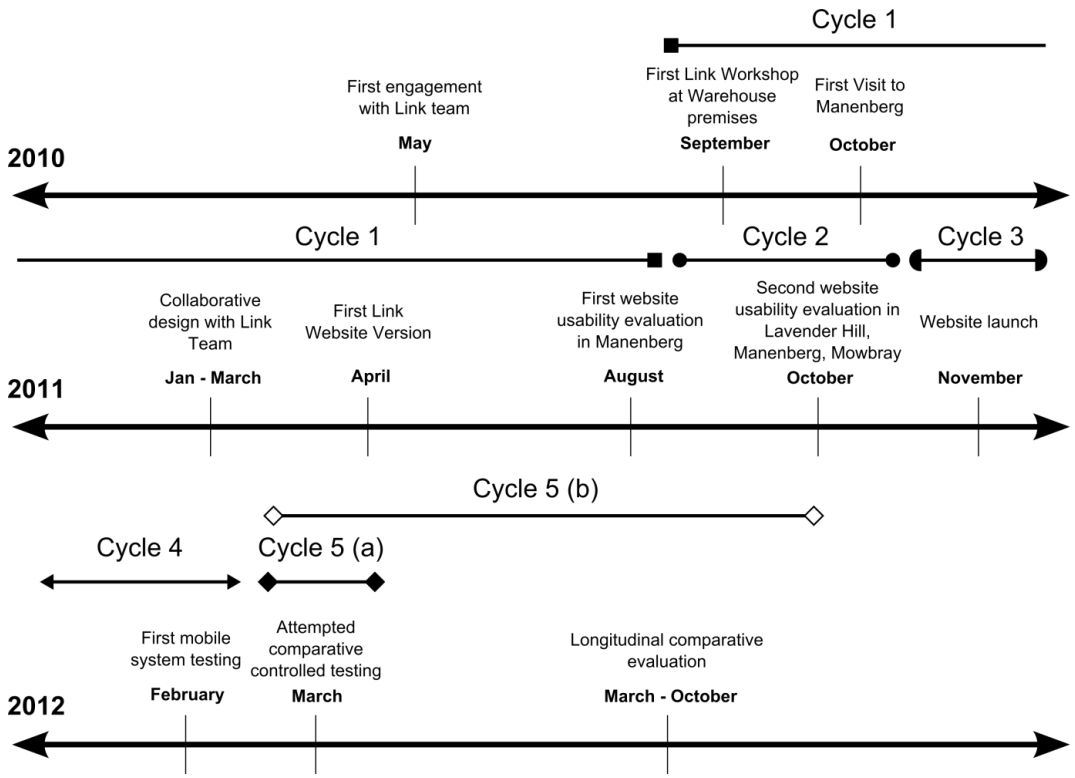

Figure 6 Research project timeline. The project began in May 2010 and ended in October 2012. We show the six action research cycles, as well as significant events – first visits to fieldwork locations, and evaluation steps in each cycle.

2 BACKGROUND

In this chapter we discuss other work which relates to our two research questions, as well as contextual information about our participants, and technology use habits of people in the same demographic.

2.1 Technology and Intermediation in the Developing World

In this section we bring together insights from other work which involves technology and intermediation (see Section 1.4) in the developing world. These insights have consequences for what other work we review in this chapter, and for how we review findings in later chapters.

2.1.1 Benefits of Intermediation to End Users

Intermediation makes technology use possible where beneficiaries lack access to technology or lack education or literacy to use it effectively [27–29]. Parikh and Ghosh emphasise this point:

> *"In India and elsewhere in the developing world, for all except the richest (and most westernized) individuals, cooperation is a requirement rather than an option for most computing interactions."* [28]

Difficulties in using technology and user preference are inter-related. When Sambasivan *et al.* discuss fear of technology as a driver towards informal intermediation [16], it is explained as a pattern amongst people "lacking technology-operation skills". Parikh and Ghosh discuss Indian bank customers and railway passengers who preferred human tellers over recently implemented automated systems for the same tasks [28].

2.1.2 Benefits for Other Actors

Intermediation may also bring benefits beyond access for the group introducing the system. Technology owners may prefer intermediation over direct use of their equipment [28]. A related benefit exists for technologists: if equipment is paid for and maintained by intermediaries or their employers, higher end devices than are commonly available may be used, as in the work of Talbot [30], and Chepken *et al.* [29]. In these interventions, Android smartphones which allow easier programming than low-end alternatives [31] were used.

For Talbot, an NGO partner felt that field officers would gain some respect from beneficiaries when they were seen to be using smartphones. As a researcher, Talbot benefited because the group of field officers was a small audience that was easier to manage in pilot phases than allowing every potential user to access their system immediately [30].

2.1.3 Negative Consequences

Intermediation does not necessarily create problem-free interaction for users. In the previous example of Indian bank and railway offices, customers endured long queues because of their preference for human tellers [28]. Sambasivan *et al.* note that in informal intermediation, "interactions are negotiated and constructed around the intermediary-user's availability" [16].

Intermediaries may make mistakes while translating beneficiary intent into input, or discard useful output based on assumptions about what information a beneficiary needs [28]. If intermediary understanding of content is poor, "information loss" may also occur [16].

Where intermediation is planned as part of a programme of use, organisers must consider the cost of employing intermediaries. This is not a problem where such intermediaries exist already. In Talbot's work, a mobile stock ordering application complemented a pre-existing process which involved the physical transfer of cash to an NGO employee. The NGO employee was thus a natural intermediary for whom Talbot could design [30]. The cost of labour may also be acceptable if, as Parikh and Ghosh report of India, "labor is cheap and abundant" [28].

Intermediaries may also bring an agenda that is unhelpful, as in the case of the Indian press who reported using content from the Central Vigilance Commission website in India. The website was set up to democratise reports of government corruption investigations, but unfortunately saw relatively little use. Press reports increased the visibility of the information, but focused only on the highest profile investigations [32].

2.1.4 Way Forward

Our attempt to support the Link team's intermediation with Internet systems is a re-balancing of its positive and negative consequences. The Link team provide good intermediation of Internet content due to subject matter expertise and existing relationships with students, but they do not have capacity to support per-user intermediation, and there is no budget for more staff. On the other hand, they had identified secondary intermediaries in the form of partner church groups and shared Internet access venues (see Section 1.6.2).

Similarly to Talbot's work [30] the possibility exists of piloting our systems with a small group of beneficiaries with whom the church groups work. However, as we re-introduce Internet technology, we expect to lose some other benefits of intermediation identified above. Technology that is outside of the norm will not be available, and there is therefore a need to test whether unassisted use of our systems is possible, because some secondary intermediaries are not connected to the Link programme and will only assist by providing access to the Internet. None have the same subject matter expertise as the Link team.

Regarding secondary intermediaries, we are given caution by other work. In India, PC kiosk operators expressed concern over a lack of commercial benefit to their participation in the aAqua agricultural information system project [33]. Veeraraghavan *et al.*[3] discuss criticism of the sustainability of PC kiosks in the eChoupal and e-Sagu systems [34]. There is no possibility of commercial benefit from the Link programme, but we could minimise additional investment by using web technologies which are compatible with older computers and slow Internet connections.

People and conditions vary greatly in different parts of the developing world. An obvious example is the difference in literacy between South Africa (70.4% literacy amongst adults over

[3] There is obvious parallel between the work of Veeraraghavan *et al.* and our own, given that they too compared mobile and PC-based information dissemination systems. We discuss their study further in Section 2.7.1

the age of 25) and India (38.7%) where most work discussed here[4] was conducted [35]. We review the specific context of our work – communities from which our users were drawn, and the Link team's relationship with beneficiaries – in Sections 2.2 and 2.3.

We are also prompted to examine the specific technology difficulties and preferences of our users, which are a product of available resources and previous experience of technology use. This is the topic of Sections 2.4 through 2.6.

2.1.5 Factors Motivating Intermediation Guide Reflection on Difficulties

We will reflect on difficulties of technology use in this project as we consider Internet-supported intermediation in the specify learning phase of each action research cycle (the cycle concept is introduced in Section 1.3.2). In Section 1.4.2 we introduced the five factors identified by Sambasivan *et al.* (cost of ownership, access constraints, habits of dependency, skill, fear of technology) that motivated people in Indian slums to seek intermediation rather than use technology directly [16]. These factors inspire our reflection.

Departure: Financial Considerations

Financial costs relate to two of these five factors. Cost of ownership is considered separately from ongoing costs, which Sambasivan *et al.* categorise as an aspect of access constraints [16]. We do not reflect on cost of ownership separately from other costs, because the issue of paying for ownership is blurry for our audience. For teenagers, we might consider a device that has been paid for by parents to be personally owned, or it might be considered owned by their parents.

Instead, we refer to "financial considerations", which include any data discovered about finance, while considering other access constraints separately. The five factors we use, then, are:

- financial considerations
- access constraints
- habits of dependency
- skill
- fear of technology

2.2 Context: Urban Poverty

2.2.1 Urban Poverty and Technology Access

Most ICT4D interventions between 1995 and 2010 target the rural poor [36]. This reflects the aggregate reality of developing world regions in which such work takes place, for instance in Sub-Saharan Africa and South Asia where only 37% and 33% of the respective populations are urban. However, in South Africa a much larger percentage (62.4%) of the population is urban [35]. Further, the aggregate reality is not static: the 5.5% rate of urbanisation between 2000 and 2012 in South Africa is similar to the rate of Sub-Saharan Africa as a whole [35].

[4] The exceptions are Talbot [30], whose work was also in South Africa and Chepken *et al.* [29], who worked in South Africa and elsewhere in Africa. Both interventions relied on intermediaries with specific funding for mobile devices to be used in their projects.

The urban poor are therefore an important demographic for ICT4D work in South Africa, and will become increasingly under-represented elsewhere if current trends of urbanisation continue but ICT4D focus remains on rural areas. The nature of the work may change as focus shifts from rural locations, for instance ICT4D work which focuses mainly on overcoming infrastructure obstacles may be more applicable to rural areas [37]. In South Africa however, proximity is not a guarantee of access. Local government charges for services such as electricity, and access is cut off when payment is not made [38].

Infrastructure access therefore becomes a question of income to afford services rather than a complete absence. An important change from complete absence is that use of low cost technologies and cost-cutting techniques can increase the amount of access possible. This impacts our users and secondary intermediaries who might have to invest in new technology (see Section 2.1.4).

2.2.2 Economic Disparity

Motivation for moving into low income areas of Cape Town (usually from rural areas) frequently involves access to work opportunities [39], but the move does not guarantee employment. Table 1 shows economic indicators for areas of Cape Town in which some of our participants lived, as well as one wealthier area for comparison. Variation between the poorer communities (first six rows) is minimal compared to the difference between them and the wealthier ward 58 (also the location of our department at the University of Cape Town).

Table 1 also shows the percentage of households living in informal housing in each area. Informal housing is poor protection against damp and fire [39], and is a marker of the most marginalised households [21].

Table 1 Census 2011 household income data shows great economic disparity in Cape Town. Many of our participants live in the wards listed in the top six rows, which are much poorer than the last, ward 58. Inhabitants of these areas also face significant social problems.

Ward[5]	Area Names	Unemployed and Discouraged Work Seekers[6]	Mean Annual Household Income (USD)[7]	Percentage Informal Housing[8]
36	Crossroads-Nyanga	32%	3,479	39.2%
37	Nyanga	39%	3,688	27.2%
38	Gugulethu-Nyanga	36%	6,054	12.2%
39	Crossroads-Nyanga	35%	3,310	55.2%
42	Gugulethu-Manenberg	29%	4,056	48.0%
89	Khayelitsha	25%	2,778	86.3%
58	Claremont-Kenilworth-Rosebank-Rondebosch	3%	41,765	0.2%
-	Cape Town	19%	18,579	20.4%

[5] Election ward area, also used in Statistics South Africa census data [40]
[6] Unemployed and discouraged work seekers as percentage of working age population (18 - 64) [40]
[7] Calculated using the mid-range and frequency values of income interval data (currency conversion: 10 ZAR = 1 USD) [40]
[8] Percentage of households in ward living in informal housing [40]

2.2.3 Venues and Apartheid Disadvantage

Figure 7 is a map of the southern suburbs of Cape Town, highlighting the venues for our work. Programming and writing took place in our research group's lab at the University of Cape Town (part of ward 58 in Table 1), while meetings with the Link team were usually held at The Warehouse. These two locations are marked with red pins.

The M5 route (marked in red) marks a significant boundary of apartheid-era racial segregation. Under the Group Areas Act of 1950, most of the previously racially mixed areas to the West of the M5 were designated "white". The legislation required "coloured" people (descendants of colonial era slaves, as well as indigenous groups) who lived in these areas to move to neighbourhoods to the east of the road [38]. Manenberg (green) and Lavender Hill (yellow) are amongst these, eight and thirteen kilometres respectively from our University. Manenberg was included in Table 1, but Lavender Hill was excluded as data for the relevant ward is misleading because it includes wealthier areas. During field work we visited one church in each of Manenberg and Lavender Hill (approximate locations marked by yellow pins).

"Black" (mostly Xhosa-speaking) people were mostly settled in townships even further away, large areas stretching South and East of Manenberg [38]. The students we met in Mowbray (blue) attended school there but travelled daily from many different parts of these townships, including those in Table 1. We met these students at a third church venue, in Mowbray (yellow pin).

Although used for discriminatory purposes in apartheid, "black", "coloured" and "white" are terms with which communities in Cape Town self identify. In one of our interactions with students from Mowbray we learned that they strongly identified with the label "black", and felt it was important for other people in South Africa to hold a racial identity too. We continue to use the terms here without quotation marks to describe the impact of legislated racial discrimination and resulting long-term social effects.

Segregation was not the only consequence of apartheid legislation. Black and coloured communities faced underinvestment in infrastructure, housing, and education. Having been moved out of areas close to business districts, workers faced longer and therefore more expensive commutes [38]. All of these disadvantages resulted in poverty that together with social ills such as gangsterism and substance abuse [39] are endemic.

Formerly white areas have enjoyed much greater prosperity than either since apartheid's end, and the city is still settled largely in apartheid patterns [38]. Therefore, when addressing poverty, The Warehouse finds itself working primarily in formerly black and coloured areas, with victims of apartheid or their descendants.

It is worth noting that although Mowbray was previously designated a white residential area (parts of it are included in ward 58 – see Table 1), we met students from black communities there because they attended school in the area. The Mowbray church where we worked is next to a transport hub through which the students passed on their daily commute. Besteman describes the phenomenon of integration in the otherwise segregated city during working hours:

> *'During the day, schools and business in white neighborhoods and the downtown become integrated spaces; people of color from outlying areas commute in as students and workers. But at night Cape Town has, as Fanie du Toit of the Institute for Justice and Reconciliation expressed it, "nocturnal withdrawal".* [38]

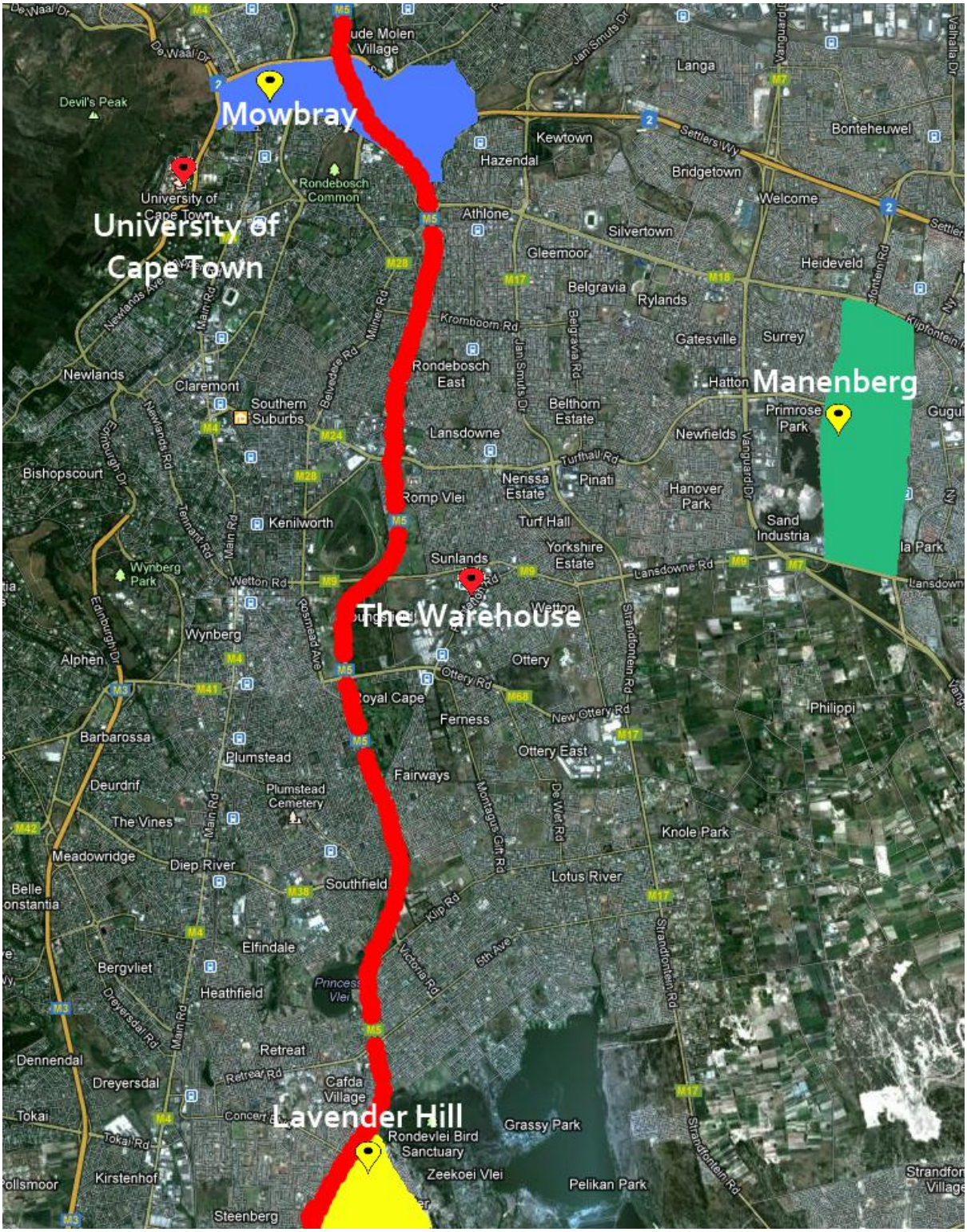

Figure 7 Map of the southern suburbs of Cape Town, showing workplaces of ourselves and the Link team (red pins) and the church locations for fieldwork (yellow pins)

2.3 Relationships with Beneficiaries

In Figure 8 we show the relationships between groups in our project. We worked directly with the inner circle – the Link team and supporting staff at The Warehouse. The outer circle represents church groups with whom the Link team had built relationships. We make a distinction between

the venue where we had direct contact with students (the church in Mowbray) and the two where contact was via church leaders (Manenberg and Lavender Hill). The diagram also shows an unnamed cluster of churches, representing churches with whom the Link team hoped to build relationships, but where they had not yet run workshops.

Large figures in the outer circle represent church or youth group leadership. The long term Link plan was that such leaders would eventually run workshops themselves. At the start of our project, the Manenberg and Lavender Hill leaders had the strongest relationships with the Link team. Workshops there were still being run by the Link team, but they relied on leaders to organise students' attendance.

Students are shown as small figures. In most cases, they are outside of the two circles, separated from us by two layers of organisation. The exception is the Mowbray group. There, access to students was not via church leadership (see Section 2.3.2 below).

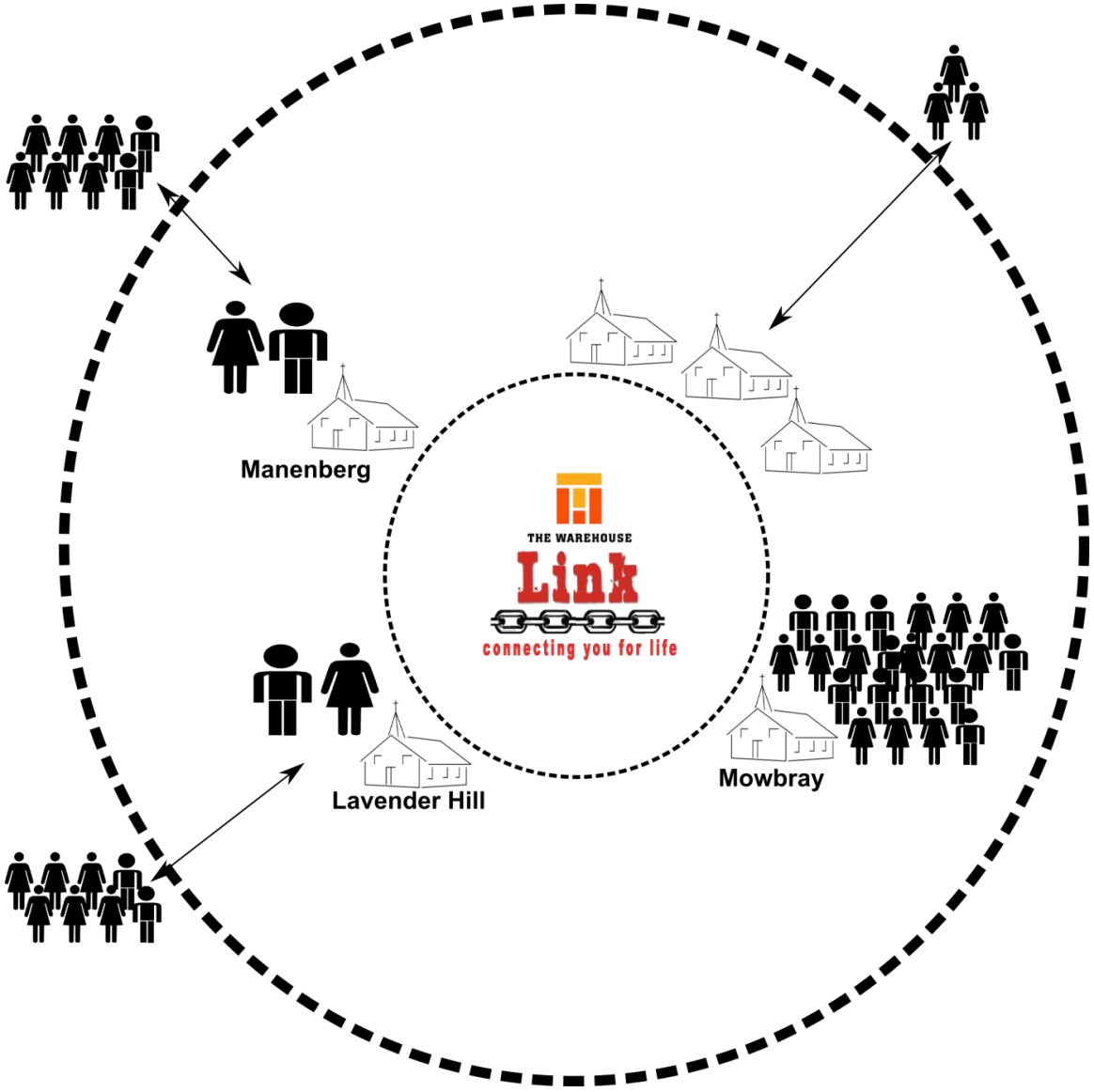

Figure 8 Important relationships for our project: the Link team at The Warehouse, church leaders (large figures) and students (small figures). We had most access to groups and figures shown at the centre of the diagram. At the outside of the diagram are students whom we could only access by negotiating with the Link team, who in turn negotiated with church leaders to arrange a meeting.

The first cycles of our project were characterised by a lack of access to end users. Any scheduled event could only take place where a number of factors operated fell into place:

- Student availability, subject to factors like school holidays and exam periods
- Willingness of the church groups to meet with Link
- The availability of Link staff to arrange and act as guides in areas with which we were not familiar

This meant that we had to negotiate carefully and plan activities with Link. The two activities where we met students were Link workshops and at the Mowbray homework club.

2.3.1 Link Workshops

The Link team engaged with students at workshops. These were designed to help students reflect on their abilities and interests, and therefore recognise what sort of career might appeal to them in the future. The workshop content also informed students of the impact of decisions in school years on their long-term goals.

For example, if a student in an early high school years chose not to take mathematics and science classes, they would not be able to enter science or engineering programmes at a tertiary level. Similar consequences exist for many decisions made in high school, but unfortunately teenagers in poor communities are often not made aware of this.

In Section 3.1.2 we describe two workshops we attended with the Link team. This was important for us at the start the project, as we needed to learn about the people for whom we were designing.

Later in the project, the Link team arranged meetings specifically for the purpose of testing the website. In those cases (for instance our first evaluation, described in Section 3.4) we lead sessions ourselves with the help of research assistants while one or more members of the Link team observed.

2.3.2 Mowbray Homework Club

In Mowbray, the Link team took advantage of a church's proximity to the taxi rank by offering free tutoring to students who were willing to walk across the road to the church (Figure 9 shows a lesson in progress). They used their network of contacts to enlist volunteers (university undergraduates and older) who had benefited from education at well resourced institutions and were able to teach a range of high school subjects – the most popular being Physical Science, Accounting, Mathematics and English. The tutoring programme began in February 2011, and as part of our engagement with the Link team the author attended and tutored on a weekly basis. This helped us build relationships with the students that lasted through the end of our project.

The students in Mowbray were not directly affiliated with the church outside of the tutoring programme. More direct interaction was possible than at the Lavender Hill and Manenberg churches, where sometimes unresponsive church leadership had to be consulted for every meeting. This allowed easier scheduling of workshops (they could displace the regular tutoring for a week) than had been possible elsewhere.

Figure 9 A tutor interacting with students at the Mowbray homework club. The author acted as a tutor and was sometimes able to perform demonstrations and usability evaluations at this venue. The venue was a church building close to the transport hub that students used to travel to and from school

2.4 National Census Data on Household Internet Access

The 2011 South African national census included a question relevant to our study[9]. The question was, "How does this household MAINLY *(sic)* access the Internet?". Table 2 shows the aggregate data gathered for several wards of Cape Town. Wards 36, 37, 38, 39, 39, 42, and 89 are low income areas in which many of our beneficiaries live (see Section 2.2). Ward 58 is a wealthier ward which we include for comparison.

Table 2 Census 2011 data shows minimal household Internet access data for low income areas of Cape Town.The top six rows are low income areas in which many participants lived, while ward 58 is a wealthier area included for comparison. In low income wards the mobile Internet is the main form of Internet access, however a large majority of households reported no access to the Internet at all.

Ward	Area Names	Home	Mobile	Work	Elsewhere	None	Number of Households
36	Crossroads-Nyanga	3%	13%	3%	15%	67%	9,770
37	Nyanga	1%	11%	2%	16%	69%	5,983
38	Gugulethu-Nyanga	5%	27%	3%	22%	42%	4,581
39	Crossroads-Nyanga	2%	12%	2%	8%	77%	8,240
42	Gugulethu-Manenberg	2%	16%	3%	10%	68%	9,188
89	Khayelitsha	1%	17%	2%	11%	69%	9,574
58	Claremont-Kenilworth-Rosebank-Rondebosch	60%	11%	13%	3%	13%	10,855
National		9%	16%	5%	6%	65%	14,450,161

High percentages of households in the low income areas report no Internet access at all. This appears contradictory to statements we have made about the popularity of the mobile Internet (see Section 1.5) amongst low income groups. We return to this in Section 2.5.

Where Internet access does exist, we note that in most wards mobile access was the most frequent form. The exceptions showed a slightly higher percentage of households reporting that their main access to the Internet was elsewhere. There is stark difference in Internet access between the high income ward 58 and other wards. The former is the only ward in which a majority of households reported Internet access, especially access at home.

When we combine these we see a need for clear distinction between studies of the Internet in high and low income urban areas of South Africa. Aggregate study of both is at risk of producing results which are unlike the realities of Internet access in either.

2.5 Internet Adoption Amongst Low Income Youth

Kreutzer surveyed 400 grade 11 pupils at schools randomly selected from within the 50 "most deprived" wards of Cape Town in a study called "Generation Mobile" [20]. This is a close match with the demographic with whom we would be working.

For both mobile phones and computers, a high percentage of respondents reported that they had used the Internet at some point in their lives (93% had used the Internet from a mobile phone, compared to 83% on a computer). However, mobile Internet access was twice as likely (68%) to

[9] Census 2011 data is freely available online through the website of the state statistics office (Statistics SA) [40], using the SuperWeb tool http://interactive.statssa.gov.za/superweb/login.do

occur on the previous day as computer Internet access (39%). Kreutzer uses this variable as an indicator of regular online activity.

MXit was the Internet activity respondents were most likely to perform regularly, though often unaware of it as Internet access. The next most popular mobile Internet activities were downloading entertainment media ("songs, videos, games or ringtones" – 35% on the previous day), using Google for "no reason" (20%), email (20%), and reading online news (18%).

Conventional computers were more likely to be used for only three activities: Internet video streaming, school research, and searching for medical information. Kreutzer explains the use of computers for video as a result of the prevalence of low-end devices. Only 25% of respondents' phones were capable of 3G, none possess a touchscreen, and the only smartphone operating system was the Nokia Symbian OS.

Regarding school and health research, Kreutzer suggests two possibilities. Either content suitably formatted for small screen mobile devices is scarce, or prior experience of computers dominating school and work had created an association with computers for these tasks.

Kreutzer acknowledges difference with averages "reported by other South African studies" (*c.f.* Section 2.4) regarding the extent of Internet use [20]. Kreutzer suggests that national figures might be different from his specifically urban study. Given minimal difference in census data between national figures and the low income Cape Town wards (see Table 2 in Section 2.4), this cannot be so.

Kreutzer discusses two more plausible possibilities. First, youth are more likely to use technology, and census respondents were likely older. Second, he points to differences in methodology. Driven by encounters with people who did not realise that instant messaging entails Internet use, he asked about both, and received responses reporting no Internet access, but frequent use of MXit [20]. If other surveys – as in the census question above – simply ask about "the Internet", significant under-reporting could occur.

2.5.1 Internet Access "Elsewhere"

Census data (see Section 2.4) showed that next to access from a mobile phone, access "elsewhere" (not at home, work, or on a mobile phone) was the most common avenue for computer Internet use. In Table 3 we show more detailed data, again from Kreutzer [20]. It indicates that secondary intermediation (see Section 2.1.4) will be less regular than direct access through mobile phones could be. Church access to technology remains an unknown factor.

Table 3 Frequency of Internet access on computers at shared venues, from Kreutzer's "Generation Mobile" study. Shared access was most likely to take place at school.

Venue	At Least Daily	Weekly	Every Few Weeks	Less Often	Total
Computer at school	24%	24%	5%	17%	70%
Computer in someone else's house	18%	12%	7%	13%	50%
Library	18%	12%	8%	12%	50%
Internet Cafe	7%	6%	4%	6%	23%

Donner and Gitau interviewed mobile Internet users, focusing especially on mobile-primary and mobile-only users [18]. Users who discussed non-mobile access did so with reference to public venues. They preferred their mobile phones because libraries offered access that was restricted to certain purposes only, and which had to be shared by many users. Internet cafes (where access was allowed for any purpose) were too costly. Some interviewees (like 30% of Kreutzer's respondents in Table 3) had never had access to a computer at school. Mobile phones had the benefit of mobility over any venue, and some interviewees preferred the familiarity of input on a numeric keypad to a QUERTY keyboard. They did however acknowledge that printing meant that they could not use their phones exclusively[10].

2.6 Mobile Internet Use

Having seen that the mobile is the most popular form of the Internet amongst low income youth in Cape Town, we discuss here three studies of its use.

2.6.1 First time users

Donner and Gitau trained women in a sowing cooperative who had never used the Internet before to access it from their mobile phones [42]. They noted a gender imbalance favouring men amongst mobile Internet users they had previously met (consistent with the MXit user base which is 53% male [19]). Despite this, their trainees accessed the Internet to use search engines, and networked through email and MXit. They document a trainee's excitement at discovering Facebook without assistance, and advanced students were able to teach other women about new activities they could perform.

Some explanation for the gender imbalance was observed in social factors: participants found that household roles left little time for Internet activities. However, as a source of information, the technology was empowering, and it allowed expression of personal preference. Other technology in participants' lives was communal, for instance television at home where male relatives determined the choice of viewing, or radio in the workplace.

2.6.2 Mobile Literacies: M4Lit Project

Philanthropic organisation The Shuttleworth Foundation [43] commissioned the M4Lit project, which investigated mobile digital literacies amongst South African teenagers. The project included two surveys and an intervention, and results were published as two reports [21, 44].

Survey respondents were Xhosa speaking high school students from low income areas of Cape Town. A requirement for selection was "easy access to a phone with GPRS". The results are thus representative of mobile Internet using youth, although questions about web access on both mobile and PC platforms were asked. Kreutzer's Generation Mobile work was an influence, and some similar patterns are identifiable:

- advantage for regular mobile web access over PC web access (45% from a PC "yesterday"; 60% from a mobile phone "yesterday")

[10] Donner and Walton later performed a very extensive investigation into the use of public access venues in Cape Town by people who used the mobile Internet as well. The study highlights the different capacities of mobile phones and computers and shows the complementary nature of the two technologies [41]. This work was only published at the end of our own study and did not affect our results.

- more use of MXit than mobile web activities (75.4% "yesterday")
- smaller differences when asking about less frequent web use (74% from a PC "ever"; 75% from a mobile phone "ever")
- computers were significantly more likely to have been used "ever" for educational purposes (59% compared to 38%), although that difference disappeared when considering the previous day (16% for both technologies)

The intervention component of the project was a short story of 21 chapters, each 400 words in length. The story was exposed through a "mobisite" (HTML optimised for small screen devices), and directly from MXit as text messages from a contact which participants could add. The mobisite allowed users to interact with each other, but only a small group managed to overcome usability problems. Further, some users expressed disapproval because opening a browser required leaving the MXit client, disconnecting them from friends.

An extensive MXit advertising campaign (normally worth several thousand USD) was provided free of charge as a corporate social responsibility service by MXit Lifestyle, Inc. [19]. The campaign brought more than 60 000 subscribers, of whom just over 17 000 read the final chapter. Subscribers were mostly from the Gauteng (home of the cities of Johannesburg and Pretoria) and Western Cape (in which Cape Town is situated) provinces, which is consistent with the subscriber base of the MXit service as a whole [19].

Demographic data from MXit included only age and provincial location. Most readers chose to read the English version of the story, but this was the case even with the first language Xhosa-speakers in a focus group, who expressed greater comfort for reading in English as a result of few Xhosa-language literacy resources available at home or at school [44].

These results continue to highlight the dominance of instant messaging over other Internet activities, which is significant for the question of relative adoption between mobile Internet and conventional web. They also indicate that text content can be consumed on low end devices (we discuss the Link team's concern in Section 1.6.3). User preference for reading inside MXit suggests that a similar approach might benefit our content. The usability difficulties encountered with the mobisite highlight the importance of ensuring that planned tasks can actually be completed before attempting to compare two systems.

That the most regularly used platform is potentially suitable for our content is promising for the possibility that Internet-supported intermediation may allow convenience to users (see Section 1.4). However, two caveats remain. First, Walton shows that education activities are more likely to occur on the conventional web even amongst mobile Internet users. Second, we did not have the same resources available that The Shuttleworth Foundation (a large research organisation [43]) did, and the study benefited from advertising which is not available to us. These were a factor in our agreement with the Link team to test both conventional and mobile Internet systems (see Section 1.6.3).

2.6.3 Beyond Entertainment: Dr Maths

Dr Maths [45] is a programme which connects volunteer mathematics tutors to high school students using MXit. Tutors connect to the service using desktop PC software that was custom built for the programme, while students connect using the normal MXit client.

Similarly to the M4Lit intervention, the programme demonstrates the willingness of a large number of MXit users – 28 000 over three years [46] – to use text messaging for purposes outside of social networking. They do so despite difficulties of expressing formulae and diagrams with only alphanumeric characters.

High subscriber count is a success for the programme, and the researchers involved position it as a potential answer to "South Africa's failure to improve mathematics… a significant obstacle to African advancement" [45]. Given the popularity of the MXit platform, it is likely that some low income students have found their way to the Dr Maths service. Intuitively, they would be more likely to seek free help from a source with significant interaction problems than a wealthier student with the resources to pay for face to face lessons. Unfortunately, the researchers have gathered no demographic data, citing ethical concerns [45]. Given disparities between wealthy and poor areas shown in Section 2.4 the programme itself provides minimal concrete evidence regarding these aims.

2.7 Developing World Mobile Technology Comparisons

Other studies have performed comparisons involving mobile technologies and interfaces in the developing world. This work provides lessons for our methodology, and we reflect on their findings as our work progresses.

2.7.1 Warana Unwired

In the Warana Unwired project, Veeraraghavan *et al.* [34] implemented a mobile phone system to replace a PC-based agriculture information system for a sugar cane cooperative in India. In the existing system, kiosk operators answered queries about crop yields from farmers using PCs which connected to a central server over the Internet.

In the new system, a smartphone and PC combination connected to the cooperative server and communicated with mobile phones that were handled by kiosk operators. Queries and responses were sent by SMS. An eight month pilot study was conducted and data gathered from system logs, observation of use, and surveys.

The primary benefit was reduced cost for the cooperative. At the start of the project many PCs at kiosks were in disrepair. The mobile phone replacements were cheaper, more rugged, and did not require continuous power. Other benefits included the fact that the system could be queried at any time (rather than during kiosk operating hours), and that kiosk operators could perform travel with the phones when visiting farmers. Use spread beyond an initial seven kiosk operators as the operators themselves advertised the system to friends. Some farmers used the system directly to issue queries immediately after delivery rather than waiting for a visit from a kiosk operator.

Veeraraghavan *et al.* compared usage between the two systems and found similar numbers of users and queries. Information was only necessary at specific times of the year, and so similar usage between old and new plus the benefits listed above constituted success. The researchers did note some difficulty with text entry on mobile phones for longer queries.

We note some differences with our work. We have already discussed (see Section 1.5) how SMS is more costly than the mobile Internet in South Africa. Further, we will require long output that is

unsuitable for SMS length messages. Methodologically, we are planning two entirely new systems, rather than a replacement for an older system. Comparing systems of similar age should eliminate factors of bad design from our results.

We have discussed the Link team's concern about the suitability of mobile phones for working with large quantities of text in Section 1.6.3. We note that the observations of Veeraraghavan *et al.* about input difficulty with long queries adds to this.

Warana Unwired participants faced a choice between sending SMS messages at their own expense or waiting for an operator. This is analogous with the choice our participants would face regarding use of computers provided by secondary intermediaries (see Section 2.1.4), or incurring some expense to access to use the mobile Internet. However, the use of Warana system was only necessary a few times a year (*i.e.*, communication costs are fixed) whereas we are hoping that our users will make regular use.

The longitudinal comparison revealed behaviour – for instance that users queried the system outside of working hours – that would not have been seen in a controlled test. This suggests that we incorporate a longitudinal study in our own comparison. It also demonstrates the value of system logging as a data gathering technique.

2.7.2 StoryBank

StoryBank [47, 48] is a combination of text-less mobile phone application plus public display used for digital storytelling. Stories were created using a mobile phone application, and then transferred to the display using Bluetooth or a USB cable connection for viewing by other community members.

In a one month long pilot in 2007, Frohlich *et al.* deployed the system to an Indian village in which local content was already being disseminated through a community radio station which was funded by two NGOs. Observations of use, story content analysis and interviews with community members, radio station volunteers and the NGOs informed their findings, which included comparison to the community radio station.

Stories produced using the StoryBank system tripled the number of radio station programmes produced in the same time. This is attributed to a high number of story authors (a snowball sample of interested villagers and their friends) compared to the small group of volunteers who ran the radio station.

Content from the radio station was also included in the StoryBank public display library, but community stories were more popular. The NGO which trained the radio station volunteers preferred development content, while StoryBank stories were more personal and offered greater entertainment value to villagers.

The same NGO suggested that tighter control be exercised over StoryBank content in order to maintain higher quality and restrict content to what they considered relevant. They also raised concerns about safety of equipment that lead to the use of mobile phones only during daylight and returned to facilitators rather than taken home, as the researchers originally intended. The NGO's contribution was vital in terms of local contact, but we recognise that local participants and partners will have values and concerns that shape research design.

In the StoryBank methodology we again see the value of qualitative observations from longitudinal evaluation. Only a small number of quantitative results were important for comparison with the radio station. The body of stories created by StoryBank users acted as a form of system logging (which may have been in place as well, Frohlich *et al.* do not specify) that was an important tool for understanding their intervention's impact.

2.7.3 CAM

Parikh *et al.* [49] created a system for data capture called CAM that combines paper and mobile phone functionality for data gathering. In the CAM system, a smartphone app translates two-dimensional barcodes displayed on a paper form into prompts (audio, images, or text) that guide users to capture structured data. The forms can also instruct the device to use network functionality (HTTP, SMS, or MMS) to transfer data captured to a central server. Paper records could be printed at the central server if a non-digital record was required.

Microfinance Self Help Groups

In 2006 the CAM system was tested for capture of financial records from micro-finance self help groups (SHGs) in India. Controlled evaluation took place with NGO field workers (who would normally assist SHG members), and with experienced web users in Seattle. Numerical data entry timing and accuracy were compared to a web based system. The field workers demonstrated improvement over four days of training and evaluation and by the final day the difference in task completion time was not significant. The Seattle group was significantly faster with the web system over all evaluations. During the evaluation Parikh *et al.* were able to identify improvements to CAM and incorporate them in later prototypes.

The web system was used only for controlled evaluation. Once input with CAM was shown to be as effective as input on a desktop computer, other characteristics of the mobile phone – mobility, suitability for rough conditions and battery power – made it superior for data entry outside of controlled environments. When in situ evaluation and later pilot took place, only the CAM system was tested.

In situ evaluation was conducted with NGO field workers who had participated in the CAM evaluation. Researchers travelled with field workers to observed them capture financial records on behalf of SHG members. Data entry time was minimal relative to the total group meeting time, and field workers were able to identify optimisations that the CAM system could bring to the group meetings that would save time if it were adopted. However, SHG members insisted that they would need to maintain their own paper records if the system was adopted.

The NGO group in India and expert web users in Seattle are analogous in terms of relative computer skill to our users (lacking conventional computer exposure) and our Link team partners (frequent computer and web use at work and home). Parikh *et al.*'s comparison between groups demonstrates that ease of use is subjective. The Link team's assessment that reading on computers is easier than on mobile phones would not necessarily be the same as our users'.

Parikh *et al.* moved away from their computer-bound web solution as soon as they entered the field because of the benefits of mobile technology in their context. We have discussed some differences already that make the decision less clear cut in our context: some computer access is possible (see Section 2.5.1), other studies have shown preference for computer use for certain

tasks (see Section 2.5), and computer access at shared venues is free, while mobile Internet access incurs a cost (raised in Section 2.7.1).

Rural Coffee Cooperative

Schwartzman and Parikh [50] used CAM to assist a Guatemalan coffee-growing cooperative with environmental and fair trade certifications. The CAM system was used by field officers from the cooperative for farm inspections. The CAM smartphone plus paper combination was tested against an existing paper inspection process, augmented by digital camera and audio recorder in order to compare equivalent functionality.

This study reveals difficulties of in situ evaluations. Users were distracted while in the field, making measurements of time unhelpful, and barcodes were difficult for the mobile phone camera to process while in the shade.

Qualitative observations improved interpretation of quantitative results: despite good Likert scale responses about usability, the authors observed hesitance from users because of a perception of the mobile phone as an expensive tool.

The researchers were conscious of long travel times and chose not to burden inspectors by making them evaluate both the CAM system and the paper process, instead choosing a between subjects methodology. We have discussed in Section 2.3 how for some of our participants there are two organisations between us and they; we expect that our methodology will be affected by similar constraints on participants' time, but also on the partner organisations.

2.7.4 Voice Systems

A number of technology comparisons have tested voice interaction:

- Sherwani *et al.* compared Voicepedia, a voice system for access to unstructured data from Wikipedia to a smartphone app with equivalent text functionality. Experienced web users found keyword input faster with the voice system, but slower for other tasks [51].
- Sherwani (with other collaborators) later compared voice with dialtone input for Pakistani health workers. Literate users found voice input faster, but illiterate users preferred touchtone input [52].
- Medhi *et al.* compared three interfaces (voice only, text only, and text plus multimedia) for mobile money transfer. Illiterate and low literate users were best with the voice interface and unable to use the text interface [53].
- Grover *et al.* compared voice and touchtone input with health workers in Botswana and found "comparable" quantitative results but users expressed preference for dialtone input [54].
- Heimerl *et al.* tested asynchronous voice messages as an alternative to SMS in rural Uganda and found it to be more popular [55].

Voice systems do not require mobile phones, but proponents give high developing world penetration of mobile phones as a reason to investigate voice interfaces [53–55]. Other mobile phone features were present in control systems.

Voice has an advantage for low literacy users, but we are sharing text content, and voice charges are very expensive in the South African context. We did not consider it for our work, but some lessons of methodology are evident.

These were all controlled evaluations, allowing shortcuts to isolate variables and prevent research difficulties. Technological limitations were eliminated as a factor where wizard of oz prototypes were used [53, 54], or where absent infrastructure was simulated [55]. The Voicepedia interface – positioned as promising for the developing world – was evaluated in North America [51].

Although we have discussed the importance of longitudinal work, we recognise the value of controlled evaluation for providing design insights which can be incorporated into future work. They can make data available where in situ work is impossible. In the face of changing conditions and multiple stakeholders, pursuing early controlled evaluations could minimise risk to our research.

2.7.5 Absence of Mobile Internet and Conventional Web Comparisons

We have not found any other developing world work which compares real-world use of equivalent conventional web and mobile Internet systems. This may be because there are many developing world contexts in which both technologies are unsuitable, and hence few researchers have considered the combination. For example, Heeks argues that high penetration makes mobile phones a more suitable platform for developing world interventions than scarce computers and fixed line networks, but uses the same argument against the mobile Internet in favour of SMS and broadcast technology [1].

On the other hand, developing world users' response to technology differs greatly from context to context. Wyche finds realities of mobile phone use in rural Kenya incompatible with other technologists' "tendency to design for smartphones, high speed data packets, and Internet access" [37], but in urban India Remy *et al.* combine smartphones with voice access as a response to increased smartphone penetration but still limited Internet use [56]. Meanwhile, we have considered mobile instant messaging use that requires Internet access but not smartphones or high speed connections (see Section 2.5).

Our comparison will contribute to knowledge by increasing understanding of two Internet technologies that are most visible in our context, and revealing factors affecting adoption which can be considered in other contexts.

2.8 Summary and Application to Other Chapters

Our work was pursued in action research cycles (the approach is described in Section 1.3.2). These are documented chronologically in Chapters 3 through 8. Information about context in this chapter was discovered during events described in early cycles, and reflection in each cycle was informed by work discussed here.

Table 4 summarises findings of this chapter, providing the source (other work, or a section of this dissertation) as well as the chapters which each section informed. Note that section numbering is used without the word "Section" as prefix.

Table 4 Summary of background information and how it pertains to other sections of this document

Section	Summary	Included Because	Informed By	Informs
2.1	• Addition of technology to Link intermediation will reduce negative consequences of intermediation, but also reduce benefits • We must design for users or secondary intermediaries resources, experience and preference • Technology use difficulties will surface, we will discuss these in terms of financial considerations, access constraints, habits of dependency, skill, fear	Related to Research Question One in 1.7	Related Work	• Website implementation in 3.1.5 and 3.2.1 • Mobile system implementation in 6.3.1 • Discussion of context and characteristics of beneficiaries in 2.2 and 2.3 • Reflection on difficulties in AR cycles throughout, *e.g.* 3.5.1, 4.5.1
2.2	Students live in areas of significant disadvantage	Required to understand context	• Studies of poverty in Cape Town • Diagnosis activities at various stages, including 3.1.4	
2.3	Venues and interactions with participants	Provides context for action research activities	Diagnosis activities at various stages including 3.1.2	Context for AR cycles throughout, *e.g.* 3.4.1, 4.4.1, 6.1
2.4; 2.5; 2.6	• Must focus on low income instead of aggregate • Higher percentage of urban youth use mobile phones than computers for regular Internet access • Mobile Internet access is used most frequently for instant messaging • Computers are linked to “serious” tasks	gives insight about participant resources, skill, and preferences	Related work	• Website implementation 3.1.5 and 3.2.1 • Mobile system implementation in 6.3.1 • Reflection in cycles
2.7	• 8 comparisons of mobile phones with other technologies in the developing world • Longitudinal and in situ studies reveal important insights about actual behaviour but produce few quantitative results • Controlled evaluations provide insight that can be incorporated in future designs and can produce results when in-situ evaluations are impractical	Related to research question two in 1.7	Related work	• Methodological insights contribute to Action and Evaluate steps in all cycles

3 CYCLE ONE – FIRST WEBSITE

3.1 Diagnose – Understanding Link

We were introduced to the Link team by a former volunteer at The Warehouse. At the time they were collecting information from the Internet and contacts elsewhere in society. At the start of our work they had already decided that a website was necessary in order to keep up with demand for information from beneficiaries. In order to avoid creating inappropriate solutions (see Section 1.2), we tried to understand the Link team and their end users. In this phase we held meetings with Link to understand their difficulties, intentions for the website, and the context in which they operated. We also attended two workshops with students who were representative of our end users.

3.1.1 Initial Meetings with Link

Our first meetings began in July 2010. Much of what was discussed has already been described in the first two chapters of this document: they sought to inform the career-related decisions of high school students from low income urban communities of Cape Town (see Section 1.6); they met these students through church groups in those communities (Section 2.3); the information that they wanted to disseminate was already on the Web, but they had to intermediate between the web and students for this content to be useful, and they did not have enough staff capacity for this (Section 1.6.1); and they wanted to create a website to augment their staff capacity (Section 1.6.2).

We also discussed system design. We realised that from a systems perspective their knowledge was disorganised, without clear distinction between goals regarding the type of data to be stored, the presentation of that data, or the use cases that would be employed. Conversation would switch rapidly between broader programme goals and system design decisions. The possibilities opened by each topic would refine – or sometimes contradict – earlier decisions. This was not unexpected given the non-technical skills of the Link team, and the ownership and enthusiasm displayed was still promising.

In order to add structure to the conversation, we worked with whiteboards, grouping notes about different facets of the conversation in different areas of the board. Figure 10 is a photograph of one of the boards from the first meeting we held. As we heard the Link team refer to a type of data such as "funding" or "skills courses" that had not previously been discussed, we added it to the list on the top left of the board. At the bottom of the same board we made a list of use cases whenever new behaviour was mentioned.

By the end of July our list of data types included:

- Tertiary education courses, including entrance requirements and opportunities available after successful completion
- Bursaries or other avenues for paying for tertiary education
- Job openings at a level appropriate to students' education and availability
- Opportunities for gaining experience, such as job shadow or internships

- Short courses or workshops which would provide or improve specific skills
- Information about entrepreneurship
- Advice about the job market, such as interviewing techniques or compiling a CV

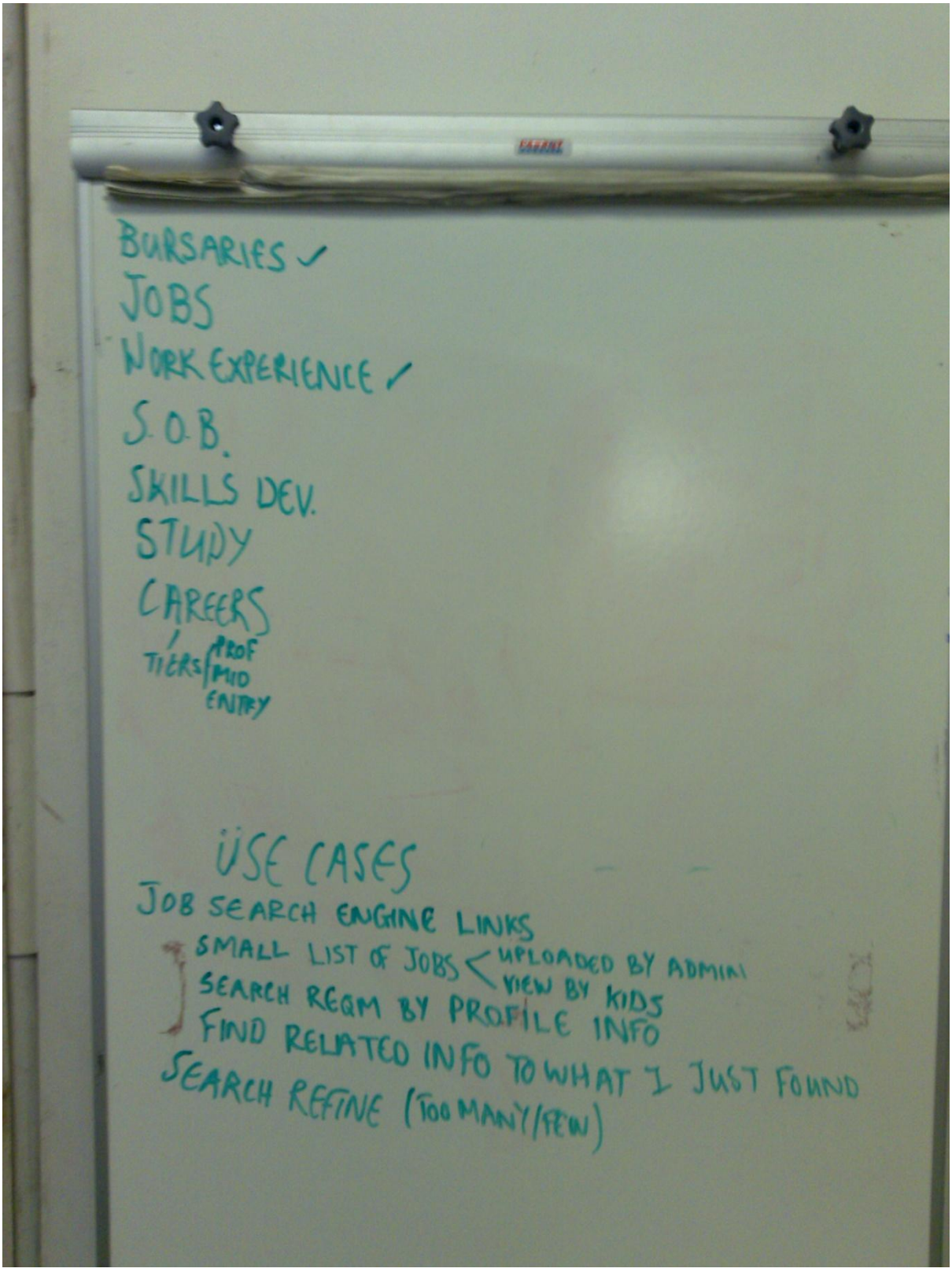

Figure 10 Picture of a whiteboard after our first system design workshop with the Warehouse, in which we discussed the list of data types that we believed the system would use (shown at top)

From this list we elaborated on each data type with the Link team to derive finer-grained data requirements. Figure 11 shows a picture of the whiteboard after our first attempt at elaboration on bursary data.

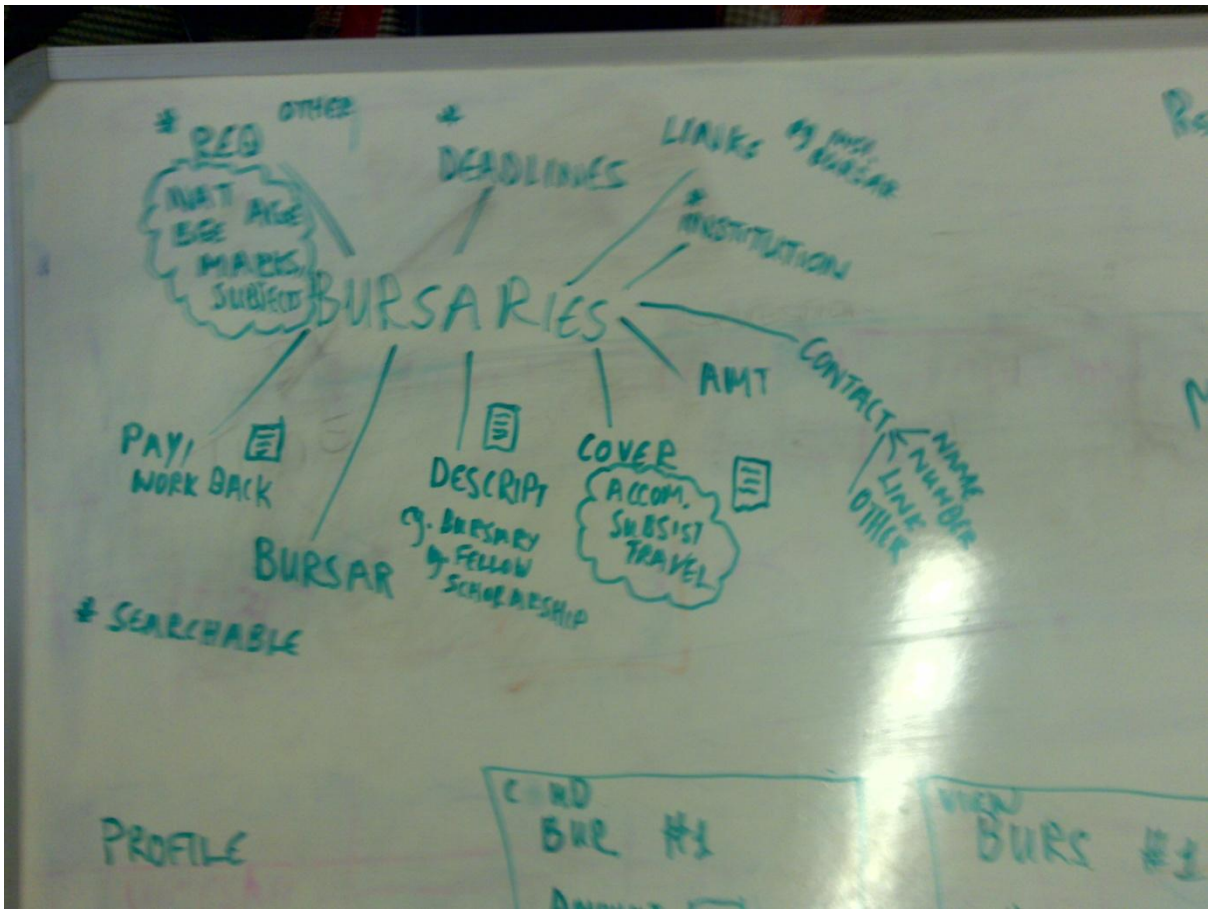

Figure 11 Picture of a whiteboard showing the data that would make up a bursary

At this stage it was harder to discern a clear picture regarding system behaviour. Conversation would frequently enter a state of confusion because we needed to understand the Link programme, but the programme itself was being shaped by our conversation.

In particular we struggled with the notion of "keywords" that we were told the students would be given after workshops. The keywords were supposed to help the website determine what information to recommend to the students, but it was not clear what these keywords would look like or how the system should determine which information was relevant to which keyword. This brought us back to the question of what sorts of data the Link team wanted in the website, and so while we kept the pictures of our whiteboard notes for future reference, it was the insights about content types which we retained for future steps in the cycle.

3.1.2 Link Workshops – The Warehouse and Manenberg

The Warehouse had been developing material and holding workshops since 2009. We attended two workshops in late 2010 in order to develop an understanding of students.

The first workshop was held over two days in September 2010 at The Warehouse (see Section 1.6); we attended the second day, with nine students. On that day the topics covered included CV writing, interview skills, decision making, study techniques and career choices relevant to the

students' individual interests and school subject choices. The first four topics were presented as a combination of big group lessons from one of the Link staff interspersed with smaller group exercises (see Figure 12) to reinforce the concepts being taught. The author participated in some of the small group exercises where an even-numbered team was required (an odd number of students were present).

In the final session the students were asked to reflect on their interests at school and discuss in smaller groups with one of several adult leaders who were present. Because of our awareness of the software development world we were given the opportunity to discuss computer related careers with one of the students who enjoyed her "Computers and Technology" class at school.

In our capacity as outside observers we were not in a position to do extensive interviews, but we were able to learn from observation of activities and brief conversations during breaks. Most of the participants were in high school apart from one who was older, had left school a few years earlier, and was unemployed. None of the students spoke English as their first language. Despite sufficient grasp of English as a second language to participate in the workshop, there were a few difficulties with written material and words which the participants had not heard before: we heard one student say, "Ek praat nie soos pastoors' kinders nie" (I don't speak like Pastor's children). From the context we knew that she felt it unreasonable for her to be expected to understand the phrase she had heard.

Figure 12 Students participate in a group activity at the September Link workshop held at the Warehouse

The second workshop we observed was at the end of October in Manenberg (see Section 2.2.3), also with nine students. This workshop was held during the youth group's normal meeting time on a Friday evening. The workshop presented an opportunity to observe one of the church leaders running a meeting.

Despite the scheduling of the workshop well in advance, when we arrived there was some confusion as to which youth group members should be participating. The adult leaders appeared to decide on sending their grade nine members on the spot. Some of the students only arrived half way through the session. There were many more youth group members present that evening than attended our workshop, underlining the fact that other priorities existed within this group for the time that they had with the students.

This workshop was much shorter than the other, starting in the evening and needing to be complete before the participants had to leave for home. For safety's sake the church paid for transport for the youth group members, and so all had to leave when the taxi arrived. In the time available, the group completed only one of the five sessions that we observed in our full day at The Warehouse. The topic of the session was decision making, which the local leader taught from the same material that was used at The Warehouse.

This group was more homogeneous than at The Warehouse. All the participants were from the primarily Afrikaans-speaking community of Manenberg, but they seemed on average to be more comfortable with English than the group at The Warehouse.

3.1.3 Technology Use Questionnaire

At both workshops we administered a questionnaire intended to determine whether these participants' (as a small sample of potential end users) were similar in technology use habits to the participants described in other work (see Sections 2.5 and 2.6). The questionnaire can be found in Appendix 9.6A. Participants struggled to answer some questions, so we show here only results from questions which were answered properly.

Table 5 Summary of responses to a technology habits questionnaire from Link workshops at The Warehouse and in Manenberg. All participants had used a computer, but mobile phone use was more regular.

	Location		
Measure	**Warehouse (n=9)**	**Manenberg (n=9)**	**Total (n=18)**
Ever used computer at home	3	6	9 (50%)
Ever used computer at school	7	6	15 (83%)
Ever used computer at library	4	0	4 (22%)
Ever used computer at Internet cafe	0	0	0 (0%)
Ever used computer (Total)	9	9	18 (100%)
Computer yesterday or today	1	5	6 (33%)
Cellphone yesterday or today	8	9	17 (94%)
Have used Google on computer	6	6	12 (67%)
Have used MXit on cellphone	7	8	15 (83%)

Table 5 shows the responses. Every student had some exposure to computers, but regular use as measured by activity "yesterday or today" was higher for mobile phones. The Manenberg group had greater computer access at home than we expected, but access to the Internet (as measured by use of Google and MXit) was again higher on mobile phones.

Based on our understanding of the apartheid racial hierarchy (see Section 2.2.3) the Manenberg group might be wealthier than the Warehouse group, which was drawn from poorer areas. We do note that neither us nor the Warehouse had any control over which specific individuals attended – these decisions were made by church leaders.

3.1.4 Intermediary-Derived Personas

In late January and early February 2011 we attempted to learn more about our end users through the definition of personas [61] which were based on the Link team's knowledge. We knew that The Warehouse possessed latent knowledge of their beneficiaries. Once in persona form, it could provide insights which would help us overcome the design barriers created by the cultural and linguistic gaps between us and our end users (we discuss difficulties of ICT4D design in Section 1.2).

We make a distinction between normal personas, which are an organisation of data collected by a researcher in direct contact with a target market [61] or extensive research conducted for marketing purposes [62] and our process. Our personas were based purely on the Link team's knowledge of our end users.. To refer to these personas, we coined the term "Intermediary-Derived Personas" [63], so-named for the Link team's role as intermediary between the Internet and students. To create these personas we held workshops where we used a persona template adapted from [64] as a guide for conversation. We asked the Link team to discuss each heading of the persona template (these are the same as the headings of the personas included in Appendix B) and made notes on a flipchart that was visible to all team members. Figure 13 shows one such page of notes. Each section of the persona template could be revised as the team realised that an aspect of the persona was unrealistic, or that the persona they were designing did not reflect the right demographic. For instance, in Figure 13 the revision of the Sindiswa persona can be seen: initially we discussed someone who had recently finished grade 12, but later in the discussion the Link team realised that they preferred to work with students who were still in school.

The end product of these workshops and subsequent revisions discussed via email were documents describing three fictional characters (ultimately they formed a complete record of these workshops rather than the aggregation of data which traditional personas are) whom each represented a segment of the population with whom Link was working:

- Sindiswa, a hard working grade 11 student from the Khayelitsha township who was driven by a desire to achieve a material lifestyle that her parents could not afford
- Leandre, a grade 12 student from Lavender Hill who had returned to school after giving birth and wanted to finish high school so that she could find work that would allow her to leave home with her child
- Themba, a 15 year-old student who dropped out after failing grade 9 because he was unconfident that he would pass the year if he repeated it

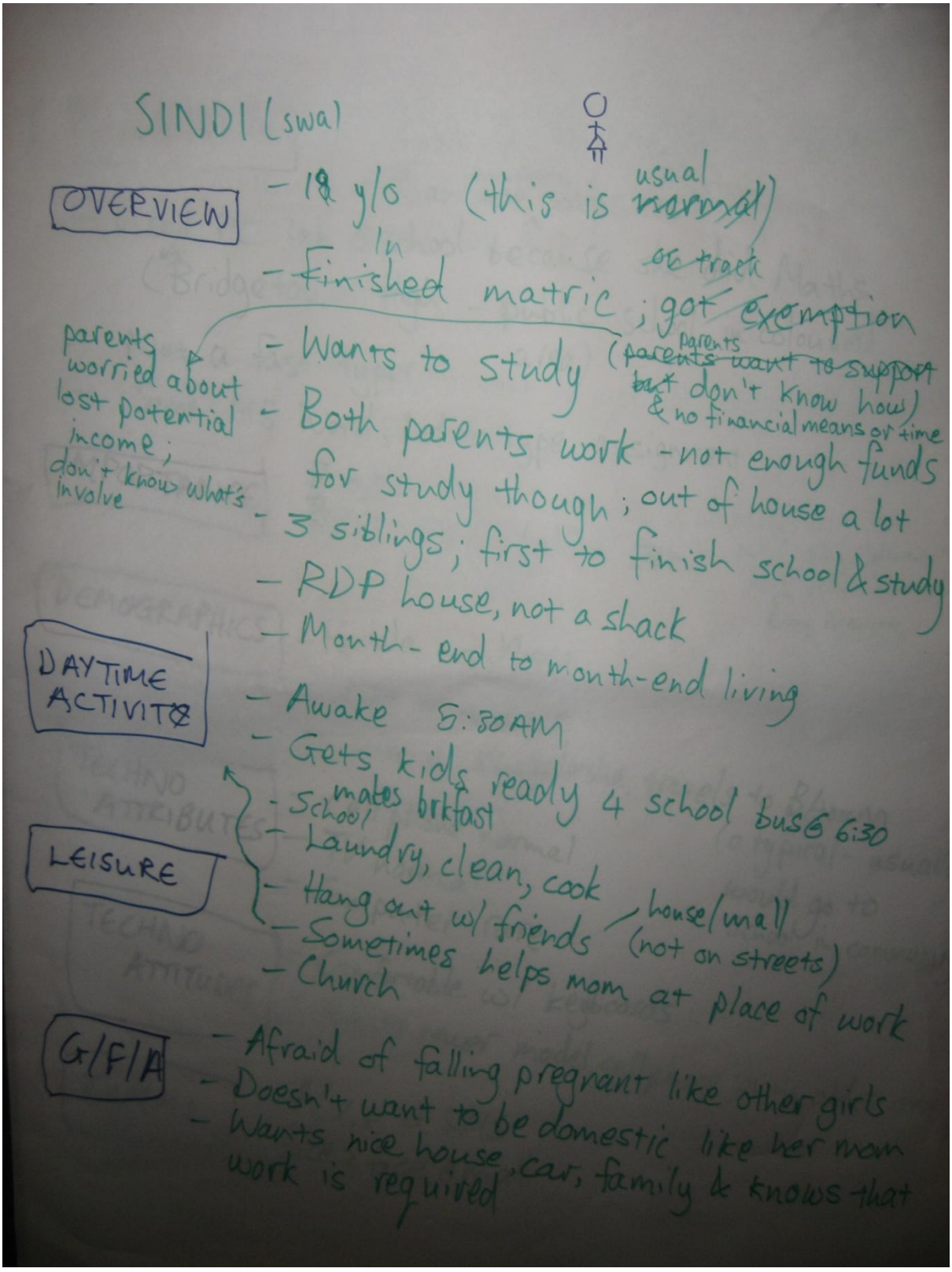

Figure 13 Page of notes from intermediary-derived personas workshop These personas were based on the knowledge of the Link team, and helped us to design for users despite minimal access to them, and improved communication between ourselves and stakeholders.

The following is an excerpt from the Sindiswa persona:

> ***OVERVIEW:*** *Sindi is a 19-year old girl from Khayelitsha. She is in grade 12 in 2011 and she hopes to study further next year. She stays with her parents in a small brick (RDP)*

house. Both her parents work – her mother as a domestic worker and her father as a labourer. They are out of the house for most of the day because public transport requires them to leave early for work and brings them home late. The money that her parents earn is enough for the family to live off, but not enough to build up savings.

Sindi has 3 siblings. She will be the first of the children to finish school. Her parents are happy that she has done well at school, but they are concerned that further study will mean a loss of potential income because she could be working instead. They do not have money to pay for studies, and are not aware of any other ways in which that they could support her dream to study.

***A DAY IN THE LIFE:** Sindi is awake at 5:30AM on a school day. She is responsible for preparing her siblings for school and ensuring that they are all on the bus on time. They journey far outside of Khayelitsha to go to school. School begins at 8AM and ends at 2PM. When they return from school, Sindi cleans the house and looks after the other children, including cooking supper. During the holidays she may go with her mother to work in order to learn how to clean.*

***HOUSEHOLD AND LEISURE:** Sindi's leisure activities are "off the street". She will see friends either at the mall or in one of their homes. She is involved in her local church youth group. Her priorities are studying for grade 12 and her household chores - she is too busy for a very active social life.*

***GOALS, FEARS AND ASPIRATIONS:** Sindi is afraid of falling pregnant and having to drop out of school. She has seen this happen to many of her peers, and believes that they have lost out on the chance to make something of themselves .*

She dreams of having a higher paying (and higher status) job than her mother, and she is aware that she will have to work hard to achieve this, although she is not completely certain of how specifically to get there. Her vision for the future that she wants is pieced together from what she's seen in the movies and on TV – she wants to wear designer clothes, own a nice house and drive a comfortable car. She would like to raise a family, but this is not a high priority in the short term. She is often frustrated that her parents lack a vision for her beyond her current role in the family.

***COMPUTER SKILLS:** Sindiswa is fairly comfortable with computers. She takes Maths as a subject, and the Maths pupils at her school get more frequent access to the computer labs than the other classes. She has used the computers to complete assignments, learning to browse websites and use a word processor. She is not a very proficient typist.*

Full text of the Sindiswa and Themba personas are included in Appendix B. The Leandre persona is excluded because the Link team's input for it was inspired by particularly sensitive case studies of at-risk youth compiled by other staff members of The Warehouse which needed to be kept confidential.

For practical reasons our persona creation approach was very limited compared to other work. (Pruitt and Grudin mention "a [persona creation] team of 22 people over a period of roughly two months" [62]), and is more akin to the "provisional personas" suggested by Goodwin for circumstances "when time is limited" [61]. Goodwin's calls provisional personas "cruder" because they are based only on the second hand knowledge of users that is conveyed by "knowledgeable

stakeholders" rather than from data gathered directly from users through interviews. In our process the Link team played the stakeholder role, but we believe their insight into people's hidden motivations is greater than both that of the leaders of the corporate environment in which Goodwin designs and the data which we could have hoped to gather first hand. The Link team drew on insights from personal interactions as well as a broad network of deeply involved stakeholders, including development experts, social workers, teachers, and community leaders. Their knowledge extended to topics such as substance and sexual abuse that our users would be unlikely to discuss with an outsider in interviews.

We identify three ways in which our diagnosis benefited from this process. First, we learned about our users without inconveniencing them or probing on uncomfortable topics. Second, the discussion it generated made assumptions explicit. For instance a decision was taken that due to a lack of person-power for translation only English language content would be provided. Third, they brought more focus to our efforts. Comparison between Themba and the other personas brought about a decision to de-prioritise the users whom Themba represented, instead focusing on those users who would complete high school.

Finally, the personas we generated informed later phases of this cycle by serving as actors for scenarios (see Section 3.3.2) in our design process.

3.1.5 Existing Technology Capacity

It was important that our system allow the Link team to capture data. During meetings and related email conversations we gained an understanding of existing capacity for technology operation at The Warehouse. All the Link staff and volunteers demonstrated desktop computer operation skills necessary for knowledge work. Significant effort had gone into capturing details of career opportunities from websites and emails into spreadsheets and word documents. Workshop material was also stored electronically.

The Warehouse already had a website based on a content management system (CMS). Content was created and maintained by a staff member with similar technology operation skill as the Link team. This suggested that a similar approach could be taken for our work, with the Link team responsible for day to day maintenance of the new website, and no requirement for new staff to operate it.

3.2 Plan – Prioritising Conventional Website

A crucial decision reached in planning was whether to proceed with a conventional website or to create a mobile system. We have discussed how youth in low-income communities similar to those in which Link operated had adopted the mobile Internet and how we hoped to apply this to non-entertainment purposes (see Sections 1.5 and 1.6.3). Our technology use questionnaire (see Section 3.1.3) had shown that most workshop attendees did make regular use of the mobile Internet. If the Link information could be disseminated over the mobile Internet, we believed it would take advantage of this.

We discussed the mobile Internet with the Link team in a meeting after constructing personas. Their decision was mentioned briefly in Section 1.6.3 but we elaborate here.

The Link team shared their awareness of the popularity of the technology amongst youth, and added that its introduction could positively affect negative perceptions of mobile phones (Bosch records perceptions of MXit as time-wasting and harbouring sexual predators [16]):

> *"It [mobile technology] can penetrate further because you are sending it out to individual locations, and not one central Internet location, so for reach it's better."* – Link coordinator

> *"...it puts a positive spin on why kids should be using cellphones more effectively. Because at the moment there's such a lot of negative press about cellphones... so, if we can get it to be a more positive thing, that's certainly a good selling point."* – Link staff member

However their idea of how it could be applied was limited to reminders which would inform students of when to seek out a computer from which to access new content on the website:

> *"...this is ... the limitation of mobile phones, is how much information can you access, and ultimately ... [you] will need to find an Internet cafe, but at least you'll know whether to actually bother to go and look for one or not, and that was the attraction of adding the mobile aspect."* – Link Coordinator

Later in the conversation the Link team mentioned personal experience of problems viewing content on mobile phones, and some misgivings about the cost of airtime. On the other hand, they were familiar with the capacities of the conventional web, and they believed that church groups who wanted to support teenagers in their communities would invest in the computer and Internet connection necessary. This would also provide opportunity for interaction and mentoring.

We preferred not to doggedly hold an opposing position on technology, heeding the words of Botes and van Rensburg who highlight a "hard-issue bias" amongst researchers as a major cause of developmental project failure [65]. Given that technology assisted development projects are more likely to succeed when the technology element is an addition to a pre-existing developmental project [66], we could not proceed alone. Fortunately, the Link team was willing to compromise. We would provide a conventional web tool first, with the promise from the Link team that we would be able to pursue our mobile Internet interest at a later stage. Their willingness was at least in part a result of the time we had spent understanding their plans for the programme:

> *"...from our conversations... you get what we're trying to do, and you see that there's value in it, and it's not just an exercise in, 'let's see if this can work'..."* – Link coordinator

Creating the website would be the action of our first cycle.

3.2.1 Optimising Implementation for Existing Technical Capacity

We hoped to make as much use as possible of the existing technology capacity we identified during the diagnose phase of this cycle (see Section 3.1.5). Having decided to build a website, we investigated the ExpressionEngine (EE) content management system (CMS) which underpinned the existing Warehouse website. The CMS required a paid license from its creators, Ellis Labs [67], but was subject to a discount for non-profit work.

EE included standard data capture and member management tools which overlapped with the functionality we anticipated was necessary. Some unique code would be required, but a community of developers existed which could provide advice (and from which later maintenance could be sought).

We used only the subset of the web client technologies that would work with the greatest number of end user machines and web browsers (we have discussed the need for compatibility with whatever technology was already in place in Section 2.1.4). We would avoid proprietary client side technologies [68, 69], and new standards which were not yet universally supported [70, 71]. We aimed to keep individual pages to the lowest number of bytes possible to cater for slow Internet connections.

The site would be hosted at The Warehouse's ISP, Hetzner South Africa [72]. The Warehouse paid hosting costs and the EE license fee required for the new site.

3.3 Act

We have discussed how designers who operate in well resourced settings (to which we were accustomed from previous professional experience) may create inappropriate technology for resource constrained settings (see Section 1.2). Our design for the Link beneficiaries was at risk of this. We did not have sufficient access to users to compensate by getting their input (see Section 2.3 for a discussion of our separation from them), but we did have the Link team as allies who could provide input on their behalf. We designed with them, placing priority on their input to compensate for our position of power as technologists.

Design began with scenarios whose actors were the personas described in Section 3.1.4. These scenarios informed a list of requirements, most of which we implemented in this cycle. We also took a PICTIVE-inspired [64] approach to interface design where the Link team created whiteboard drawings of how they thought the website interface should look.

Implementation followed design. The complete EE implementation consisted of configuration, scripted templates, PHP code for functionality not built in to the CMS, and data. The process of creating a site using the EE CMS is discussed in Appendix D; in this section we discuss the interface and plans for data capture.

3.3.1 Reduced Availability of Link Staff

The Link team had already helped us define personas (see Section 3.1.4). Despite the success of having all of the Link staff together to debate contentious issues, the Link coordinator asked that she be the only staff member to participate in further design. She wanted the focus of other staff members to be elsewhere. In some meetings a volunteer joined us. The volunteer's contribution was related to her professional experience in the recruitment industry rather than knowledge of the beneficiaries.

3.3.2 Scenarios

We met with the Link coordinator twice to define scenarios. The main actors in our scenarios were the Leandre and Sindiswa personas (see Section 3.1.4), supported by church leaders.

Leandre's main goal was to find full time work that she could begin after writing her final high school examinations. Sindiswa's goal was to get a qualification that would lead to a white-collar career. Each scenario described a set of steps towards these goals that the Link team hoped could be completed with the assistance of the Link website. The Link Coordinator told the story of the desired future in which the website would operate. We intervened only when we became aware of an inconsistency between scenarios. The full text of all scenarios can be found in Appendix C.

We present one of the scenarios here as an example. The actor is the Sindiswa persona whose excerpt we included in Section 3.1.4. The title is, "Sindiswa look up courses":

> *'Sindi has decided to investigate Occupational Therapy as a possible career. The facilitators at the Link workshop informed her that she should plan ahead for her studies, as decisions she makes this year will affect her later. Sindi visits the community centre and logs on to the LINK website. She searches for information about occupational therapy and finds courses related to the degree. She finds B.Sc. Occupational Therapy offered by UCT and despite some hesitance at the required mark for maths – a code 5 – she writes down entrance requirements and cost of the course. She then views information about the same course at UWC. To her relief she notes that UWC has a lower requirement for mathematics, only a code 3, and that the course is cheaper than at UCT.*
>
> *At the bottom of the information about the UWC course are two links to information about funding. The first takes her to the "UWC Undergraduate Funding Opportunities" web site, which contains a lot of information and is very intimidating. After struggling with the site for a few minutes, she decides to visit the other link. This time, she is directed to a list of funding options on the LINK site. She notes two options, one of which covers tuition and textbooks and subsistence, but which requires higher marks than she currently has. The other just covers tuition, but Sindi is pleased to see that her marks are good enough to apply. She may have found a way in which the financial burden on her parents can be reduced.*
>
> *Her next step is to talk to the youth worker at church. He suggests that Sindi look at some factors other than entrance requirements and cost before deciding on one institution or the other. Since her ultimate goal is to find a job, he suggests that she look at job adverts and try calling employers to find out if they make a distinction between UCT and UWC graduates.*
>
> *A few days later she again visits the community centre and logs on to the LINK web site to look up jobs involving OT. She finds three job adverts and writes down the contact details to make her inquiries. Over the next week she calls the numbers after school. The people who answer the phone are impressed that she is calling them before she has even begun studying. They inform her that they are more interested in how a graduate performs during the year of community service than they are in where she studies. Heartened, Sindi makes a mental note to start filling out application forms.'*

This scenario – like all others – takes place in a desired future where all other elements of the Link programme have fallen into place. Sindi has taken initiative a year before she finishes school to investigate a career that interests her. She is aware that she can consult leaders at her church and those leaders are willing to listen and capable of offering useful advice. Further, the Link data is sufficient for Sindiswa to find two study programmes in her field and at least one relevant job

advert. This combination of factors being realised would constitute multi-faceted success for the Link programme.

Scenarios also allowed us to define requirements. The requirements helped us to track progress and informed data capture, and are listed in Appendix E.

3.3.3 Draw interface

We held four design sessions in March 2011 with the Link team. The intention was to create drawings collaboratively that would inform the user interface. We worked with whiteboards and asked the Link team members to draw the interface as they expected to see it. Figure 14 shows one of the design sessions in progress.

Figure 14 Collaborative interface design in progress. The Link team coordinator (right), is shown drawing interface elements while a volunteer (left), takes notes

Following the design sessions we created wireframe mock-ups using a software package called Pencil [73]. These were based on the whiteboard drawings from the design sessions but were more legible, and occasionally included details added from notes that were not reflected in the original drawing. An example of the two formats can be seen in Figure 15.

3.3.4 Four Scoped Site Sections and Access Control

During the collaborative design a major decision was taken to split content on the site into four sections. Visiting a section would narrow a search to a specific scope:

- **Jobs section:** job openings and internships
- **Study section:** courses and bursaries at tertiary education institutions (also known as the "qualifications" section in early development)

- **Skills Development section:** short courses and work shadow opportunities that would allow students to build their skill set over a short period
- **Start a Business section:** this section would eventually hold information useful to entrepreneurs but at this stage was an empty placeholder

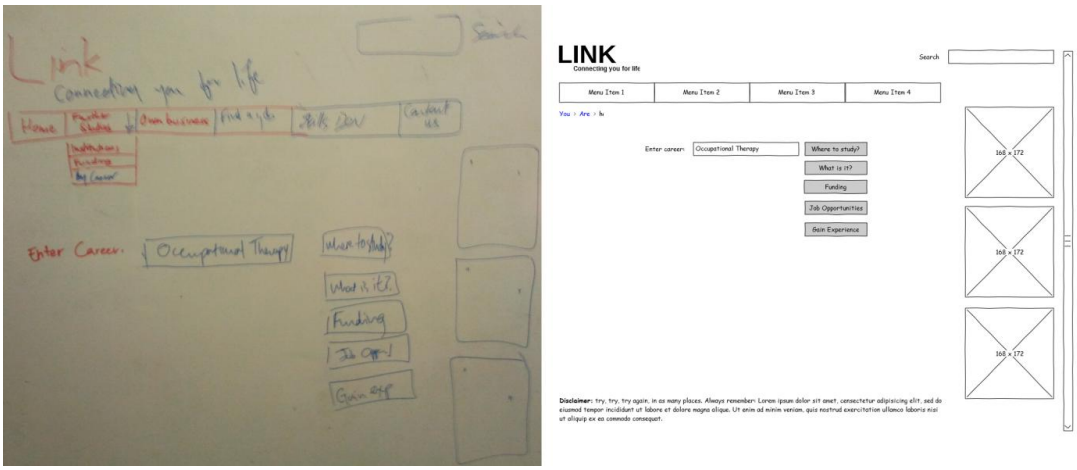

Figure 15 Whiteboard drawing and wireframe mock-up of the same screen from design workshop

According to the Link team, each section would fulfil the goals of different groups of users. Restricting results to content that matched those goals would save users time and effort.

The jobs section and bursaries in the study section would only be accessible with a username (given to students who attended Link workshops). The Link team preferred to restrict access to teenagers who were not from wealthy communities (see Section 2.2.2) where social networks already provide significant resources. Further, they wanted students who accessed this content to have been through the preparation that their workshops offered. The content was to be curated with the help of personal relationships in the business world, and they wanted users to be ready to take full advantage of the opportunities offered, rather than providing contacts with the same flood of applicants who already used more public channels.

3.3.5 Limits of Design by Non-Technologists

These detailed design sessions enabled us to better understand the functionality that the Warehouse wanted. We were pleased with the enthusiasm that resulted in interface design being drawn rapidly in front of us, but we found that we were pushing the limits of what could be designed by people who did not have a technology background. The designs were sometimes inconsistent, and the Link team were not familiar with HTML interface norms. For instance:

- Multiple items in a hierarchical menu pointed to the same page
- Text box input elements were used to display static text
- Buttons were used to link to static content rather than to perform actions
- Free text was used to choose between pre-set options.

These were likely the result of greater familiarity with desktop software than the web (differences include that web pages are generally stateless, and that static content on the web is different from dynamic content because the latter requires special processing). They were also not accustomed to describing interfaces at this level of detail.

These misunderstandings could have affected usability or introduced complex code that would increase the human capacity necessary for code maintenance. It was therefore important for us as technologists to interpret the Link intentions given in these drawings into a form which would work within appropriate technology constraints.

3.3.6 Interface for End Users

Development was iterative: as we coded each feature we deployed it to a test website so that the Link team could comment and we could make improvements where necessary. An important benefit of this agile-inspired process was that the Link team could begin data capture once the appropriate features were complete. A screenshot from an early iteration can be seen in Figure 16.

We tested that the site looked the same in multiple browsers, including older versions. We did not test mobile browsers, because the focus of this cycle was on reaching students at conventional computer infrastructure.

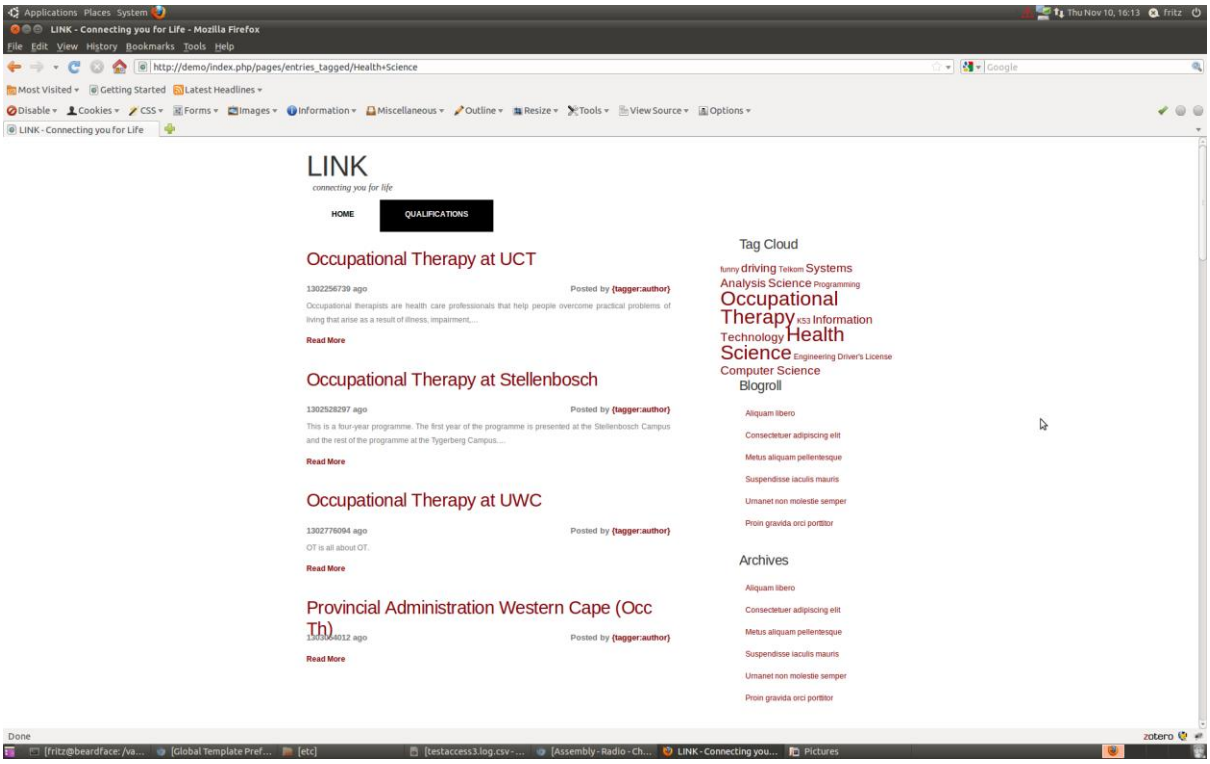

Figure 16 The earliest version of the Link website showing a list of "qualification" entries, with a summary and links to more detailed information. Deployment of early iterations allowed us to receive feedback from the Link team.

Much of the feedback we received in the subsequent months related to what data should be captured. We considered the Link team to be experts on this topic and so followed their instructions closely. We also received aesthetic input. A staff member at The Warehouse who had graphic design training produced drawings (see Figure 17) of a visual theme for the site. We attempted to emulate this theme wherever possible within technological constraints. Central to the appearance of the site were the icons which identified the different sections of the site: a representation of a famous landmark at the University of Cape Town for the study section, a briefcase for the jobs section, a handshake between two people in suits for business and two open hands for skills. We did not discuss whether the association between icons and content would be

apparent to users (many of whom would not have visited the University of Cape Town, for instance), but the use of the icons and colouring was consistent throughout.

Figure 17 Warehouse staff member's visualisation of the home page which users would encounter when first visiting the Link site. This drawing inspired a theme for the site that was used throughout.

We include three screenshots here to show the state of the site before we began our first evaluation phase. Figure 18 shows the page users saw when they first reached the site. From there they would navigate to one of three sections which would allow them to search (see Figure 19). Entries in lists linked to a detail page, shown in Figure 20.

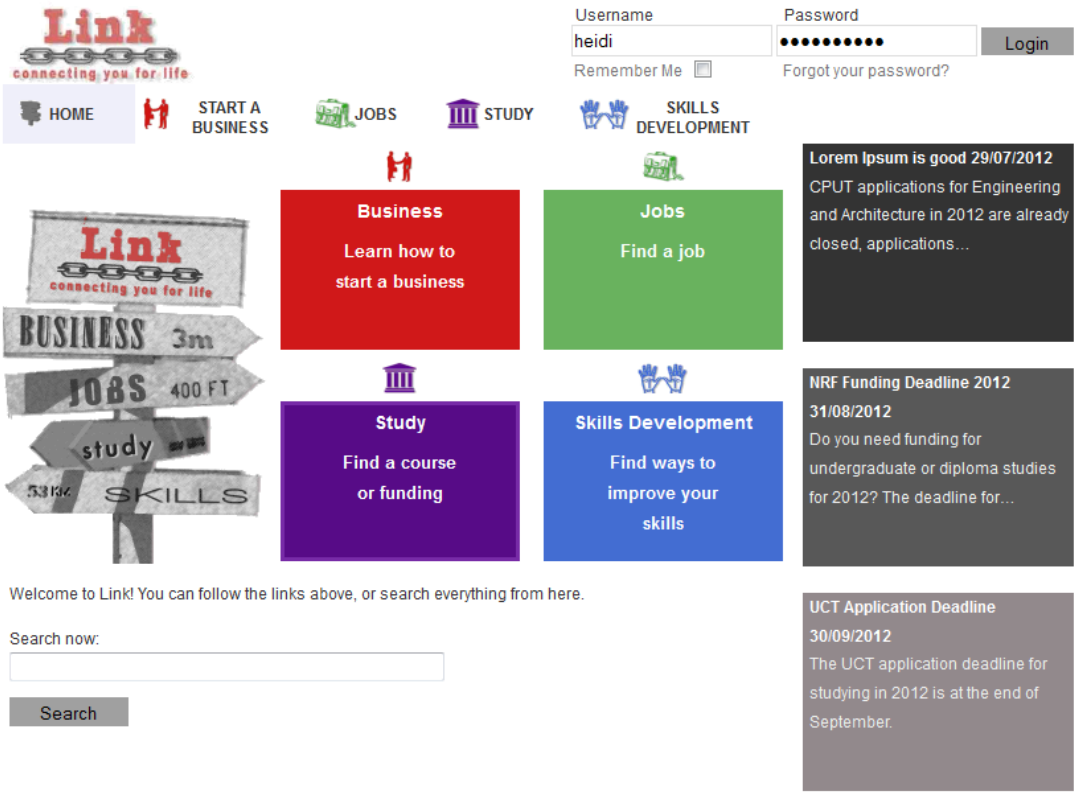

Figure 18 Screenshot of website home page as it looked for first user testing in August 2011. Menu items, signpost and central blocks all contained links to the scoped sections of the site, although in the central blocks only the text and not the whole block could be clicked.

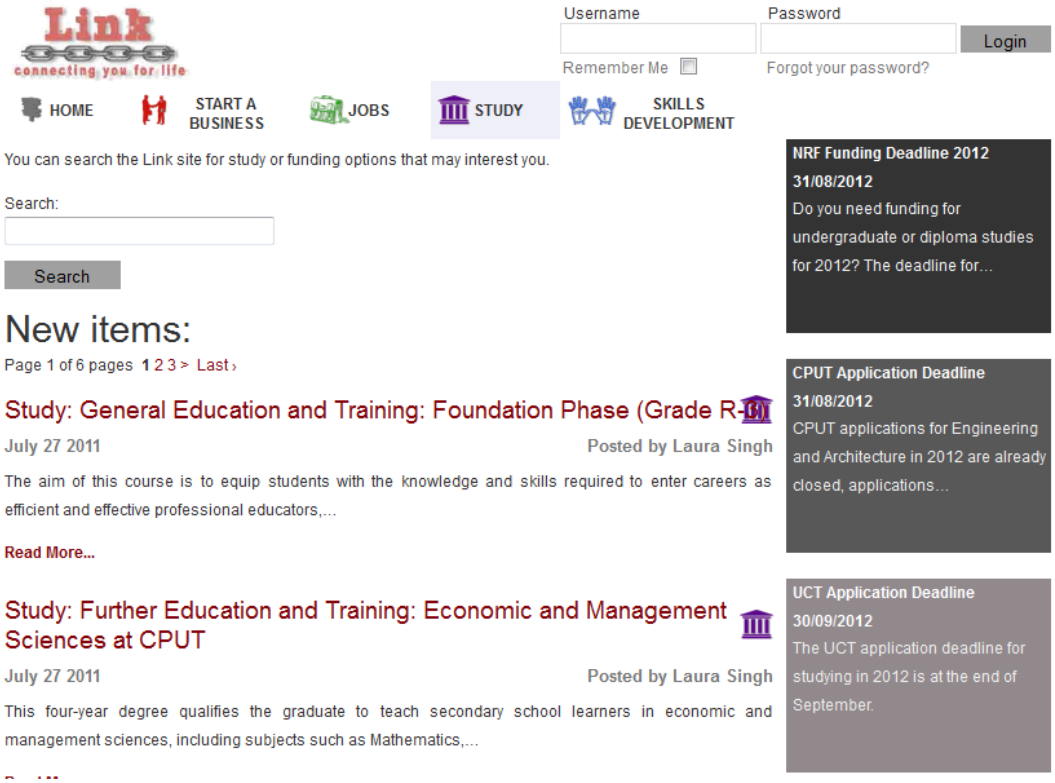

Figure 19 Website search page example at August 2011. Before searches a list of entries ordered by date of capture is shown.After a search is performed the list is ordered by relevance to the search query. Faint highlighting of the menu item corresponding to the current section was intended to keep users aware of the scope of their search.

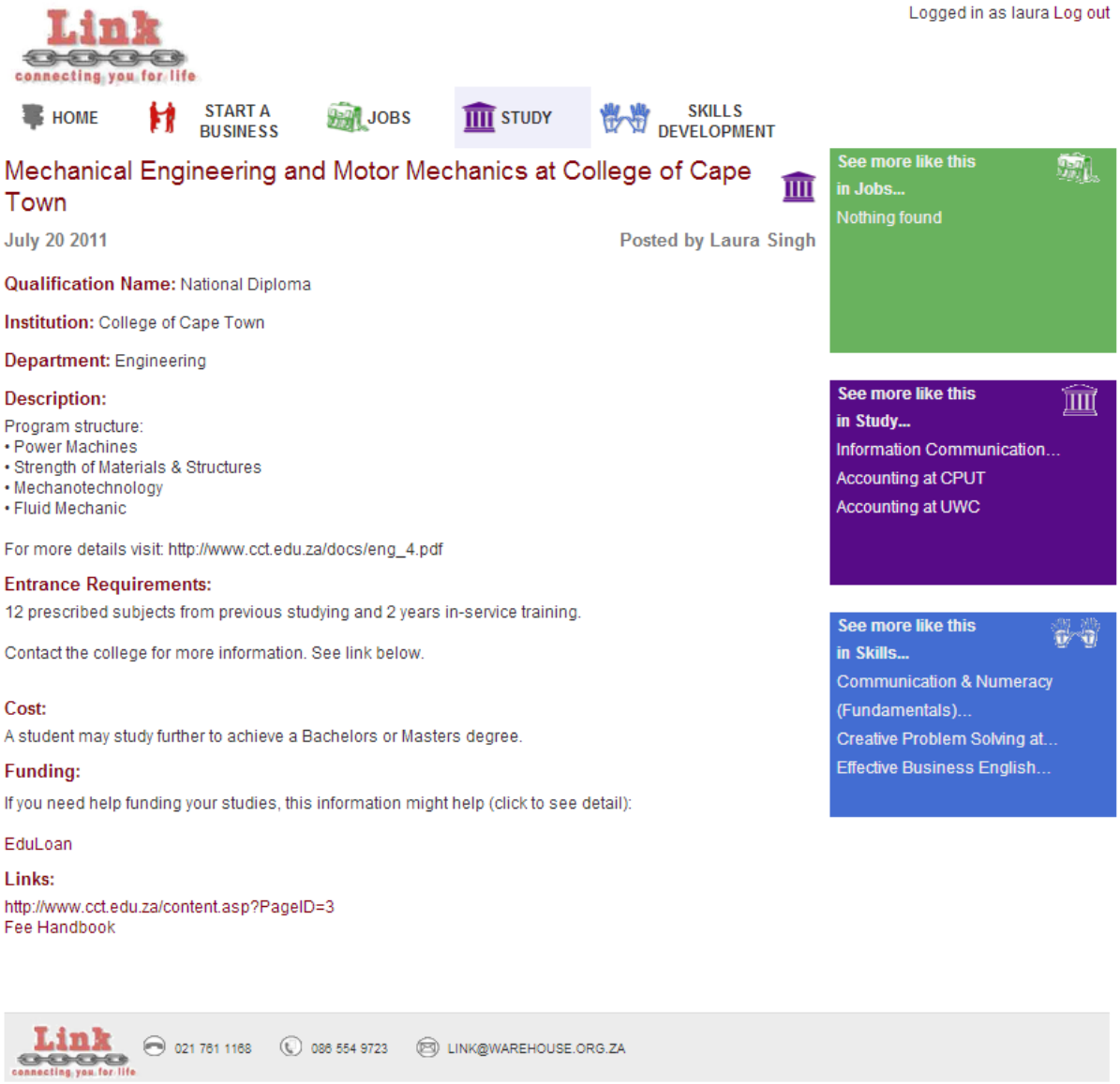

Figure 20 The detailed view of an entry in the Study section of the website. Pages for entries of other types are functionally equivalent but show the fields relevant to those entries. The right hand side "related blocks" show links to similar content in other sections.

3.3.7 Data Capture

As data capture could begin before we completed development, the Link team requested that we define exactly what data was necessary so that they could organise the content they already had.

Together with a volunteer, we produced a spreadsheet to guide their data capture and our development of data capture functionality. The content of the spreadsheet was informed by:

- The volunteer's expertise (she had previously worked in the recruitment industry)
- The work we had done in 2010 with the data model (see Section 3.1.1)
- Data that had been captured by the Link team before 2010
- Requirements we distilled from scenarios
- Conversations between the volunteer and the rest of the Link team

Setting up the data capture forms on the Link website was a matter of configuration of pre-existing ExpressionEngine features rather than new code. A sample data capture page is shown in Figure 21. Link staff members would capture data using these forms.

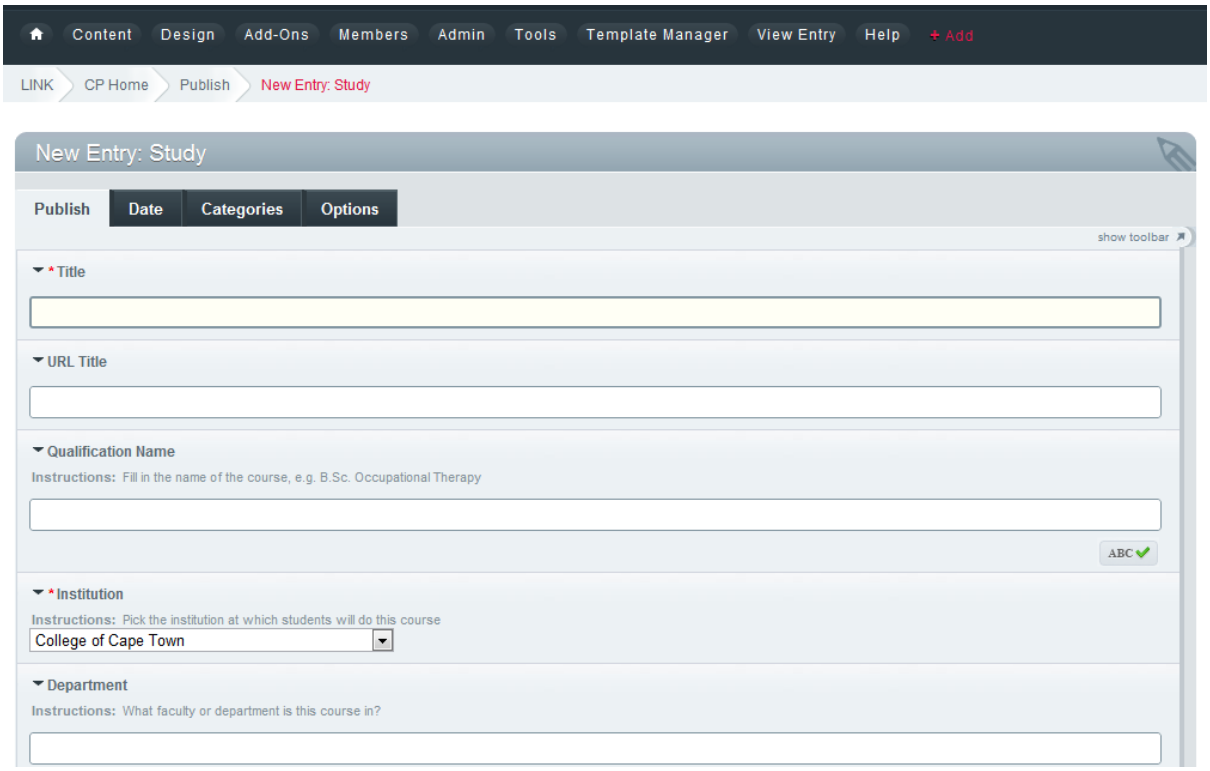

Figure 21 An ExpressionEngine page used for data capture by the Link team. The fields on each page are pre-configured so that data for each entry type (in this case, a tertiary study course) is consistent.

An important discussion during this process involved the Themba persona (see Section 3.1.4). Some content that had been captured in earlier spreadsheets focused on people who like Themba had left school early. The programme preferred to focus on beneficiaries who were on track to complete secondary schooling, so this content was ignored and the time used to capture other data.

3.4 Evaluate

We tested the new website by running a usability evaluation with Link beneficiaries. Observing use would reveal difficulties beneficiaries would face in both general Internet use and of our site specifically. It would also be important if we wanted to claim that future comparisons between it and a mobile equivalent (see research question two in Section 1.7) were valid result of technology differences and not because of usability problems with the website.

3.4.1 Venues and Date

Our first evaluation took place in Manenberg and Lavender Hill, areas we discussed in Section 2.2.3. The sessions took place on Thursday August 4th (Lavender Hill) and Friday August 5th (Manenberg) at churches that partnered with the Link programme. We met in the evening during the regular youth group hours.

3.4.2 Participant Selection

The Link team provided introductions to adult leaders, who in turn introduced us to the high school students with whom we would be testing. We worked with two male grade 12 students in Lavender Hill and four (one pair of female grade 12 students and another pair of one grade 12 and one grade 11 male students) in Manenberg.

3.4.3 Method

We observed the students interacting with the site and then asked about their experience. Students worked in pairs, as per constructive interaction [64], at a laptop which we supplied. We brought more than one computer to the site so that more than one pair of students could be evaluated in parallel. The Link coordinator had stressed to us that Link's relationship with the churches would be affected by how long our evaluations took.

Figure 22 Cycle One usability testing of the website with students in Lavender Hill

Tasks were designed for the session and documented in a script, which can be found in Appendix F. The tasks we could set were limited by the amount of actual data in the system. It was impractical to instruct users to search according to their own interests, given that only around 50 entries on a limited range of topics had been captured up to that point. Instead, we gave tasks based on our scenarios (see Section 3.3.2), and prepared data specifically for the test. By doing this we ensured coverage of the full range of functionality.

Our team consisted of a facilitator who gave instructions to the students and an assistant who took notes. A Link staff member took photographs. Figure 22 and Figure 23 show our seating arrangement: students in the centre in front of a laptop, with facilitator and assistant on either side.

Figure 23 Cycle One usability testing with students in Manenberg

Rather than relying on an Internet connection, we installed both web browser and server locally on the test laptop. Although the Link team's longer-term aim was for the website to be accessed over the Internet from these same buildings, the short time available for testing made it important to minimise possible points of failure. One task required interaction with an external site. We saved the specific page of that site to local disk.

Severe difficulty meant that the notes of facilitator and assistant consisted almost entirely of instances in which the participants were unable to complete tasks. We identified underlying causes which cut across all tasks and grouped the list of problems accordingly. The following subsection discusses the causes (each is a heading), using specific events to illustrate.

3.4.4 Results

In this section we review the major outcomes of our testing.

Issues Related to Computer Literacy

Despite working in pairs, in each case a leader emerged who controlled the computer mouse and keyboard, with the other only offering suggestions. We preferred not to interfere with the dynamics between partners, but this did have the consequence that we could only observe the hands-on computer skills of the leaders.

All users seemed comfortable with basic web browsing skills, following hyperlinks and using the browser back button. One participant demonstrated facility with the mouse middle button scroll wheel.

We observed two difficulties shared across groups. First, none of the users demonstrated touch-typing capabilities. The need to look at keyboard and not screen while typing resulted in errors. For instance, if the cursor was not in a text box before typing, the users could type several words before realising that their typing had no effect. Second, fine positioning of the mouse was not easy. This became an issue when clicking on the central blocks on the home page, where only the text was hyperlinked (see Figure 18), as opposed to the whole block.

The users adapted by being more deliberate in their actions as the sessions continued. These difficulties slowed them down but we believe that other issues caused greater obstacles for the users.

Visibility of List Controls

Participants spent long periods reading without interacting with the site. When a task required that specific information be found, the participants most often read through lists rather than searching.

The first page of each section (a list) allowed access to all the entries in the site, as long as page navigation controls were used. Unfortunately these were hard to spot. In Figure 24 we show a typical list, with the page navigation controls circled in red.

Only the ten most recent entries were visible on the first page. Had we not prompted participants to search, they would have missed a large percentage of the available data. After searching, the page controls were still not used, but search ranking by relevance made navigating beyond the first page less important.

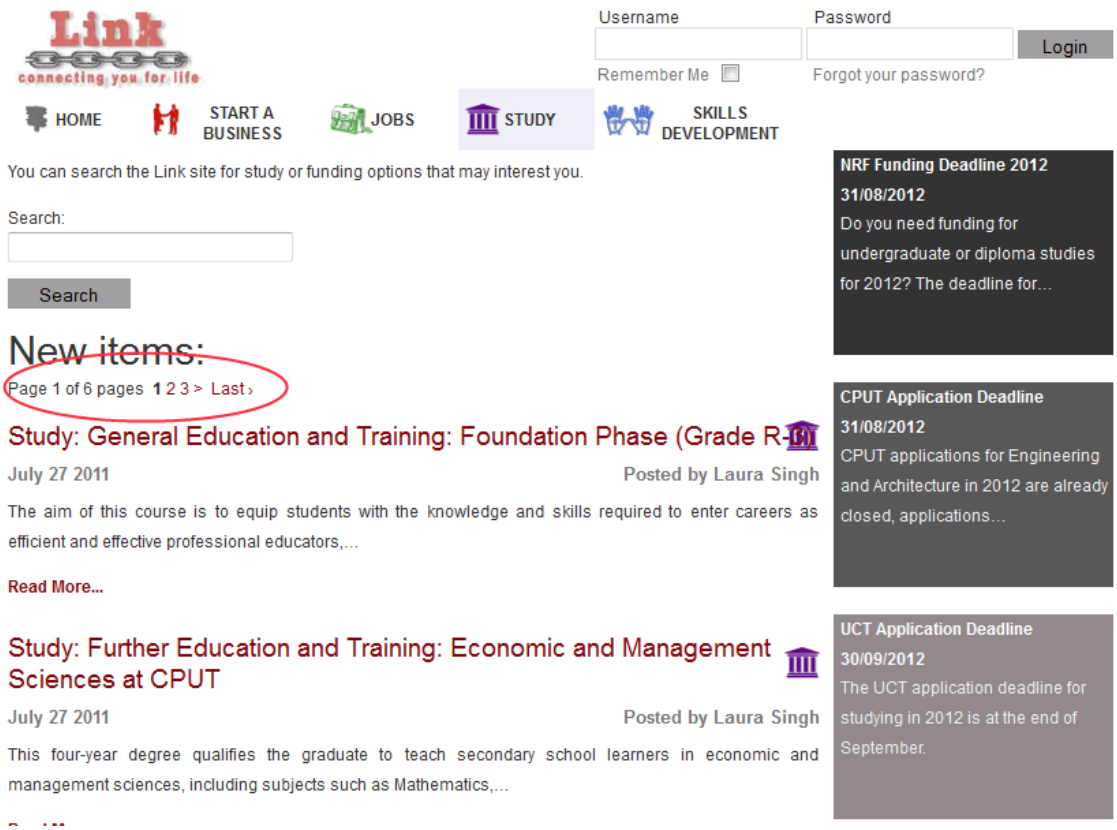

Figure 24 Website list navigation controls were unused in Cycle One testing. Here they are highlighted on a typical list in the site, but users did not easily spot them unassisted.

Menu Navigation and Visual Cues

All attempts to complete tasks were made with the help of the scoped sections of the site (see Section 0); the global search box on the home page was ignored. This may have been a conscious decision, or it may have been that positioning and design made it invisible. Figure 25 shows the home page with the search box circled in red.

The scoped sections offer the advantages and disadvantages of a hierarchical data organisation: fewer distractions from irrelevant data, but also the possibility of missing a useful option if the wrong section is entered. Accordingly it was important that users understand which section of the site they were browsing, and that they be able to navigate back to the home page or into a different section.

Once in a scoped section of the site, the menu bar was the only means of navigating to other sections and the only visual cue regarding the current site section. We highlight the menu bar on a scoped search page in Figure 26. The faint blue background colour on the "study" menu item indicates the current section. Clicking on any other item in the menu navigates to a different section of the site.

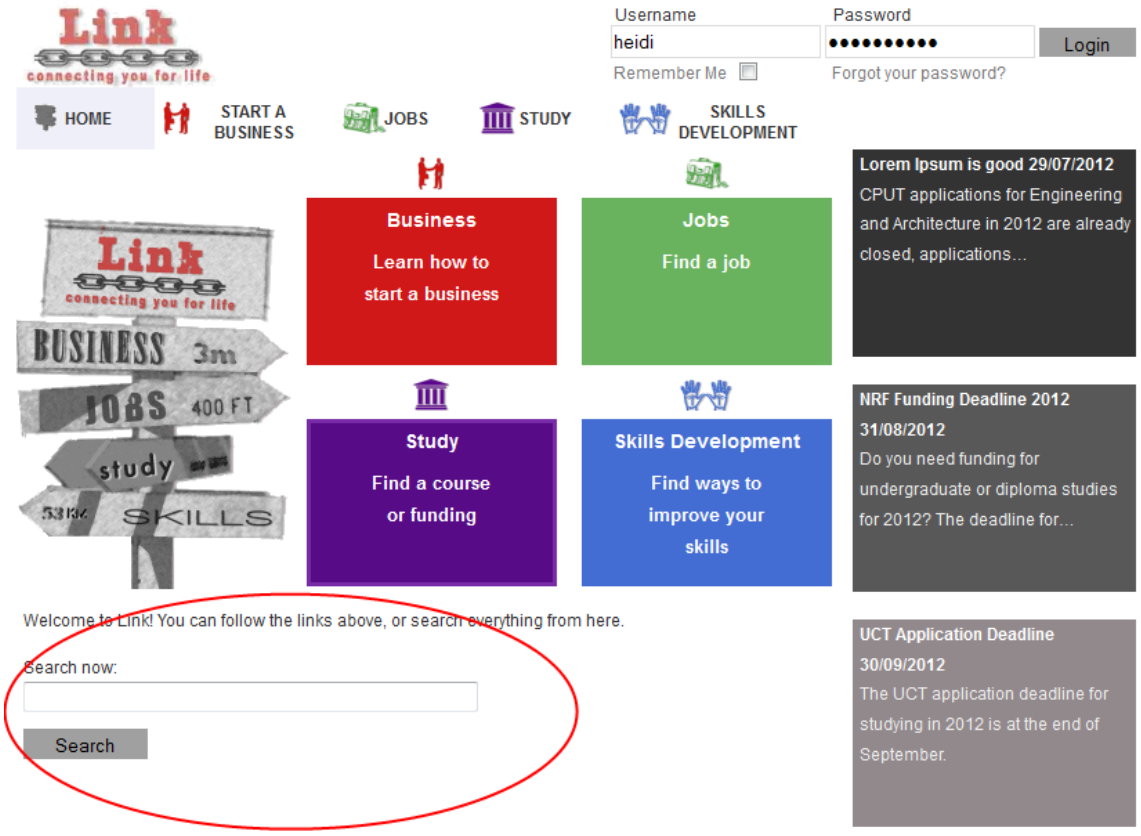

Figure 25 The global search controls on the home page were unused in Cycle One testing. Here they are shown circled in red.These could have alleviated some navigation difficulties we observed, had they been used.

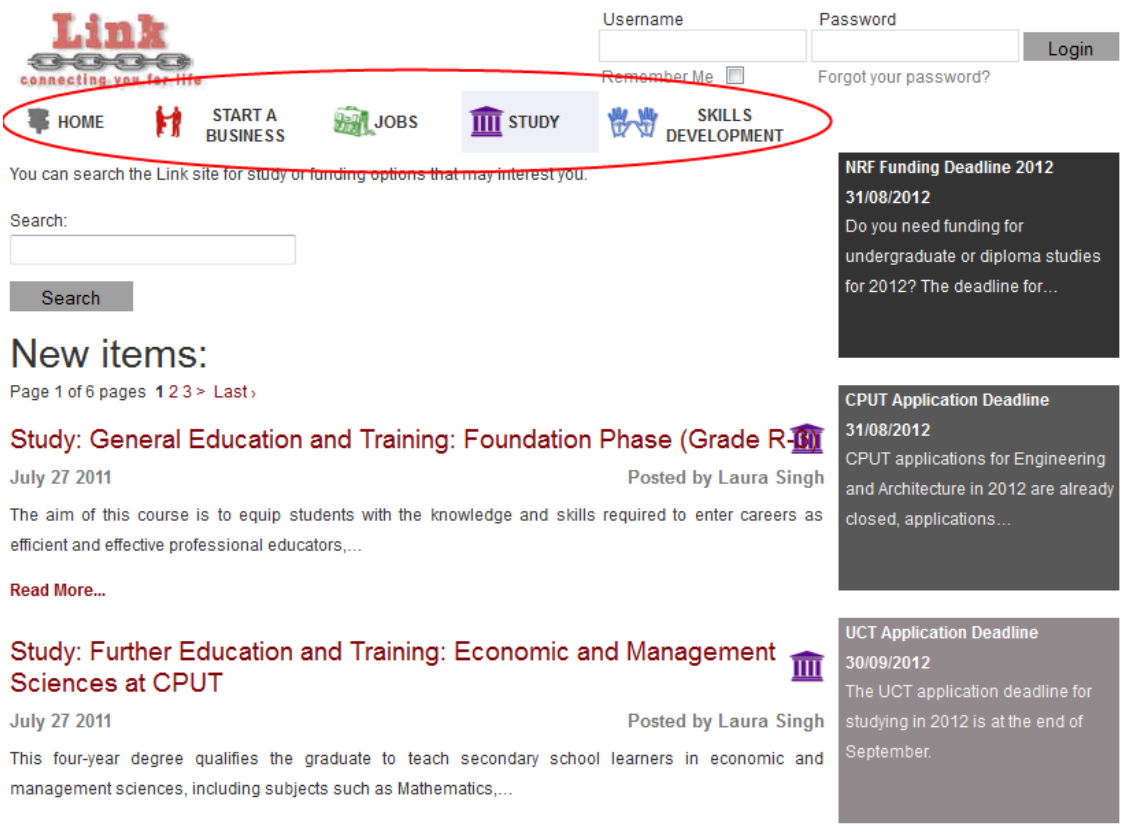

Figure 26 The menu navigation was not visible at crucial junctures. Here it is highlighted in red. The menu was intended to provide navigation controls and context to the user but was not considered for important tasks.

The given cues were insufficient. For example, after completing a task in the skills section, we asked one pair to begin the job search task. They did not spot the "jobs" menu button which would lead them into the jobs section, despite having previously used the "home" button to its left. After a long pause the pair discussed the possibility that they might enter the text, "jobs" into the search box on the skills page, which would not provide useful data. Stronger indications of context and navigation affordances were necessary.

Visibility of Related Information

An important function of the site was its ability to lead users to new information based on searches they made and entries they viewed. The "related" lists of entries on the right hand side of every search and individual entry page (circled in Figure 27) were created for this purpose. Unfortunately no users spotted the information.

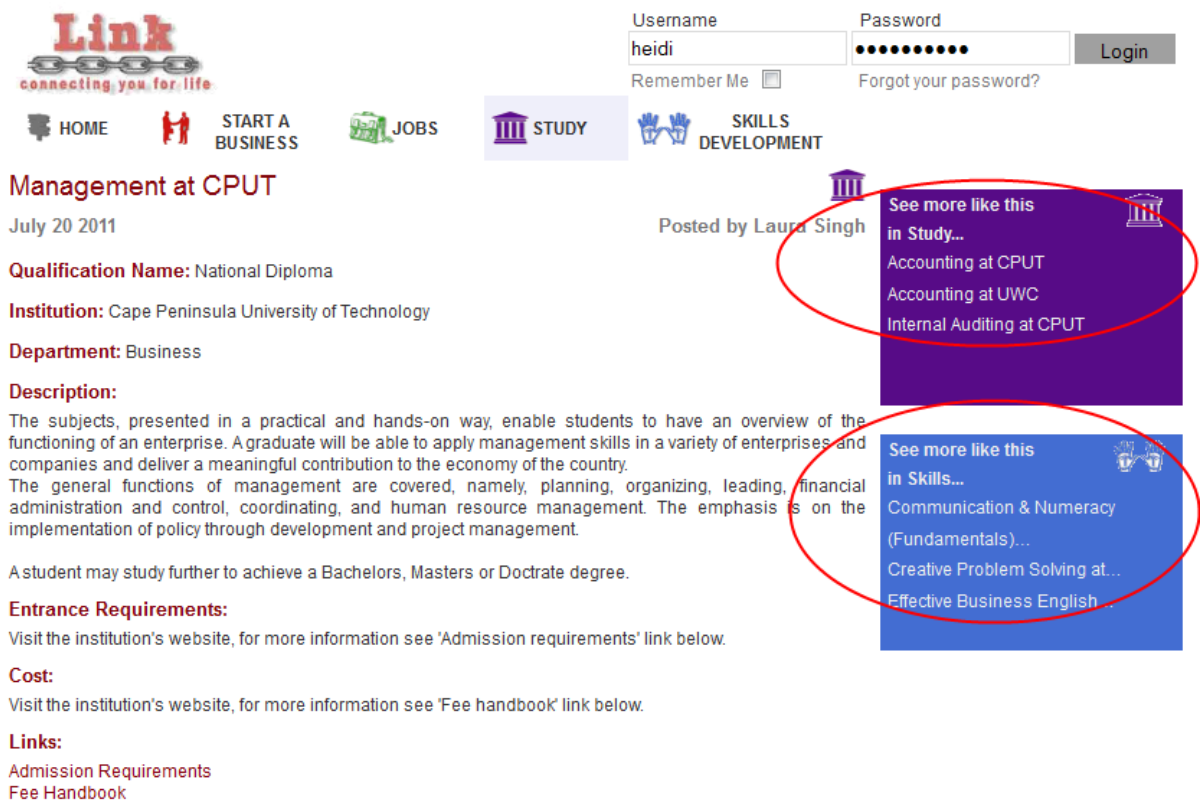

Figure 27 Unused related information elements are highlighted on an entry detail page

Data Capture Policies

We had agreed the fields that would be captured for each different type of content, but the existence of free text fields allowed for variation in data capture approach. The tasks we chose were designed to elicit users' reactions to all available content types, with the intention of informing the Link team's approach.

We discovered a discrepancy between participants' interests and the available entrance requirement and fee data for tertiary courses. Instead of displaying this data directly on our site, the Link team had captured links to academic institution websites, where our users would theoretically be able to find the information for themselves.

Unfortunately, pages from a sample external web site proved intimidating. We had to offer explanations about the purpose of the information in front of students and prompt heavily before they would take action. Using the external pages required combining information on our site with information from the external pages. Our users were not adept at this: they struggled, for instance, to use the information on our site about a course to identify which of several fees listed on an external page (see Figure 28) was relevant.

Students Level of Readiness

We hoped to learn whether our participants would be able to apply the content usefully. This question proved difficult to answer. On the one hand, the pair in Lavender Hill decided that a hypothetical friend should not apply for a job based on the dates listed on our site and the

knowledge of when the friend would be writing exams. In so doing they proved their ability to combine their own knowledge and the contents of our site to reach new conclusions. On the other hand, one of our Manenberg groups recommended one job entry over another because "it has more information", rather than reading the contents of each and thinking about the task.

In another scenario, what we thought was a simple task proved difficult. Investigating university courses for a hypothetical student whose favourite school subject was accounting would, we hoped, result in an immediate search using the word "accounting". Unfortunately the students hesitated. One group requested more information about the person, while others just looked at the items in the list without performing any action and would not commit to a recommendation.

The council of the **University of the Western Cape** reserves the right to amend all fees without prior notice.

TUITION FEES FOR 2011 – SOUTH AFRICAN STUDENTS

Tuition fees are charged per module within a prescribed programme. Students, who registered for more or fewer modules that prescribed, will be charged accordingly.

Prescribed Undergraduate fees	
B.CH.D I to V	R31 220 Per annum
B.Ed	R17 300 Per annum
BOH (Bachelor of Oral Health)	R20 090 Per annum
Economic and Management Science (e.g. B.Com Gen, B Com (Acc), B Admin etc)	R17 300 Per annum
Arts (e.g. BA, BBibl)	R17 300 Per annum
Science (BSc and B Pharm)	R18 880 - R20 900 Per annum
Comm & Health (BA (SW), BSc(Phys.Ther), B Sc(Occ. Ther) etc)	R17 300 - R24 080 Per annum
Geology II or III is taken	R19 000 Per annum
LLB	R17 300 Per annum

Figure 28 List of annual fees on a university web page external to our website. Users struggled to use this page to determine course fees of a course on our site.

3.5 Specifying Learning

3.5.1 Internet-Supported Intermediation

Several difficulties – which would affect whether the website could support intermediation – emerged from this cycle. We categorise them in terms of financial considerations, access constraints, fear of technology, skill, and habits of dependency (see Section 2.1.5).

Although evaluation was controlled, in the diagnosis phase, we did gather some data related to access constraints and financial considerations. The technology use survey at Link workshops indicated (just as in the studies discussed in Sections 2.5 and 2.6) that a high percentage had used ICTs at some point in their lives. In Manenberg a higher percentage than we expected had used a computer at home, making it possible that – other factors being addressed – household members could act as secondary intermediaries, and in turn the website could support the Link team's intermediation.

During the usability evaluation, various issues of skill occurred. Data capture policies (which required students to visit other websites) and usability issues prevented task completion. Changes in future cycles might improve upon these. However, website and computer operation skills which slowed users were not something that we would be able to improve upon, as we did not have time to train users. Fortunately, these did not prevent task completion.

Some users' hesitancy to act on instructions during the evaluation might be a consequence of fear of technology, but this might also be related to usability issues.

We did not gather data about habits of dependency directly from students, except for the students in Manenberg who had access at home. This was positive, but outside the expectations of the Link team, with whom we had discussed personas (see Section 3.1.4) whose parents and guardians were materially poor, unsupportive, or abusive, and therefore unlikely to provide access.

Other evidence related to secondary intermediaries included:

- In the plan phase, the Link team suggested churches could provide access to the website (see Section 3.2)
- In the action phase the actors we created for scenarios accessed the site at a neighbour's house and at a community centre
- The Manenberg church group appeared unready for the Link workshop we observed (see Section 3.1.2), indicating a possible lack of buy-in, but a leader from the group did run the workshop

3.5.2 Adoption

Relative adoption was not a major focus of this cycle, as we had only built one system. Our technology use survey in the diagnose phase (Section 3.1.3) did indicate some advantage in regular use for mobile phones, but also that computer use was more frequent than we expected.

In the usability evaluation we found that students could use the conventional web albeit slowly, but until we observed similar activity on the mobile platform, we could not conclude whether this was positive or not. On the other hand, it would be important to improve on usability problems on the website in future cycles, because a comparison between a mobile interface and a poor desktop interface would make for flawed research about the two platforms.

4 CYCLE TWO – WEBSITE IMPROVEMENTS

Cycle Two ran from mid August 2011 until the end of October 2011. This cycle was the first involving the group of students at the homework club in Mowbray (see Section 2.3.2).

4.1 Diagnose

We began by reviewing the results of the previous cycle. In email conversation the Link team raised concerns about our evaluation having taken longer than they had promised the church leadership, and that the scenarios we had used were difficult for students to relate to:

"The sessions were quite long, as responses were written down, and the use of scenarios made interaction a bit too directed" – email from Link staff member

"The scenarios seemed difficult to follow or respond to – not sure it was the best way to have the learners interact with the site. In Scenario 2: they had to choose from 4 different jobs, without really knowing the candidate well. Using abstract examples are difficult for kids in less affluent communities, and this made interacting with the site more difficult." – email from Link staff member

We revisited the reason for using scenarios in evaluation one (see Section 3.4.3), that there was not enough data in the system for students to find content related to their own interests. Fortunately as more data was being captured we anticipated that we would not need to rely on hypothetical questions in future evaluations.

In that conversation we also discussed hesitancy and navigation problems that students had with the site. In mid-August 2011, we met with the Link team to discuss further. The main topic of that meeting was user interface changes which the Link coordinator believed would address both problems:

- Cosmetic changes to UI elements, especially on the home page to draw users to pages beyond the first
- Removing entry lists that were not ordered by relevance
- Adding default terms, *e.g.* "study" to entries in our search index so that the words used in the menu would not return empty results when entered as search queries
- Addition of the global search bar to every page

It is easiest to discuss the specific implementation and rationale behind each change together; we do so in Section 4.3.1.

We also discussed the data capture approach and our observations of users interacting with external sites. The weight of opinion from those who were present at the evaluation was sufficient to convince other Link team members that a reference to an external site was insufficient for important information like entrance requirements of a course.

4.2 Plan

The difficulties observed in Cycle One would prevent useful activity from taking place even if users did have access. It was therefore unlikely that the website could support intermediation without change, and so we needed to act to improve the site.

A school holiday was approaching in October 2011, during which the Manenberg youth group was holding a week long retreat. The Link team hoped to have time to work with approximately 40 students there. At the retreat and in sessions shortly thereafter in Lavender Hill and Mowbray, we would introduce the site to new users. A second usability evaluation would confirm whether the changes we made had the desired effect.

4.3 Act

We describe here the changes we made to the Link website for Cycle Two. These changes were mostly the proposed solutions to usability problems discussed in the diagnose phase. We also had time to implement more of the requirements on the list we created in cycle one (see Section 3.3.2).

4.3.1 Usability Solutions

The usability problems identified during the diagnose phase of this cycle and our solutions are discussed here. We also explain how the problems and solutions are consistent with other work on usability (mostly Nielsen's usability heuristics – reproduced in [64]).

New Page Header

Two changes were made to the top of all pages: a more visible menu bar, and a new global search function. See Section 3.3.6 to view the home page as it was in the first cycle, when users did not make good use of menu controls. The Link Coordinator requested that we make it more visible.

The screenshot in Figure 29 shows the new page header. Navigation controls are more visible as a result of changing colours and employing a tabbed metaphor to create clearer contrast between selected and unselected items.

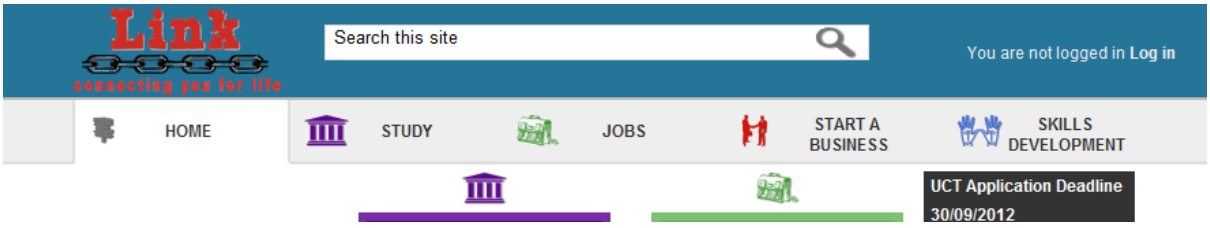

Figure 29 The website page header was improved for Cycle Two, including menu with tab metaphor and repositioned global search box. These better highlight the user's current "location" in the site and make search possible from any page of the site.

Also visible in Figure 29 is the global search box, which was previously at the bottom of the home page (see Figure 25). This addition to the header allowed users to search the whole site from any page. Users who did not understand the site navigation would be able to reach pages outside of the current section using this control.

These changes are consistent with Nielsen's usability heuristics [64]: clearer contextual information improved the "visibility of system status"; the tabbed metaphor added a "match between system and real world"; and moving the global search bar favoured "recognition rather than recall".

Home Page

Apart from the header on every page, the home page was altered to lead users beyond it to the content of the site. The changes are circled in the screenshot shown in Figure 30. At position A, the "advert" blocks are smaller so as to give more importance to other content. The appearance of the blocks at position B has been subtly altered with a lighter border to create a more three dimensional feel. We hoped this would lead users to the conclusion that they contained "clickable" links, rather than assuming that they were purely decorative. These changes are consistent with Nielsen's heuristic, "recognition rather than recall", by making potential actions more visible [64].

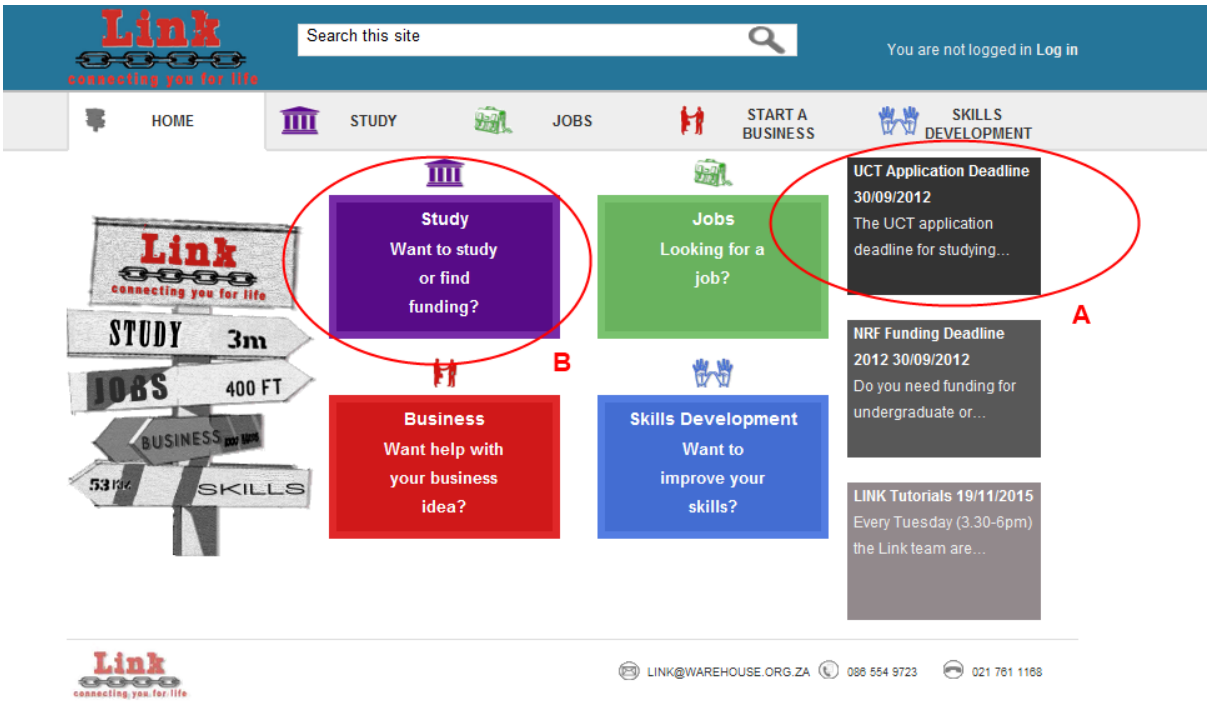

Figure 30 The improvements to the home page for Cycle Two. "Adverts" on the right (position A) are made smaller relative to other elements, and the border of the blocks at position B is made lighter to highlight their importance as navigational elements.

Search Entry-Point Changes

Figure 31 is an example entry point to a scoped section (in this case, study), which previously showed a list of entries ordered by date of capture. In our results of the previous cycle (see "Students Level of Readiness", page 69) we noted that users read these lists without searching. The Link coordinator asked us to remove these. She believed this would prevent distraction by irrelevant information. Her judgement was intuitive, but is consistent with the finding of Walton *et al.* that novice web users who were not used to working with large amounts of text attempted to consume content from start to finish instead of using skimming and scanning techniques to leap to the most important portions of a page [14].

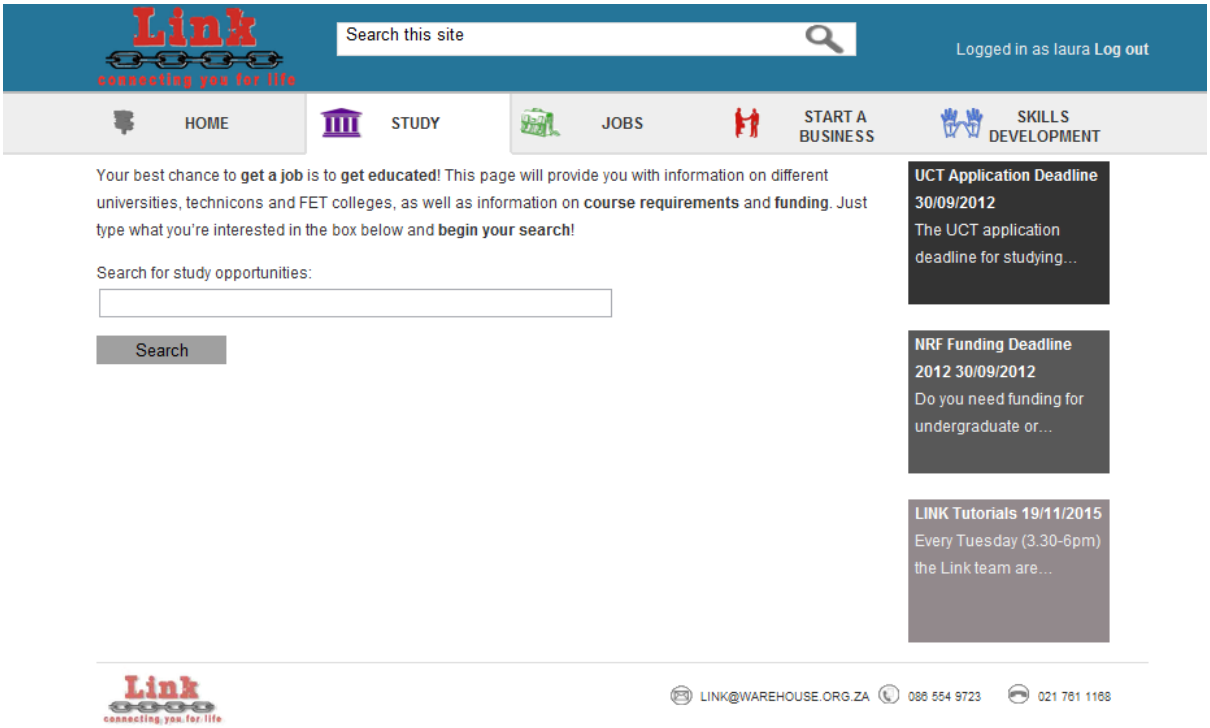

Figure 31 The study section entry point showing only search controls. To prevent users from reading entries unrelated to their interests, the Link team requested that no list of entries be shown until a search is performed.

Search Results Changes

Three cosmetic changes were made to the presentation of search results (see the search results pages as they appeared in Cycle One, Figure 19, for comparison). The most important was making pagination controls more visible. These controls can be seen at point A in Figure 32. There is a stronger contrast between the click-able controls that lead to other pages, and the number indicating the current page being viewed.

Point B shows an entry summary in search results. The section icon for each entry was moved to the left next to the name of the section. Vertical space was conserved by removing date, author information, and unnecessary white space. These changes make the distinction between different items more prominent.

Point C shows the presentation of related items. Text was changed to the same font and colour as the rest of the site, and the column moved to fit vertically underneath the menu. We hoped that this would help users see this interface element.

Changes at positions A and C make actions more visible, as per Nielsen's "recognition rather than recall" heuristic. The change at position B contributes to "minimalist design" [64].

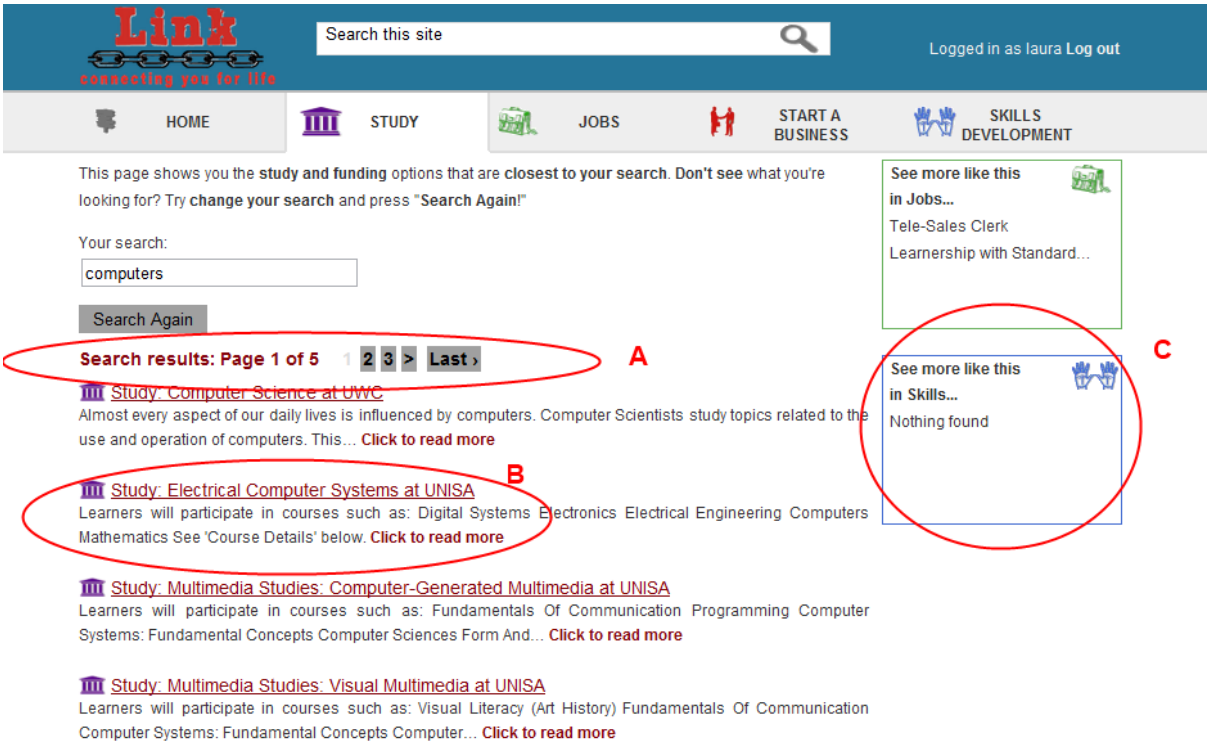

Figure 32 Cosmetic changes made to the search results pages in Cycle Two. Pagination controls (position A) are more visible than in Cycle One, search results are made easier to distinguish at position B, and related items at position C have been moved to directly underneath the menu.

4.3.2 Previously Unimplemented Requirements

Advanced Search

We piloted advanced search features for the jobs section. New filters that make use of structured fields in our data have been added to the search form shown in Figure 33. The feature was used in two of our scenarios (see "Leandre: Search Jobs" and "Leandre Read About Skills Development" in Appendix C). In them, the Leandre persona is able to reduce the number of jobs she needs to view, and learns about the importance of improving her skills by observing how many more jobs are available when she performs a search for jobs requiring a driver's license, which she does not possess.

The default settings on the form showed all entries, but users could filter by drivers license, education level and language fields if they see more entries than are relevant. Once the search is complete, the results page shows the same form (as in Figure 32).

Related Funding Links

On course detail pages, we added links to relevant bursaries. The links can be seen in Figure 34.

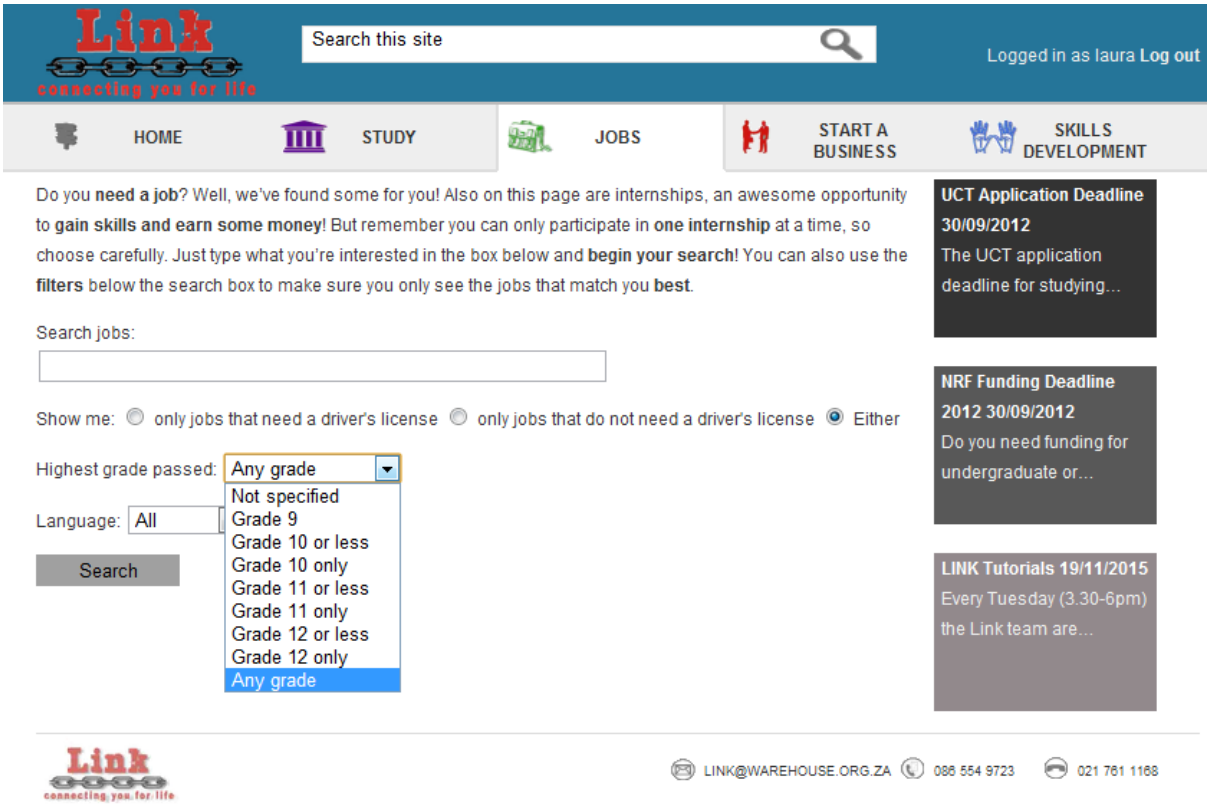

Figure 33 New filters on the jobs search page. These advanced search features were amongst the original requirements left unimplemented in the first cycle.

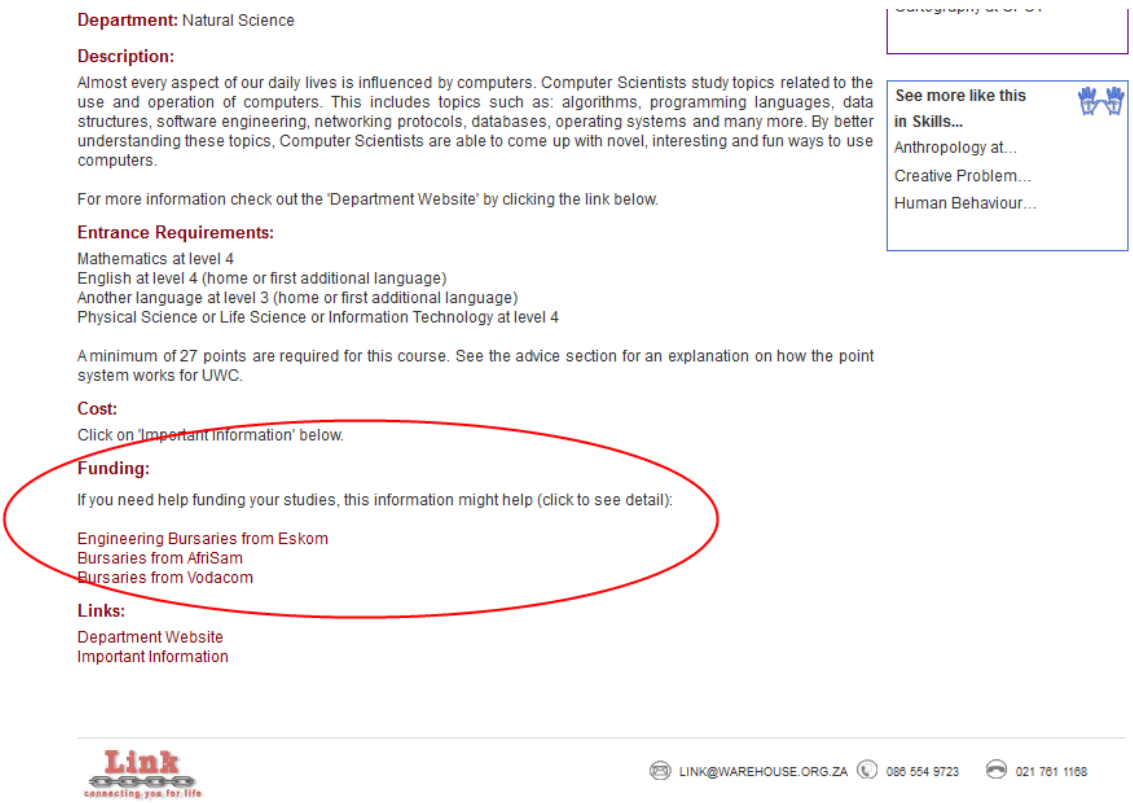

Figure 34 New links were added to funding opportunities from study entries.

4.4 Evaluate

In the previous cycle we found that students were capable of completing tasks using our website when assisted, but that without assistance they were hesitant and missed much of the information that was on the site. In this phase we performed usability testing to assess the effectiveness of the changes we made to address these problems.

4.4.1 Venues and Date

Our Cycle Two changes were completed just before the October 2011 South African school holidays. Unfortunately, the Manenberg youth group cancelled our scheduled session with only a few hours notice, due to the leaders of the group deciding that other activities were higher priority for their school holiday retreat. Our first evaluation session was therefore delayed until a week after the holidays, to when we could visit the Lavender Hill group. The following week we met with students in Mowbray, and we visited Manenberg on the 21st October.

When we did visit Manenberg, it appeared that the Link team's contact had forgotten our arrangement: the church property was locked, and once it was opened, the only students who joined us had come to the church for a dance class. We did not have information about the reason for cancellation, but it was clear that the Link staff member who travelled with us was disappointed.

4.4.2 Participants

The Mowbray group provided the bulk of participants for the second evaluation. The other groups made fewer students than we expected available. In total, we saw twenty students:

- Eleven from the Mowbray group, all in grade eleven, divided into five groups of two and one individual
- Six from Lavender Hill, divided into three groups of two
- Three from Manenberg, who all worked as individuals

Where an odd number of students was available, it was necessary to work with a least one individual instead of pairs. In Manenberg we elected to work with individuals instead of groups because we brought more facilitators than students, making it possible to run three simultaneous sessions.

4.4.3 Method

As in Cycle One, a facilitator gave tasks to students who sat in front of a computer. The evaluation was run at larger scale than before: we added a third venue to the two from our first evaluation, and worked with more students at each. We again brought laptop computers to each venue rather than relying on existing infrastructure.

The group of facilitators comprised ourselves, the Link team, and four assistants recruited from our research group. Each facilitator was given a script (see Appendix G) to help them guide students.

In response to concerns from the Link team about the effectiveness of tasks based on scenarios (see Section 4.1) we no longer asked students to reason about a fictitious friend. The tasks were

now directed at the students themselves, asking them to find information that was of personal interest. This was possible because the Link database had grown significantly since the end of the previous cycle.

Interestingly, the shift from fictional to personal tasks is the opposite of that made by Medhi *et al.* in [74], in which a participant who had a job was upset when she was asked to perform a user interface evaluation job search task as if she did not have a job. In response Medhi *et al.* asked participants to assist hypothetical friends rather than search for information for themselves. We hoped that our new evaluation style would be less problematic because for a high school student to consider tertiary education is more positive than for an employed person to consider unemployment.

The script started with time for students to use the site without specific tasks. This "experimentation" time allowed us to see how the students would engage with the site when not prompted by instructions. Once the students had experimented to their satisfaction, the facilitators directed students with prescribed tasks.

We gathered data from several different sources:

- Pre-evaluation questionnaires administered by the Link team
- System Logging
- Facilitator observations
- Direct feedback from participants

We describe each data gathering approach below.

Technology Use Questionnaire Revisited

We re-used the technology use questionnaire from Cycle 1 (see Section 3.1.3) in Mowbray to establish whether the existing level of access to technology at the new venue (see Section 4.4.1) was similar to that observed in Lavender Hill and Manenberg.

Participant Interest Questionnaire

Before the Manenberg and Lavender Hill events, the Link team administered brief questionnaires which asked participants to list their interests and the careers that they felt they might follow. The activity was interesting to us because it simulated the context in which future users would be introduced to the site: following a workshop in which they reflected on their interests and future direction. Comparing participants' actual searches to their reports of their own interest allowed us to test whether the site allowed students to act on their intentions.

System Logging

System logging provided a detailed record of every action requiring a system response and what that response was. Since each computer involved ran its own web server, it was possible to tie actions to a specific pair of participants. This made some quantitative analysis possible and allowed us to verify facilitator observations. Timestamps on HTTP requests allowed us to calculate time difference between each action and its successor as a measure of duration.

Facilitator Observations

Facilitators made notes during the evaluation. We reviewed their notes and interviewed each facilitator to clarify uncertainties. These were most detailed where events focused facilitators' attention: unexpected events, difficulties and answers to direct questions in the script. System logging complemented their observations by providing a detailed record.

Direct Feedback

After participants used the system the script called for facilitators to ask specific questions about the experience. We discuss the feedback over several different sections of the results in order to improve understanding of other data.

Unfortunately incorrect printing of the script resulted in the questions not being asked for three of the twelve groups. In addition, answers to direct questions were generally brief and participants appeared hesitant to give negative feedback (unwillingness to criticise outsiders and new interventions is a phenomenon documented in many contexts [91]). We therefore took special note of direct criticism.

From the combination of methods, we identified behaviour common to multiple sessions (see Figure 35 for an example of the process of analysis), extreme individual cases of difficulty, and unexpected behaviour. Although extreme or unexpected incidents are not the norm, it was important to review them in order to understand who would be at risk of repeating them outside of the test environment, and if necessary to fix those issues over which we had control. Facilitator observations were the main way of identifying these, but also served to explain the patterns of other, more quantitative methods.

The combination of the above data is the content of the following subsection. These observations were grouped by a pseudo-chronological order of an interaction with our system: attitudes before use, ability to translate intent into search, search behaviour and reaction to content found or not found, and finally the overall reaction to our system. The headings of the following subsection reflect that grouping.

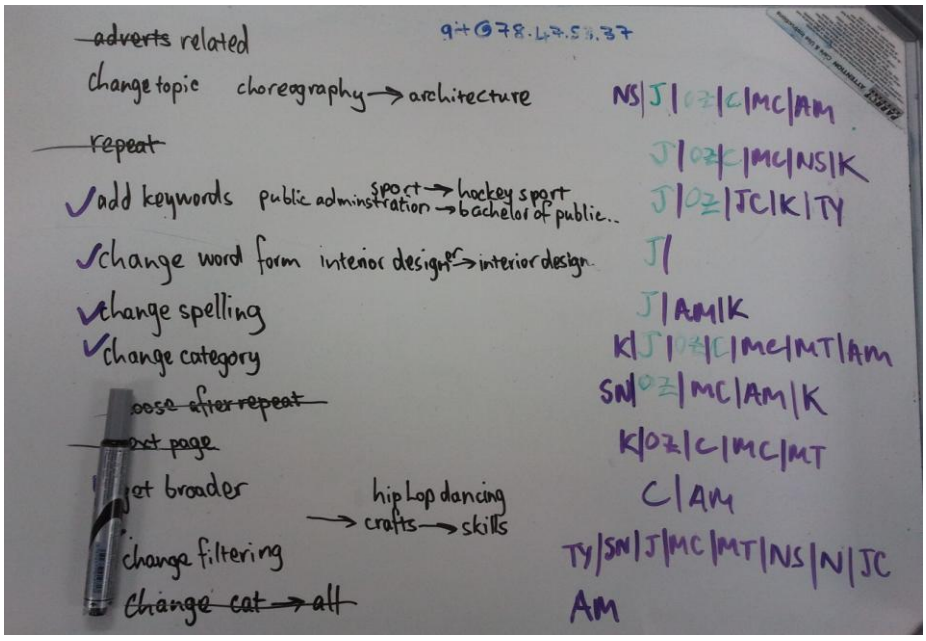

Figure 35 Example of cycle two analysis process: whiteboard tabulation of search improvement strategies (discussed under "Emergent Search Improvement Strategies", page 86) by the pairs of participants who applied each strategy. This portion of the analysis process combined system logging and facilitator observations.

4.4.4 Results

We report results from Cycle Two usability testing here. Participants are identified using double initials. Pairs are marked with an ampersand separating individuals. No student participated more than once.

Technology Use Habits In Mowbray

We asked students at the Mowbray homework club to complete the same technology use questionnaire that we used at workshops in Lavender Hill and Manenberg in the diagnose phase of Cycle One (see Section 3.1.3). Their responses are shown in Table 6.

The patterns of Cycle One (see Table 5) were maintained: all students had used a computer at some stage in their lives, but a much higher proportion reported regular mobile phone than conventional computer access.

Table 6 Technology habits questionnaire responses in Mowbray. The data shows higher regular mobile phone use than conventional computer access, consistent with the Cycle One survey of Lavender Hill and Manenberg students.

Measure	Mowbray (n=11)
Ever used computer at home	3
Ever used computer at school	1
Ever used computer at library	6
Ever used computer at Internet cafe	1
Ever used computer (Total)	11
Computer yesterday or today	2
Cellphone yesterday or today	11
Have used Google on computer	9
Have used MXit on cellphone	10

Desktop Computing Skill

In this section we report our observations of user capabilities at the level of hardware, operating system, and web browser.

We observed slow and inexact use of input devices. This is consistent with inexperience rather than encountering these devices for the first time. No-one appeared surprised that the pointer on the screen reflected movements made using a mouse or that text input required choosing a combination of keys on the keyboard.

Unfamiliarity with web browsing was indicated by a number of people who attempted to double click rather than single click. This is also evidence of prior computing experience, with interfaces that do require a double click.

Scrolling appeared unfamiliar to some. One pair who had scrolled down to the bottom of a page asked their facilitator for help because, "we want to go back". They had forgotten that navigation elements that were not currently visible were available at the top of the page.

One user who had clearly not had good instruction exhibited a problematic habit but compensated with an interesting workaround. She would click the PC mouse with her whole hand, rather than just pressing the left mouse button. This frequently caused the right-click Windows context menu to pop up, making use of Windows software a frustrating experience. However, in Internet Explorer, the top context menu item when right clicking on a hyperlink is "Open", and any subsequent click with the pointer correctly positioned – right or left – causes the browser to follow the link. The student was therefore able to reach her goal, albeit in an inefficient manner. The inefficiency was more pronounced when she attempted to scroll through lists longer than the vertical screen length. She would position the mouse on the scrollbar, inadvertently right click, and move to the "Scroll Down" item at the bottom of the context menu.

Internet Explorer was less forgiving in another situation. While entering a search query, a student accidentally deselected the text box in which she was typing. When she pressed the backspace key, instead of removing a mistyped character, the browser moved a page back in the browser history, leaving her trying to complete an action which was not available on the page showing in the browser. This response from the browser is unfriendly toward users who are not able to focus on both screen and typing.

Fortunately, difficulties like those above appeared more frustrating than crippling, and the facilitators were always able to correct the resulting errors if necessary.

Successful Translation of Intent into Searches

Lavender Hill and Manenberg participants answered questionnaires about their skills and their possible future jobs. We show these answers in Table 7.

After set the task of using the site – without being given detail as to how – all but one of the groups performed a search without further prompting. The exception was a pair who entered text into the global search control but hesitated and asked for instruction before clicking the search button. We show the first search entered by each group from Manenberg and Lavender Hill in Table 8.

Table 7 Participants from Manenberg and Lavender Hill reported skills and jobs that they thought they possessed or could pursue. This would later be used to determine how well students' were able to translate their intentions into useful actions on the website.

Who	Skills	Jobs
CT	crafts,dancing,teaching, presenting	university lecturer, choreographer, politician|
JL&CA	decorating parties (JL), leading (JL), cleaning up mess (JL), listen well(JL), leadership (CA), reading (CA), IT (CA), good listener (CA)	interior decorator (JL), market business (JL), social worker (JL), computer literacy (CA), mechanical engineer (CA) chef (CA)
JT	drawing/sketching,dancing/teacher,soccer/stretch instructing, presentations/debating	architect, graphic designer, choreographer
KA	sports/soccer, dancing, drawing	Dancing
MP&CE	leadership (MP), good listener (MP), giving advice (MP), teachable (MP), facilitation skills (CE), youth development skills (CE), sport (CE), leadership (CE)	interior designing (decorating) (MP), computing (MP), social working (MP), youth development (CE), sports instructor (CE), facilitation (CE)
MS&TV	athletics (MS), good with directions (MS), soccer (MS), problem solving (MS),	mechanic (MS), professional athlete (MS), racing car driver (MS), working

	manufacture jewellery (TV), good communication (TV), helpful (TV), Sunday school teacher (TV)	in a jewellery workshop (TV), own my own business (TV), work in a jewellery factory (TV)

The importance of the first search is that it gives a picture of what the participants thought was an appropriate use of the site before prompting could affect their choice of input. The JL&CA group's search "interest" appears to have been affected by the facilitator's introduction, that "you could use it [the site] to find something that *interests* you". However, their second search, which was also made without prompting from the facilitator was "interest interior decorating". All six groups had therefore searched without prompting for something which matched their goals.

Table 8 First queries entered by Lavender Hill and Manenberg groups in Cycle Two usability evaluation.In all but one case the queries match an interest indicated by these groups before the evaluation.

First Search Queries		
Group	**Query**	**Category**
CT	dancing	Study
JL&CA	interest	Skills
JT	choreography	Skills
KA	dancing	Study
MP&CE	youth development (Drivers License: No, Education: Grade 10 only, Language: English)	Jobs
MS&TV	jewelery	Skills

Overall Search Outcomes

In Table 9 we present the number of search results pages viewed by each group together with the number of occurrences of each possible outcome. Those include:

- Results were found for 182 searches, while 75 returned no results
- Of the 182 pages with results, our participants chose entries from slightly less than half (83)
- Groups chose multiple entries from some pages: 154 entries were viewed in total

Table 9 Search outcomes for each group in Cycle Two. Approximately two-thirds of search pages viewed included results, and participants viewed entries on around 40% of those.

	Search Pages Viewed	**Without Results**	**With Results**	**Searches None Chosen**	**Searches Chosen**	**Entries Viewed**
AS&MG	30	3	27	15	12	16
CT	23	6	17	9	8	14
JT	51	25	26	11	15	20
JL&CA	19	4	15	13	2	3
KA	22	4	18	9	9	27
MP&CE	14	7	7	2	5	15
MS&TV	17	6	11	6	5	6
NM	12	2	10	7	3	4
NK&SN	15	1	14	11	3	6
OM&ZM	31	9	22	10	12	30

SM&NK	11	4	7	4	3	7
TM&YM	12	4	8	2	6	6
Total	257	75	182	99	83	154

Searches Resulting in Entries Chosen

The number of entries viewed by participants (154) was comparable to the number of searches which returned results. In Figure 36 we show a graph of the number of searches performed and different outcomes per category. The high number of job searches probably reflects the fact that the evaluation script made skills and study search tasks optional, but jobs tasks mandatory. However, the high number of entries actually viewed in the study section compared to the jobs section reverses the trend, and is more consistent with the high volume of data captured for that category.

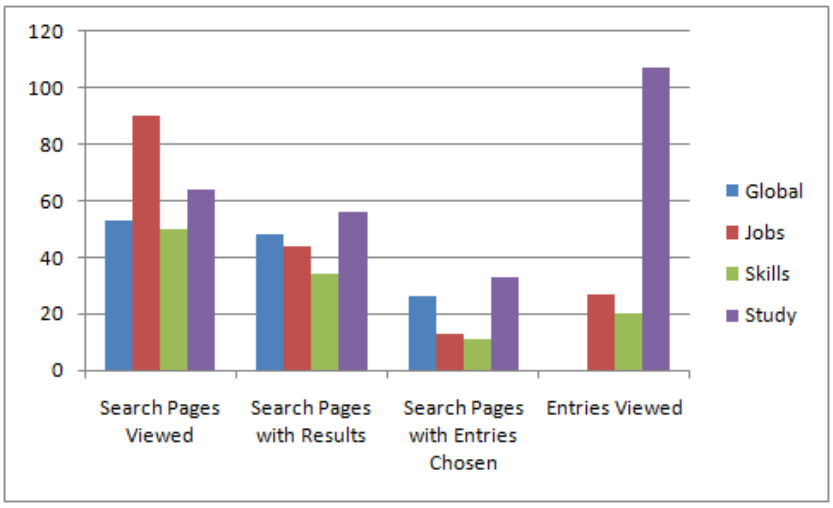

Figure 36 Search outcomes per category. The most popular search category was for jobs, which was the mandatory part of the evaluation, but most entries viewed were in the study category, where most data had been captured by the Link team.

In addition to choosing entries, participants had the option of moving between the first and later pages of results, where more than one page existed. The majority of entries chosen were chosen from the first page of results, which is reasonable since results were ranked by relevance. The page controls were used a total of 32 times. The act of switching pages had some important effects:

- Where many entries were related to a single topic, pages after the first still contained relevant information. For example, AS&MG chose to view the entry, "Education at UWC" on the second page of results for the query "teaching".
- For very broad searches, ranking by relevance had no effect, and later pages were as likely to contain useful information as the first. In one such case, CT used the query "study" in the study section. She chose to view entries from the second and fifth pages, but not from the first, third or fourth.
- Some users browsed multiple pages before using the browser history to return to a previous page of results to choose an entry.

In some cases, entries were chosen from search pages, but from the related information blocks (see position C in Figure 32 on page 76) instead of the list of results. These blocks allowed

students to choose to visit the entries that were most relevant to their search in other sections of the site – useful if they had started searching from the wrong section.

Search Results Unusable for Very Inexperienced Web User

We saw only one case where a participant appeared incapable of using search results without intervention. In this case, NM lacked awareness of the norms of web interfaces.

NM was one of the participants operating the system without a partner, in front of two facilitators. When the site returned results for her first search, she was confused by controls which allow the current search query to be altered and retried. The button which would initiate a revised search was labelled, "Search Again" (see Figure 32). NM misinterpreted this as an instruction to her to repeat the search. The result was the same page of results, with the same button text, causing her to repeat the process twice more before she asked the facilitators to explain the site's behaviour.

NM's interpretation was not unreasonable so much as contrary to the norms of web interfaces, specifically that buttons initiate actions rather than providing instructions. Other participants would have only a vague or implicit awareness of this concept, but none made the same mistake.

In the same session, the facilitators learned from NM that she had misinterpreted the page numbering on search results. In her mind (1) represented the first year of post-school training, (2) would indicate second year level courses and so on. This solidified our impression that she had not been exposed to similar interfaces. She appeared to be unique amongst all participants in the level of difficulty she experienced.

Factors Negatively Affecting Quality of Search Results

The combination of search technique, functionality and available data could have a negative impact on results before participants could decide whether or not to choose an entry:

- **Lack of Data:** Some well-formed searches were unsatisfactory because no relevant data had been captured. Some searches were for very niche occupations, such as "hip-hop instructor". Another participant was very concerned about the difference between "interior design" and "interior decorating", making us aware that the Link team would need to become well versed in many fields.
- **Query Deviation from Text Index:** The site would sometimes not recognise different forms as related to entries in the search index, for instance not relating "maths" and "mathematics".
- **Scoped Exclusions:** Students missed relevant data because it was not in the section they expected (see Section 0). Searches were sometimes issued in a category in which no relevant data had been captured: "computer i.t." is not an unreasonable search in the jobs section, but relevant data had only been captured in other sections. A participant who could not afford full time study searched for "architecture" in the skills section, but found nothing because it is not a field one enters through short courses.
- **Spelling:** Some searches contained misspelled keywords, and the site did not correct this. Fortunately relevant information could still be found based on other words: results for "chamical engineer", for instance, had some overlap with results that would have been obtained given the correctly spelled "chemical engineer".

- **Incorrect Advanced Search Filtering:** In the jobs section, it was possible to further filter jobs using controls not present on the other search screens. Unfortunately, we saw students who used the filters without spotting subtle distinctions, for instance selecting "grade 11 only" instead of "grade 11 or lower" under the "highest grade passed" option. In so doing, they removed relevant results. In some cases, they proceeded with different queries under the same filters, again missing out.

Emergent Search Improvement Strategies

In cases where participants did not like the results of a search, they could adjust the input and try again. We observed the following strategies, ordered by descending number of groups which employed them:

- Adjusting filter controls on the jobs search page (eight groups) was effective when filters were changed from more restrictive options to less.
- Moving to a different section of the site to use the same query (seven groups) was useful when good data existed elsewhere.
- Adding keywords (five groups), *e.g.* changing "sport" to "hockey sport", or "public adminstration" (sic) to "bachelor of public adminstration" (sic). The text search functionality applied a boolean OR to search keywords, and more keywords reduced the impact of misspelling
- Changing spelling or word form (three groups), *e.g.* "interior designer" to "interior design", or "carpantry" (sic) to "carpentry". This was effective where the search index did not include the original form but did include the new.
- Choosing a broader query (two groups), *e.g.* moving from, "hip hop dancing" to "crafts" to "skills". This strategy made it more likely that data would be returned, but less likely that it would be relevant.

We note that because of these strategies, search results which did not interest users drove them to perform more searches. Unfortunately, when confronted with irrelevant results, some users incorrectly drew the conclusion that they had exhausted the available information. The most frequent piece of direct feedback we received was that a particular topic was not in the site. Had all groups used the above strategies, more relevant data would have been found.

'No Results Found' Pages Hindered Search Improvement

75 searches returned no results. Figure 37 shows the page presented to users when a search returned no results. None of the UI elements common to other pages are present on this (see screenshots in Section 4.3.1). This was problematic for us:

- Participants appeared unsettled by the sudden change to the interface.
- The screen hid the available options for further action from users.
- The previous page in browser history took the system back to the state it was in before the search was made, preventing suggestions about content in other categories

We asked facilitators to pose the question, "Was there anything annoying [about the site]?" to participants, but participants were reluctant to respond, except for one, who commented on the number of searches that resulted in this page.

Figure 37 A search without relevant results displayed an unhelpful screen. It was inconsistent with the rest of the site and showed users no user interface elements that could be used to recover.

Response to Entry Detail

The aim for the cycle was to make more data visible than in the previous cycle where entries could not be found. We discuss here the reception given to entries by students. This was harder to observe than the response to search results, because we were not responsible for the capture of actual content, and so did not have the same level of control as we did over the search process.

Entry Detail Viewing Behaviour

The normal behaviour when viewing entry detail was to stare at the screen intently while reading content. There were only a few visible indications of engagement:

- One student asked for pen and paper and wrote down what he read word for word, but stopped writing after the second or third entry
- Another participant found content related to his work at the time and commented on which aspects were familiar
- A pair wanted to write down the contact email address for a part time job advert that they found

System logging allowed us to identify two improvements over Cycle One. Participants then had spent significant time browsing a list of only the ten most recent entries, missing many older entries, and not viewing the detailed content (see "Visibility of List Controls", and "Students Level of Readiness" in Section 3.4.4). In this evaluation, participants on average spent three times as much time viewing entry content, and every group viewed content that was older than the tenth most recent. Appendix H provides this data in full.

Direct feedback on the content covered was sparse:

- Participants commented where they expected more detailed information.
- AS&MG took issue with content that was obviously incorrect, specifically an engineering degree with very low mathematics requirements (30-35%).
- AS&MG expressed a desire for the site to include audio and video content.

- CT found it surprising but positive that entries representing courses included contact details.

Navigation Away From Entry Detail Pages

From an entry detail page, the only action possible apart from reading was to navigate away. Several interface elements allowed this:

- **Browser back button:** more than half of all navigation away from entry detail returned to the search page on which they found the entry. This was preferable to other options discussed here, as the existing search could be changed slightly rather than retyping the entire query.
- **Menu Navigation in Page Header:** the page header was the other major route for navigation away from an entry detail page, usually to move to a different section via the menu.
- **Global Search in Page Header:** only three groups searched directly from an entry detail page
- **Related Blocks:** Only three groups used the related blocks, and only a few times each. Participants could move directly from one entry to another without having to return to a search first. We also saw a "second chance" effect, where participants found entries on topics for which that they had stopped searching. Unfortunately a lack of data sometimes lead students to entries they had already seen.
- **Bursary Links on Courses:** This was not used often. When asked how they would find funding information about a course, most participants thought that they should return to previous search results. One group assumed that the global search functionality had some contextual awareness and typed "where do you get bursaries of this career" and, "can a university offer you a bursary" into the search box. Unfortunately when students did follow the entry detail links to bursaries, what they found was often unrelated. This was a consequence of the site recommending those bursaries that were most related out of a small pool of bursaries that had been captured up to that point.

Overall Feedback

Most of the direct feedback received has already been discussed. We include here feedback which related to overall impressions:

- **Unfacilitated Use:** Only two people expressed doubt about about using the site on their own. NM had said before the session: "I only know how to play games on a computer". We discuss her difficulty with search in "Search Results Unusable for Very Inexperienced Web User" on page 85.
- **Language:** The language on the site was easy to use according to six of the groups, with one more saying it was "ok". Two groups were negative about the language. MP&CE mentioned "words I don't see every day".
- **Expectations:** in two cases the site offered pleasant surprises. JT answered, "Bursaries, yes, it actually showed me something". The site's mere existence surprised the other: "I didn't know I could search for a job on a computer, I [only] knew about newspapers".

- **Functionality not Found Useful:** One person mentioned that they found the inoperable Start a Business section pointless.

We also record here unsolicited feedback received after three of the sessions:

- In Manenberg, a church leader who watched our evaluation expressed his support for the programme and site, saying, "This is what we need."
- Also in Manenberg, after telling us how he hoped to use the site at school in the afternoons, KA asked, "When is it ready?", followed by, "Must be soon, must". He also told us that a friend and "all" his teachers would be interested to see the site.
- In Lavender Hill, one of the participants asked us if the site could also be made available "for mobile", saying, "we have our phones all the time".

4.4.5 Discussion of Results

Users were more involved than in the first evaluation, and as a result we gained insight about functionality that was unused previously. We draw the same conclusion as in evaluation one regarding desktop computing skill – a lack of skill was a hindrance, but not critical.

Search was a natural component of use, and first time searches reflected the users' interests. The large number of searches recorded informed conclusions about the search process:

- Users who had not any exposure to the typical web search process would struggle, but if our sample of participants proved representative, these would be rare.
- When users did form appropriate queries, search results could be negatively affected by user spelling and input which the search index could not process properly.
- Users adapted their input when searches did not yield interesting results. Strategies based on visible clues – such as filters with multiple options on the job search page – were the most frequently used
- The screen displayed when no results were found made it difficult for users to apply search adaptation strategies.

Once searches were complete users chose entries to view. Improvement over previous cycles was demonstrated through more time being spent to view entries than search, and the date of publication no longer determining whether an entry was seen or not.

At the end of this evaluation, our results showed that if relevant data existed, our site could help users to find it. Despite this being their first time using it, some users adapted their input to forms that the site could better work with.

4.5 Specify Learning

4.5.1 Internet-Supported Intermediation

We again (as in Section 3.5.1) categorise evidence about whether the website could support Link team intermediation by financial considerations, access constraints, fear, skill, and habits of dependency.

Users demonstrated skill necessary to complete the tasks we set. The most serious difficulties would have affected any desktop web search tool, but were not issues which we could address, as they were products of a lack of general computer operation skill. Fortunately only one of twenty students was completely unable to use the website without intervention.

A lack of engagement in the previous cycle was a sign of possible fear of technology. In this cycle most students indicated that they would be able to use the site on their own. It is possible that as in the experience of Schwartzman and Parikh [50] – see "Rural Coffee Cooperative" in Section 2.7.3 – our participants preferred not to give us negative answers directly, but we note that in the case of *NM* who dissented, we also recorded that her experience of the site was different to other participants (initially, she was unable to use it – see "Search Results Unusable for Very Inexperienced Web User", page 85).

Evidence about the possibility of dependency relationships leading to intermediation was limited to our technology use questionnaire (see Section 3.1.3). We note that access to a computer at home was lower in the new Mowbray group than in Manenberg.

As Cycle One, there was conflicting evidence about the potential for secondary intermediaries. Positive signs were feedback from the student who told us he would access the site at school, and the church leader who expressed support of the website during the evaluation. On the other hand, this leader was at the Manenberg church where we had had scheduling difficulties (see Section 4.4.1).

We made no change to anything that could affect access constraints or financial considerations related our website. As with the other two groups, all students had used a computer at some point in their lives.

Actual access to the site would be important to examine further. We would test this by making the site available without providing Internet access or computers ourselves in future cycles.

4.5.2 Adoption

As we still had only one system, minimal new comparative data could be obtained in this cycle. We did gather new data about technology access levels in the Mowbray group, where previously identified patterns (see Section 3.1.3) were maintained. All students had accessed a computer at some point in their lives, but regular mobile Internet access was much more likely than computer access. We also had the unsolicited feedback of one student who asked if she could access the website on her mobile phone.

We note that because most students had been able to complete tasks successfully, our eventual comparison between this website and a mobile system would not be impaired by our implementation of the site. Unless we could duplicate the aspects of the site which lead to students developing strategies improving search results (or other factors proved more important), the mobile system would be at a disadvantage.

5 CYCLE THREE – WEBSITE DEPLOYMENT

Cycle Three ran from the beginning of November until the end of December 2011. It was the first in which we gathered data about Internet-supported intermediation which was not initiated by ourselves in a controlled environment.

5.1 Diagnose and Plan

In the previous cycle we had seen Link beneficiaries use the website successfully when they did not need their own computers and Internet connection. To test real-world Internet-supported intermediation, we now needed to make it available over the Internet.

We met with the Link team in early November to discuss minor improvements. It was not necessary to implement all before going live as the site could also be updated after. These improvements are listed in the Act phase of this cycle (Section 5.2). The major action of the cycle would be to migrate the site to The Warehouse's ISP where it could be accessed over the Internet. The official launch date – chosen to allow completion of changes and for all members of the Link team to be present at The Warehouse – was 22nd November 2011.

5.2 Act

We list the changes made in this cycle chronologically: first those made before launch, then the deployment of the site, then post-launch changes.

5.2.1 Pre-Launch Changes

We made a number of small changes to the website before launch. These are included here for completeness, but were not the main focus of the cycle.

Home Page Changes

We believed – based on observations of user struggles with input devices – that reducing the need for exact positioning of the mouse pointer would be beneficial. Most problematic were the centre blocks on the front page (see Figure 30), which required positioning the mouse pointer precisely on the text in the block.

The only way to achieve the goal of making the whole of each block click-able was to replace the HTML and CSS elements which made up the blocks with an image. We had initially resisted this approach because images for each block would be a significant addition to the previous page size (20KB relative to the existing 60KB), hindering slow connections. Fortunately even after this addition the front page of the site was around a tenth of the size of the Google home page.

The switch to images also allowed us greater control over the style of each button – shading gave it the appearance of affordance. The result can be seen in Figure 38.

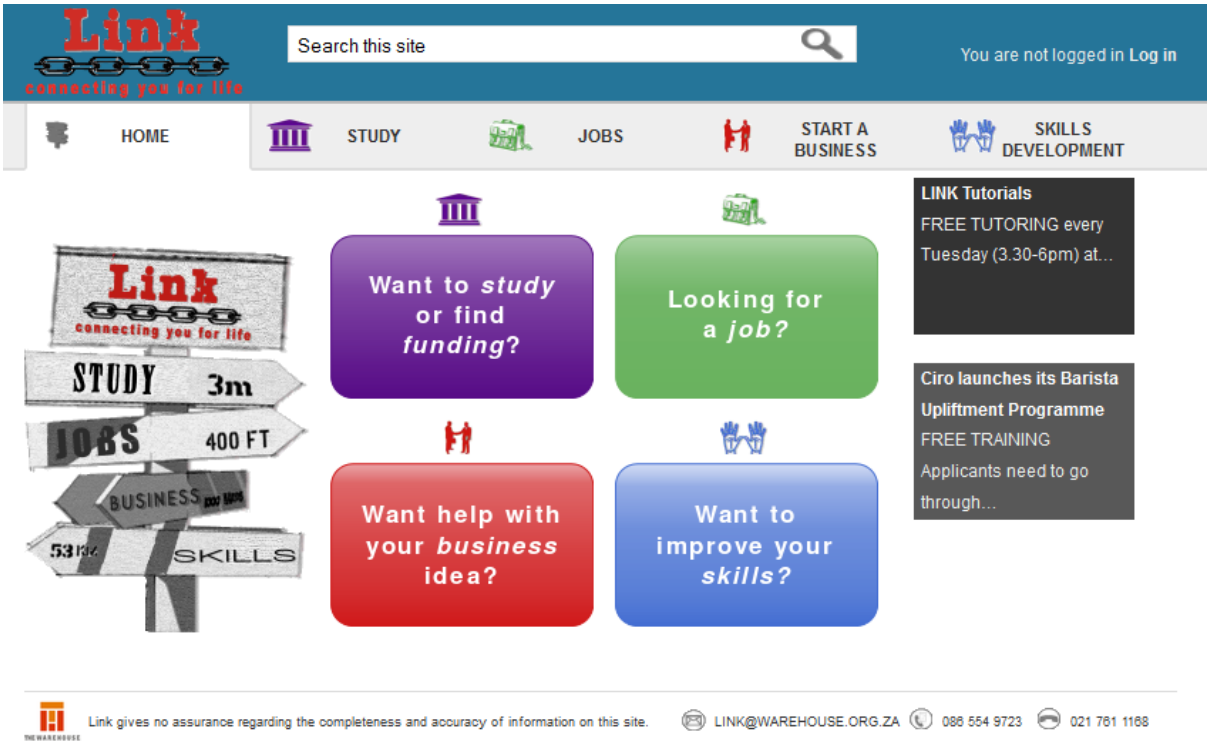

Figure 38 Appearance of the home page at the time that the site was launched in Cycle Three

Easier Access to Login Controls

Previously, the site responded to any attempt to access a section to which the user did not have access with a page requesting them to follow a link to a login page. This can be seen in Figure 39. By moving login controls directly onto that page, shown in Figure 40, this became a single step.

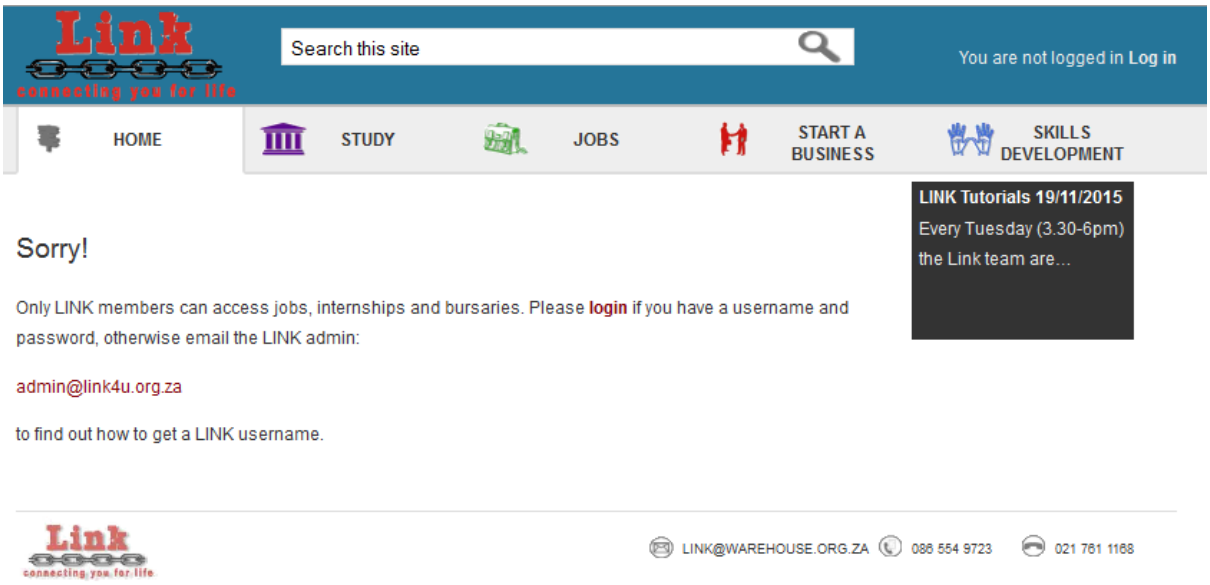

Figure 39 Access restriction page as it appeared in previous cycles

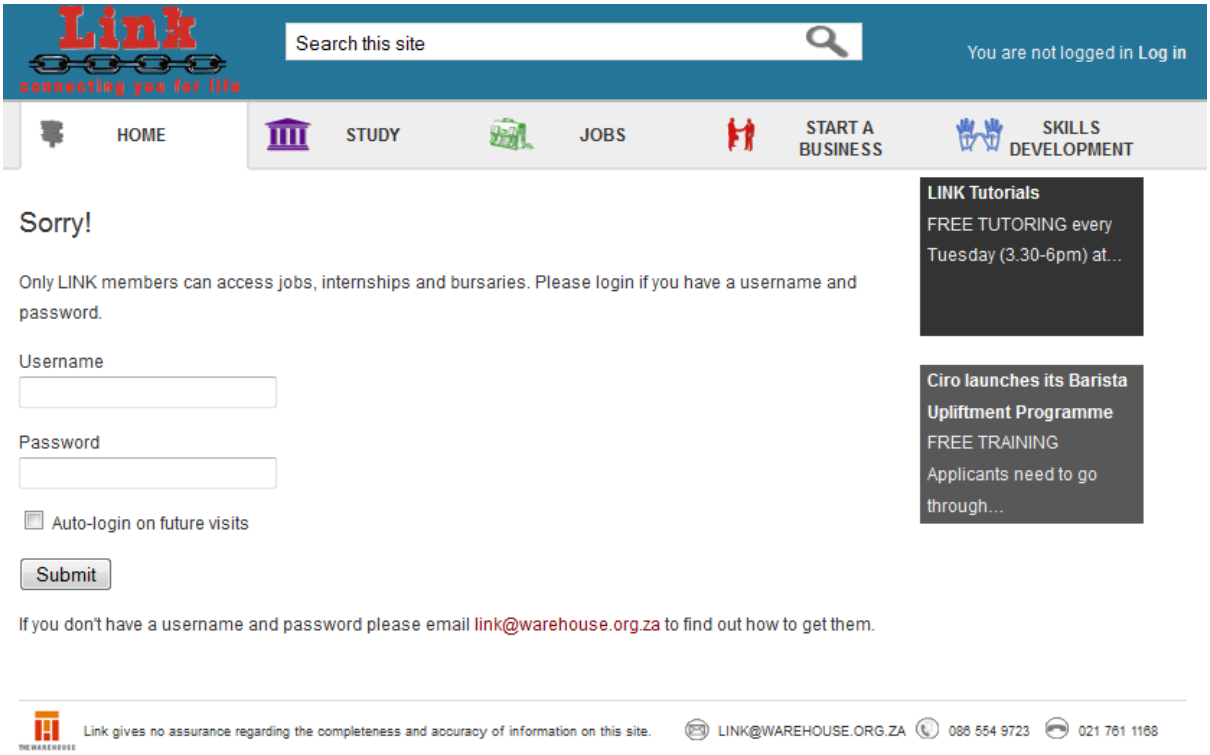

Figure 40 Access restriction page after changes made before launch of the site

5.2.2 Launch

The official moment of deployment took place in the presence of the Link team and other staff at The Warehouse on 22nd November 2011. The Link team demonstrated the site briefly to colleagues. The Director of The Warehouse gave positive feedback and recommended some sources of information which the Link team could consult.

By the end of November, the Link team had created 55 usernames for students across the three locations in which we had worked.

5.2.3 Post Launch Changes

After launching, we addressed another issue that had arisen in Cycle Two, the "no results found" page which hindered users' ability to improve their searches (see "'No Results Found' Pages Hindered Search Improvement", page 86).

Instead of displaying an empty page (see Figure 37), we now displayed a message indicating that nothing could be found, on a page that was consistent with the rest of the site (shown in Figure 41). We believed that the presence of other navigation elements on this page would make for easier recovery from a search which yielded no results.

5.3 Evaluate

The goal of evaluation was to observe unprompted and unassisted use. We would not be present when users logged in, and with the Link team on leave for most of December and January we had no feedback from students or church leaders. We therefore had to rely exclusively on automated logging.

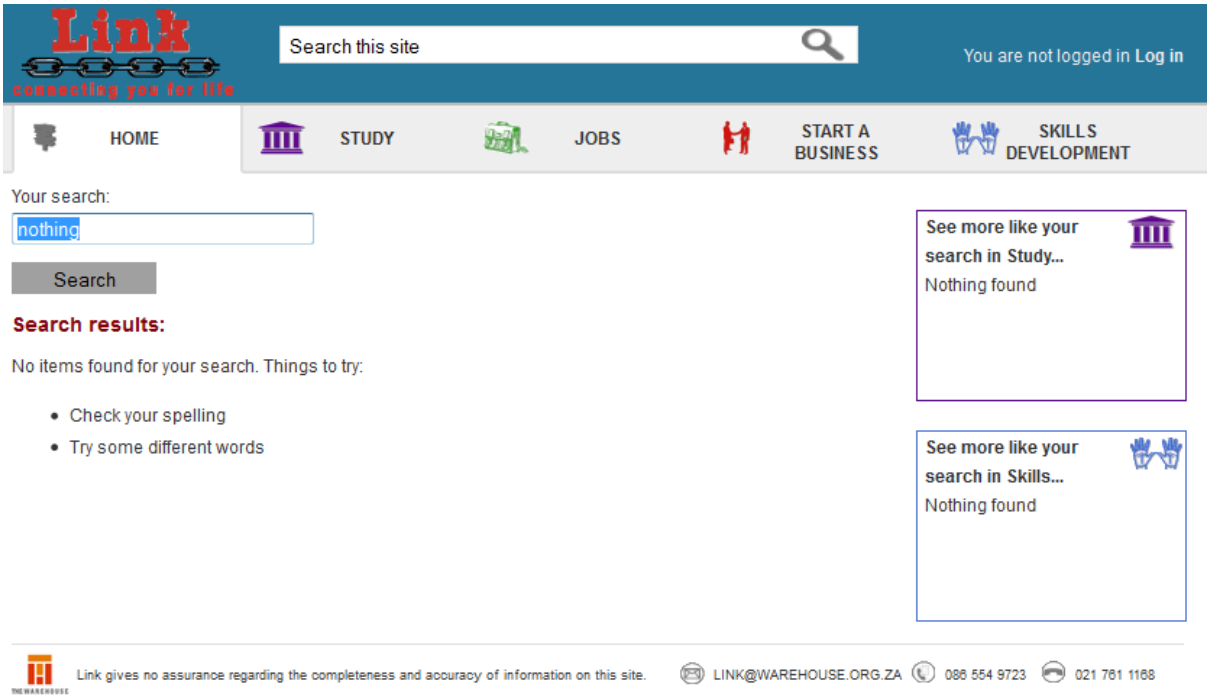

Figure 41 New page presented to users when no results were found for a search. Previously the site hampered recovery by presenting a page with only an error message. In this version all of the navigation elements that are present on other pages are visible.

Users were not required to log in, and we knew that some who were not intended beneficiaries had heard of it (other warehouse staff and their contacts). Taking data from non-beneficiaries into consideration could impair our research. They might have greater exposure to technology than our users, or have no personal interest in the content. We therefore ignored requests from a number of sources:

- Any request generated from our university or The Warehouse (identifiable by IP range allocated to those institutions)
- Requests generated from outside of South Africa (identifiable by IP geolocation)
- Automated requests, for instance from search engine crawlers (identifiable by user agent)

We implemented the above rules as a Ruby language script which mined daily log files generated by our web server for information specific to this project, and produced CSV files which we reviewed in Microsoft Excel.

5.3.1 Results

We list here analysis of site usage before the end of 2011. Churches were only informed of the site's launch after login names were created on 29 November, so we ignored requests made before then. We record 78 page views in 18 sessions. In Table 10 we list the ten sessions which consisted of more than one page view. These account for 70 of 78 page views.

Two sessions can be tied to specific students from Lavender Hill because they used allocated login credentials. Both had seen the site before, LW in Cycle One and JL in Cycle Two. Both sessions involved at least one search and viewing at least one entry. Both users accessed the site through a Blackberry device. User agent strings identify that both used the same model, but different

cellular service providers. Either separate devices were used or a single device shared but separate SIM cards used (common practice for sharing costly devices while maintaining separate identity [75]).

Table 10 Site visits made between November 29 and December 31 2011. Only five sessions involved even one search, and only two users followed links to entry content. These two could be identified as participants in previous cycles from Lavender Hill, both using Blackberry devices.

Start Date	End Date	# Requests	# Searches	# Entries	Browser	Logged In?
29/11/2011 21:12:27	29/11/2011 21:12:56	2	0	0	Blackberry 8520 contract to MTN	no
01/12/2011 12:26:06	01/12/2011 12:26:45	5	0	0	Chrome / Windows 7	no
01/12/2011 14:33:20	01/12/2011 14:33:38	3	0	0	IE 9 / Windows 7	no
01/12/2011 15:46:55	01/12/2011 15:47:01	3	0	0	HP TouchPad / WebOS	no
05/12/2011 15:09:15	05/12/2011 16:11:53	17	7	0	Chrome / Windows 7	no
06/12/2011 23:31:00	06/12/2011 23:37:00	7	1	1	BlackBerry 8520 contract to MTN SP	JL – Lavender Hill
07/12/2011 11:43:39	07/12/2011 13:18:18	4	1	0	Chrome / Windows 7	no
07/12/2011 23:22:20	07/12/2011 23:22:51	3	1	0	Chrome / Windows 7	no
08/12/2011 21:44:38	09/12/2011 01:15:07	23	7	5	BlackBerry 8520 contract to Vodacom SP	LW – Lavender Hill
09/12/2011 11:52:29	09/12/2011 11:57:05	3	0	0	Chrome / Windows 7	no

Only five sessions listed in Table 11 involved any searches, and the only sessions which involved an entry being viewed are the two we have discussed already.

Including single requests, a maximum of 18 of the 55 Link students to whom we thought the site had been advertised could possibly have visited. Some of these might not be Link students, as filtering failed when Warehouse staff accessed the site from outside their offices. Repeat visits would also have lowered the number of unique visitors. For instance, of the eight single request visits, four were visits to the same page from the same ISP and using the same version of the Safari browser, but more than 24 hours apart. It was possible that these were all a single user.

5.3.2 Discussion of Results

The 18 visits recorded could represent as much as 30% of the 55 users that the Link team had registered on the site. However, only two instances definitely involved intended beneficiaries. It was a positive sign that they remembered how to use the site without further intervention, especially LW who had only seen it in Cycle One, before Cycle Two changes.

The remaining visits demonstrated minimal engagement (9 searches from 3 visits, and no entries viewed). These users were either uninterested in the content or encountered a problem that prevented them from proceeding further.

5.4 Specify Learning

5.4.1 Internet-Supported Intermediation

With only two students having viewed web content in over a month, the site was – disappointingly – not providing support for intermediation.

Negligible use indicated that no suitable secondary intermediaries had acted. Access constraints and financial considerations – which did not affect previous, controlled evaluations – could have been the main reason for the lack of activity. This would have been consistent with our understanding of access to the conventional web from other work (see Section 2.5). Successful operation in the previous cycle (and by two students in this) indicates that the cause was unlikely to be fear or a lack of skill. It was more likely that the one page visits were from people who were not the intended beneficiaries, who would be more likely to visit without interaction.

Unfortunately, two other possibilities existed which prevented us from drawing strong conclusions. First, news of the site's launch may not have been communicated to all students. In Section 2.3, we discuss how both the Link team and partner church groups were involved in this communication. At least two visits were from students, but it was possible that others had not heard.

Second, the Link career guidance content may not have been of interest to the majority of students, or such content might be available from other sources. It would be important to investigate the other possibilities before assuming this to be the case, as the need for content had been a fundamental assumption of the programme since before our engagement began.

5.4.2 Adoption

The two Lavender Hill students' use of mobile phones instead of computers indicated that the latter were harder to access. This would be a legitimate outcome of our investigation into adoption, although if this was easy, the question of why so few had done so remained. Some explanation might lie in the fact that we had not optimised the website mobile Internet browsers.

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6 CYCLE FOUR – FIRST MOBILE INTERFACE

At the start of 2012 we began Cycle Four, which ran until the start of mid-year school holidays. In this cycle we moved beyond the conventional web for Internet-supported intermediation to allow content to be accessed via mobile phones.

6.1 Diagnose

When we discussed the website's poor reception with the Link coordinator in February 2012, she explained that the site had not been advertised to the Manenberg or Mowbray groups. A re-organisation of Manenberg leadership left the Link team without reliable contacts. Requests for a meeting received no response, despite the encouraging unsolicited feedback we received in Cycle Two (see "Overall Feedback", page 88).

At the Mowbray group, by the time of the website launch the students were writing exams and had two weeks left before school ended for the year. After the exam period started few students visited the homework club.

Thus only the Lavender Hill group were informed about the website's launch. The Link team had asked their leadership to distribute username and password information to the 17 members of that group who were in grade 11 or 12. This information was distributed on 6 December 2011.

A Link staff member visited Lavender Hill to ask about their experience of the site. She was only able to get confirmation from three students that they had used it. They indicated that they had not found anything that was interesting, one commenting that the information had "not changed much" since the evaluation in Cycle Two.

6.2 Plan

In the plan phase we had to choose between improving the website further or building a mobile Internet system. The latter would allow us to begin our investigation into relative adoption of the mobile Internet and conventional web.

Any changes to the website would only help the few existing users. Increasing this audience would require effort from the Link team to engage further with the existing groups and create relationships with new groups. We proceeded with development of the mobile system while that process took place.

A prototype system received positive response from a Link staff member, and the Link coordinator agreed that we could test it in Mowbray.

6.3 Act

In this section we describe the implementation of our mobile system, which we called LinkChat. The name is derived from the way in which users access the system by issuing commands from mobile instant messaging (or 'chat') clients like MXit.

6.3.1 Mobile System Technology Choice Rationale

Understanding the choice of technology requires some knowledge of differences between mobile communication technologies. Where technical terms and acronyms are used we refer the reader to this document's Glossary.

Our mobile system had to be usable from the low end phones that were already in the hands of most users, without high end features such as fast Internet connections or touch screens (we discuss this in Section 1.5). However, it should use slower Internet communication (like GPRS or EDGE) for cheaper interaction than SMS or USSD (the latter is a communications technology which allows simple interaction between mobile phones and cellular operator systems, usually menu driven).

Statistics from MXit [19] indicated that it would also have to be portable across multiple device families. For instance, Blackberry devices were amongst the most popular devices used for MXit, but only accounted for two of nineteen devices with greater than one per cent share of the total user base.

These requirements could be met by an application for Oracle's Java ME platform (MXit itself is implemented using Java ME) or a website optimised for mobile use. These platforms unfortunately suffer from fragmentation[11] that would strain our development capacity should we adopt either. Another compelling reason against these approaches is that they would require users to exit MXit, which Walton's M4Lit interviewees (discussed in Section 2.6.2) disliked.

Because the Link content was pure text, we could adopt the M4Lit approach of exposing content as text messages too. A text only interface would allow operation using familiar text entry controls, and would not require formatting instructions that could be interpreted differently by different devices. MXit and other mobile IM clients are analogous to web browsers for our text interface.

MXit in fact offers its own API which allows developers to include more graphical elements in "MXit portals" [77], but we wanted our system to allow users a choice of more than one IM client. The XMPP protocol [78] allows many different IM services to interoperate with each other. We could use it to connect a system of our own making to the Google Talk IM service, which in turn interoperates with a number of other mobile IM services, including MXit. We were confident that between the MXit and Google Talk services, no Internet-enabled mobile phone would be without a client that could reach our own.

6.3.2 Mobile System Architecture

In Figure 42 we show the architecture of the LinkChat mobile platform. Users send text commands from an IM client on their mobile phones to the LinkChat contact (a Google Talk address). Our code (written in the Ruby programming language [79]) would then invoke the same functionality on the Link web server which served search results to the website, and send data

[11] For instance the Oracle documentation regarding device fragmentation warns that "...it is almost impossible to write a single version of an [Java ME] application that can run on every handset." [76] Even the limited interface elements of HTML would require testing multiple configurations: the nineteen most popular MXit devices feature between them six different screen resolutions [19], and a number of different mobile browsers run on each.

back to the user as more text messages. Using the same search functionality allowed us to be certain that data and search results were exactly equivalent on both systems.

6.3.3 Initial LinkChat Interface Design

In this section we demonstrate the functionality of the LinkChat interface through chat log excerpts. Note that the bold highlighting of the chat username is for the purpose of readability in this document, and not something over which we had control.

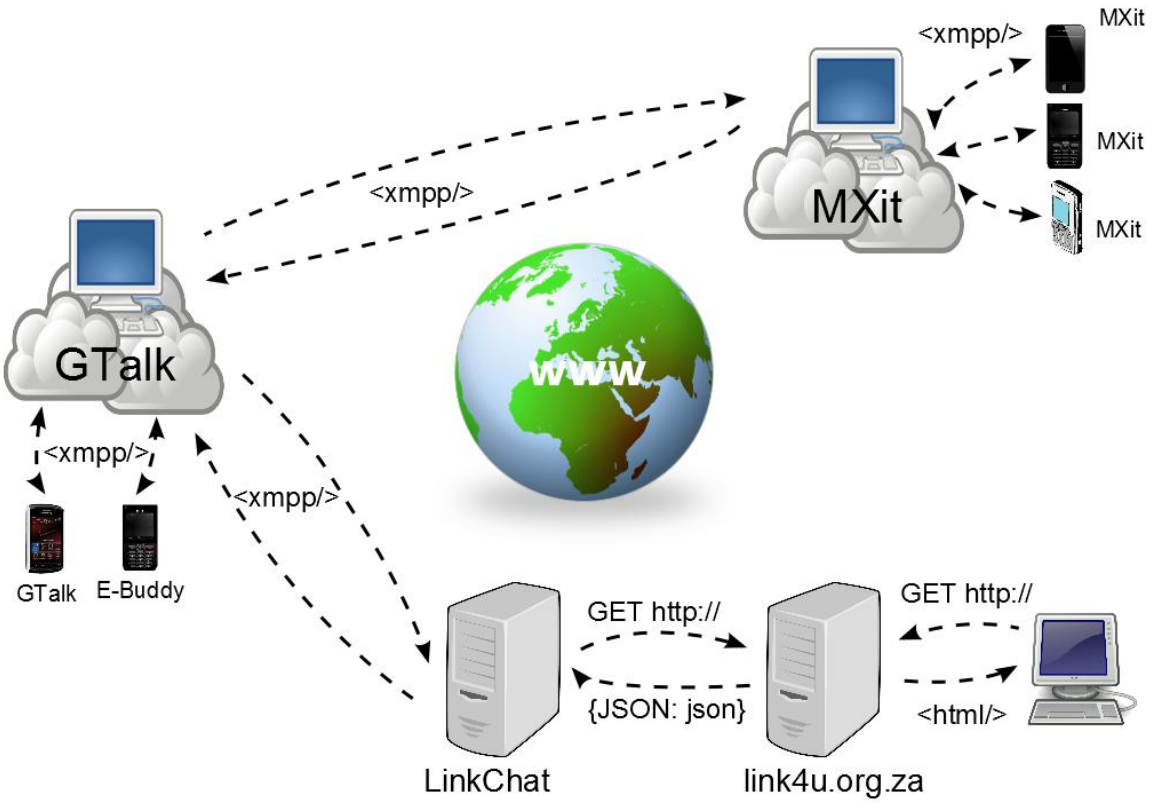


Figure 42 LinkChat system interaction between MXit, Google Talk, and the LinkChat service. The technical design eliminated differences in content between the Link website and mobile system by sharing a single database and search functionality between both.

Because of the unstructured nature of text input, we allowed any message from the user to initiate a session:

> **me**: start
> **LinkChat**: Welcome to LinkChat!
> You can use me to find courses or degrees at university or college. If you don't know what to send me, look at the instructions I give between # # symbols.
> #Send me your search query#

By analogy with the web, IM clients are the "browsers" of this interface. We limited ourselves to UI elements which behaved predictably regardless of the client used, *i.e.* plain text. Some markup is common between Google Talk and MXit, for instance using asterisks to mark emphasis, but this worked only when chat messages were exchanged on the same services. In cross-service

messages, the markup characters were displayed literally rather than being interpreted for formatting.

The first message a user received explained the purpose of the interface and that future messages would include instructions about acceptable commands, listed between hash symbols. In the absence of markup, they were intended to draw the user's attention, identifying the available actions.

The first action available was to send a search query. Any response was interpreted as a set of keywords for a search. In this prototype, users could only search for course entries.

Compared to normal duration between chat messages, performing a search was lengthy, and so LinkChat updates the user and offers the option to cancel:

> **me**: electrician
> **LinkChat**: Searching, please wait...
> #Send 'cancel' if you want to stop the search#
> The results are sent as a numbered list to the user:
> **LinkChat**: Results page 1 of 2:
> 1. Mechanical Engineering and Motor Mechanics at College of Cape Town
> 2. Electrical Engineering at CPUT
> 3. Electrical Engineering at College of Cape Town
> #Send '1', '2', '3' or 'next' or 'search'#
> **me**: next
> **LinkChat**: Results page 2 of 2:
> 4. Electrical Engineering at UNISA
> #Send '4' or 'back' or 'search'#
> **me**: 4

Search results are presented three titles at a time, using pages as a metaphor. "Next" or "back" commands navigate between them.

An entry is chosen by sending the number next to the title. Fetching an entry is again a lengthy process, and so the opportunity to abort is given:

> **LinkChat**: Fetching entry, please wait...
> #Send 'cancel' to go back to list#
> Assuming the instruction is not cancelled, the entry detail is sent as a single message:
> TITLE:
> Electrical Engineering at UNISA
> QUALIFICATION NAME:
> National Diploma
> INSTITUTION:
> UNISA
> DEPARTMENT:
> Science, Engineering and Technology
> DESCRIPTION:
> Learners will participate in courses such as:
> Introduction To Programming

Digital Systems Electronics
Electrical Engineering
English For Academic Purposes
Computers
Mathematics
Learners can specialise their degree by majoring in the following subjects:
Electrical Clinical Engineering; Electrical Computer Systems; Electrical Electronics And Electronic Communication; Electrical Mechatronics; Electrical Power Engineering or Electrical Process Instrumentation.
See 'Course Details' below.
NQF LEVEL:
6
HOURS:
Part time
DURATION:
The course consists of 3 levels, which can be completed in a way which works for the learner.
COST:
Visit the institution's website, for more information see 'Important Documents' link below.
COURSE DETAILS:
http://j.mp/wm0DHV
CONTACT UNISA:
http://j.mp/yTkv8c
IMPORTANT DOCUMENTS:
http://j.mp/zUxNFs
#Send 'back' or 'search'#

We use what formatting is available to ease reading these lengthy messages. Field titles are capitalised, and each field is separated from the next by new line characters. One IM client, 2Go [82] would not display new line characters, making our content hard to read. As a result we chose not to advertise the fact that LinkChat could be reached from it.

No hypertext reference markup was available, so we made use of the URL shortening service, bit.ly [83] rather than display full-length URLs. This would take fewer lines of the display and make it easier for users to copy the URL down.

Finally, we describe how the interface helps users to recover from errors:

LinkChat: Results page 3 of 15:
7. Chemical Engineering at UNISA
8. Electrical Engineering at UNISA
9. Marine Engineering at CPUT
#Send '7', '8', '9' or 'next' or 'back' or 'search'#
me: exit
LinkChat: I'm sorry, I don't know how to respond to 'exit'. If you don't know what to send me, look between the # # symbols:
#Send '7', '8', '9' or 'next' or 'back' or 'search'#

When the user sent a command which the LinkChat code was not expecting, a response is sent, echoing the problematic message and pointing the user to the instruction list. State is returned to where it was before the error, and the instruction list repeated.

6.3.4 Subset of Website Data

We made only a subset of website data available through LinkChat. All content from the website's study section (see Section 0) was available. Other sections could be added in future without changing the mobile interface, but as more than three quarters of the website content was in the study section we felt this was sufficient for our research. Rather than the username and password for access to the site, a list of known instant messaging contacts would be allowed to access funding content, and others would not see it.

6.4 Evaluation

We attempted a formative evaluation of the LinkChat system at the end of February 2012, with 5 students from the Mowbray group.

6.4.1 Participants

The specific participants chosen were dictated by the setting:

- The first group we saw was made up three students who were sent to us after arriving together: *SN*, *LA* and *YM*. We feared that three was more than we could watch at one time, but preferred not to exclude anyone. System logging would be able to track the system actions taken by all.
- The next student, *NK*, was sent to us at the half-way point in the afternoon tutoring, when students normally switched tutors and subjects.
- Conscious of our dual role as experimenter and tutor, we chose to spend an hour tutoring before we asked another student, *OM*, to help us test at the end of the day

6.4.2 Method

This evaluation was similar to the evaluation performed in Cycle Two (see Section 4.4.3). Four of the students had used our website then so we explained that we were making the content from the website available through MXit. We asked users to search for content that interested them while we watched and made notes (we worked without assistants).

6.4.3 Results

Participants made a total of seven searches and viewed the content of eight entries in 45 minutes total usage. All participants were willing to attempt use of LinkChat. A lack of enthusiasm shortened some interactions, but we saw enough use to observe mismatches between our expectations and actual user behaviour.

Observations Relating to Platform

Participants displayed mixed levels of enthusiasm towards mobile IM. When asked which mobile IM clients they had used before, *SN*, *YM*, and *OM* all named the same two clients: MXit and 2Go [82]. *SN* appeared especially enthusiastic, messaging friends on MXit while we were talking to the

other two students in her group. *NK* used MXit on her friends' phones during school hours, but rarely at home. *LA* was recalcitrant on the topic. She did not identify with IM and would not discuss her reasons. We preferred not to jeopardise the relationship between her and the tutoring group (including ourselves in our role as tutor) by forcing the issue.

The mobile system created Google Talk messages programmatically to communicate with IM users. None of the students had ever communicated with a Google Talk contact. Fortunately, after we helped them add the contact, the messaging process was identical to communicating with normal MXit contacts.

All participants, including the reluctant *LA* were capable of entering text, although *LA* was either unconcerned by or did not notice some inconsistent capitalisation: for one query she typed, "AS AN AVERAGE STUdent can i…". There was a noticeable difference in speed of entry between *LA* and *SN* who was both most enthusiastic and most competent.

We observed what seemed to be habitual strategies for dealing with delays. In the MXit client, *SN* would switch tabs and cycle through menu options rapidly while waiting for responses to her messages. Despite the rapid interaction she did not ever accidentally take actions that would affect the conversation. This seemed to us to be the digital equivalent of impatient finger tapping. *OM* sent blank messages to the LinkChat contact when he felt responses were taking too long.

At the end of the first group session, *SN* insisted on deleting her MXit credentials from the client on our phone. In so doing she demonstrated an awareness of identity theft. *OM*, who had also been using his own credentials did not display the same concern, leaving behind MXit ID and password that would have allowed us to sign in as him and send or read his messages.

Reception of LinkChat Interface

Communicating the purpose of the session to students was difficult at first. When we asked them to use MXit, *SN* asked us, "What do you want us to do? Must we teach you?" Referring to testing of the Link site four months prior did not appear to help.

The moment of understanding was when she saw the content: immediately upon viewing an entry *SN* asked us to write down the LinkChat Google Talk address so that she could use it at home. This gave us an impression of great enthusiasm. She then switched to a different phone (also ours) and signed in with her own MXit account. We assumed she would continue to use LinkChat while we worked with other students. However, examination of system logs later revealed that she had not sent any further messages to LinkChat. Evidently her interest in MXit did not include an urgent desire to use our system.

LA and *NK* were – especially relative to *SN* – unenthusiastic about mobile IM, and this transferred to their reception of LinkChat. When we wrote down the LinkChat details for *SN*, fellow group member *YM* was happy to accept the information, but *LA* was not interested.

NK was interested in the content but said that she would rather use our website from computers at the local library. This was despite confirming that library rules only allowed usage for a shorter period than the time it took to reach the front of the queue, and some afternoons she might queue and never reach the front.

Finally, *OM* was absorbed by LinkChat. We began testing near the end of the day and so we asked him what time he wanted to leave the venue. Once he understood the interface he started using it without intervention, and continued until almost 15 minutes after the departure time he had indicated.

Long Queries

The Link search technology was built with short queries made up of a few keywords in mind. However, all except *OM* attempted to use full English phrases to communicate with LinkChat, for instance:

- "When did you issue a bursary"
- "AS AN AVERAGE STUdent can i study accountant"
- "Minimum requirements for a Human resources degree"

The first example was puzzling, as we had explained that LinkChat did not yet include bursary information. We assume the misunderstanding and poor grammar to be consequences of students' second or third language English.

Lengthy queries have minimal impact apart from the possibility of returning irrelevant entries because of common words. In processing the third example above, "for" and "a" would be discarded, but "requirements" was not, and it occurred in many different entries. Fortunately, in this session relevant entries were still returned. We did not record any spelling errors in this evaluation.

Exposing the interface as a MXit contact may have communicated that the system had human-like capacities, which the use of personal pronouns "me" and "I" would not have dispelled. Unfortunately, a direct answer to any of the above queries was beyond LinkChat. We did not see the extensive abbreviations and switching between languages described in the M4Lit project [21] and so conclude that our participants did not feel like they were communicating with a peer.

Unintuitive Instructions to Users

After providing information requested (search results or entry content), LinkChat sent instructions between hash signs to indicate what the possible subsequent actions were (see Section 6.3.3). Unfortunately, users frequently did not notice the instructions. Even when they did see them, misinterpretations occurred.

Frequently, queries were issued when the system was not expecting them. The instructions included every available action, including, "#Send … 'search'#". The literal message "search" indicated to LinkChat that it should interpret the next message as a query, but users sent their queries unannounced.

NK at first thought that commands required the use of a hash sign. This was especially problematic on a twelve button mobile phone keypad with no visible hash sign. Anyone who made the same mistake while would have experienced extreme irritation.

NK also sent "b" instead of the valid instruction "back". We did not know if this was deliberate abbreviation or the result of accidentally sending an incomplete message.

Learning Through Search

OM attempted to use LinkChat as a dictionary. When he came across a term with which he was unfamiliar (for instance, "financial advisor"), he would perform a new search using the phrase. In this case, the entry he chose to read next was "Financial Information Systems at CPUT" which did not seem likely to shed light on being a financial advisor. However, as the Link team captured more data, the strategy could become more successful.

6.5 Specify Learning

6.5.1 Internet-Supported Intermediation

Assuming the group of students we worked with in this cycle were representative of the majority, the introduction of our mobile Internet system showed positive and negative signs for Internet-supported intermediation. Skill at using the platform was not an obstacle to these adept mobile phone users. Some issues with the user interface were uncovered, but we could change the system to address these.

The IM users had already overcome financial considerations to a degree that would be sufficient for use of our system. Access constraints would not affect those who carried mobile phones with them. Other students identified secondary intermediaries – peers and family members – from whom they could borrow devices.

However, it seemed some students would consciously *avoid* our mobile system because we used mobile IM as a platform. It was uncertain at this stage whether this represented fear of the technology, or some societal constraint on the use of MXit (for instance, Bosch reports negative perceptions of the technology as time-wasting and harbouring sexual predators [89]).

For more certainty about whether Internet-supported intermediation would be useful for the Link programme, we would need to evaluate with more users.

Level of Interest in Content

At the end of the previous cycle, we discussed the possibility that a lack of interest in the Link content would undermine our research. We consider this possibility again by reviewing the range of negative responses.

One of these – *NK*'s preference for the Link website – included interest in the content. *LA*'s dislike of MXit did not seem to be related to the content. Finally, *SN*'s use of the time in the evaluation to message friends may have reflected a lack of interest. Thus only one of three negative responses (one of five total) appeared uninterested in the content.

6.5.2 Adoption

We still had no evidence about unassisted adoption, but it was possible to compare with qualitative insight from the previous cycle.

The mobile system appeared to have a polarising effect. *OM* was very interested, but we had also witnessed hostility toward MXit (*LA*), preference for the website (*NK*) and apparent uninterest in our system (*SN*, who wanted to use MXit but did not use our system while unsupervised). Neither

extreme of interest or uninterest had been observed previously. Which platform would be adopted by more students would apparently depend on which of these students best represented the rest of our audience.

That said, the group in this cycle appeared to have more skill using mobile phones than previous groups did using desktop computers, and the proportion with access to mobile phones was – just as our technology use questionnaires had predicted in Section 4.4.4 – much higher than to computers. For the website to become more popular, more students would have to visit the library as *NK* did.

To answer the adoption research question properly, we would still need to conduct a longer term evaluation in which both systems were advertised to a large group of students.

7 CYCLE FIVE (A) – REAL-WORLD USE ENDS CONTROLLED TESTING

In this cycle we attempted to compare our systems in controlled usability evaluations. However, the cycle was cut short after we began to see real world usage that had potential to compromise evaluation.

7.1 Diagnose

Up to this point, the mobile system had only been exposed to a small audience, only some of had seen the website. This audience had provided useful insight about usability flaws, but demonstrated varying interest in actual use (see Section 4.4.4). To understand which attitudes (enthusiasm or unenthusiasm) were representative of the majority, we would need to demonstrate the system to a larger audience.

We also recognised a need to address usability flaws of the mobile system which would hamper the system's support for intermediation, and compromise comparison with the website.

7.2 Plan

After we communicated the results of the previous cycle, the Link team agreed that we could continue gathering data with the Mowbray group. We planned for controlled testing. The need for longitudinal evaluation remained, but the experience of Cycle Three, in which minimal use resulted in minimal data from system logs (see Section 5.3.2) lead us to prefer to start with use that we initiated. As we note in Section 2.7.4, controlled testing allows data to be gathered when in-situ evaluations become problematic. If longitudinal evaluation did not yield data later, we would still have the data from this cycle.

We would fix the usability flaws already identified, and then perform a task-based evaluation with both mobile and web systems. Working with both systems would allow us to compare usability results, and allow investigation of Internet-supported intermediation even with students who rejected one system.

7.3 Act

In the previous cycle, we noted that there was a mismatch between input expected by LinkChat and that given by users (see Section 6.4.3). We describe here how we changed the interface before introducing more users.

7.3.1 User Input Cues

Originally, LinkChat sent prompts for further action to users between hash symbols as follows:

> **LinkChat**: Results page 3 of 15:
> 7. Chemical Engineering at UNISA
> 8. Electrical Engineering at UNISA

9. Marine Engineering at CPUT
#Send '7', '8', '9' or 'next' or 'back' or 'search'#
me: next

Some users did not notice these instructions, while they made *NK* think she had to include hash signs in her own messages. On the other hand, the requirement to send numbers to pick an item from a list was easily understood. We changed prompts for further action to work in the same way:

LinkChat: Results page 3 of 15:
7) Chemical Engineering at UNISA
8) Electrical Engineering at UNISA
9) Marine Engineering at CPUT
n) Next page
b) Back
s) Search
me: n

NK had sent one letter abbreviations, which the previous version of LinkChat did not respond to properly. This version accepted abbreviations.

7.3.2 Response to Unexpected Input

We had observed that users would send searches while the system was not ready for search query input. Previously, the system would inform the user that there was a problem and suggest the possible commands which could be issued:

me: computer science
LinkChat: I'm sorry, I don't know how to respond to 'computer science'. If you don't know what to send me, look between the # # symbols:
#Send 'next' or 'back' or 'search'#

Since unexpected searches were common, we made the response to unexpected input include an option to search for the given text so that users would not have to retype their query:

me: computer science
LinkChat: What do you want to do? Choose a letter:
s) Search for 'computer science'
b) Back to search results for 'chemical engineering'
r) Restart
me: s

Users could now perform their search, return to previous activity if their input was in error, or restart their chat session with a single letter command.

7.4 Attempted Evaluation

In this section we report on the controlled test we began in mid-March 2012, which turned out to last only a single week. In the next (Section 7.5) we relate how controlled testing became superfluous in the face of real world use.

7.4.1 Method

Because we planned to gather data for several weeks, we were willing to work with fewer students per week and therefore did not run simultaneous sessions with multiple facilitators. We worked with three students in the first and only week. The specific students were chosen by the Link team.

Each session was guided by a script, shown in Appendix I. The script had three components:

- A timed text entry exercise, in which students were asked to write specific phrases using a mobile phone and a desktop computer
- A search exercise to be performed on the website
- A search exercise to be performed with LinkChat

In the first activity we recorded the time to enter text as a measure of skill which would be independent of the user interface specifics of our systems. Durations were recorded using a stopwatch. Students practiced with a different phrase on each platform, before being given a single phrase to enter on both. We controlled for learning effect by having half start with the mobile phone, and the other half with the computer.

The two search activities involved students searching for two entries which we named, one on each platform and answering a question about the content. We recorded the number of prompts required to find the entry as well as a description of any errors encountered.

7.4.2 Results

We list here the results from the single week's testing.

Timed Text Entry

Table 11 lists the time taken to enter a given phrase by each participant. In each case text entry took longest on the platform that the student started with, although the difference between *CM*'s two results was minimal. Without more students, assigning significance to these results is difficult.

Table 11 Results of Cycle Five (a) timed text entry activity: text entry took longest on whichever platform students were introduced to first, but with only three participants statistical inference is not possible.

Who	Phrase	Time Mobile	Time Desktop	Started With
CM	electrical engineer	18.54s	19.00s	Desktop
ZK	chemical engineer	19.33s	10.32s	Mobile
MH	computer science	12.64s	16.55s	Desktop

Search Activities

All students were able to complete the search tasks with minimal prompting, except for *MH* who would not have successfully negotiated the website interface without our assistance. Her biggest difficulty was a problem we had observed before: she used her whole hand with a PC mouse instead of left clicking (see "Desktop Computing Skill", page 81). She had expressed some hesitance when switching from the mobile system to the website.

The only LinkChat error recorded was also with *MH*. She sent a period instead of '1' (the two characters are accessed via the same key on the 12 button keypad). Recovery came through our new support for unrecognised input (see Section 7.3.2). From the request for clarification, she restarted the chat session and was able to proceed without prompting.

We received two expressions of support for the LinkChat interface. *ZK* told us that she preferred LinkChat because information was easier in the small area of a mobile phone screen than on the 15 inch laptop screen we had used. *CM* told us that she wouldn't delete the LinkChat contact (she signed in under her own account on our device), because she wanted the contact to persist across all other devices on which she signed in.

7.5 Controlled Testing Aborted due to Unsolicited Usage

Shortly after the start of the cycle our system logs began to show unsolicited use of LinkChat, from students with whom we had worked in February (See Section 6.4). We proceeded anyway because if they lost interest, the data from controlled testing would become more important. However, by mid-March the system logs showed more than twenty unique MXit IDs. In addition, some of those IDs represented multiple users: two of the students from our Mowbray group had demonstrated LinkChat to peers at school. In this section we describe this unsolicited activity.

7.5.1 First Users Continue Use Outside of Observation

The first incident of unsolicited use was over the weekend following our first evaluation in February (see Section 6.4). We were implementing the changes for this cycle, and we had accidentally left our test server running and accessible to anyone with the GTalk contact details. Searches were performed from IDs that corresponded with *SN* and *OM*, who were in our first evaluation.

SN used LinkChat for ten minutes on the Friday evening, while *OM* had two approximately thirty minute sessions on the Saturday and Sunday. *OM*'s earlier enthusiasm made him the most likely candidate for further engagement, but *SN*'s use was unexpected. When she chose to message friends rather than use LinkChat in our evaluation we were disappointed and assumed she had no interest (see Section 6.4.3). In retrospect, her request that we write the contact details down for her seemed consistent with mild interest but not immediate concern.

While *ON* had used his own MXit account on our phone (as a result saving the LinkChat contact for use on all other devices), *SN* had used our account. Use from her own account indicated that she had understood our instructions (see "Observations Relating to Platform", page 102) on how to add the contact. The same was true for *YM* who signed on a few days later.

We had already implemented some of this cycle's changes (see Section 7.3) before these students signed on. The interface was therefore different from what they had previously encountered.

Fortunately there was no indication of difficulty with the new style of interaction – from the outset, students used abbreviated commands as per instructions from LinkChat.

7.5.2 Use Spreads Without Intervention

The histogram in Figure 43 shows the number of new MXit IDs that contacted LinkChat per day. We have discussed the first few days of unsolicited use. Three of five students from the February evaluation used LinkChat in the first week after: *SN*, *OM* and *YM*. A fourth user from the February group, *NK* began to use LinkChat from March 13. On that same day we introduced three new students (*CM*, *ZK*, and *MH*) to LinkChat for the start of this cycle's evaluation.

A month after the evaluation, LinkChat had received messages from 27 unique MXit IDs. We had personally introduced eight students to LinkChat, of which seven were identifiable in system logs. After her reaction in our February evaluation, we doubted that the eighth, *LA*, would ever use LinkChat (see Section 6.4.3), but she could have been amongst the 20 other new users recorded in the month. A minimum of 19 users had therefore been taught how to reach LinkChat by someone other than ourselves.

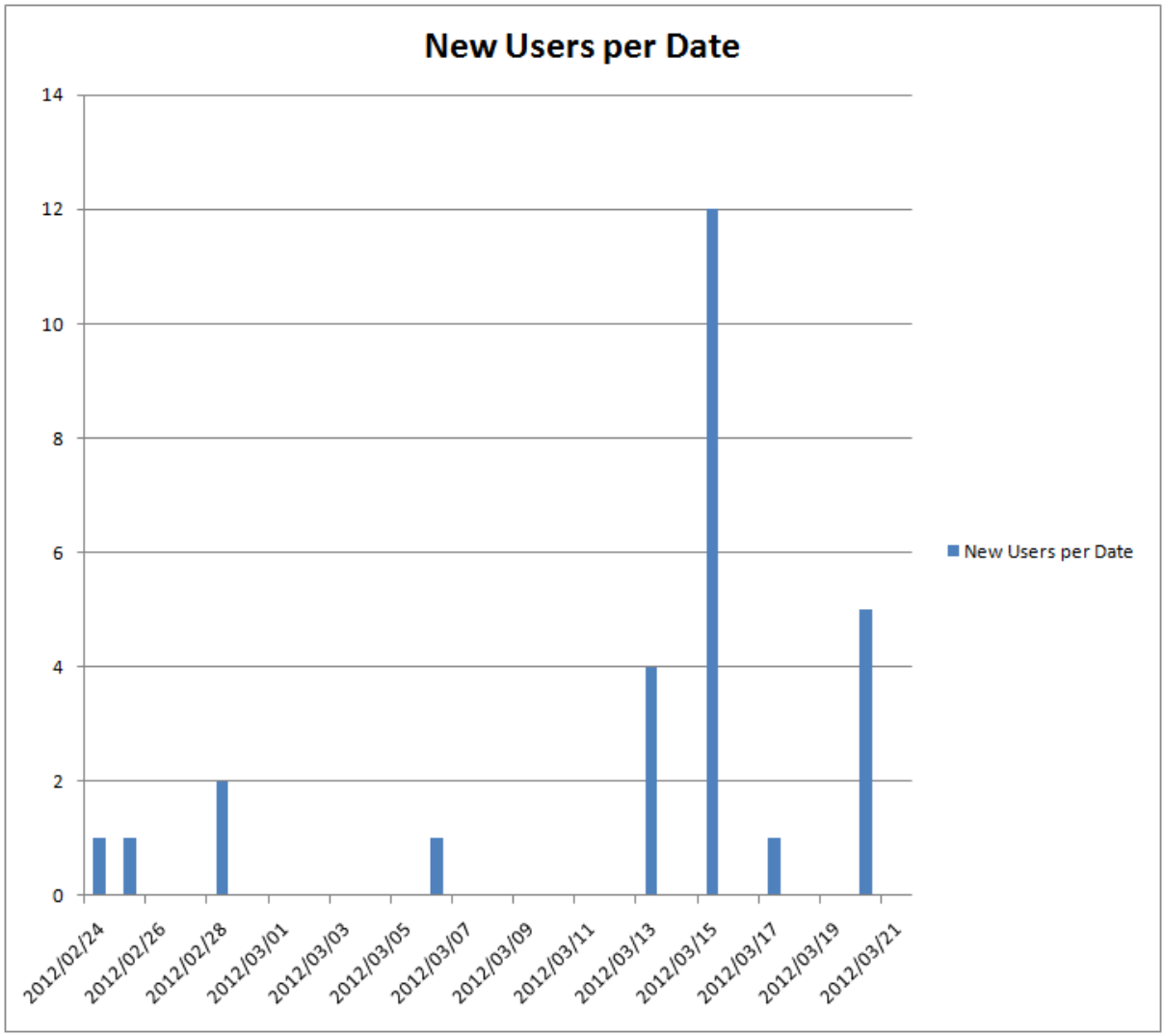


Figure 43 Number of new MXit IDs accessing LinkChat per day in the first month after our February 2012 evaluation. All use was unsolicited; participants in the evaluation continued use after the evaluation concluded, but without our prompting. Most new users were introduced when two students demonstrated the system to classmates at school on March 15, 2012.

The day with the largest number of new users was March 15. A few days before, the author received this message from a Mowbray student, *MG*, on Facebook:

> *"Me and [AS] have came up with a briliant idea on how we can spread the word about your wabsite and we gona d it at school starting from tomorrow yeah.*
>
> *And wa our names there if theres space on the 'thank you list' bt if ther isnt no sweat w doin this 4 ya*
>
> **peace*"*

We had not yet shown LinkChat to *MG* or *AS*. We were pleased with *MG*'s initiative but uncertain about how we could acknowledge his contribution and how the Link team would respond to the idea of singling out students with a "thank you list". We suggested that we talk at the homework club the next day, but we did not see *MG* there.

On the 15th, *MG* sent a "please call me" message to us. When we responded he informed us that he wanted to demonstrate LinkChat to peers at school but that it was offline. We were making code changes at the time, but started the server so they could proceed. By the end of the day twelve new MXit IDs had used LinkChat to perform 89 searches.

7.5.3 More Interactions and Greater Engagement than Website

In Cycle Three we reported on the interactions observed in the first month of web use. We re-use some of the measures applied then for easy comparison. Number of searches performed and number of entries viewed transfer easily. Number of sessions is applicable if we consider one session to be all interactions with LinkChat from a single MXit ID on a single day. If we exclude the three sessions from controlled testing, we record 220 searches performed and 157 entries viewed across 60 unsolicited sessions.

Figure 44 shows the distribution of sessions as characterised by number of searches and entries viewed in each. This is heavily skewed towards small numbers of searches and entry views with a mode of one for both variables. However, this is still substantially better than the equivalent results for the website (see Section 5.3.1). The number of interactions that resulted in neither searches nor entries viewed is only two out of 60, or three percent. The website at the equivalent stage had received eighteen distinct visits, thirteen of which (70 percent) did not involve either. It also had no visits similar to the four LinkChat sessions that involved more than ten searches.

7.5.4 End to Controlled Testing

The pursuit of a controlled evaluation approach while real use continued seemed artificial. Contextual factors at play in the students' home environments would not be present at the homework club venue, and our presence as observers could affect students' behaviour. In addition, if many students gained experience with LinkChat and not the website, comparison between the two would be compromised. Rather than proceed, we halted to reflect, before beginning a new cycle.

7.6 Specify Learning

The major discoveries of this cycle was that students had continued using LinkChat and were introducing their peers to it. This was a change outside of our action in this cycle, and caused an important change of direction in our research process. As only controlled evaluation (which was cut short) involved both systems, most of the evidence we can discuss here relates to LinkChat.

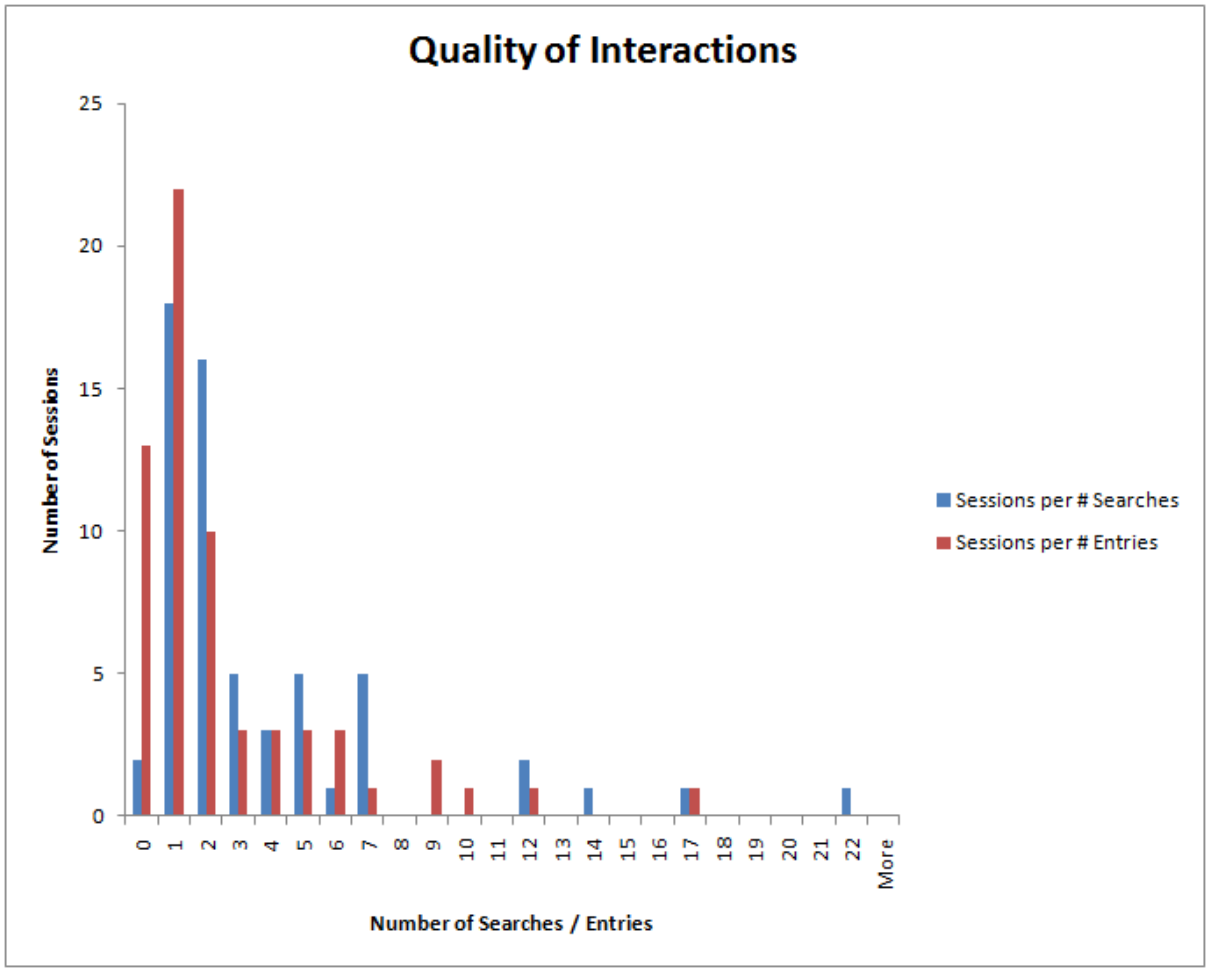


Figure 44 The majority of unsolicited LinkChat sessions included at least one search. Many consisted of only a small number of searches performed and entries viewed, but this still demonstrated much greater engagement than visits to the website did.

7.6.1 Internet-Supported Intermediation

For the most part, unsolicited use of LinkChat allowed students to benefit from Link intermediation, as all but two sessions did involve searches. Students who had seen LinkChat in the previous cycle continued using it despite the interface changing (see Section 7.3) after that demonstration. They were also able to teach new people to use the system.

In controlled testing, new users of LinkChat demonstrated the skill necessary for successful searches, and *MH* managed to recover from an error without our help. Students did not appear affected by any fear of mobile technology, but we discuss the hesitance of *MH* towards the website in the next section.

We did not observe anything related to financial considerations or access constraints directly. However, we note that unsolicited use of LinkChat took place without any special arrangement for devices to be made accessible, and without subsidy of airtime costs. Interestingly, in the M4Lit study (discussed in Section 2.6.2) Walton found that schools discouraged the use of mobile phones during school hours [21]. In this cycle demonstration had proven possible at *MG*'s school – a common access constraint suspended at least temporarily.

We did not gather data about habits of dependency. Relationships between peers had lead to knowledge of LinkChat spreading, but we do not consider these to be dependency relationships.

7.6.2 Adoption

In this cycle, the spread of LinkChat between peers had brought our user base to triple the number with whom we had personally worked. By comparison, even the most optimistic interpretation of website at the equivalent stage (see Section 5.4.1) would put the number of visitors at one user more than the number to whom it had been advertised (see Section 6.1).

Unsurprisingly, the greater adoption of the mobile system correlated with the high percentage of access to the mobile Internet by teenagers, as recorded in our technology use survey in Mowbray (see Section 4.4.4) and in other work (see Section 2.6). This might prove crucial given that in Cycle Four we realised that the Manenberg church would not be participating in the programme, and hence would not be providing secondary intermediation.

There also appeared to be some correlation between responses to our two systems in this cycle's controlled evaluation, and their use outside it. *MH* demonstrated apprehension towards the website but not to LinkChat, and she was able to search without assistance (including recovering from an input error) using LinkChat, but not on the website. *CM* felt that the smaller screen of a mobile phone reduced the skill she needed to operate it compared to a 15" desktop screen. We weigh this against the responses of the previous cycle from students who expressed a preference to not use LinkChat at all (see Section 6.5.2), and the success of students in Cycle Two at adapting their input to the website for better search results (see Section 4.5.2).

Despite evaluations of the website having been run in Manenberg and Mowbray, the official launch had only been advertised in Lavender Hill. LinkChat had only been demonstrated to students in Mowbray, and its introduction would be fresh compared to the memory of our website evaluation. The possibility existed that the different behaviour in each group was due to differences in community rather than because of differences in technology. In Lavender Hill LinkChat could have received the same reception as the website, while perhaps in Mowbray proper advertisement could lead to similar diffusion of knowledge about the Link website. The next step in our study should be to advertise both systems within one group.

At present, data about in the wild use was limited to system logging. More qualitative investigation of why one technology might spread but not another would be helpful because unlike system logging, they could provide information where use was not taking place.

8 CYCLE FIVE (B) – INVESTIGATING REAL-WORLD USE

In our final cycle we advertised our two systems and gathered quantitative and qualitative data gathered over several months. That students were using our systems without intervention in Cycle Five (a) was the starting point in choosing our action. However, we evaluated that action using data that had already begun accumulating in previous cycles. Website logging was running already in November 2011 when the website launched, while LinkChat logs were being recorded at the start of the previous cycle. The cycle ended at the end of October 2012.

8.1 Diagnose

In this cycle the Link team informed us that they were leaving The Warehouse NGO and moving to another group called Connect-SA [84]. They would no longer be working with the churches in Manenberg (with whom they in any case had no contact since Cycle Two) and Lavender Hill. The Mowbray group thus became our only audience.

Some members of the Mowbray group had seen the website in Cycle Two (see Section 4.4) but had not been told about its launch at the end of 2011. In Cycle Four NK wanted to know more about the website, so we gave her the URL (see "Reception of LinkChat Interface", page 103), and we had shown the website to three more students in Cycle Five (a), for a theoretical total of 22 beneficiaries who could be interacting with the Link website (we did not prevent the 18 users from Lavender Hill from using it after the work there ended). We had advertised LinkChat to eight students in Cycles Four and Five (a). We knew that LinkChat had been advertised to others by some of those students as well.

We were capable of controlling only the number of students to whom we advertised directly. At Mowbray we had advertised LinkChat to a slightly larger number of people than the website (most who were part of the large website evaluation in Cycle Two did not know about its launch). In order to test how the larger Mowbray group would react, it was important that they be aware of both systems.

8.2 Plan

When we discussed the progress of our research, the Link team agreed that we could advertise the to the Mowbray group, and indicated that using homework club time for questionnaires and interviews would be consistent with our agreement to exchange our technical skills for opportunities to perform research (see Section 3.2).

They also requested that we be available to help introduce new students to the website. We attended the homework club each week to tutor in any case, and we would be able to gather more data by observing new users.

8.3 Act

On April 17 2012 we demonstrated both systems to all students at the Mowbray homework club. Students sat in groups around laptop computers to use the website and a mobile phone was passed between students for them to see LinkChat. The intention was not to evaluate students' skill and so we did not record students' actual use in detail.

We were concerned that the details of accessing each system (*i.e.* the website URL and how to add the LinkChat contact) would not be easily remembered by students, and so we distributed flyers at the homework club the following week. The flyer is shown in Figure 45.

We unfortunately do not have attendance records for these two weeks, but attendance records for later weeks show an average weekly attendance of 31 students.

Figure 45 Flyer distributed in April 2012 at the Mowbray homework club to help students remember the details of how to access the systems and what content was available through each.

8.4 Evaluate

Evaluation of the two systems took place after advertising them at the Mowbray homework clubs.

8.4.1 Method

System Logging

Log files for the website were gathered between 22 November 2011 (launch during Cycle Three – see Section 5.2.2) and 31 October 2012, approximately eleven months. Log files for LinkChat were gathered from the day of first unsolicited use on 24 February 2012 (see Section 7.5.1) until 31

October 2012, or around eight months. This includes data gathered during previous cycles, but not analysed in detail then.

Where possible, users who were not beneficiaries (we discuss the misleading nature of data from non-beneficiaries in Section 5.3) were excluded from analysis. This was easiest with LinkChat, because all communication on MXit is tied to a unique user account. It is likely that some visits from non-beneficiaries did affect our website log analysis.

Interviews and Demonstrations

Between late March and Mid June 2012 we conducted semi-structured interviews with six students who were regular visitors to Mowbray, and demonstrated the systems to five newcomers who only attended the homework club for the first time after our April advertising. In the demonstrations we attempted to understand students' level of skill while guiding them through the use of LinkChat and the website.

Over this period, the homework club attempted to operate a second afternoon a week (a Thursday in addition to the normal Tuesday). The invitation to students was that although few tutors would be available, the venue would be a safe space for homework. We conducted some interviews then, but Thursday meetings were not well attended (some weeks with no students). Availability thus became the overriding factor in participant selection, and as a result students whom we interviewed tended to be those whom we had met and tutored most often.

By this stage we had already gathered some months of system logs (obviously, more by the later interviews). That data shaped our interviews, and the interviews themselves became a tool for analysis. In response to the clear quantitative advantage demonstrated by mobile, we asked why this was the case, through questions about where and when use of each system could take place. As in previous cycles we report the qualitative feedback that related to the quantitative results (for example "Scarce Computer Access Tied to Specific Venues and Hours", page 124), but also the exceptional (*NK*'s frequent use of LinkChat, but other students' indication that they were not interested – see "Reasons for not using MXit", on page 128), and the surprising (we discuss the events of the classroom demonstration that caused the end of the previous cycle with the student responsible on page 127).

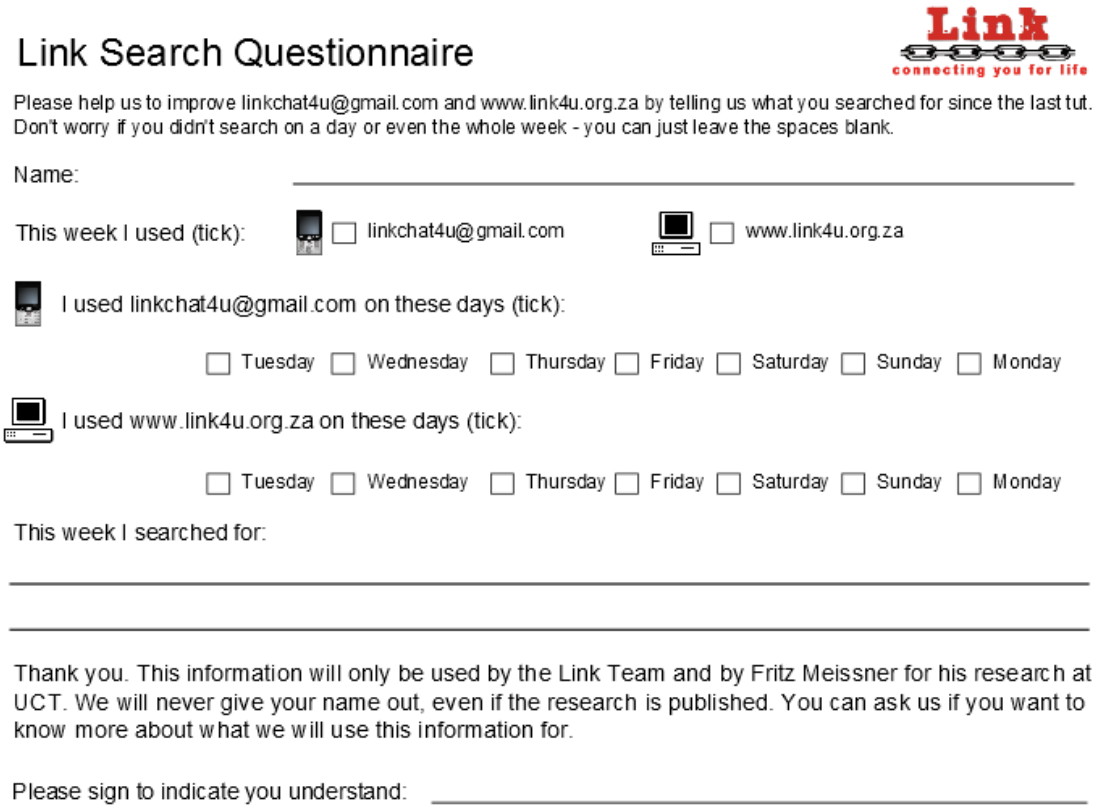
Reported Use Questionnaires

Questionnaires were an attempt to gather data quickly. The homework club existed for tutoring, but while interviewing, as many as ten students to whom we could have been allocated were missing out. Interviewees themselves did not complain, but the Link team did ask us to be economical.

We asked students in Mowbray to complete a questionnaire each week in May and June 2012 about their use of our systems. We hoped responses would help us match students to logged behaviour, especially for the website (even identifying a set of interactions as being performed by a single person remained difficult).

The first questionnaire used for the first three weeks is shown in Figure 46. It required students to report per system which days they used each. Unfortunately many students had difficulty remembering exact search dates, and some omitted the date section entirely. In the following weeks several students complained that they had already completed the questionnaire,

apparently unaware that new data was needed each week. Some answers were identical to the previous week, but system logging did not show corresponding activity.



Link Search Questionnaire

Please help us to improve linkchat4u@gmail.com and www.link4u.org.za by telling us what you searched for since the last tut. Don't worry if you didn't search on a day or even the whole week - you can just leave the spaces blank.

Name: _____

This week I used (tick): ☐ linkchat4u@gmail.com ☐ www.link4u.org.za

I used linkchat4u@gmail.com on these days (tick):

☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐ Monday

I used www.link4u.org.za on these days (tick):

☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday ☐ Monday

This week I searched for:

_____

_____

Thank you. This information will only be used by the Link Team and by Fritz Meissner for his research at UCT. We will never give your name out, even if the research is published. You can ask us if you want to know more about what we will use this information for.

Please sign to indicate you understand: _____

Figure 46 First version of reported use questionnaire after demonstration in Mowbray. Students did not adequately differentiate between sections of the form intended for specific days and systems.

Figure 47 shows the questionnaire revised after week three. It attempted to show more clearly that we expected a report of the preceding seven days, but did not require exact dates of use. We also added a question which allowed students to provide suggestions for changes which they thought might improve the systems.

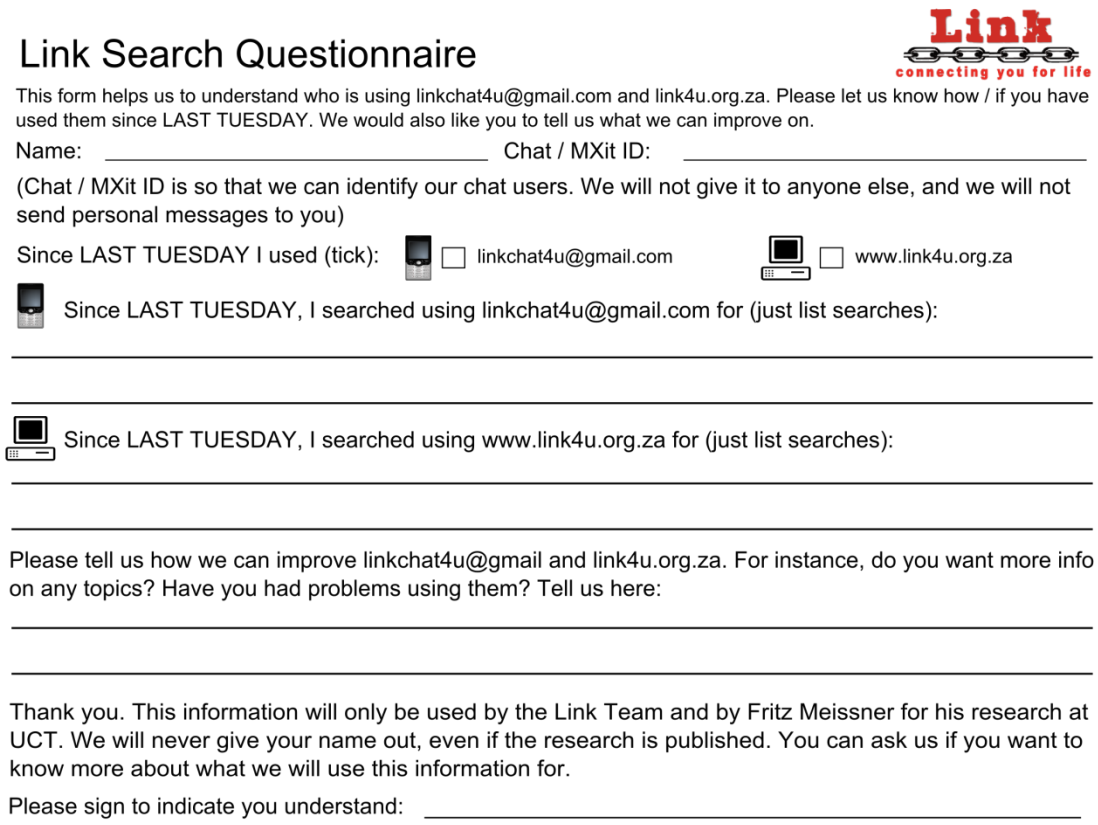
These forms may have had some effect as a regular reminder of our systems' existence. This might amplify pre-existing usage patterns, but the inclusion of sections for both systems meant that it should affect both equally.

8.4.2 Quantitative Results

In this section we report quantitative results obtained through analysis of system logs. We also briefly discuss questionnaire responses, which were of poor quality. In general, the mobile system enjoyed significantly higher usage, despite being deployed for fewer months.

Poor Data from Reported Use Questionnaires

Even after adjusting the form based on early results (see above), reported use data was useful only to connect a few unidentified users to LinkChat, and none to the website. We found many contradictions between what students reported, and system logs. Some students reported searches that had not taken place rather than leaving the questionnaire blank. This may be due to participant response bias [85].



Link Search Questionnaire

Link
connecting you for life

This form helps us to understand who is using linkchat4u@gmail.com and link4u.org.za. Please let us know how / if you have used them since LAST TUESDAY. We would also like you to tell us what we can improve on.

Name: _____ Chat / MXit ID: _____

(Chat / MXit ID is so that we can identify our chat users. We will not give it to anyone else, and we will not send personal messages to you)

Since LAST TUESDAY I used (tick): ☐ linkchat4u@gmail.com ☐ www.link4u.org.za

Since LAST TUESDAY, I searched using linkchat4u@gmail.com for (just list searches):

_____

_____

Since LAST TUESDAY, I searched using www.link4u.org.za for (just list searches):

_____

_____

Please tell us how we can improve linkchat4u@gmail and link4u.org.za. For instance, do you want more info on any topics? Have you had problems using them? Tell us here:

_____

_____

Thank you. This information will only be used by the Link Team and by Fritz Meissner for his research at UCT. We will never give your name out, even if the research is published. You can ask us if you want to know more about what we will use this information for.

Please sign to indicate you understand: _____

Figure 47 Reported use questionnaire used for weeks four to eight. The form required less accuracy in terms of the exact dates on which students used our systems, and attempted to communicate that what was required was information for the previous week only. Unfortunately accuracy was still unsatisfactory.

Others misread the questionnaire and reported activity for the wrong week or wrong system, or wrote answers which were unintelligible. Students did not share our research priorities: there were students who received the form at the start of an afternoon (sometimes giving us the impression that completing it each week was tiresome), but left without completing it. They may not have understood why we wanted the data. Our impression – based on regular conversation difficulties during tutoring – was that addressing this with an explanation would have required one on one interaction and several repetitions, defeating the object of quick data gathering.

The section asking for suggestions about how to improve the systems was less difficult. Responses to that section were about the topic and quantity of data the systems made available, and could be addressed by the Link team capturing more data.

Mobile Used More and More Frequently

Table 12 shows numerical results from system logs. Despite being deployed for longer, only the number of unique users recorded is higher for the website. This number is subject to quirks of web analytics: thrown off by the use of multiple browsers and sharing of devices, or expired tracking data. By contrast, MXit IDs uniquely identified LinkChat users, even across devices. Other numbers are significantly higher for LinkChat, as LinkChat visitors engaged more and more frequently.

Table 12 System logging shows LinkChat was used more than the website. More unique users supposedly visited the website, but this is an unreliable number.

	Measure					
System	**Days Live**	**Unique Users**	**Searches Performed**	**Entries Viewed**	**Searches / Day**	**Entries / Day**
LinkChat	251	56	811	796	3.23	3.17
Link Website	345	111	116	52	0.34	0.15

The higher usage of LinkChat is consistent over the entire duration. Figure 48 shows the number of searches performed per month on each system, while Figure 49 shows the total number of daily visits (each data point represents all access by a single user during one day) in each month. The lines representing the two systems only touch in February 2012, when LinkChat was only online for six days.

The maximum in LinkChat usage (both graphs) is due to diffusion in March 2012, while we attribute the increase in the number of visitors to the website in October 2012 (Figure 49 only) to referrals from Google, *i.e.* not people connected to Link. We note that other website activity did not similarly increase.

The number of searches for LinkChat appears to be tapering in later months. This may be due to students exhausting the content that interested them. 90% of all content that was available during these months was captured before we advertised LinkChat.

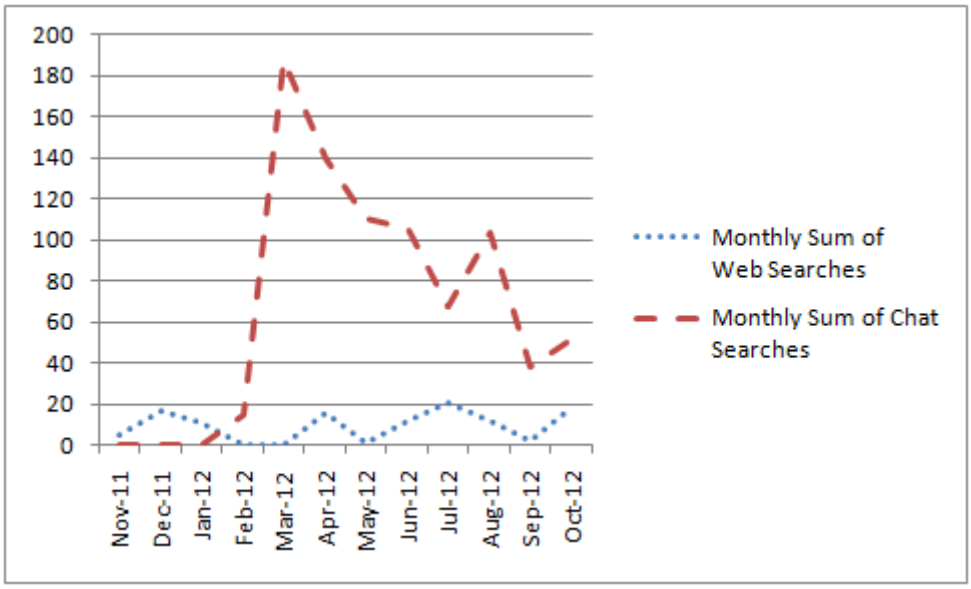


Figure 48 More searches were performed using LinkChat in all months of deployment.

Visits on Multiple Days

Table 13 shows that more than 90% of website users visited on one day only, while 51% of LinkChat users visited on more than five different days, and 23% visited on more than ten days.

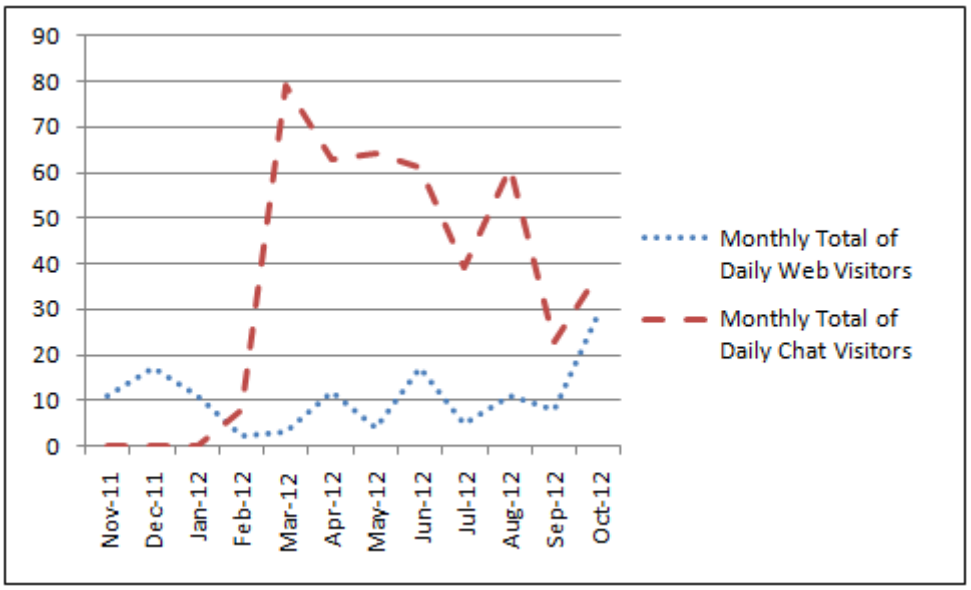


Figure 49 LinkChat interaction is spread over many visits on separate days. The increase in website visits in October 2012 is due to non-beneficiaries finding the site through Google. There is no corresponding increase in the number of searches.

Table 13 User visits to LinkChat and the Link website on separate days. LinkChat users were much more likely to visit on multiple days than website users.

	Measure							
System	**# Unique Users**	**Min. Days**	**Max. Days**	**Median**	**Mean**	**1 Day Only**	**> 5 Days**	**> 10 Days**
Link website	111	1	5	1	1.17	102 (92%)	0 (0%)	0 (0%)
LinkChat	56	1	45	6	7.87	12 (21%)	31 (55%)	14 (25%)

Hours of Access

Figure 50 shows the distribution of interactions over the hours of the day. The number of chat requests (messages from the user to LinkChat) and web page views (considered equivalent) are shown as a percentage of all interactions.

Interactions with the website mostly occurred during office hours, while interactions with LinkChat were more evenly distributed across the whole day. Just over 20% of all LinkChat interactions took place between 11PM and 9AM.

Access to Content

Table 14 shows the portion of entries viewed per system, excluding repeat views. LinkChat users viewed 74% of all content, website visitors only 8%. The difference in number of entries available is explained in Section 6.3.4.

Table 14 LinkChat users viewed a larger percentage of available content than website users.

	Measure	
System	**Entries Available**	**Unique Entries Viewed**
LinkChat	230	170 (74%)
Link Website	302	23 (8%)

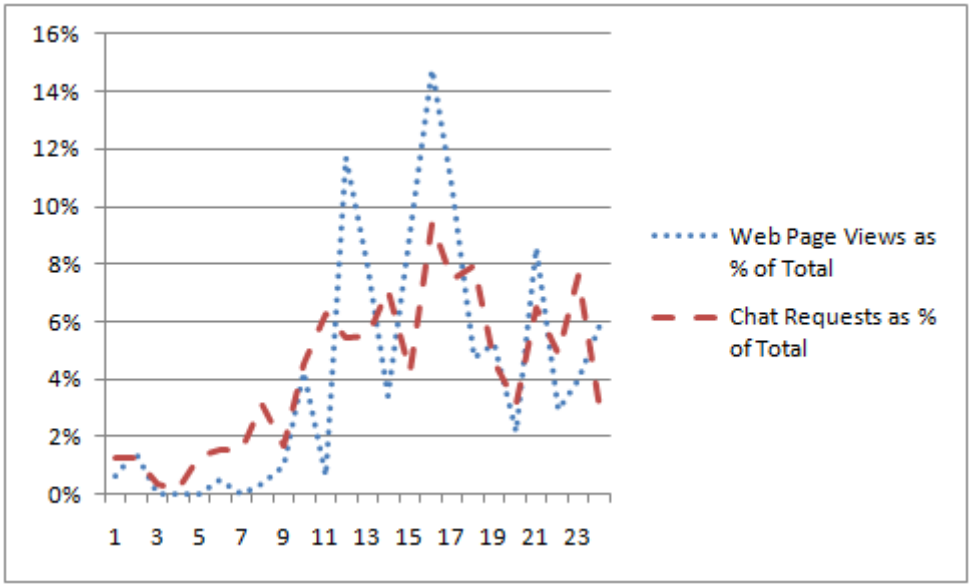


Figure 50 Distribution of interactions are more concentrated in office hours for the website. Mobile requests were more evenly spread over the other hours of the day.

Some entries were viewed more than once. Table 15 summarises the extent of repetition. Entries available on LinkChat were viewed on average 3.52 times, and on the website 0.17 times. 18% of entries viewed from LinkChat were viewed once only, 55% more than once, and 17% more than 5 times.

Table 15 Repeat views of single entries. 55% of LinkChat content was viewed more than once, compared to 2% of website content.

	Measure					
System	**Max. Views**	**Mean Views**	**= 0 Views (% of entries available)**	**= 1 view only (% of entries available)**	**> 1 views (% of entries available)**	**> 5 Views (% of entries available)**
LinkChat	30	3.52	60 (26%)	42 (18%)	128 (55%)	38 (17%)
Link Website	9	0.17	279 (92%)	16 (5%)	7 (2%)	3 (1%)

Table 16 shows entry viewing behaviour of users. One LinkChat user was far more active than others: *NK* viewed 71 unique entries a total of 172 times, while the next most active viewed only 34 unique entries. Nonetheless, other users also show greater engagement than website users. Every LinkChat user viewed at least one, and 52% more than 5 different entries. Not a single website user viewed more than 5 unique entries.

Single Point of Access to Multiple Original Sources

One of the original aims of introducing technology to the Link programme was to make information that was on the Internet already simpler to find. A goal of our systems was to provide a single source with consistent navigation that is less effort than understanding the multiplicity of sources – university websites, company job listings, career websites – that make up the Internet (see Section 1.4.1).

Table 16 Entry viewing behaviour of users. The number of LinkChat users viewing more than 10 entries is higher than the number who viewed only one entry. Most LinkChat users viewed more than 5 entries, while most web users viewed none.

		Measure						
System	**All Entries / Unique Entries**	**Min. Views**	**Max. Views**	**Mean Views**	**Median Views**	**= 1 View Only (% all users)**	**> 5 Views (% all users)**	**> 10 Views (% all users)**
LinkChat	All	1	172	14.13	7.5	5 (9%)	35 (63%)	23 (41%)
	Unique	1	71	9.23	6	5 (9%)	29 (52%)	17 (30%)
Link Website	All	0	14	3.06 (excluding 0 values)	1 (excluding 0 values)	9 (8%)	2 (2%)	2 (2%)
	Unique	0	5	1.89 (excluding 0 values)	1 (excluding 0 values)	10 (9%)	0 (0%)	0 (0%)

Figure 51 demonstrates that (at least for LinkChat) our users have been saved effort by being able to access content from multiple sources through a single system. We plot how many different sources were consulted by the number of users who accessed that number of sources. The blue LinkChat line shows the majority of users making use of three or more sources. *NK* remains an outlier at 18 different sources, more than double the number of different sources viewed by any other user.

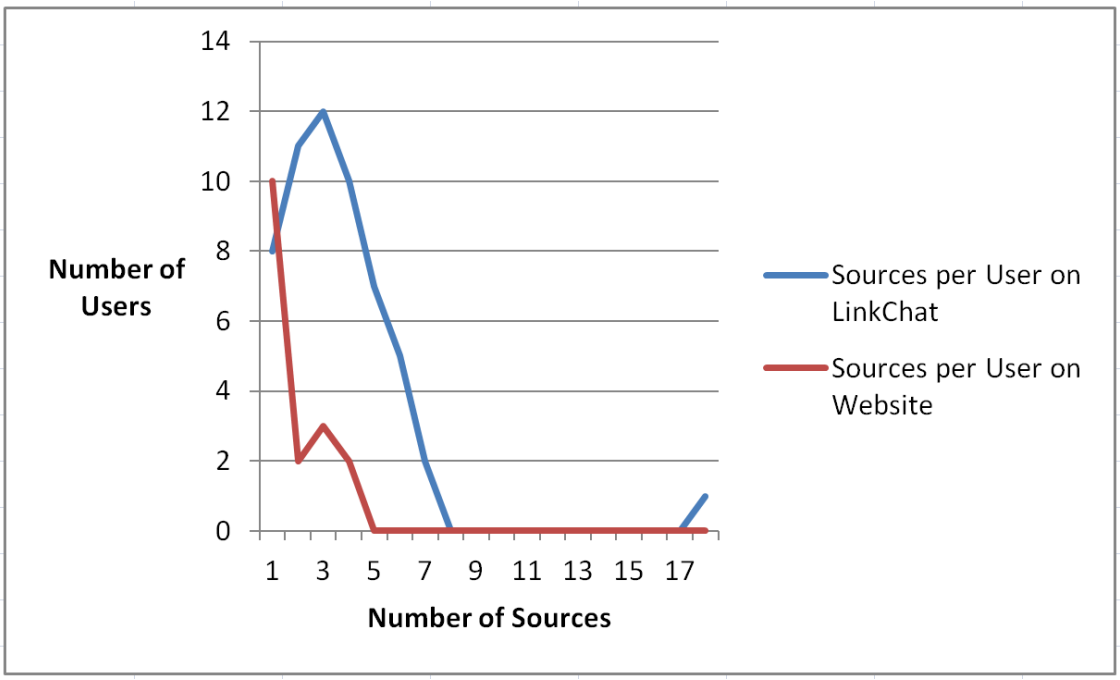


Figure 51 Number of sources and number of users viewing content from those sources. This shows that for LinkChat (with much higher activity) the goal of creating a single system to expose content from multiple sources was achieved.

Figure 51 shows viewing behaviour for three sources. Many entries from a single source did not guarantee proportionately many views. Content from the source with the most content available,

the University of South Africa, was viewed much less than content from the Cape Peninsula University of Technology (similar number of entries captured) and the University of the Western Cape (less than half the number of entries). This may be a result of student interest in specific institutions, for instance the University of the Western Cape is closest to where the majority of the students lived.

These sources represent 75% of all content available through LinkChat, and 79% of all entries viewed. Similar statistics for all other sources is available in Appendix J.

Table 17 Number of entries available and views thereof for three major institutions. Courses offered by major Cape Town academic institutions comprised the majority of content and were also the most viewed. Content from these sources comprises 75% of all content available.

Measure	Institution	Entries Available	LinkChat Views (Unique Users)	Link Website Views (Unique Users)
Highest number entries available	University of South Africa	72	67 (21)	17 (6)
Highest views	Cape Peninsula University of Technology	70	336 (35)	14 (8)
Highest views as % of available	University of the Western Cape	29	223 (33)	9 (6)

8.4.3 Qualitative Results

Pre-Existing Sources of Information

Existing search behaviour took the following forms:

- NG and AH said that they did not have access to information similar to what Link offered elsewhere, and had not tried to use Google for this purpose.
- MG had not searched for career guidance information but had used Google for other purposes.
- YM and NK both searched for career guidance information at the library.

The Internet was not the only source of information similar to Link. ZM did not use computers, but demonstrated some knowledge of local institutions when she told us that correspondence-only institution did not appeal because she did not want to study alone. YM reported that a friend had found printed booklets with course descriptions and entrance requirements. Although these are "use anywhere" resources, they each contained information for only a single university.

Scarce Computer Access Tied to Specific Venues and Hours

Computers were not seen as portable devices (one student mentioned a laptop, but it did not move with her). Evidence we gathered about computer access was related to home, school or public library.

Home

At "home" access was enabled through relationship with the owner: *MG* used his older sister's work laptop "once or twice a month" when he visited her, *NM* mentioned her father having a computer for work and *AS* had access to a computer once a week when he visited his mother's former employer. *AM* explained to us that it was not normal for his peers to have access to computers at home, estimating that perhaps twenty percent of his classmates at school might have a computer in the home.

School

All interviewees attended the same school in Mowbray, which had a computer room. Access was naturally restricted to hours when students were physically present at school (we did not ask about access after school hours, but we do know that students had a lengthy bus journey to and from home and were careful not to take the bus much later than normal office hours).

Library

A public library was near to the students' school and the tutoring venue. Access to the library was free and we heard of the students taking shelter there on rainy days after school. The library had working computers that could be used while the library was open during office hours – for the students' purposes this would have been between the end of their school day and 5pm.

Hours Available Shared with Non-Computer Behaviours

During the hours in which computers were available, students had other demands on their time, some academic (for instance, each week students attended our homework club in the same hours that the public library was available, and also attended a school organised "study group") and some not: school work and chores such as making tea and cleaning at home.

NK related that when she used computers at the library, her peers told her that she was "wasting her time". *AM* and *ZM* claimed to be too busy to use the public library. *ZM* did not own a library card, an indication that she had never entered one. Students also faced lengthy commutes between home and school. NM told us that she travelled between an hour and ninety minutes each day.

Venues Shared by Many Users

No venue offered computers in a one computer per user ratio. At home, *AM* suggested that family members would have other priorities for the computers, such as a brother who wanted to play games (his hypothetical example).

All students had theoretical access to a library (by applying for a free library card) and to computers at school, but these venues had many more users than computers, and had different strategies for dealing with the demand. In libraries once a user got to the front of a long queue, they had a maximum time period of 45 minutes within which to work. For YM, the waiting period was, "kind of boring", and the allotted duration per user was less time than NK and YM wanted. "Not good... I didn't finish my things", said YM, who felt even more pressurised because of a slow Internet connection. On weekends she might pay more for transport to a less crowded and noisy library than her local one.

At school, priority access to computers was for classes in a "science" stream. *NK* estimated that this amounted to less than a quarter of her school. When access did happen for the science students, it was shared with others at the same computer. A student outside of the science stream reported that she had used school computers during a life orientation lesson once, but that the teacher present had not offered any assistance when she had difficulties. MG was in the science stream, but when we asked how often he could use a computer he referred to visits to his older sister's home every few weeks rather than to time at school. This may mean that his access at school was less frequent than visits to his sister, or that he did not see the school computers as relevant for the purposes we spoke about (perhaps reserved for school work only).

Alternative Uses for Computers

When students were able to make their schedule and the available computing resources align, other priorities competed with the Link website. We heard about social networking ("I have to Facebook first… have to check" – YM) and games.

Two students were already searching for similar information to what the Link site offered. When NK was using the web, she was satisfied with what Google offered. Despite her expressed preference for the Link website when she first saw LinkChat (see Section 6.4.3) she had not used it since. She told us it had "slipped her mind".

Lack of Skill and Confidence with Computers

Interviewees reported a range of skill with computers. MG and NK mentioned basic computer lessons in primary school (approximately six years earlier). MG was particularly confident in his own abilities and did not feel that he ever needed help. YM and NK told us that help was not necessary for computer use, and using keyboard and mouse was not problematic, but also gave indication that computer use felt cumbersome: "It's [using Google] a process", said YM. NK felt that she could not make much of her 45 minute library sessions because of she was not accustomed to computers. AM, who felt that he spoke for the majority of his peers shared her opinion: "I'm not used [to computers]", making access when it did occur less fruitful. For NK, the most time consuming activity was deciding what topics to pursue. This had improved as her interests had stabilised over time: "now search same, every time".

New Behaviour Resulting from LinkChat

When interviewees spoke about their exposure to the Link content, they were describing LinkChat:

- LinkChat gave students a realistic impression of how their current grades compared to tertiary entrance requirements. AM told us, "I want to upgrade my level. These requirements made me to see that, they gave me a spirit to work hard".
- OM had discussed two courses from LinkChat with his life orientation teacher at school. He wrote the course details down rather than showing her his mobile phone, because he was worried about being asked to do a demonstration of the system to classmates in similar fashion to MG (see "LinkChat Diffusion Amongst Peers" below).
- MG saved content from LinkChat using the "save messages" functionality in the MXit client. He would still require a data connection to access these messages, but they would

be accessible without having to perform a search and would remain available even if our system shut down.

Confidence, Expertise and Convenience with Mobile Phones

Students had greater access to mobile phones than to computers. Some students had mobile phones with them at the homework club, which other students did not seem to find unusual. *NK* and *YM* carry phones with them, but spoke of using a friend's device at school or borrowing from a family member at home. Mobile phones were therefore not restricted by venue because when users travelled, someone nearby could help with access.

Cost too, was not problematic, at least on MXit; some students had SIM cards from the Cell C operator [86] which does not charge for data used to access MXit because of an agreement between the two parties [87]. OM estimated that an evening on MXit chatting to friends would cost him R0.30 (0.03 USD). *NK*, whose use of LinkChat was far greater than any other user (see "Access to Content", page 121) used around two megabytes of data, which would cost USD 0.4 at standard South African mobile data rates. She confirmed that LinkChat was, "not too expensive".

Greater access to mobile phones had created comfort with feature phone interfaces. AM contrasted his experience with mobile phones with his reservations about computers, saying, "I know the phone". When we used a feature phone as conversation aid during an interview, MG told us, "you are too slow".

A theme of convenience regarding LinkChat emerged as a result. AM preferred LinkChat, because "It doesn't waste time," and YM felt it was useful "…when in a hurry". NK preferred to use Google to the Link website, but that expressed preference did not seem to apply to our mobile system – she was the most frequent user of LinkChat, performing 118 searches on 37 different days. For the students who had not engaged in searches like these before, the Link content was obviously new, but the lack of restrictions on the platform which delivered the content was different from any previous source of similar information.

LinkChat Diffusion Amongst Peers

More LinkChat users had been recorded in system logs than we had advertised the system to directly, and we met students who knew of LinkChat before they attended the homework club for the first time. Peers passed on knowledge of LinkChat in three ways:

- **Face to face:** NK and YM told us of demonstrations to school friends on the friends' phones.
- **Online, through MXit features:** We had seen MXit purely as a platform for disseminating text, but it could also advertise. OM told friends in another city about LinkChat while messaging them. CM gave a friend at a different school her MXit password. The friend then used her own phone to access LinkChat from CM's account.
- **Classroom demonstration:** In Cycle Five (a) we related how LinkChat was demonstrated at school by one of the Link beneficiaries, MG (see Section 7.5.2). When we interviewed him in this cycle we learned more. He and AS had told their Life Orientation teacher at school about both systems. The teacher asked them to demonstrate LinkChat to their class, but told them that it would not be possible to demonstrate the website until the

school computer room was available for students to visit, perhaps at the end of the term. When the demonstration of LinkChat took place, the website was not mentioned.

Reasons for not using MXit

In Cycle Four we met LA, who was uninterested in MXit and unresponsive about her reasons for this (see Section 6.4.3). We met two more students who were uninterested in MXit in this cycle. One was willing to discuss her preference: *NM* found reading difficult, and this made her uninterested in computers or mobile phones, especially text-centric IM. The other was reticent, similar to *LA*.

In order to understand other reasons, we asked MG – himself an enthusiastic mobile phone and MXit user, but (like Bosch's MXit user interviewees in [89]) aware of negative perceptions – what reasons he thought people might have for not wanting to discuss the topic.

His opinion was that these students were a minority, and fell into two camps. Some might be embarrassed about only having "tilili", a slang word with which his peers described a phone with no features beyond voice calls and SMS.

Others were constrained by societal expectations. MXit had "a bad side and a good side", and some students would be affected: "...because I'm a pastor's son, I'm gonna ruin his reputation [if I use MXit]". Teachers' children might be similar, although some of his teachers themselves used MXit.

Later in that interview MG indicated that he uninstalled the MXit client voluntarily during exam time for the sake of his studies, but this was temporary.

8.5 Specify Learning

8.5.1 Internet-Supported Intermediation

In this cycle we gathered sufficient evidence to answer our research question about Internet-supported intermediation:

1. Can we increase the impact of Link team intermediation, and reduce the inconvenience for student beneficiaries, if we provide a system that implements Internet-supported intermediation? If not, what prevents the new information source from being used?

Our mobile Internet system had supported Link team intermediation for 56 people who were either students in relationship with Link or had been introduced by those students. Most users accessed the system on more than one day: more than half (31 users) on 5 or more days, and one quarter (14 users) on 10 or more days. 52% (29 users) viewed 5 or more different entries, and 30% (17 users) viewed 10 or more.

The website attracted minimal use. In previous cycles we have discussed difficulties introduced by Internet-supported intermediation using five factors: financial considerations, access constraints, skill, fear of technology, and habits of dependency. These difficulties mostly apply to the website, but as we consider them it is possible to contrast the difficulties of the web with the reasons why the mobile system was useful. This comparison is also relevant to our second

research question, and so rather than discuss difficulties of the conventional web here and then repeat them there, we postpone discussion until Section 8.5.3.

Our Internet-supported intermediation process provided benefits for both Link team and students. They are a combination of the convenience of direct access to the Internet (discussed in Section 1.4.1) and the tailored content that knowledgeable intermediaries can offer (see Section 1.4.2).

Convenience Benefit

Students were not restricted by venue or time when they accessed LinkChat. We knew of access at school when students were together, but also from their homes. System logging showed that access took place at all hours of the day.

In previous Link team intermediation (we give an example in Section 1.6.2), students visited a central location for a group meeting, at a time when the Link staff (for whom the travel and time involved was also non-negligible) could make themselves available. This was no longer necessary for students to receive information.

Many students made repeat visits to the same information on different days, and many students viewed multiple entries. Thus information could be used many times over while only requiring effort from the Link staff to capture it once. The Link staff had therefore spent less effort engaging with students than would be required for equivalent dissemination without our systems.

Content Benefit

Our system created opportunities for students to benefit from filtering and structuring performed by the Link team.

Students were saved the effort required to operate multiple websites by consulting multiple sources through a single system. We did not attempt to measure usability difficulties of other sources; that assembling information from the broader Internet was difficult for students was a fundamental assumption of the Link programme.

8.5.2 Adoption

After advertising both website and mobile Internet system to the same audience over the same period, data from system logging answered our research question about relative adoption:

2. Is there a difference in adoption between mobile Internet and conventional web technologies when both are available to low income urban youth as options for accessing content outside of the domain of entertainment?

There is convincing difference between the adoption of the mobile Internet system and that of the website. Quantitative data showed that while the mobile system's users accessed multiple entries on several days, more than 90% of the data available on the website went unseen. There does not appear to have been any difficulty created by the fact that content is not entertainment-related.

In the next section we draw qualitative conclusions about the difference between the two systems.

8.5.3 Factors Motivating Intermediation

Fear of Technology

AM linked his preference for not using the website with his inexperience with computers (see "Lack of Skill and Confidence with Computers", page 126). This was similar to the expressed hesitance of *NM* in Cycle Two (see "Confidence, Expertise and Convenience with Mobile Phones", page 127) and observed apprehension from *MH* in Cycle Five (a) (see "Search Activities", page 110) before they used our website. *NM* and *MH* used the website anyway (they may have felt pressure not to refuse the request of facilitators), and were both the worst performing members of their groups.

Enthusiasm about computers from *MG* and *NK* was correlated with more access than their peers, but not on a daily basis like they had to mobile phones. Comfort with a technology therefore need not require daily use.

However, their enthusiasm did not result in significant use of the website. Thus fear of computers in general made some students uninterested, but a lack of fear was not sufficient to guarantee interest in our specific system. Further *NK* expressed apathy towards MXit (see "Reception of LinkChat Interface", page 103), but became LinkChat's most frequent user.

Skill

A lack of skill was not what prevented the majority of students from using our website . In previous cycles, most demonstrated skill with the web platform that was not incompatible with operating the website (see "Desktop Computing Skill", page 81). However, students could only access computers through secondary intermediaries (mostly schools and libraries) where rules constrained their activity (we discuss this later in this section). Thus a greater level of skill became necessary because of limited time.

A mixture of reported perception and observations of use (in previous cycles) contributed to our understanding that skill with the mobile Internet was greater than with the conventional web (see "Confidence, Expertise and Convenience with Mobile Phones", page 127). It would thus enjoy advantage where time was limited, but in fact fewer constraints on access meant that the need for efficiency was also lower.

Habits of Dependency

As minors in full time study, students depended on their households. However, the phenomenon of habits of dependency driving intermediation could only occur where older household members (parents or siblings) had access to technology themselves.

We found evidence that it was rare for households to own computers, but they had access to mobile phones (consistent with other work discussed in Section 2.5). As a result, some students had access to mobile phones when they were at home, which was sufficient to use LinkChat. On the other hand, their dependency relationship with older household members could have no positive impact on access to the website. Even where family members did own computers, this

would feature the same competition for use from other family members as we knew existed with libraries.

We note that family relationships can bring restrictions too, as in the case of students whom *MG* speculated would refrain from using MXit because of their family's position in society (see "Reasons for not using MXit", page 128).

Financial Considerations

The ongoing costs of conventional web access had to be subsidised by state institutions (apart from the minority who had access at home). We did not discuss financial constraints to conventional web access explicitly, because access was more about whether students wished to queue at the library than about affordability.

On the other hand, our users (or their families) would have to pay the cost of mobile Internet access. This did not prevent ownership by family members, or some students from carrying mobile phones with them. We became aware of the arrangement between the Cell C [86] mobile operator and MXit, whereby the operator does not charge for data to MXit. This would make access to our service free. However, even where users did pay, their costs were low.

We note *MG*'s report that people who did not own mobile phones might fear the perception of their lack of access as a marker of poverty. There was no such reluctance with computers, which were unaffordable to most. Thus we note that while the lower cost barrier made it normal for most students to use the mobile Internet, a minority would be less likely to use the lower cost mobile Internet than the higher cost conventional web.

Access Constraints

We have discussed how a lack of personal, household or peer ownership of computers forced most students to resort to secondary intermediation from institutions like school or the library, while mobile phones were carried by students, or borrowed from friends and family. The former allowed access only at specific places and times, and with constraints on duration or purpose (see "Scarce Computer Access Tied to Specific Venues and Hours", page 124). The latter were more flexible. Using our website would require students to subordinate their schedules to the timetable of the secondary intermediary, while LinkChat could be used when it was convenient.

The greater adoption of the mobile system was advertising between students (see "LinkChat Diffusion Amongst Peers", page 127). Shared information was immediately relevant because the technology necessary to access it was widely available. In the extreme case of the classroom demonstration, the school could not provide immediate access to the conventional web, but the students had their own means to access the mobile system.

A small number of students would not use the mobile system due to negative societal perceptions of MXit (see "Reasons for not using MXit", page 128). We are unsure whether any form of intermediation between one of these students and our mobile system could have addressed their concerns.

9 CONCLUSION

We conclude by drawing together reflection from each of our cycles regarding our two research questions and method, reflecting on action research, summarising the contributions of our work, and discussing future work.

9.1 Successful use of the Internet to Support Intermediation

The first research question we investigated (see Section 1.7) was:

1. Can we increase the impact of Link team intermediation, and reduce the inconvenience for student beneficiaries, if we provide a system that implements Internet-supported intermediation? If not, what prevents the new information source from being used?

Our systems have supported intermediation by using appropriate technology for our beneficiaries while allowing the Link team to control the content. The effort that the Link team expends in the process is no longer a function of the number of users who access their information, while students no longer need to be present in a specific time or place to meet the Link team. Hence providing Internet support for Link team intermediation has increased its impact, and reduced inconvenience for their student beneficiaries. We elaborate on this answer in the following sub-sections, as well as reviewing the difficulties that had to be overcome during our iterative process.

9.1.1 Control over Technology and Content

The difference between our systems and direct access to the Internet is that we have used technologies suited to students' resources, and the Link team curates the content. The biggest change in technology was the move to the text based mobile system, which comes to the fore when we discuss difficulties that our users had with our systems (Section 9.1.4) and when we discuss our second research question (Section 9.2).

Our systems gave the Link team the capacity to capture content they felt best suited to users' reading level and interests, without irrelevant or incorrect information. We have shown that while using our mobile system (which accounts for the vast majority of use – see Section 9.2), most users have consulted content originally from multiple sources. This reduces effort compared to direct Internet access, where the same content could only be accessed by understanding and using multiple different interfaces.

9.1.2 Link Team Effort Unaffected by Number of Users

Despite tailoring content to a specific group of users, the effort required of the Link team is independent of the size of that group. Unsolicited use (by students outside our presence, without our initiation, first discussed in Section 7.5) exemplifies this. Since even a first introduction to the system could be performed for students by their peers, the number of users grew beyond those to whom we had advertised directly.

Similarly, the amount of content each user viewed (we have identified users who performed multiple searches and viewed multiple entries), or how often they wish to access content (most did so on several different days) does not affect the Link team. Our systems allowed the Link team to support frequent queries by *NK* (see "Access to Content", page 121) as easily as they could the student from Lavender Hill for whom a single visit was enough to establish that the content related to her interests had not changed since she first saw it (see Section 6.1).

The task that remained for the Link team lay in capturing a breadth of knowledge sufficient to match the interests of a group of users, rather than catering only for specific individuals. This required some anticipation, and some content did go unseen. However, of the content that was available through the mobile system – the technology which best suited users' resources – only a quarter of information was not accessed, while more than half was viewed more than once. Further, even in the Link team's original interaction with students they had to anticipate what students' interests were on a first meeting (see Section 1.6.1). In that process, communication the same content again would require a second meeting, unless the student were in the initial meeting. A second student accessing it through our system experienced no such restrictions.

9.1.3 Beneficiary Access Unaffected by Link Constraints

Before our systems, students could only access information when they were co-present with Link staff, who could only operate in one location at a time, and mostly during office hours. Meetings had to be scheduled to ensure that Link team and students were in the same place and time. As we experienced in this project (see Section 4.4.1), meetings could be difficult to schedule and attendance was not guaranteed.

By contrast, we have shown – especially for the mobile system – that students accessed our systems at all hours of the day and in different parts of Cape Town (they lived in many different locations, see Section 2.2.3). The inability to defer use of the website to times when other priorities did not compete proved to be a major reason for its lack of adoption. We discuss this further in "Access Constraints" below.

9.1.4 Difficulties

Internet support for intermediation was a response to difficulties that the Link team had in intermediating Internet content. The use of Internet systems to address problems of Internet use was perhaps counter-intuitive, and hence the research question we followed included room to investigate why our efforts might fail. Despite the ultimately successful implementation, we are able to report on reasons why different aspects succeeded or failed here.

Financial Considerations

Severe financial constraints affected the low income youth demographic with whom we worked. The options for overcoming financial barriers which would prevent Internet support for intermediation were either to access the conventional web at no cost from state sponsored institutions (libraries, schools) or to pay Internet access charges from mobile phones, which imposed a smaller but non-zero financial burden. We created systems for both possibilities.

Our mobile system was optimised so that access would not impose greater expense than was already being incurred, and ultimately costs proved acceptable for most (see "Confidence, Expertise and Convenience with Mobile Phones", page 127). We learned that the cost of mobile

phone ownership was enough to alienate a minority, but fortunately most potential users carried their own devices, or could borrow from family and friends.

The Link team was initially concerned about the cost of mobile Internet access (see Section 1.6.3). That the mobile system received greater attention than the conventional website is perhaps counter-intuitive from a purely financial perspective. Fortunately, we were able to create a mobile interface that required minimal data consumption and hence added minimal cost to existing mobile Internet use. Further, free web access at institutions imposed other constraints, which we discuss next.

Access Constraints

Both the Link team and ourselves were aware of technology access constraints at the start of the project. The Link team's answer to this was to encourage church groups to act as secondary intermediaries, and to hope that state institutions already intermediating for access would suffice otherwise (see Section 1.6.2). We assisted by using web technologies suitable for low end computers and Internet connections that such secondary intermediaries would most likely be able to provide (see Section 3.2.1). We also worked with mobile technology that we thought was directly in the hands of beneficiaries.

Mobile phones were personally carried by some, but secondary intermediaries still proved significant in the eventual outcome for both mobile and web. Churches were sometimes unhelpful (see Section 4.4.1), and ultimately the relationship ended (Section 8.1), but we found interesting results from other actors.

Where secondary intermediaries had significant "per beneficiary" access to the necessary technology they were helpful, as in the friends and family who loaned mobile phones to students who were without. On the other hand, where secondary intermediaries had minimal access relative to the number of potential users, additional access constraints were created to manage sharing. For instance (amongst other issues discussed on pages 124-126) school computers were reserved for certain pupils, and were unavailable even for a demonstration which was sanctioned by a teacher.

Some students were unwilling to work within constraints such as long queues at public libraries, and had no access to computers as a result. For those who did pursue access, they chose interests that pre-dated our system – social networking, for instance – over our website during the minimal time available.

In general these access constraints applied more to the conventional web than to the mobile Internet. The only access constraint we recorded that mobile Internet users faced was that a minority were prevented from access due to social standing of family members combined with perceptions of MXit as a negative influence.

Lack of Skill

Internet-supported intermediation was hindered where it required skill that was lacking. In early website evaluations, tasks were completed, but slowly. We did not find evidence of real-world use of our website, but students reported that skill issues for general website use were exacerbated by the short time available for use at intermediary institutions. This creates a cycle of minimal practice leading to less productive use of the minimal time available.

Fortunately, students had more time and were more skilful with the mobile system due to prior experience of mobile instant messaging. Apart from early user interface issues, they were capable of using the system without intervention. Outside of our presence, they coped with a changing interface without receiving new instructions on how to operate it.

We compare the website's vicious cycle (few opportunities to become skilled, and more need for skill to make the most of those opportunities) with a virtuous spiral of mobile skill: more skill from previous experience, and less competition from other users and priorities to pressurise opportunities for access.

Fear of Technology

Fear of technology, where explicitly expressed or observable (only in a minority) was consistent with poor outcomes in controlled evaluation. We note that this evidence was recorded before actual use took place, *i.e.* that general fear of the web platform affected our specific system. One student linked this with minimal experience of computer use, and a general lack of access at school or home. On the other hand, expressions of enthusiasm about the web in general from some students were not enough to make them use our site. We attribute this to competing interests for their time.

There is strong contrast with the general reaction to the mobile Internet and our system, which was characterised by self-initiative. Students used mobile phones to access the website before we had discussed the possibility with them. Others used our mobile system in their own time, and advertised to and taught their peers after our first demonstration, before we had even considered the possibility of unsupervised use ourselves.

Habits of Dependency

As minors in full time study there is no doubt that our users were in dependency relationships which paid for their living. However, other household members did not have access to computers themselves, and so students could not turn to them for assistance. However, these relationships did enable access to mobile phones, allowing their use at home.

9.2 Greater adoption of Mobile Internet than Conventional Web

The second research question we investigated was:

2. Is there a difference in adoption between mobile Internet and conventional web technologies when both are available to low income urban youth as options for accessing content outside of the domain of entertainment?

For the most part the results discussed here were obtained in Cycle Five (b), mostly documented in Section 8.4.2. We found significant difference in adoption between the mobile Internet and conventional web platforms, with the mobile system being far more popular. In eight months (three months less than the website), mobile users performed eight times more searches than website users, and viewed sixteen times more entries, despite the existence of more content on the website (see Section 6.3.4). The only exception is that system logging reports a high number of website visitors, but we have discussed how this could be unreliable as an indicator of real user numbers, and uncertainty about whether they represented the students with whom Link worked (*e.g.* in Sections 5.3.1 and 8.4.2).

9.2.1 Mobile Advantage Sustained over Duration and Multiple Users

The advantage for the mobile was sustained over all months of parallel deployment in terms of number of searches performed and entries viewed. Although there were fewer unique mobile users than website users, the amount of mobile interaction is higher because of repeated visits from mobile users. More than half of the mobile users visited on five or more separate days, while 92% of website users visited once only.

We concluded at the end of Cycle Two that where data existed students had the skill to use the website to find it (see Section 4.4.5). That only 10% of visitors viewed even a single entry despite this reinforces our belief that the majority were not the intended beneficiaries of the site (63% of mobile users viewed more than five entries, leading us to believe that content was not the issue).

9.2.2 No Rigidly Held Preference for Computers Outside Entertainment

Ours is the first developing world comparative, longitudinal intervention involving these technologies outside of entertainment, but the result is consistent with other studies of mobile Internet use (see Sections 2.5 and 2.6) where existing use for entertainment was investigated. We conclude that where such studies documented more frequent use of computers than mobile phones for non-entertainment tasks, this was not due to rigidly held preference.

9.2.3 Contrast with Difficulties of Conventional Web

We only explicitly began measuring adoption once both systems were available, while the Internet-supported intermediation was the focus of earlier cycles. Discussion of the first research question foreshadowed the answer to this in frequent references to differences between our two systems. Section 9.1.4 above discusses in more detail, but in brief the reasons for greater adoption of the mobile system were:

- Mobile phones were personally owned and our system did not increase spending significantly beyond current expenses, while personal ownership of computers was unusual;
- Some institutions could act as secondary intermediaries and made website access free, but not convenient;
- Family and friends were available in convenient times and places, but only had the resources to act as secondary intermediaries for the mobile system;
- Convenience allowed our mobile system to be used when other priorities did not compete for their attention, and allowed enthusiastic students to share knowledge with their peers;
- Many students were skilful mobile phone and instant messaging users, but were slow with the conventional web, which was a hindrance given short periods of access to computers.

We have noted some caveats which would negatively affect engagement with the mobile Internet: the cost of Internet-capable mobile phones could prevent access for some, while societal perceptions of a family could conflict with negative perceptions of mobile instant messaging (see “Reasons for not using MXit” on page 128). Therefore although the mobile Internet appears capable of reaching more users than the conventional web, there is a minority whom it will not reach.

9.3 Reflections on Method

We reflect here on the impact of each of our methods on this project.

9.3.1 Intermediary-Derived Personas and Scenarios

In Cycle One (Section 3.1.4) we created intermediary-derived personas to help us understand users in their absence, and make the Link team members aware of each others' assumptions. These results were published in [63]. The personas served as characters in the scenarios which informed requirements, data capture, and tasks for usability evaluation. However, their influence diminished as we prioritised other factors such as technical constraints, the time available for development, and the Link team's ideas of how the system should function. We identify a long-lasting impact of these on the data model (see Section 3.3.7), which was largely unchanged after Cycle One.

9.3.2 Usability Evaluations

Controlled usability evaluations provided a number of insights about our system interfaces from a small number of users, despite being conducted by artificially eliminating the difficulties of access (users did not need their own computers, phones, or Internet connection). They allowed us to gather formative insights that informed design and data capture, and summative insights about students' level of skill and fear. This is consistent with how other studies have benefited from controlled evaluations (discussed in Section 2.7.4). However, expressions of support for a system were unreliable as indicators of future use.

It was important that the process be quick, because the Link team placed a high value on their beneficiaries' time. To that end we used multiple facilitators in simultaneous sessions in Cycle Two, and system logging from Cycle Two onwards. The latter gave us an accurate record of use without requiring continuous note-taking from facilitators. We discuss system logging further in Section 9.3.5.

9.3.3 Questionnaires

Questionnaires allowed us to gather data quickly about pre-existing technology use in Cycles One and Two, which was useful for comparison with similar data from other work. However, there was data we did not report, as responses indicated poor understanding of (or no response to) some questions.

We found them even less helpful when we asked students in Mowbray to report weekly use of our systems in Cycle Five (b). Incomplete and inaccurate (as revealed by system logging) answers appeared linked to a lack of understanding of their purpose and a mismatch between the value of accurate answers to students and to ourselves.

9.3.4 Interviews

In Cycle Five (b) interviews helped us to gather detailed insight about the use of our systems outside of observation. The value of this can be seen in comparison with other methods. Direct observation also provided qualitative data, but was always in artificial conditions, with our devices and without other users or activities to distract. System logging could not detect attitudes or context, and did not provide data when no use occurred.

On the other hand, interviews were slow to complete, making them costly for students in terms of the tutoring (the reason they were present – see Section 2.3.2) which they were not receiving while being interviewed. This was partly because of the level of detail required, but also because students' English was not well-suited to reflective questions.

9.3.5 System Logging

System logging provided data over eleven months (eight for the mobile system) about real-world use. The data was recorded when we were not present with users (most of the week), when there was no communication with students during school holidays, and even when we did not realise that students knew they could access our systems (when first unsolicited use took place in Cycle Five (a)). It also provided a complete record of use in controlled evaluations (Cycles Two, Four, and Five (a)). Finally, it helped us to check the accuracy of other feedback, for instance leading us to exclude flawed data from reported use questionnaires (Section 8.4.2).

9.4 Action Research

In our discussion of Action Research (see Section 1.3) we mentioned three important characteristics of AR projects: they triangulate between multiple methods, they are cyclical, and they prioritise participant input. We discuss the impact of each here.

9.4.1 Triangulation of Methods

Triangulation was valuable because as the project progressed, the type of data we needed (qualitative, quantitative, detailed or not) and the constraints in place (especially the amount of direct interaction with students) changed. Each method overcame weaknesses of the others in terms of the type of data it gathered and the appropriateness of the method to the setting. Examples of this are visible in our reflection on methods above, none of which could be described in isolation (apart from personas and scenarios, which were used for design and not to gather evidence).

9.4.2 Benefits of Iteration

Iteration provided several benefits:

- It encouraged trust from the Link team through the early delivery of a tangible artefact (the website), which they were able to show to staff and leadership at The Warehouse (see Section 5.2.2)
- Evaluation in Cycle One informed the Link team's approach to data capture (see Section 4.1)
- User interfaces were improved by addressing difficulties that users had in earlier evaluation (for example, Section 4.3.1)
- We could review and alter our methods to better suit the context, for instance moving from abstract tasks for usability evaluation in Cycle One to non-abstract in Cycle Two (see Section 4.4.3)

9.4.3 Prioritising Participant Input

Our entire research project rested on the efforts of the Link team, who acted as the "human access points" (see Section 1.2) who would ensure that we avoid the pitfalls of design in developing world contexts. They had built relationships with the church groups with which we worked, and established the homework club where we tutored. Without them, we would not have had access to users to test our research questions, nor a clear use case for the technology we wanted to investigate.

Working with Link team contacts had significant consequences for our research. We prioritised the website over the mobile system despite our mobile Internet research theme being meaningless without the latter, and we had to respect their preference for quick meetings with students who were chosen by the Lavender Hill and Manenberg church leaders, rather than being carefully selected by age, gender, or other characteristics. Our methods reflected these constraints: multiple simultaneous usability evaluation sessions (or multiple students in each session) allowed faster data gathering, and an emphasis on system logging avoided the need for co-presence with users.

Gathering data also became easier once the author embedded himself in the Link programme's Mowbray homework club as a tutor. In Cycle Five (b) we were able to choose some interviewees based on previous conversations and awareness of usage from system logging. The deep involvement in the homework club gave us an appreciation of the Link programme goals for those meetings, and so we considered how much time we spent tutoring compared to interviewing.

9.5 Summary of Contributions

To organise the contributions our project makes, we return to the themes with which we began this dissertation, in Sections 1.4 and 1.5.

9.5.1 Internet-Supported Intermediation Theme

We have demonstrated Internet-supported intermediation in answering our first research question. We implemented Internet systems to support an NGO as it intermediates between high school students from low income urban communities of Cape Town and conventional web career guidance content. We have shown reduced effort for beneficiaries compared to direct access to the web by providing content from multiple sources through a single interface, and by delivering content over mobile instant messaging, a technology many already used. The change in technology also allowed new, secondary intermediaries to emerge: students were able to borrow Internet-enabled mobile phones from family and friends who could not provide conventional web access.

We have shown that our systems have reduced the intermediary's effort because they can now provide content without being affected by the number of beneficiaries who need it. Further, beneficiaries are not constrained to accessing the information only when and where NGO staff are present. This has given them flexibility to use our system when higher priority activities do not compete.

9.5.2 Mobile Internet in Urban South Africa Theme

We have made a contribution to knowledge about the mobile Internet in urban developing world contexts by investigating the relative adoption of mobile Internet and conventional web systems. We have shown that our mobile Internet system was preferred by low income youth in Cape Town to an equivalent conventional website for consuming non-entertainment content. This indicates that this group does not hold rigid preference restricting the mobile Internet to entertainment use cases. We have shown that for the majority, use of the mobile Internet – unlike the web – could take place in convenient places and times, because of high rates of mobile Internet adoption in their communities. However, some people could choose not to engage because they perceived that not owning an Internet-enabled mobile phone would open them to ridicule, or that negative perceptions of mobile instant messaging would create controversy for their family.

9.6 Future Work

Future work could expand our work to other intermediary groups, content domains, and using functionality beyond text offered by IM platform-specific infrastructure.

The Link programme demonstrated the capacity to operate our data capture functionality, and their beneficiaries are capable of accessing the mobile Internet. In order to generalise, our systems could be implemented with other intermediary groups. Such an engagement would provide an opportunity to test the potential for intermediary-derived personas and scenarios (see Sections 3.1.4 and 3.3.2) to communicate the purpose of our systems to those groups. Given the value of clarifying Link programme assumptions that the process demonstrated, a new persona creation process might be of value to new partners.

In this study we experimented with disseminating content using technology in the domain of career guidance content. However, the group with whom we worked at the Mowbray homework club has information needs in other domains. The author has identified that fundamental concepts from early mathematics education are forgotten in later years of high school, causing very poor performance. An automated practice system deployed over mobile instant messaging could address this, while allowing investigation of what interaction is suited to the text messaging medium. We have discussed the Dr Maths (see Section 2.6.3) programme, in which live tutors are connected to students over MXit. It would be important to investigate whether their efforts, and those of similar programmes such as MXit's own education initiative, Reach [88] overlapped.

MXit has its own API [77] for developing "MXit Apps", which allow limited graphical and markup support. We avoided this for two reasons. First, at the time of development the supported API required the use of proprietary technologies, but this is no longer the case. Second, it would have prevented our audience from using IM clients other than MXit with our mobile system. In fact all did use MXit, and might benefit from additional MXit functionality. Work which expanded the functionality available could investigate the effects of different interface elements on an audience which is most experienced with text.

Our work is closely tied to that of Sambasivan *et al.* (who focused on intermediation in the developing world, see Section 1.4.2) and Gitau and Donner (who investigated mobile Internet use in urban South Africa, see Section 2.6.1). Both groups point out restrictions to access related to

gender. This has not been a focus of our study due to our inability to control for gender in our subjects. Section 2.3 discusses how our access to participants was restricted to those whom NGO and church groups were willing to introduce us to, and time with them was constrained by those groups' concerns (see "Reported Use Questionnaires" on page 117 for an example and unsuccessful attempt to work around it). Future work could be conducted with audiences such as the Mowbray homework club whom this work has shown to have a high level of access to the mobile Internet, to investigate gender disparities.

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APPENDICES

A Technology Use Questionnaire

LINK QUESTIONNAIRE – ABOUT YOU

Name: _____

Date: _____

Street / Area Name: _____

School Subjects: _____

Interests, Sports: _____

Instructions

Don't worry if some of these don't make sense! Just ask if you have any questions, and try to answer accurately. This is only for my research. You don't have to tell your answers to anyone else, and I will never give out your name to anyone.

Part I: Computers

1) _____ **When last did you use a computer? (circle)**

a. Never
b. Before this year
c. This year
d. This month
e. This week
f. Yesterday or today

2) _____ **Where have you used a computer? (circle)**

a. School
b. Internet café
c. Library
d. Home
e. Other (write) _____

3) _____ **If you circled any options in question 2, where did you use a PC most often? (write)**

_____

4) _____ **Which of these have you ever done on a computer? (circle)**

a. Email
b. Internet
c. Word or Excel
d. Listen to music
e. Watch videos
f. Use Google
g. Facebook
h. Research / Study
i. Other (write) _____

5) _____ **If you circled any options in question 4, which have you used… (write)**

a. Yesterday or today _____
b. This week _____
c. This month _____
d. This year _____

Part II: Cellphones

1) _____ **When last did you use a cellphone?**

a. Never
b. Before this year
c. This year
d. This month
e. This week
f. Yesterday or today

2) _____ **Where have you used a cellphone? (circle)**

a. School
b. Home
c. Shopping mall
c. Other (write) _____

3) _____ **If you circled more than one option, where do you use a cellphone most often? (write)**

_____

4) _____ **Which of these have you used on a cellphone? (circle)**

a. SMS
b. Call
c. MXit
d. Opera
e. Facebook
f. Google
h. Listen to music
i. Bluetooth
j. Internet
k. Other (write) _____

5) _____ **If you circled any options in question 3, which have you used… (write)**

a. Yesterday or today _____
b. This week _____
c. This month _____
d. This year _____

B Personas

Full text of two personas is included here. In Sections 3.1.4 and 3.3.2 we refer to a third persona, Leandre. The Leandre persona is excluded because the Link team's input for it was inspired by particularly sensitive case studies of at-risk youth compiled by other staff members of The Warehouse.

B.1 Sindiswa

OVERVIEW: Sindi is a 19-year old girl from Khayelitsha. She is in grade 12 in 2011 and she hopes to study further next year. She stays with her parents in a small brick (RDP) house. Both her parents work – her mother as a domestic worker and her father as a labourer. They are out of the house for most of the day because public transport requires them to leave early for work and brings them home late. The money that her parents earn is enough for the family to live off, but not enough to build up savings.

Sindi has 3 siblings. She will be the first of the children to finish school. Her parents are happy that she has done well at school, but they are concerned that further study will mean a loss of potential income because she could be working instead. They do not have money to pay for studies, and are not aware of any other ways in which that they could support her dream to study.

A DAY IN THE LIFE: Sindi is awake at 5:30AM on a school day. She is responsible for preparing her siblings for school and ensuring that they are all on the bus on time. They journey far outside of Khayelitsha to go to school. School begins at 8AM and ends at 2PM. When they return from school, Sindi cleans the house and looks after the other children, including cooking supper. During the holidays she may go with her mother to work in order to learn how to clean.

HOUSEHOLD AND LEISURE: Sindi's leisure activities are "off the street". She will see friends either at the mall or in one of their homes. She is involved in her local church youth group. Her priorities are studying for grade 12 and her household chores – she is too busy for a very active social life.

GOALS, FEARS AND ASPIRATIONS: Sindi is afraid of falling pregnant and having to drop out of school. She has seen this happen to many of her peers, and believes that they have lost out on the chance to make something of themselves.

She dreams of having a higher paying (and higher status) job than her mother, and she is aware that she will have to work hard to achieve this, although she is not completely certain of how specifically to get there. Her vision for the future that she wants is pieced together from what she's seen in the movies and on TV – she wants to wear designer clothes, own a nice house and drive a comfortable car. She would like to raise a family, but this is not a high priority in the short term. She is often frustrated that her parents lack a vision for her beyond her current role in the family.

COMPUTER SKILLS: Sindiswa is fairly comfortable with computers. She takes Maths as a subject, and the Maths pupils at her school get more frequent access to the computer labs than the other classes. She has used the computers to complete assignments, learning to browse websites and use a word processor. She is not a very proficient typist.

INFLUENCE: Grade 11s and 12s represent are likely to be the LINK programme's most important participants. Younger teenagers are less likely to be pursuing the opportunities that the programme offers. Assuming that the Grade 11s and 12s who do plan on finishing Grade 12 make up 70% of the user base, the majority of these (say, 50% of the total) will be Xhosa like Sindiswa. The remaining 20% will likely be evenly split between English and Afrikaans coloured students.

DEMOGRAPHICS: Sindi is from a Xhosa family that has been living in Khayelitsha long enough to have received an RDP house. She has two working parents so the family is surviving, but they are not earning enough to invest in anything beyond month-end to month-end living. The fact that she goes to school in Bridgetown instead of to a local school is unusual, particularly given that amongst her parents' generation it is unusual to prioritise the schooling of a girl child.

TECHNOLOGY ATTRIBUTES: Sindi is used to the technology that she has seen in her own and friends' homes: TV, Radio and cell phones are normal. Her house has electricity, however the prepaid metre sometimes runs out towards the end of the month. She does not often use a computer, but she is comfortable with the use cases that she has encountered at schools.

TECHNOLOGY ATTITUDES: Sindi is comfortable with the modes of interaction that a computer requires. Computers do not excite her, but she is aware that many jobs require their use. She is excited about new cell phone models that she has seen; she feels her own is old and would happily trade it in.

COMMUNICATION: Sindi talks face to face with her friends when visiting them or at the mall. She uses MXit to chat with friends, but is very careful about who she adds as a contact. If she is not at home and needs to contact her parents she will send an SMS or a Please Call Me.

QUOTES:

"I don't want to just get pregnant like those other girls, or do drugs... and go to jail"

"I don't want to be a domestic worker"

"I want to buy a house for my parents"

"I wish I knew how to use computers better"

REFERENCES:

Heidi and Bronwyn's exposure to Care for Kids and reports that they have heard from C4K workers. Hoping to have someone from C4K review these personas.

LINK experience – Meeting kids at workshops and individual career guidance, conversations with priests and school teachers

Media – News & documentaries

Robyn – school teacher and trainer of government school English teachers, specialising in 2nd language English teaching

B.2 Themba

OVERVIEW: Themba is a 15-year old boy from Gugulethu. In 2010 he failed his Grade 9 exams, and he doesn't want to repeat the year because his peers will be two years younger than him and he will face ridicule from the students who passed and moved on to grade 10. He has thought about applying to study at a FET college, but he doesn't have the funds to do so. He has also thought about what work he could find, but according to the law he is too young to work.

Themba is an orphan. He and his younger brother live with their uncle and his family. Eight people live together in the shack in total. His uncle and oldest cousin are working; his uncle collects state child support grants for him and the other children in the house.

Most of his friends have continued their schooling. This year they are doing Grade 11.

A DAY IN THE LIFE: Themba wakes up late, at around 10AM. During the day he visits his old school to find out whether his friends are in class. If some are not, he will hang out with them next to the school premises. If he finds no-one, he may try begging at a nearby traffic light. He knows that any money he brings in will encourage his uncle to continue allowing he and his brother to stay with them.

HOUSEHOLD AND LEISURE: After school hours are over Themba comes home to help the other children in the house and do some cleaning. This will include fetching water, clearing out garbage or sweeping. He wants to be seen to be helping where he can so that his uncle does not send him and his brother to an orphanage.

In the late afternoon Themba will play soccer with friends in the street. He used to play for the school team, but this is no longer an option for him since he did not enroll for 2011.

On Friday evenings he attends the local church youth group. On Saturdays he spends more time with friends. Recently they have started experimenting with alcohol during the weekend. On Sunday he and his brother go to church, which lasts from mid-morning until well into the afternoon.

GOALS, FEARS AND ASPIRATIONS: Themba is well aware that he and his brother are not a priority for their uncle. He wants to move out so that he and his brother can get away from the abusive behaviour that their uncle sometimes exhibits. He realises that this will require some sort of income, and next year his uncle will not even be paid a social grant on his behalf, as he will be too old. Because of this, he hopes that he can find a job when he turns 16 – he fears the consequences if he cannot. Dreams of finding work are limited to the subsistence benefits it will offer.

He desperately misses the relatively stable household he remembers having when his parents were alive. They both passed away after contracting AIDS.

He has little interest in having a girlfriend, although he does enjoy the company of girls. He has been sexually active since he completed his initiation.

COMPUTER SKILLS: Themba's computer skills are very limited. He has seen a computer at school, but he has attempted to use one only once or twice. The school computers are mostly kept locked away from the students and are typically only available to staff. His only other option for accessing a computer would be to visit the local library. At the library the queues to use the

computers are long, and each person is allowed a maximum of 30 minutes. They are often out of order due to cable theft, and the Internet access is very slow. Themba does not have a library card.

INFLUENCE: Themba represents a "worst-case scenario" user. Perhaps 10% of users may be in similar positions. The LINK website must be readable, and the content usable by Themba. There is some concern about whether he will be able to understand English content at all; however, the overhead of translating the articles on the site is beyond the current scope of the programme. Performance is a priority for "Themba users" – he must be able to download content in a 30 minute library session should he have the opportunity.

DEMOGRAPHICS: Themba is Xhosa by community and language, although he identifies with the "mixed" culture of the township. He is adept at code-switching between English and Xhosa, but his English is poor. His classes were taught in the same mixture of Xhosa and English that he uses to speak to his friends, despite the formal relationship between pupils and teachers. He has limited opportunities to practice spoken English, but his pronunciation is passable. His spelling and comprehension of written English are very bad.

TECHNOLOGY ATTRIBUTES: Covered in Computer Skills

TECHNOLOGY ATTITUDES: Themba is used to cellphones, TV and radio, even though in his own home there is no electricity. He enjoys the music TV shows that he has seen when visiting friends. Computers intimidate him.

COMMUNICATION: Themba owns a SIM card, although he does not have his own cell phone. To use the SIM he borrows his oldest cousin's phone, or alternatively one that belongs to a friend. He uses SMS and MXit for text messaging. He spends a large portion of his day talking to friends at church, and on street corners.

QUOTES:

"How must I get money?" – about surviving

"No-one cares"

"It's too difficult" – about plans for improving his education

REFERENCES:

Heidi and Bronwyn's exposure to Care for Kids and reports that they have heard from C4K workers. Hoping to have someone from C4K review these personas.

LINK experience – Meeting kids at workshops and individual career guidance, conversations with priests and school teachers

Media – News & documentaries

C Scenarios

In Section 3.3.2 we discuss the creation of scenarios with the Link coordinator. The full text of all seven scenarios is listed here.

C.1 Sindiswa: Look Up Tutoring

During the school term Sindi has grown concerned about her performance for Pure Maths. She is getting a code 3, and although this is comparable to many of her peers, she knows that many more careers will be available if she improves her mark by at least one symbol by next year. One Thursday after school, Sindi visits the Khayelitsha Community Centre which is near to her home. Once she gets to the front of the queue for computer use she begins her 30 minute session. She logs on to the site and searches for maths tutors. She browses for a while, looking for the places which are closest to her home (it is not safe for her to travel after dark), cheapest and which offer Mathematics. She chooses the four best matches for her criteria, and writes down the contact details of each. As she still has 10 minutes left in her session, she opens her Yahoo Mail to write to the advertised email addresses. Each email asks about the tutoring hours and attempts to confirm availability of maths tutors. She also wants to know if it is possible for her to pay for her lessons at the end of the month, so that she only has to ask her parents for money once a month. She does not expect an answer immediately, but will come back the following week to see their responses.

The next evening at her youth group she shows her list of contact details to the youth leader. She believes that his advice may help her save time searching on the website. He informs her another girl at the church is already going to one of the places on her list. When she hears the price and the travel distance involved she crosses that option off her list of four.

On the following Monday after school Sindi goes back to the community centre to check her email for responses from the tutoring companies. She is pleased to see that the response from the closest option to her home is willing to let her pay at the end of the month and has sent a list of possible lesson times. She replies to the email to indicate that she will come to her first lesson the following Monday after school.

C.2 Sindiswa: Search Careers

Sindi has heard from the LINK workshop leaders that she must investigate several different career options. She understands that because many things can go wrong in the years before she enters the professional world, she should cultivate ‘Plan B’. She wants to know what she needs to do now in order to keep her options open later. With this in mind, she visits the community centre in order to use the LINK web site.

She searches the list of careers on the site using her most important subjects – pure mathematics, life sciences and physics. The site returns an extensive list of careers, and she follows links to a couple of different articles. She looks through the descriptions of careers in the sciences, but she doesn't have a strong desire to pursue academic knowledge, which is listed as one of the major reasons to enter the field. Her interest is piqued when she looks at the information about careers in the finances. The work is generally during normal office hours and the article mentions that on average the pay is expected to be better than in many other fields. The article advises her to make a note of the specific careers in the field, and identify people she knows who have those

jobs so that she can ask them questions. The advice includes a list of helpful things to find out about: do they enjoy the work, what a typical day looks like, how long and where they studied etc. She writes down the questions and a few others that she thinks of as she writes.

C.3 Sindiswa: Look Up Internships

Sindi is looking for information about becoming a Medical Technologist on the LINK web site. She finds an article about the career and notices that it lists several related careers, amongst them Medical Technician. When she views the Medical Technician article, she sees that there is a paid internship for Medical Technicians at Groote Schuur Hospital. She has not encountered the idea of internships before, and she is excited by the possibility that she could earn money while studying, because this would take financial pressure off of her parents. She knows that this is something that she would apply for if she were finishing Grade 12 this year, but she feels that she can't do anything about it now.

The next time she sees her Youth leader at church, she mentions the internship, and he suggests that she ask if she can go visit the hospital during the school holidays to find out what the job is like. She agrees and calls the hospital to ask about the possibility of doing a work shadow day. The hospital agrees to have her visit during her April school holidays .

In April when Sindi visits the hospital she is excited to meet the staff, but quickly realises that the environment is not one in which she wishes to work – it's quite sterile and not very sociable work. She decides to scratch the medical technologies options off of her list, but she will be on the look out for other internship opportunities.

C.4 Sindiswa: Look Up Courses

Sindi has decided to investigate Occupational Therapy as a possible career. The facilitators at the Link workshop informed her that she should plan ahead for her studies, as decisions she makes this year will affect her later.

Sindi visits the community centre and logs on to the LINK website. She searches for information about occupational therapy and finds courses related to the degree. She finds B.Sc. Occupational Therapy offered by UCT and despite some hesitance at the required mark for maths – a code 5 – she writes down entrance requirements and cost of the course. She then views information about the same course at UWC. To her relief she notes that UWC has a lower requirement for mathematics, only a code 3, and that the course is cheaper than at UCT.

At the bottom of the information about the UWC course are two links to information about funding. The first takes her to the "UWC Undergraduate Funding Opportunities" web site, which contains a lot of information and is very intimidating. After struggling with the site for a few minutes, she decides to visit the other link. This time, she is directed to a list of funding options on the LINK site. She notes two options, one of which covers tuition and textbooks and subsistence, but which requires higher marks than she currently has. The other just covers tuition, but Sindi is pleased to see that her marks are good enough to apply. She may have found a way in which the financial burden on her parents can be reduced.

Her next step is to talk to the youth worker at church. He suggests that Sindi look at some factors other than entrance requirements and cost before deciding on one institution or the other. Since

her ultimate goal is to find a job, he suggests that she look at job adverts and try calling employers to find out if they make a distinction between UCT and UWC graduates.

A few days later she again visits the community centre and logs on to the LINK web site to look up jobs involving OT. She finds three job adverts and writes down the contact details to make her enquiries. Over the next week she calls the numbers after school. The people who answer the phone are impressed that she is calling them before she has even begun studying. They inform her that they are more interested in how a graduate performs during the year of community service than they are in where she studies. Heartened, Sindi makes a mental note to start filling out application forms.

C.5 Leandra: Search Jobs

As her trial exams finish in October, Leandre is aware that grade 12 will soon be over. She knows that at the start of December she will have more time to work. She casts the net wide by searching over the next several days.

At her neighbour's flat, she logs on to the site and searches for jobs that require a matric and English. The site presents her with a list of five jobs, all of which are current. She eliminates two because they require shift work and she cannot leave her child alone during the evenings. A third offers a lower hourly rate than her current job and she will just stay on at PicknPay if there is nothing with a higher wage.

Two job adverts remain: one for a shoe store sales person at Nyanga Junction and another for a sales position at a call centre in Woodstock. She writes down their contact details to find out more about each.

C.6 Leandre: Consult Link Advice

Leandre has found two job adverts for positions that suit her. She called the phone numbers on the adverts and was asked to send in a CV. She has previously compiled a CV as part of a Life Orientation assignment, but she remembers seeing an article on the LINK web site that looked like it could be helpful with updating the document.

She visits the site from her neighbour's computer in order to read the article. It includes a list of sections that should be in her CV, and describes what sort of content to include in each. She copies the section headings down using pen and paper so that she can work on updating her CV from home, without needing her neighbour's help.

The next evening she returns to her neighbour's flat to type up her CV in MS Word. Once she has completed this she emails the document to the call centre in Woodstock. She CCs her neighbour's work email address so that her neighbour can help with printing the document. She plans to drop hard copy of the CV off at Nyanga Junction for the other job in person.

C.7 Leandre: Read About Skills Development

While using the job search functionality on the LINK web site, Leandre has always searched for jobs that do not require a driver's license. Each time she does this she notices that the site informs her that although it currently returns only a handful of job adverts, around twenty more are available for jobs that do require a driver's license.

Out of curiosity, Leandre searches for jobs that require a driver's license and sees that there are many delivery truck driver positions available with higher pay than her current hourly rate. The website also offers her the chance to search for places to learn how to drive. She had never previously considered the job as a possibility, but she knows the drivers at PicknPay, and thinks that she would be more hard working and dedicated than they were she in their position.

She follows the link and is presented with some information about the benefits of learning to drive. She also sees a list of places that teach one how to drive. She takes down the contact details of an NGO which has a driving course that costs less than the other options. She will follow up once exam time is over.

D Customising the ExpressionEngine Content Management System

ExpressionEngine (EE) is a PHP CMS that allows administrators to store data in a MySQL database. It underpinned the Link website, first introduced in Section 3.2.1.

Each item of data is called an "entry". Each entry belongs to a "channel", which is a collection of meta-data that define the rules for data capture and storage that will apply to every entry in the channel. An entry is "published" by capturing data using forms in the CMS control panel.

In the following figures we show screenshots of the standard EE control panel:

- In Figure D-1 the control panel home page shows the range of functionality available to administrators
- Figure D-2 shows an example of the field definitions that dictate how an entry will be captured
- Figure D-3 shows the data capture page that administrators use to publish data

Once content has been captured from the EE control panel, it can be viewed by users through web pages that the CMS produces dynamically. These pages are based on EE templates (shown in Figure D-4). These consist of HTML with embedded script-like instructions that the CMS parses before displaying content to the user. A template may for instance instruct the CMS to retrieve an entry based on the URL for which an HTTP request has been received, and display certain fields of that entry inside the specified HTML elements.

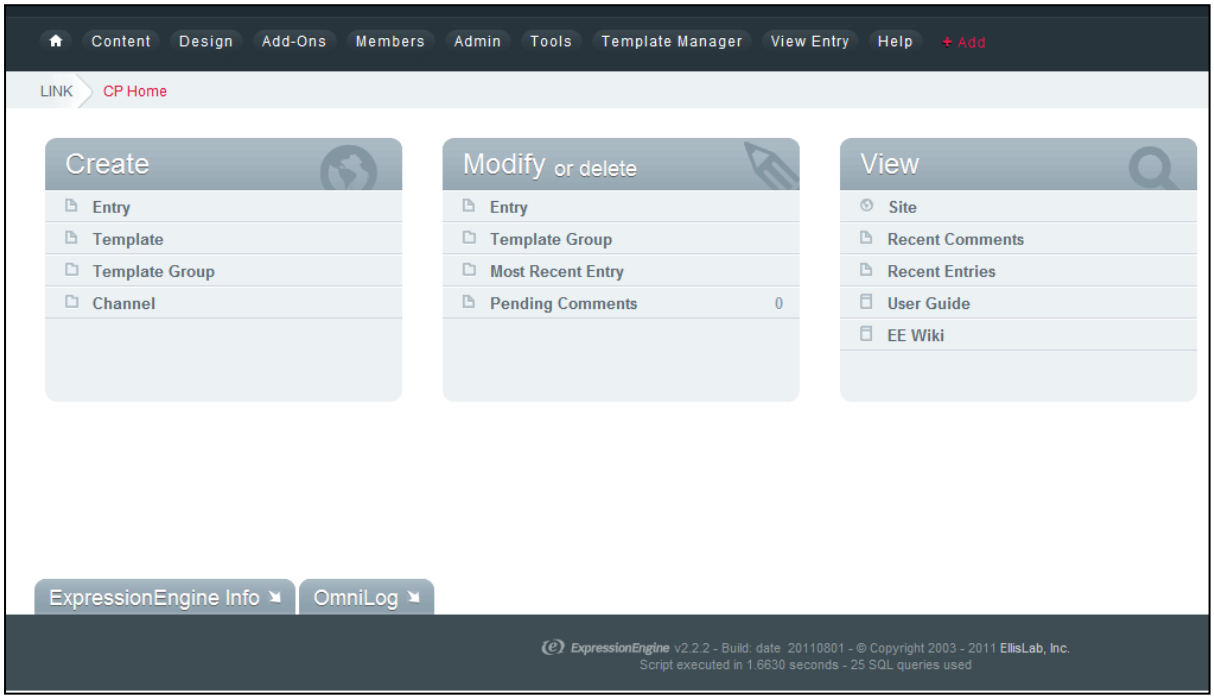

Figure D-1 ExpressionEngine control panel home page which allows administrators to publish or modify entries

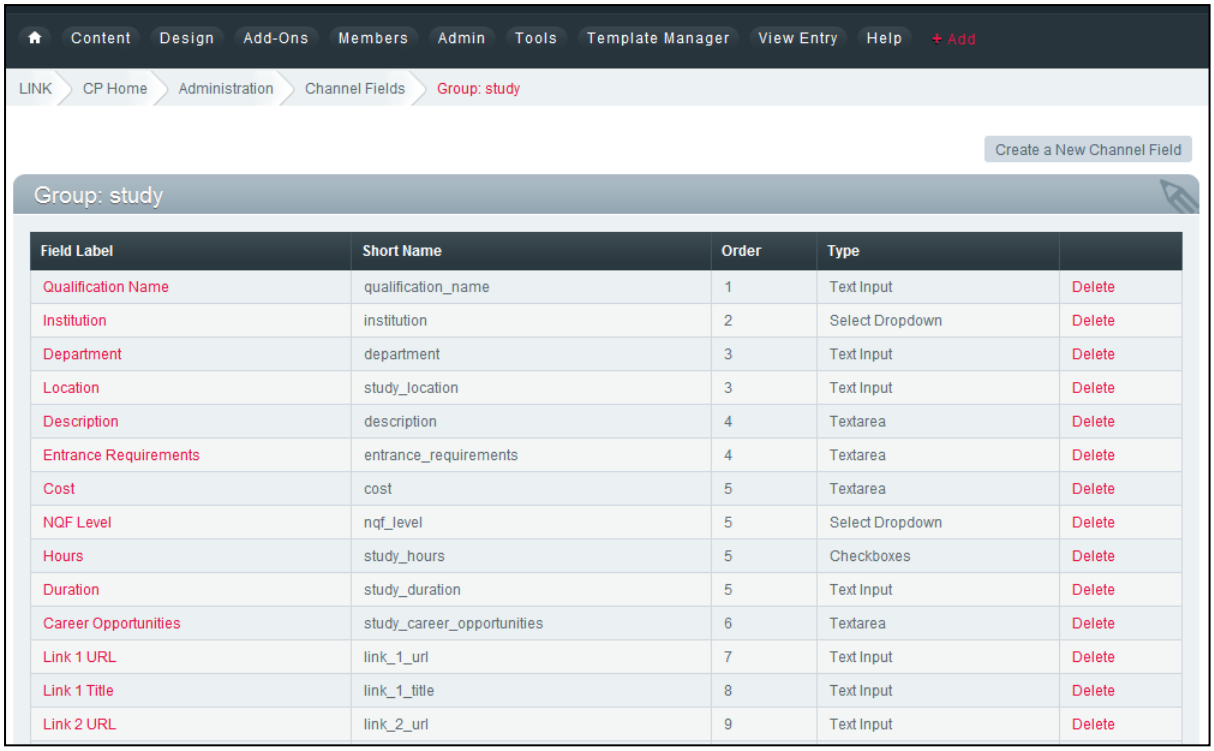

Figure D-2 An example of a list of fields that determine what information is captured from the EE control panel for an entry

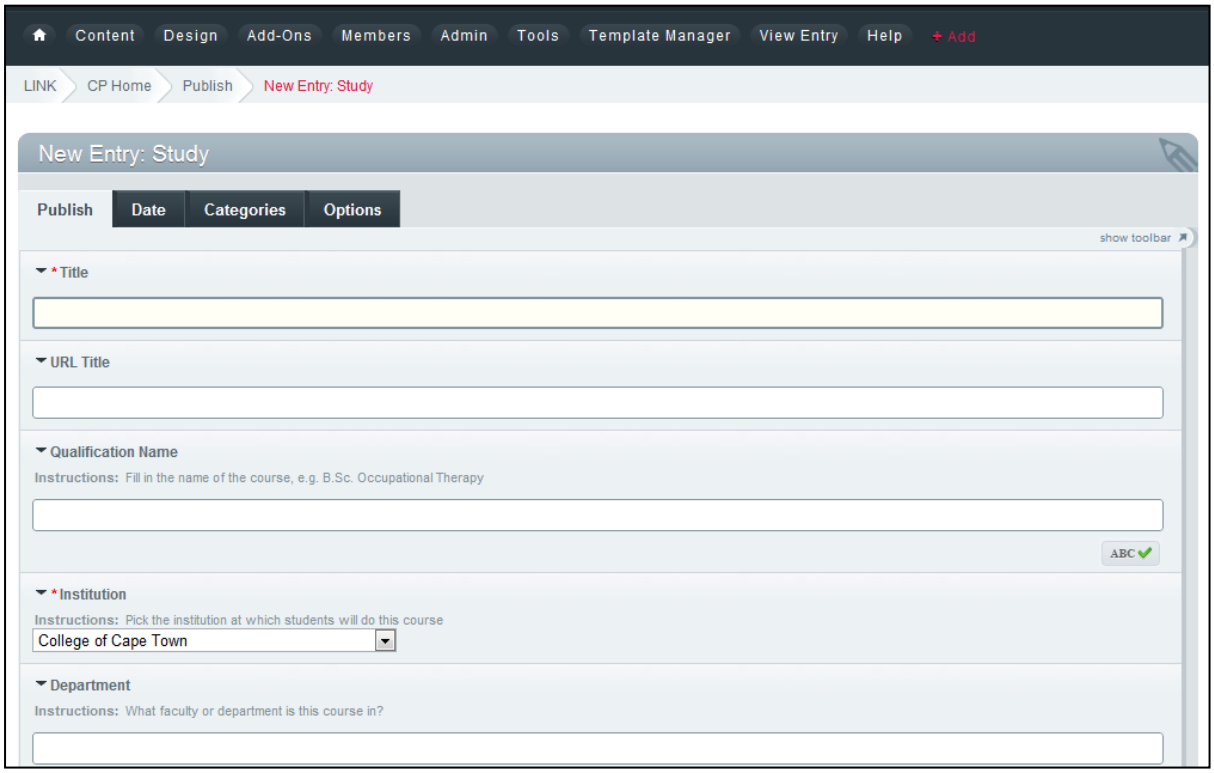

Figure D-3 An example EE control panel publish page from which an entry is captured

```
{head}
{embed="pages/login_side"}
{embed="pages/menu" loc="qualify"}
{contentwrapper_top}
{exp:channel:entries channel="study" entry_id="{segment_3}"}
    <div class="post">
        <h3 class="title_study"><a href="#">{channel}: {title}</a></h3>
        <div class="entry">
        {if qualification_name}
        <p><h4>Qualification Name:</h4> {qualification_name}</p>
        {/if}
        <p><h4>Institution:</h4> {institution}</p>
        {if department}
        <p><h4>Department:</h4> {department}</p>
        {/if}
        <h4 class="newline">Description:</h4>
        {description}
        {if entrance_requirements}
        <h4 class="newline">Entrance Requirements: </h4>
        {entrance_requirements}
        {/if}
        {if cost}
        <h4 class="newline">Cost:</h4>
        {cost}
        {/if}
        <!--<h4 class="newline">Funding:</h4>
        <p>If you need help funding your studies, click on the options below:</p>
        {exp:tagger:related entry_id="{segment_3}" channel="funding" limit="3"}
            {if tagger:no_entries}{/if}
            <a href="/index.php/pages/funding_detail/{tagger:entry_id}">{tagger:entry_title}</a><br/>
        {/exp:tagger:related}-->
```

Figure D-4 An screenshot of ExpressionEngine template code in an editor. Templates are a mixture of HTML and EE script tags

The data processing capabilities of EE templates are determined by 'modules' installable by administrators. These are made up of one or more PHP classes. Some are installed by default, while others are available from EllisLabs [67], the creators of the CMS, or from third party developers. The author wrote some modules himself, most notably a full text search module with the ability to rank results by relevance, for which there was no equivalent from the EE community that met all requirements.

E Website Requirements

	Requirement	Scenario
1	Search for tutors based on school subject	Sindi tutoring
2	Tutoring offers can include location, price, contact details, potentially subjects offered	Sindi tutoring
3	Search career articles by required school subject	Sindi careers
4	Career articles can include: benefits of jobs in the field, typical working hours, salary range, good questions to ask people in the field, list of specific jobs	Sindi careers
5	Search for career information by job title	Sindi internships
6	Search for internships by job title	Sindi internships
7	Internships information includes: where, who can apply, pay, description	Sindi internships
8	Search for courses by career	Sindi courses
9	Course information includes: entrance requirements by subjects, institution, price, duration	Sindi courses
10	Course information can include links to external sites	Sindi courses
11	Funding options on LINK site can be reached from course information	Sindi courses
12	Funding information includes: institution, extent of funding, requirements	Sindi courses
13	Job adverts searchable by career	Sindi courses
14	Job adverts include contact details	Sindi courses
15	Jobs can be searched by: matric yes/no, drivers license yes/no, language	Leandre jobs
16	Job advert information can include: salary / wage, working hours, contact details	Leandre jobs
17	Web site includes advice articles	Leandre advice
18	Site makes visitors aware of CV advice article even when not actually viewing it	Leandre advice
19	Advice article about CV creation	Leandre advice
20	Job adverts include email addresses	Leandre advice
21	Job search reports number of jobs for criteria similar to those currently in use	Leandre skills
22	Skill information includes description of benefits	Leandre skills
23	Short courses are searchable by skill	Leandre skills
24	Short courses information includes: contact details, venue, costs	Leandre skills

F Cycle One Website Usability Evaluation Script

This script was used in the usability evaluation described in Section 3.4.

FACILITATOR GUIDE – LINK WEBSITE EVALUATION AUGUST 2011

STUDY AND FUNDING

Notes:

- You don't have to use my wording for the questions, try keep the tone natural to the conversation
- Try notice what they argued over, what they agreed on immediately etc
- Don't worry if they don't get what you're asking or leap to some completely different conclusion, just write down what they do do. Only step in when you get to the next question if there is some info they missed that they will need.
- Note what takes them longest, what takes quickest
- Time is not super important, just note approx by the computer clock how many mins they take.
- Ask why they followed actions, note what they say

TASK 1

I have a friend who is in grade 11. Her favourite subject at school is accounting. She doesn't know what she wants to do as a job, but she thinks she should go to college or university. Can you use the website to help her find some courses that she might want to take?

If they ask specifically about what marks for subjects give them the information from the information sheet at the back)

Things to watch out for: *What draws their eye? Did they click on any of the items to see if they could spot any differences?*

Notes:

TASK 2

My friend has to choose from all of the different options, which one would you suggest? Is there anything notable in the list, anything that stands out?

Things to watch out for: *Do they latch on to the subjects idea and enter those into the search bar? Do they search in the study section or the global search?*

Time taken:

Notes:

TASK 3

(Click on "Accounting at UWC") If she wanted to know what marks she needed, where would you suggest she look? (Give them some time, then follow the admission requirements link if they haven't) From this page can you work out if she makes it? (Give them her marks if they ask)

Things to watch out for: *Do they spot the admission requirements link and click it? Is the UWC site understandable?*

Time taken:

Notes:

TASK 4

(Go back to the Accounting at UWC course) She likes the look of this course and she thinks she has the marks. Can you help her work out the cost of the course?

Things to watch out for: *Do they find and follow the link to the fees section of the UWC site? Can they process the UWC site to find the correct info (R17300)?*

Time taken:

Notes:

TASK 5

She might need help paying for that, what options do you think she has?

Things to watch out for: *Do they notice the "related funding" info at the bottom of the course page? Do they click on EduLoan*

Do they click back to the site, or do they fumble around on the external page? (don't let them waste a lot of time on this... if they don't go back to the site, prompt them to do so)

Time taken:

Notes:

TASK 6

(Click on Eduloan) Can you find some other course that you think this money could pay for?

Things to watch out for: *Do they go back to search results or do they notice and use the related bar?*

Time taken:

Notes:

JOBS

TASK 7

I have another friend who is just finishing grade 12. His family needs money, so he needs to start working straight away. I'm going to show you four jobs, which ones do you think he could do and should apply for?

(Jobs: Field Worker, Typist / Data Capture – Technical, Pharmacy Store Coordinator, Help Desk Clerk Wynberg)

Things to watch out for: *Users are able to read through the requirements to see "grade 12" in the list? Do they rule out jobs with requirements like experience, extra diplomas, driver's license. Are they actually reading the text? At the end, ask them why they eliminated / chose their winning option.*

Time taken:

Notes:

TASK 8

My friend's mother is sick. He has a baby sister who needs to be looked after in the evenings, and he is the only one who can do it. How would that affect your choice?

Things to watch out for: *do they comprehend the connection between having to stay home in the evening and excluding certain jobs based on the hours required? Users patient enough to click one at a time through jobs for information? Will users try short-circuit the process by searching 'part-time' or something similar?*

Time taken:

Notes:

WORKSHADOW / INTERNSHIP

TASK 9

(Show jobs list) Some of those search results come up with "internship". What would you expect those ones to be about? (let them click on one if they want to and see if that info helps them)

Things to watch out for:

Time taken:

Notes:

TASK 10

(Repeat for skills development list) – Some of those search results come up with "workshadow"

Things to watch out for: *do they comprehend the connection between having to stay home in the evening and excluding certain jobs based on the hours required? Users patient enough to click one at a time through jobs for information? Will users try short-circuit the process by searching 'part-time' or something similar?*

Time taken:

Notes:

POST-TASK QUESTIONS

1. (Show the home page) Is there anything you see that you have no idea what it would do? (Ask about "skills development" etc. Any words that didn't make sense to you or you don't understand?

2. What was the hardest question to answer?

3. Ask about disagreements (if any

4. Do you think it would be helpful to see a list of topics on the site? Like say you see "Healthcare" or "Administration" and if you click on it you see all the courses or jobs that are about that topic?

5. Is there anything you would want to change about the site?

G Cycle Two Website Usability Evaluation Script

This script was used in the usability evaluation described in Section 4.4.

FACILITATOR GUIDE – LINK WEBSITE EVALUATION II - 13 OCTOBER 2011

AIMS

After the previous evaluation we found that users didn't see a lot of the data on the site – they often wouldn't look past the page they were on, so they missed important pieces of info. This seemed to be because they didn't spot important links and navigation features.

With this evaluation session we aim to:

- See if our fixes have worked
- Identify any factors that will affect whether they use the site or not when we are not around

When the students are using the web site, try keep an eye out for the following:

- Do they use menu or home page blocks?
- Do they use front page search or scoped search?
- Do they try searching without being told to?
- If they do search, do they notice that there is more than one page of data? Do they click on the page number links to see the next page?
- Do they ever notice or click on the box with the "See more like this in..." info?
- From jobs, do they use the advanced search features?
- Does it seem like having a list of "all" Study or "all" Jobs etc would help?
- Anything where the site doesn't do what they seem to think it should, or where they get stuck.

PART I – CAREER GUIDANCE GROUP SESSION

Everyone will write down their skills, and their top 3 careers.

PART II – STUDENTS EXPERIMENT WITHOUT INTERVENTION

In pairs the students will use the website. Ask them to spend some time looking at the site. Prompt them to click around if they just stare at the screen, then let them do their own thing. If they start doing stuff that looks like it's from part IV try move naturally into those tasks.

PART III – GOALS

Ask students: **"Would you use a site like this? What would you want to use it for?"**

The reason we ask is that we are trying to be sure of what this person thinks is important to them. We may find out that there is something new that they want to do that we haven't covered.

Note what they say regardless of how relevant it feels to this evaluation or the capabilities of the site. They could say, "I think it will help me to eat ice-cream" - just be polite and write it down. Be sure to give both people time to answer, prompt the person who is less vocal if necessary: "Is there anything else you want to do on this site?"

PART IV – SPECIFIC TASKS

You may have observed the students doing some of this already. In the interests of time try not to make them repeat things they have already done. Start with the section of the site that seems closest to the answer they gave when you asked them about their goals for using the site, this will ensure that we cover the things that are important to them. If you don't start with jobs, make them do jobs second.

We will lay out tasks for each section of the site, and give them hints if they struggle. Start with the least specific hint and move to the most specific. If they complete a task using a less specific hint, move on to the next task.

Taking **NOTES:**

- You don't have to use my wording for the questions, try keep the tone natural to the conversation
- Try notice what they argued over, what they agreed on immediately etc
- Don't worry if they don't get what you're asking or leap to some completely different conclusion, just write down what they do do. Only step in when you get to the next question if there is some info they missed that they will need.
- Note what takes them longest, what takes quickest
- When something in one task is very similar to a previous task, try notice whether they learned from the previous task and don't have to be prompted on how to do it again.

JOBS

1. **"Can you find a job that suits one of you using the site?"**
    a. HINT: **"Maybe there is something in the skills that you wrote down earlier that will help you?"**
    b. HINT: **"Maybe one of your top 3 jobs will be like something in the site"**
    c. HINT: **"Try typing one of your skills or jobs into the search box on the screen"**
    d. HINT: **"I've got a list of jobs in the site here. Maybe pick one that would be interesting. Can you find it in the site?"**
2. If the job has something in the related section, ask, **"Do you think there might be other similar information in the site?"**.. see if they head to related. DON'T USE THE WORDS "See more like this"... the aim is to see what they spot on their own without leading them to the answer.

NOTES:

STUDY

1. "Can you find a course to study that suits one of you using the site?"
    a. HINT: **"Maybe there is something in the skills that you wrote down earlier that will help you?"**
    b. HINT: **"Try typing one of your skills or top jobs into the search box on the screen"**
    c. HINT: **"I've got a list of all the courses in the site here. Maybe pick one that would be interesting. Can you find it in the site?"**
2. Once they come to a course that has something in the related section: **"Do you think there might be other similar information on the site?"** see if they head to related. DON'T USE THE WORDS "See more like this"... the aim is to see what they spot on their own without leading them to the answer. *If they already did this for the jobs thing then don't ask again.*
3. **"If you can't afford the course, where would you look for a way to pay for your studies?"** *(Do they look at the funding section on the page or do they go back and search, "funding"?)*

NOTES:

SKILLS

1. **"Do you feel like there are any skills you would like to improve on that might help you get a job? Try finding some information on that now"**
    a. HINT: **"Is there a skill that you would like to add to the list that you wrote down earlier?"**
    b. HINT: **"Try typing in that skill into the search box on the screen."**
    c. HINT: **"I've got a list of short courses and job shadows in the site here. Let's pick one that would be interesting. Can you find it in the site?"**
2. Once they have an entry in front of them: **"What do you think you would learn from this course or job shadow?"**

NOTES:

H Entry Detail Viewing Improvements between Cycles One and Two

This data was obtained from system logging for usability evaluation in Cycle Two (see Section 4.4.4). The content provided here is summarised under "Entry Detail Viewing Behaviour" on page 87.

We contrast the time spent viewing entry detail with time spent viewing search results (which also involved a large amount of text) in Table 18. The total and mean time spent by participants on each activity is shown.

Table 18 Time in seconds spent by each group on viewing search results and entry data. Engagement as measured by viewing time was greater for entry detail than for search results: an improvement over Cycle One when participants viewed lists of entries without selecting entries.

	Search Viewing Time (S)	Mean Search Time	Entry Viewing Time (S)	Mean Entry Time
AS&MG	704	23	1225	77
CT	1093	48	1501	107
JT	1288	25	804	40
JL&CA	727	40	490	163
KA	430	20	2250	87
MP&CE	338	24	1526	102
MS&TV	856	54	684	114
NM	341	28	766	255
NK&SN	404	27	1106	184
OM&ZM	618	21	1124	37
SM&NK	209	19	1066	152
TM&YM	697	58	1258	210
All	7705	30	13800	90

All except three groups spent more time viewing entry data than search results. The exceptions were for users who were focused on content which did not exist, or was not in the section they wanted (*e.g.* JT was excited by the possibility of a short skills courses which would be compatible with full time work, but searched for architecture which requires full degree programmes). Even amongst the exceptions the mean entry time is higher than the mean search time.

In evaluation one, by not moving beyond the first page of a list of entries ordered by date of capture, participants limited themselves to viewing only the ten most recent entries captured. In

Table 19, we present the dates of publication of the most and least recent entries viewed by each group, and the number of times that each group viewed an entry that was older than the tenth most recent in its section. The results show that participants in evaluation two were not restricted by the age of entries.

Table 19 Content creation date of entries viewed in evaluation two:every group viewed entries older than the most recent, an improvement over evaluation one.

Group	Entries Viewed	Date Most Recent	Date Least Recent	Older than 10th
AS&MG	16	2011/10/06	2011/07/12	7
CT	14	2011/10/06	2011/07/05	3
JL&CA	3	2011/09/16	2011/07/01	3
JT	20	2011/10/06	2011/07/01	17
KA	27	2011/10/06	2011/06/30	17
MP&CE	15	2011/10/06	2011/07/06	4
MS&TV	6	2011/10/03	2011/07/20	4
NM	4	2011/10/06	2011/07/19	2
NK&SN	6	2011/10/03	2011/07/06	2
OM&ZM	30	2011/09/22	2011/07/05	30
SM&NK	7	2011/10/06	2011/07/20	6
TM&YM	6	2011/09/20	2011/07/05	6

I Cycle Five (a) Comparative Usability Evaluation Script

This script was used in the attempted comparative usability evaluation described in Section 7.4.

FACILITATOR GUIDE – COMPARATIVE CONTROLLED EVALUATION – MARCH 2012

INTRODUCTION

PARTICIPANT NAME:

I've built a website for you to use. This is my project for the university. I also built a bot for MXit. I'll show that to you just now. I want to understand how to make it better so I need your help. Is that ok?

I need to understand how easy it is for you to write text using a computer or a cell phone. In a moment I'll show you a phrase, you can look at it, and then let me know when you want to start typing. I'm keeping time, but don't worry I'm not testing you! And I will never tell anyone else how long it took.

1. Phrase: Platform: Time:
2. Phrase: Platform: Time:
3. Phrase: Platform: Time:
4. Phrase: Platform: Time:

INTRODUCE WEBSITE

Here's the website. You can use it to search for long courses, like degrees or diplomas at college or university. You can also use it to search for short courses, or jobs. When you want to search jobs, click here (indicate). When you want to search for short courses, click here. When you want to search for courses to study, click here. When you want to search for everything, click here.

Today we're only going to look at study courses. I'll show you. Imagine you wanted to search for computer science. You could do that by typing "computer science" here. Then you click "search" and the website will show you a list. You can choose one of those that looks interesting to you, like this one (electrical computer systems at UNISA). You'll see there's different sections, with different information about the course.

I'd like you to try now. Try searching

Intended Entry & info:

Prompts required:

Errors (spelling):

Errors (understanding of material):

Errors (software):

INTRODUCE MXIT

I'd like you to try now. Try searching

Intended Entry & info:

Prompts required:

Errors (spelling):

Errors (understanding of material):

Errors (platform / hardware):

Errors (software):

J Website and Mobile System Content Views per Original Source

Source	Organisation Type	Entries Available (* = not available through LinkChat)	LinkChat Views (Unique Users)	Link Website Views (Unique Users)
ABSA Bank	Corporate	2	1 (1)	0
Accenture	Corporate	1	1 (1)	0
Afrisam	Corporate	1	3 (1)	0
Afrox	Corporate	2	4 (1)	0
Air Traffic and Navigation Services	Government	1	1 (1)	0
Ambutek	Corporate	1	0	1 (1)
Cape College	Academic	1	2 (2)	0
College of Cape Town	Academic	9	27 (12)	1 (1)
Continuing Education for Africa	Academic	24 *	0	1 (1)
Cape Peninsula University of Technology	Academic	70	336 (35)	14 (8)
Department of Education	Government	1	1 (1)	1 (1)
Eduloan	Corporate	1	1 (1)	0
Link	Link Team	19	79 (25)	1 (1)
Northlink College	Academic	2	2 (2)	0
National Student Financial Aid Scheme	Government	1	1 (1)	0
Old Mutual	Corporate	1	0	1 (1)
Shoprite	Corporate	1	5 (2)	0
Standard Bank	Corporate	1 *	0	1 (1)
University of Cape Town	Academic	11	30 (14)	2 (2)
University of South Africa	Academic	72	67 (21)	17 (6)
University of the Western Cape	Academic	29	223 (33)	9 (6)
Vodacom	Corporate	1	3 (2)	0
Wellington Hugenote College	Academic	1	3 (2)	0

PLAGIARISM DECLARATION

1. I know that plagiarism is wrong. Plagiarism is using another's work and pretending that it is one's own.
2. I have used the IEEE style for referencing and citations. Each significant contribution to, and quotation in, this thesis from the work, or works of other people has been attributed and has been cited and referenced.
3. This thesis is my own work.