DIGITAL DOORWAYS AND THE ANALYSIS OF SOFTWARE APPLICATION USAGE IN 'UNASSISTED LEARNING' ENVIRONMENTS IN IMPOVERISHED SOUTH AFRICAN COMMUNITIES

by

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I declare that DIGITAL DOORWAYS AND THE ANALYSIS OF SOFTWARE APPLICATION USAGE IN 'UNASSISTED LEARNING' ENVIRONMENTS IN IMPOVERISHED SOUTH AFRICAN COMMUNITIES is my own work, and that all sources used or quoted in the study have been indicated and acknowledged by means of complete references.

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Kim Lawrence Gush Date

Abstract

The Digital Doorway (DD) project provides computing infrastructure in impoverished communities in South Africa. DD terminals offer opportunities for unassisted- and peer-assisted learning of basic computer skills, and varying computing activities ranging from entertainment, to independent research.

This study addresses software application usage, and how it relates to user demographics (age and gender) and location, in order to better understand both the user base, and the nature and extent of DD interactions.

A mixed-methods approach is employed, involving log-files, interviews, questionnaires, and naturalistic observation; to build up a holistic picture of application usage and user behaviour at selected sites.

Important issues with respect to ICT for Education and Development in the DD context, are addressed. Analysis of the data indicates notable trends, and relationships between age, gender, location, and application usage. User behaviour and environmental effects on usage are discussed, and recommendations provided for future DDs and similar initiatives.

Keywords: Computer literacy; Community informatics; Design-based research; Digital divide; Digital Doorway; ICT in education; ICT for development; Mixed-methods research; Technologically disadvantaged; Unassisted learning

Afrikaanse opsomming

Die Digitale Deur (“Digital Doorway”) (DD) projek verskaf rekenaar-infrastruktuur aan arm gemeenskappe in Suid-Afrika. DD terminale bied geleenthede vir selfstandig-en portuurgroep-ondersteunde leer van basiese rekenaarvaardighede, asook 'n verskeidenheid van rekenaar-aktiwiteite wat wissel van vermaak tot onafhanklike navorsing.

Hierdie studie spreek die gebruik van sagteware toepassings aan en spesifiek met betrekking tot die demografie van gebruikers (ouderdom en geslag) en ligging van terminale, om sodoende die verbruikersbasis, asook die aard en omvang van DD interaksies beter te verstaan.

'n Benadering wat ‘n kombinasie van metodes, insluitende log-leêrs (“log files”), onderhoude, vraelyste, asook natuurlike waarnemings gebruik, is toegepas om sodoende 'n holistiese profiel van die gebruik van toepassings, asook verbruikersgedrag op geselekteerde terreine te bepaal.

Belangrike aspekte van IKT (Inligting en Kommunikasie-Tegnologie) vir Onderrig en Ontwikkeling in die DD konteks word aangespreek. Resultate van data analises dui op beduidende tendense en verwantskappe tussen ouderdom, geslag, ligging en gebruikstoepassing. Verbruikersgedrag, asook die effek van die omgewing op sagteware-gebruik, word bespreek en aanbevelings vir toekomstige DDs en soortgelyke inisiatiewe gemaak.

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&

Our Heavenly Father, the author of life and source of true wisdom.

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Introduction

1.1 Introduction

Computers are increasingly more pervasive in current society. Whether for work- or leisure related activities, there is an ever increasing demand for computer- and information literacy skills amongst users of all age groups and origins. Rural and impoverished communities in South Africa and Africa are no exception. Eisenberg, Lowe and Spitzer (2008:39) describe information and technology (IT) literacy as the 'basic skills set of the 21st century', however, access to physical infrastructure and appropriate software to enable the acquisition of these skills, is limited. In 2009, a mere 23% of schools in South Africa were equipped with computer centres (Department of Education, 2009). There is also a dearth of computer teachers in rural South African schools. There is a need for computer infrastructure, computer literacy training and relevant content in impoverished areas with technologically-disadvantaged populations. Further, given the short supply of computer infrastructure, the existing capacity should be used in the most effective ways possible.

Increased access to computer technology and the development of computer skills may be accomplished in various ways, including the accelerated roll out of computer laboratories and information kiosks. However, a previously little-explored alternative, which may co-exist with other support facilities, is the provision of resources for independent *unassisted learning*, *peer-assisted learning* or *minimally invasive education* (MIE) (Gush & de Villiers, 2010; Mitra, 2000). According to Dangwal, Jha and Kapur (2006:295): 'MIE demonstrates a special case of the interplay of information technology (computers) and learning processes and emphasises the role of self-directed and participatory learning'.

In 2002, the Meraka Institute (Information and Communications Technology Unit) of the Council for Scientific and Industrial Research (CSIR) in Pretoria, initiated a cross-disciplinary project known as the 'Digital Doorway' (Smith, Cambridge & Gush, 2005). The Digital Doorway (DD) is a standalone rugged multi-terminal computer system that is placed at various strategic sites in impoverished areas of South Africa. Multiple DD sites – over 200 – are currently in operation as of 2011. The DD is designed for independent, open-ended use, where learning takes place without formal training. The target group comprises users of all ages, but primarily youth between the ages of 10 and 25.

The research study described in this dissertation is concerned with the usage of software applications on the DDs. The study is situated within a variety of disciplines including education and e-learning, community informatics, software design and social aspects. The problem statements to follow serve as a foundation and motivation for the research.

1.2 Problem statements

1.2.1 General problem statement, and the Digital Doorway

In many marginalised and impoverished South African communities, computer infrastructure, computer centres, computer teachers and basic computer literacy skills are limited or non-existent. How can this situation be addressed?

Various attempts are being made to engage with this problem. The DD project is one such initiative – deploying freely accessible, rugged computer kiosks, for informal unsupervised learning in the basic use of computers; the development of information literacy skills; and the provision of a variety of educational, recreational and informational content.

1.2.2 Specific problem statement

Where socio-technical solutions such as the DD have been implemented, resources are often extremely limited and need to be shared between many individuals in the community. The software resources should thus be used in the most efficient way possible, in order to achieve maximum effect. Inherent to making these resources more efficient, is a clear understanding of how they are being used, both from a social and physical perspective, as well as from a software usage perspective. The latter requires research into usage of the applications, in order to better understand the extent of their use; and the usage patterns of various types of users. This leads us to the main objectives of this study, which is to accurately determine the type and frequency of software applications accessed at DD kiosks, and to determine the relationships between specific application usage and user demographics (age and gender), as well as between application usage and site location.

The complexity of the problem, due to the many different software applications available to users, may be simplified – for the purposes of this research – in two ways: i) grouping applications with shared characteristics into broad categories, and ii) limiting the study to a subset of the total possible sites.

1.2.3 Motivation for the study

This study is motivated by a need to better understand the usage of information and communication technologies (ICTs) in rural and impoverished areas, particularly in cases where previous exposure to technology has been non-existent.

The following quotes highlight the potential for ICTs to bring about social change, and the importance of appropriate content:

> *'If wisely used, investments in information, knowledge, and ICTs can help generate wealth and jobs, build bridges between governments and citizens, forge relations among organisations and communities, and improve the delivery of essential services to poor people. While some people are sceptical about their direct contribution to poverty alleviation, there are signs that ICTs can contribute to development goals - if they are used properly. Proper use is crucial and is based on local needs and circumstances. [Proper use] requires actions to enhance the connectivity of countries and people, to ensure that the new tools are accessible, and to foster and develop suitable content.' (Ballantyne, Labelle & Rudgard, 2000:1-2).*

> *'Use of ICTs is limited by lack of awareness and skills, and by insufficient access to trained personnel, know how, equipment, services and infrastructure. The initial and recurring costs of acquiring a computer and an Internet connection are often prohibitive. A lack of appropriate content can also limit use.' (Ballantyne, Labelle & Rudgard, 2000:2).*

In a study on the feasibility of ICT diffusion and use amongst rural women in South Africa (Kwake, Ocholla & Adigun, 2006), the researchers mention the importance of appropriate content, both in terms of language and subject matter, as well as the need to significantly reduce the hindrances to accessibility, either before or during the provision of the technology.

The DD kiosks, which form part of a countrywide learning and information access platform, were installed in order to help meet identified needs, through unassisted learning, or 'unsupervised computer use' (van Cappelle, Evers & Mitra, 2004:1). The understanding gained from this research will assist in the customisation of future DD content, and inform the researcher as to the effectiveness of the unassisted- and peer-assisted learning paradigms.

1.3 Objectives of the research

This research therefore aims to analyse application usage and user activity at a representative selection of DD computer terminals in rural and impoverished communities in South Africa, in order to better understand the activities of the users.

This research sets out to answer the following questions:

Research Question 1: Given free access to computer infrastructure containing a variety of software applications and content, what categories of applications are used by various age groups on Digital Doorways?

- What are the general trends amongst all users regarding application usage?
- Are there notable relationships between the age of users and the categories of applications accessed?

Research Question 2: Does gender have an impact on extent of use and on application usage?

- What are the general trends amongst males and females regarding application usage?
- Is there a relationship between the gender of users and the categories of applications accessed?

Research Question 3: How does the physical situation of the Digital Doorway installation affect the types of applications accessed?

- Does the physical situation of the device (e.g., in a library, a school, a community centre, etc.) affect the types of application that are accessed?
- Which applications are underutilised by the intended target groups?
- Are there noticeable differences in behaviour around, and usage of, DDs at varying localities?
- What is the impact of the site environment on the physical usage?

Research Question 4: What is the relevance and applicability of these results to future unassisted learning terminals?

- Do the results of RQ1, RQ2 and RQ3 help in better understanding the desires and needs of target users?
- What lessons are learned for future development, selection and presentation of applications?

Research Questions 1, 2 and 3 may be represented by the two diagrams below (Figures 1.1 and 1.2). Within an impoverished community, people of varying ages and genders are exposed to technology – in this case the DD – within a particular context (e.g., a library or school). Users access content such as information or entertainment software delivered by means of the technology.

The green and red lines highlight the research questions of interest, namely i) the relationships between *users* and *content* (applications accessed by users), and ii) the relationships between *context* (or location) and *content* accessed.

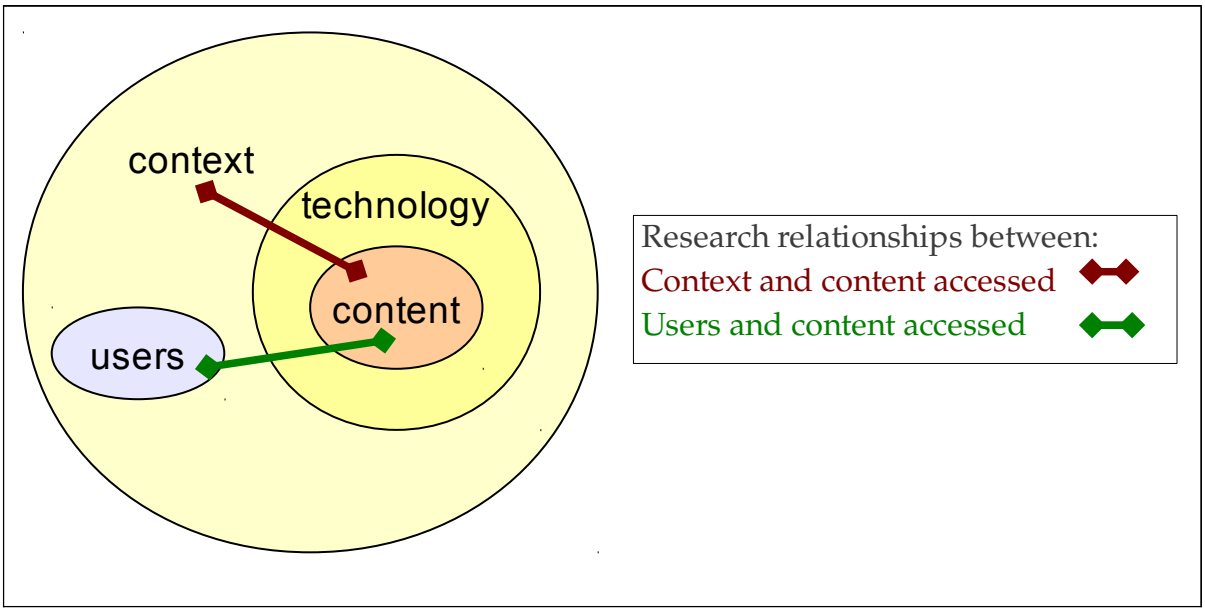


Figure 1.1: Research Question 1 & 2: Illustration A

The above diagram may be expanded to include specifics as they relate to this study, pictured in Figure 1.2.

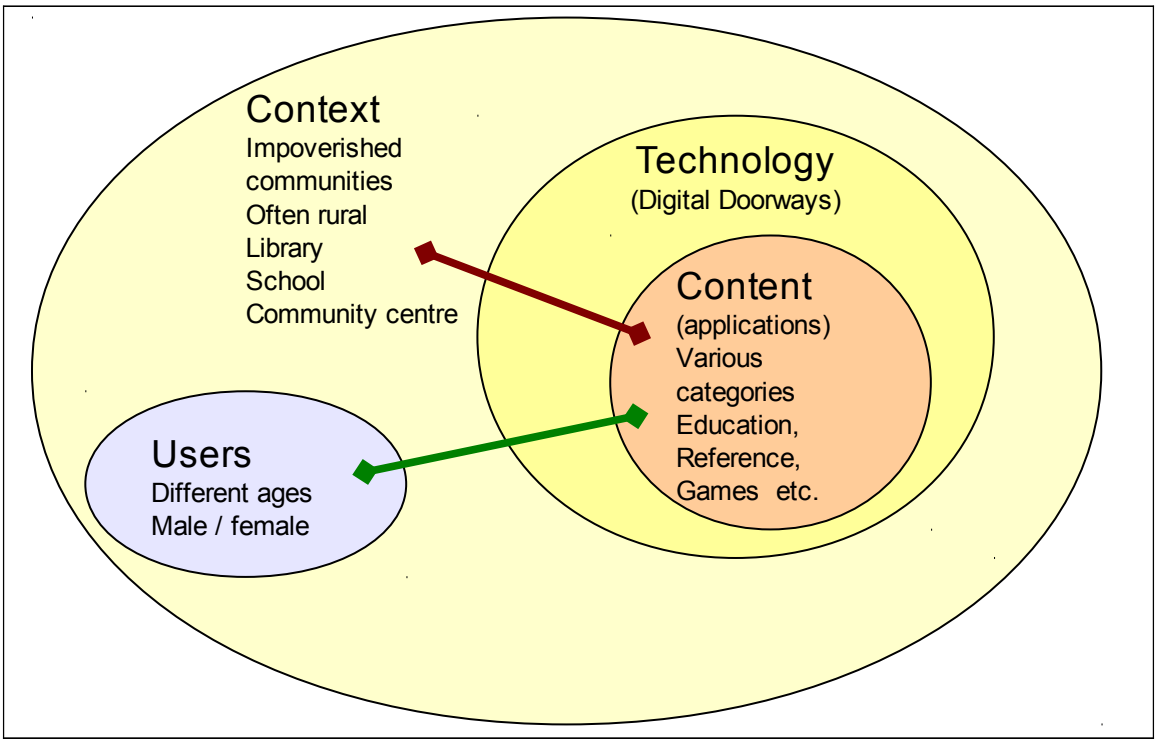


Figure 1.2: Research Question 1 & 2: Illustration B

1.4 Research design and methodology

1.4.1 Structure of the study: the 'building'

This research project is a subset of the greater Digital Doorway project in which the researcher has been involved since its inception in 2002. The Digital Doorway is a cross-disciplinary research and implementation project that spans a wide range of disciplines, the most important ones being systems engineering (hardware design and software implementation), informal learning (unassisted or peer-assisted learning) and community informatics – a blend of technological and social factors (Stillman & Linger, 2009).

'Completing a research project is like completing a building. Your ultimate goal when constructing the building may be to have a roof over your head. Before you can put the roof up, however, you have to erect the walls; and before you can erect the walls, you have to lay the foundations.' (Olivier, 2004:11). Using the analogy of a physical structure, this research project is represented in terms of the following 'building' (Figure 1.3). This theme structure is reproduced with highlights and annotation at the beginning of each chapter to represent the subject matter of that chapter.

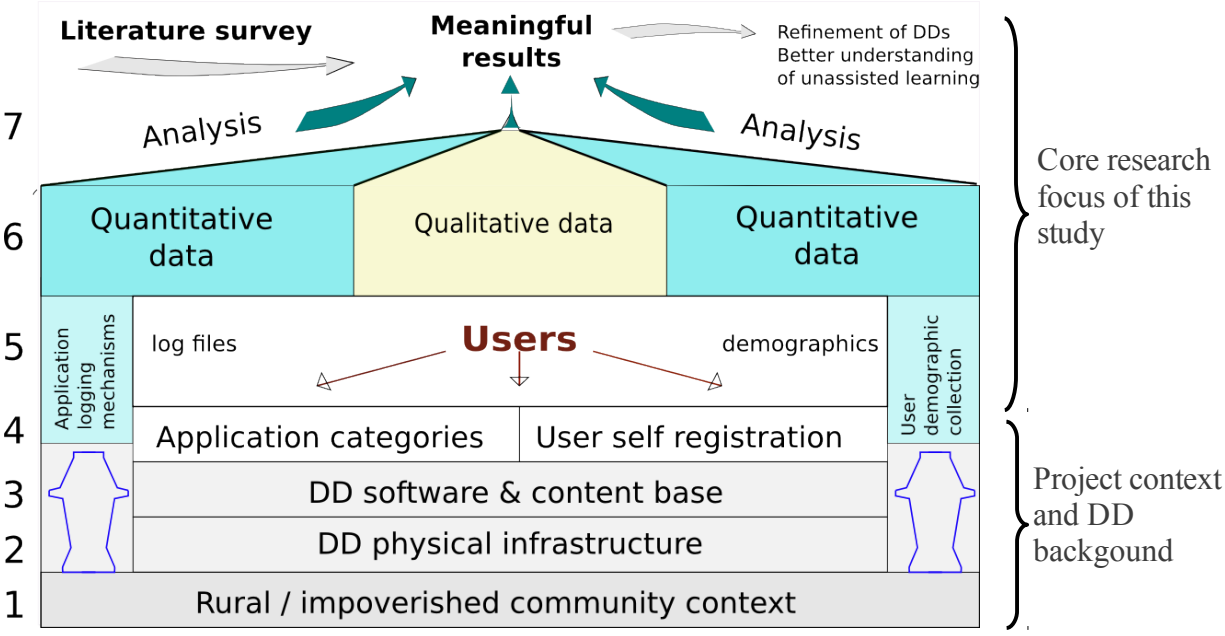


Figure 1.3: Research project structure and layering

The lower three layers, namely 1, 2 and 3, and the lower side wall represent the DD project in general. The main aspects of these layers are: software accessible through physical infrastructure within a rural or impoverished community; with technical infrastructure in place to transmit data from the site to a central location. More details about the DD are provided in Chapter 4.

Layer 1: The environment into which the DD computers are placed – always impoverished, often rural and remote.

Layer 2: The physical DD hardware.

Layer 3: The operating system and software applications accessible on the computers.

Layers 4 to 6 represent the core focus of this research study. Data is collected on user demographics (through a user self-registration process) and usage of the built-in software applications. Applications are categorised into major groups of education, games, reference, office, system, video/audio and edutainment. The analysis of application usage, as well as relationships between demographics and application usage are combined with the findings of qualitative studies and literature survey support. This will provide results relevant to both the academic community and practitioners involved in the deployment of similar systems in the future.

Layer 4: Each of the applications is assigned a unique category. Data collection occurs by means of wrapper scripts and registration forms embedded in the software. Each new user to register a user name at a DD, inputs age, gender and various demographic details. Each menu item in the applications and resources menus is wrapped in a script that records date, time and user name of each application hit.

Layer 5: Users represent a diverse collection of people of both genders from a variety of backgrounds and age groups. They access the content on the DD and in so doing, populate log files of data; a core element in this study.

Layer 6: Quantitative data is collected from the log files and categorised, in order to facilitate analysis. Qualitative data collection is done by means of interviews, questionnaires, and observation.

Layer 7: Quantitative data is analysed in order to shed light on how applications are being used and how application usage relates to demographics of users. Qualitative data is analysed to provide further illumination on specific cases.

Results from the layer 7 analysis provides primary data. This data, together with a survey of related literature, which forms secondary data, is used to inform future refinements on community informatics projects in general and the DDs in particular. The data also provides generalised results on trends in application usage amongst impoverished users of different ages, genders, and backgrounds.

1.4.2 Research model. 'Framework for design'

Figure 1.4, based on Creswell (2009:5), illustrates the overall research design of this study, the details of which are covered in Chapter 5. Under each of Creswell's three components of design, namely philosophical worldviews, selected strategies of inquiry, and research methods, respectively, those applied in the present study are highlighted in red blocks.

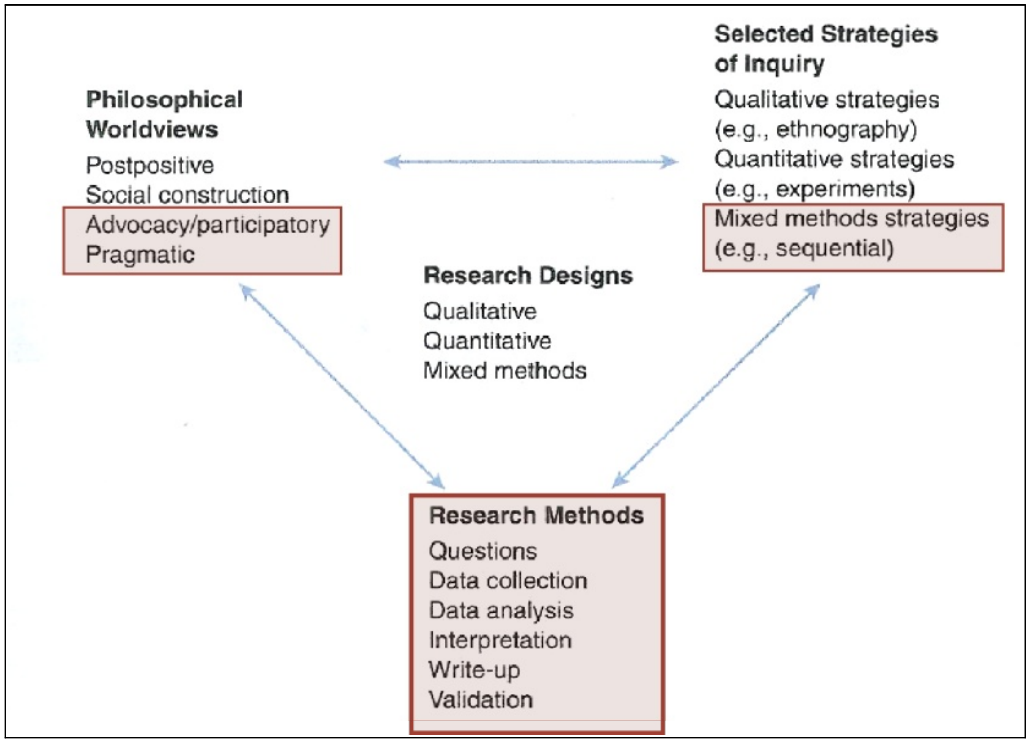


Figure 1.4: Research design, adapted from Creswell (2009:5)

This study uses a mixed-methods strategy of inquiry; an advocacy/ participatory as well as pragmatic philosophical worldview; and research methods that involve progressing from the initial research questions, through data collection and analysis, interpretation, write-up and validation.

1.4.3 Simplified representation of the research process

The research process, based on the model proposed by Oates (2006:33), is illustrated in Figure 1.5. The motivation for the study and related work and literature help define the research questions. In order to answer the research questions, survey and case study strategies are employed. Multiple data generation methods are used, including log files, interviews and questionnaires. Both quantitative and qualitative data analysis is done.

Chapter 5 discusses the research methodology and process in detail.

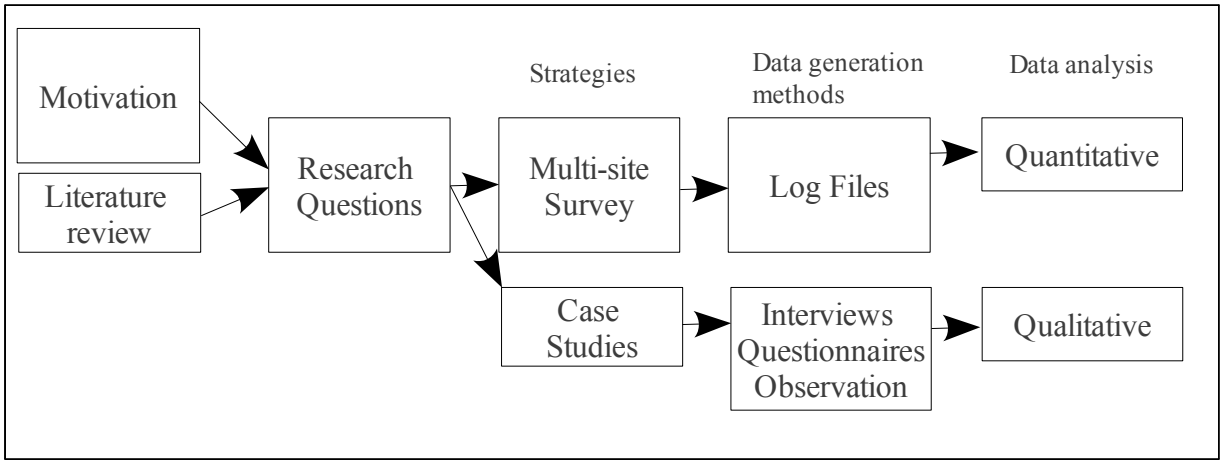


Figure 1.5: Research process (Oates, 2006:33)

1.5 Assumptions, limitations and delineations

This study aims to extract the most accurate and meaningful information possible from the data obtained, however, certain assumptions, limitations and delineations need to be mentioned. While specifics will emerge in subsequent chapters, the most important ones are listed below:

Assumptions:

The following assumptions have been made:

- That data input by users (age, gender etc.) is correct. Attempts have been made to identify incorrect data and eliminate it from the study datasets.
- Where analysis of the data results leads to recommendations and general comments, it is assumed that the data under study is a good representation of the complete data of the population under consideration.
- It is assumed that users have an adequate understanding of the English language and that the answers provided via the user self-registration form and in the interviews/questionnaires are accurate representations of what the user wished to communicate.

Limitations:

The main limitations and constraints of this study are:

- The study is limited by the amount and accuracy of the data, which was obtained as per the next bullet.
- The study is restricted to a specific set of sites, selected by well-defined criteria to establish (in the case of the quantitative study) a representative sample.

- Most analysis of the quantitative data is limited to registered users only.
- The quantitative study is based on ten selected sites, and the qualitative study is limited to four selected sites.
- Due to various software instantiations in the field, a small percentage of the applications were not present on all DDs. These applications will be under-represented when compared with applications that are present on every machine. The categorisation of applications in this study however, reduces the impact of these discrepancies, though the reality of this situation needs to be mentioned.
- The intention is that no limitations should be imposed on use of DDs at the various sites. For example, children should be able to use DD terminals at libraries and community centres, and in schools, adult users from the community should be allowed to use DDs after school hours. Nevertheless, due to the vagaries of human behaviour and policies of administrators, it cannot be guaranteed that this open-door policy is implemented across the board.

More details regarding the limitations of the log file analysis, are:

- The quantitative log files do not record applications launched from the command line. It is possible that certain technologically advanced users may, on occasions, use this method to launch applications, which would then not be logged. This would be of greater concern if this study was a comparison between novice users and expert users, however, the very small percentage of applications possibly launched in this manner is unlikely to significantly affect the results.
- As it is only possible to compare age and gender differences of application usage for registered users, much of the analysis excludes data obtained for guest users. The latter may, however, be used to look at general trends in site-for-site comparisons. Approximately ten percent of total usage was by registered users.

Delineations:

The following delineations are applicable:

- It is not the purpose of this study to investigate learning *per se*. The study does not investigate long-term educational effects of unassisted learning.
- The research focuses on the nature and extent of usage of the various software packages installed on DDs. The term ‘unassisted learning’ in the title serves as an adjective, not as the subject or object of the study. The term is used in the title to set the context for the usage analysis.
- The study does not include detailed analysis of sociological aspects of users' circumstances outside the DD context.

- The study excludes the possible implications of language differences on application usage.
- The set of over 200 DD sites distributed around South Africa was reduced to 156 candidate sites for investigation. From the 156 sites, criteria were used to filter out a sample of 10 representative sites for quantitative analysis.
- DD sites outside South Africa were not included in this study.
- Interview/questionnaire data was limited to 60 users, from four sites.

1.6 Ethical aspects

From the initial phase of the DD project, great care has been taken to ensure that relevant community leaders at each of the proposed installation sites were consulted and included in the research process. They were informed of the project objectives and consulted on possible locations for the DD terminals. Moreover, they assisted in the appointment of site custodians to clean and restart the machine when necessary, as well as to report any hardware or software failures. This consultation with the community members obtains buy-in to the DD concept and remains a key component of each installation.

Users at the original sites (where permanent security cameras were installed) were informed via a note on the user desktop background that all activity was being monitored. Observations of user behaviour at such sites were kept anonymous. Individual names of users were also not associated with the behaviour observed by researchers. In the present study, visual data is limited to anonymous snap shots of activity for illustration purposes.

All research in this study involving user registration data and user log files upholds the rights of a user to privacy through the use of pseudonyms rather than real names. Case study analysis did not link personal user information (e.g., name, phone number or address) to data from that user.

In the case of interviews, the user, custodian, or facilitator signed a consent form, agreeing to participation in the research study. Participants were informed of the purposes of the study, before being interviewed, or completing the question template.

While it is impossible to foresee every consequence of a research and implementation project such as the DD, the primary goal was, and still is, to improve the lives of the users. Ultimately, the community is the primary reason for the research, rather than mere involuntary participants in the research process. In the words of Olivier (2004:24), ‘the participants are treated as ends themselves, rather than merely as means to an end’.

For these reasons the researcher is confident that the DD project, and this associated study, both maintain acceptable, uncompromising ethical principles.

An application for ethical clearance, along with consent forms and an outline of the topics and questions addressed in the interviews/questionnaires was submitted for approval to the Ethical Clearance Committee of the College of Science Engineering and Technology at UNISA.

The UNISA Ethical Clearance Agreement and the consent forms are included in Appendix F.

1.7 Dissertation chapter layout

The study is composed of the following parts:

Chapter 1: Introduction

Chapters 2 to 4: Theory and background information

Chapters 2 and 3 present the findings from a literature review focused on work related to the DD project; ICT in rural South Africa; unassisted learning and e-learning initiatives; and software usage in various contexts. Chapter 4 describes the DD intervention in general, helping to place this study in context.

Chapter 2: Literature study of related work in South Africa and India;

Chapter 3: Literature study of users and software application usage;

Chapter 4: The Digital Doorway intervention – background information;

Chapters 5 to 7: Practical component

Chapter 5 describes the details of the research design and methodology while Chapter 6 goes on to describe the quantitative analysis of log files obtained from a selection of DD sites with particular reference to the research questions highlighted earlier. Chapter 7 describes the qualitative findings obtained from site visits, during which observation, interviews, and questionnaires were used at certain designated sites, to build up a richer sense of activities and software usage at these sites.

Chapter 5: Research design and methodology;

Chapter 6: Quantitative data collection and analysis;

Chapter 7: Qualitative study – on-site interactions and analyses;

Chapter 8: Discussion and conclusions

This section sums up the study with closing discussions and conclusions.

Appendices

Additional code listings, tables, figures, and information related to, but not included in, Chapters 1 to 8.

Figure 1.6 depicts the different chapters and their interrelationships.

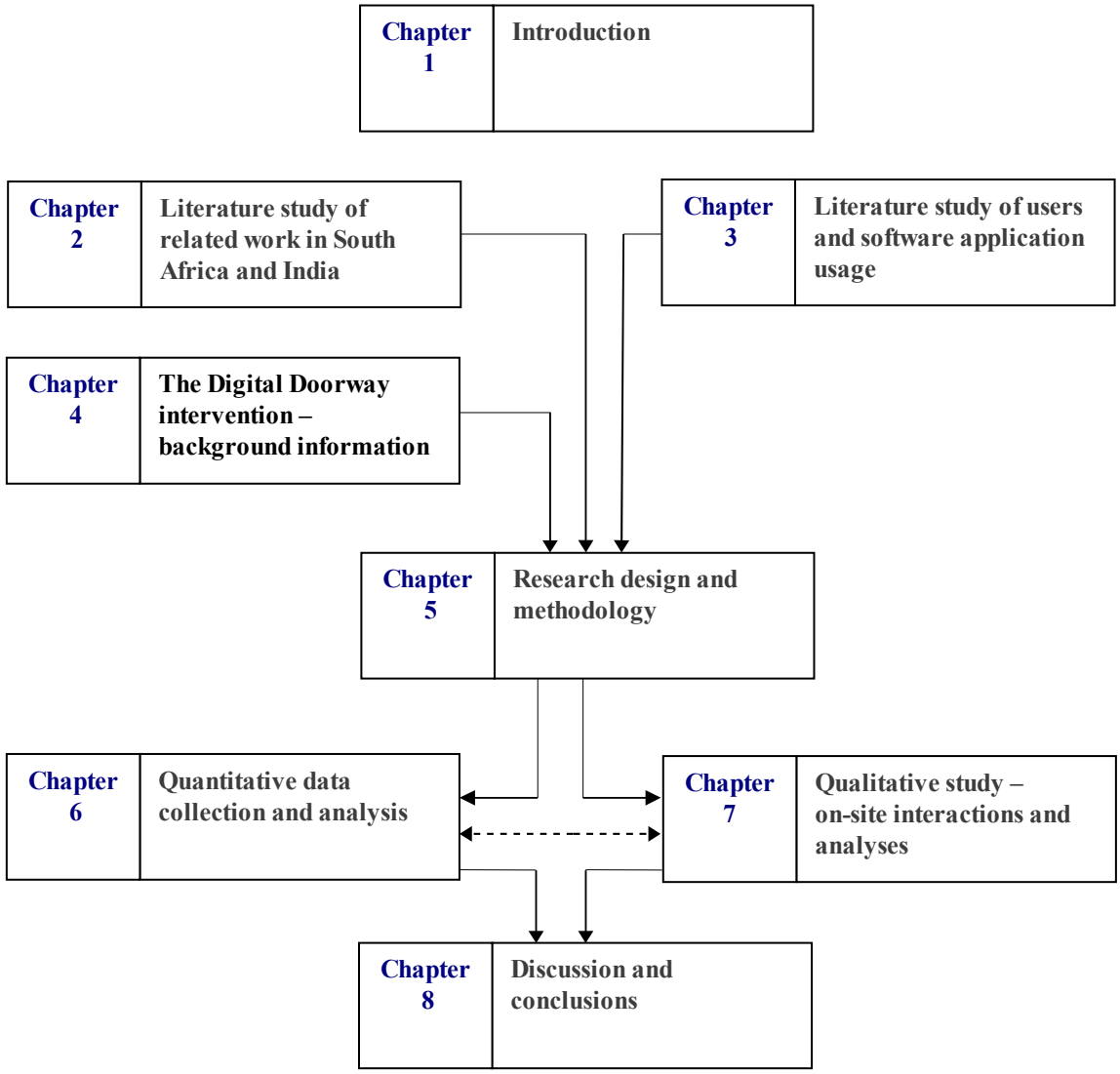


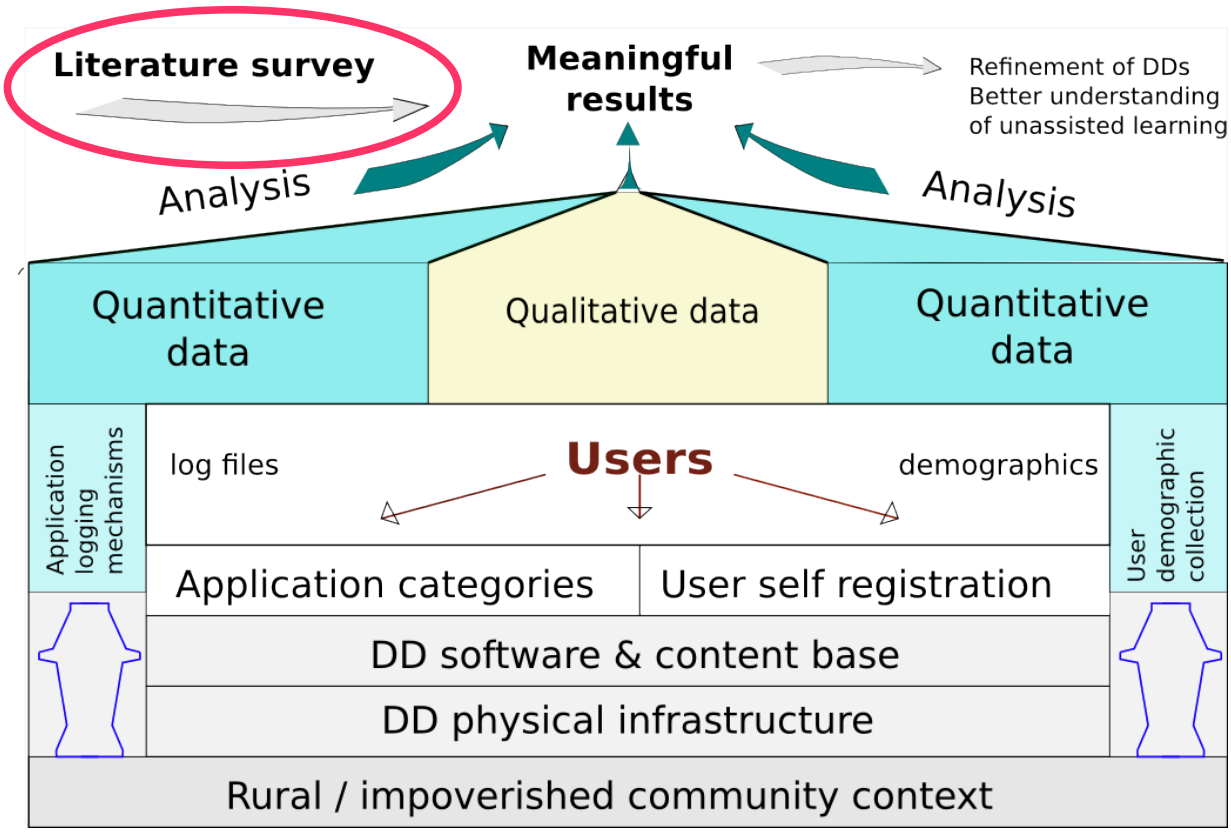
Figure 1.6: Chapter layout and interrelationships

– 2 –

Literature study of related work in South Africa and India

There is creative reading as well as creative writing.

– Ralph Waldo Emerson



2.1 Introduction

Primarily, this chapter overviews relevant aspects of the *information and communication technologies for development* (ICT4D) domain, and looks at previous studies in the area of unassisted learning in impoverished and technologically barren societies. Due to the novelty of this type of system, there are few precedents discussed in the literature, apart from the pioneering work in India, of Dr. Mitra, which is discussed in some detail in Section 2.5. The chapter also covers aspects of ICT in rural South Africa and some e-learning concepts related to the DD project. Some notable observations regarding application usage, age, gender and location emerge while studying these other projects. Certain concepts encountered in the literature are applied to features and characteristics of the DD.

2.2 Information and communication technologies for development (ICT4D)

Various existing social and societal problems create barriers to people owning and using information and communication technologies (ICTs). These problems include illiteracy; cultural barriers; lack of computer skills; insufficient technological knowledge; restricted access to computers; lack of Internet access; and inadequate usage opportunities (Ngcobo & Herselman, 2007). Local economic development in rural South Africa is severely compromised by a lack of infrastructure, services and know-how, especially in the ICT arena (Jacobs & Herselman, 2005).

ICT4D relates to application of ICTs within a community in order to improve the social or economic lives of the members of that community. The term *community informatics* (CI) is used to describe the convergence of communities and informatics. With informatics implying more than computer science alone, but rather 'the capacity to act on and through the technology with which one is working... the applications of its technology, ...its use in and on the world in which we are living' (Gurstein, 2000:i). Furthermore,

> *'Community informatics pays attention to physical communities and the design and implementation of technologies and applications, which enhance and promote their objectives. CI begins with ICT, as providing resources and tools that communities and their members can use for local economic, cultural, and civic development, and community health and environmental initiatives among others. CI includes the technology/ICT and the 'user' (and the 'uses'), and is as concerned with community processes, user access, and technology usability as it is with systems analysis and hardware or software design' (Gurstein, 2000:i).*

Gurstein (2010) also uses the term *digital transition*, referring to when a country (or community) moves from a pre-digital, largely manual framework of communications and transaction management, to one that is digitally based.

Raju (2004), in his paper entitled 'A case for harnessing information technology for rural development', refers to the digital divide and its various dimensions, as understood by Norris:

> *'The concept of the digital divide is understood as a multidimensional phenomenon encompassing three distinct aspects. The "global divide" refers to the divergence of Internet access between industrialized and developing societies. The "social divide" concerns the gap between the information rich and poor in each nation. Finally, within the online community, the "democratic divide" signifies the difference between those who do and do not use the panoply of digital resources to engage, mobilize and participate in public life' (Norris, P, cited by Raju (2004:234)).*

Whether we talk about bridging a digital divide, or promoting a digital transition, the process of achieving successful ICT4D interventions requires certain steps: understanding the problem, access to technology, sustainability of the technology, and social/resource factors (Herselman and Britton, 2002). With an intervention such as the DD, it is not sufficient to provide the technology, and even make it sustainable, without understanding the community and its problems, and involving the social aspects surrounding the technology. Thus the socio-technical nature of this study.

Fernandes, Jagdale and Fernandes (2007) mention that the digital divide goes beyond the concepts of infrastructure and connectivity, relating also to learning and training so that 'individuals can use, leverage, and benefit from the infrastructure' (Fernandes, Jagdale & Fernandes, 2007:74).

Following a study on three rural communities in KwaZulu-Natal involving semi-structured interviews and questionnaires regarding the use and benefits of ICTs to those communities, Ngcobo and Herselman (2007) identify the following factors of greatest importance:

- Stimulating a positive attitude towards change in the context of introduction of ICTs;
- Ensuring that the technologies are appropriate;
- Combining traditional and modern technologies;
- Empowering communities to lead their own development; and
- Recognising the importance of technology, as well as the necessity for it to be appropriate and sustainable.

2.3 Digital Exclusion

According to Herselman and Britton (2002), resource-deprived learners have less opportunity to take part in the information-based economy, which is increasingly reliant on computers. They have little involvement in the education, training, entertainment and commercial activities afforded to resource-enabled people. Those who lack access to ICT tools are increasingly at a disadvantage, which necessitates raising the level of digital inclusion by increasing access to and use of tools of the digital age. Herselman and Britton further state that the very technologies that cause the rift between the digital haves and have-nots may be used to bridge that rift. Importantly, the problem of digital exclusion needs to be viewed holistically, addressing areas of resource inequalities, financial access, cognitive access and content access.

The DD project is concerned with each of these aspects, addressing resource inequality by providing infrastructure; financial limitations by making the systems free and accessible to anyone; cognitive aspects by encouraging self-learning; and content access by being a repository of information (Gush, de Villiers, Smith & Cambridge, 2011). The goal is to provide rural telecommunications infrastructure in such a way that all stakeholders benefit (Andrew & Petkov, 2003).

Table 2.1 gives an indication of the computer penetration in South African schools for all nine provinces. It is clear from these figures, that most provinces, with the exception of Gauteng, Northern Cape and Western Cape, are badly under-serviced. Provinces with penetration below 20% are highlighted in red.

Table 2.1: School computer centres in South Africa, 2009. (Department of Education, 2009)

Province	Number of Schools	With Computer Centre	% With Computer Centre
Eastern Cape	5715	596	**10**
Free State	1643	353	21
Gauteng	1994	1510	76
KwaZulu-Natal	5835	982	**17**
Limpopo	3918	428	**11**
Mpumalanga	1540	254	**16**
North West	1740	391	22
Northern Cape	609	314	52
Western Cape	1466	886	60
Total	**24460**	**5714**	**23**

In a study on the feasibility of ICT diffusion and use amongst rural women in South Africa (Kwake, Ocholla & Adigun, 2006), the researchers surveyed 200 participants in rural and impoverished areas of South Africa on their perceptions of the benefits of ICT. The survey revealed that a large percentage (28.5%) of the participants felt that ICTs were unavailable or inaccessible to them and difficult to use. A further 12.5% indicated that ICTs were costly and unaffordable. These were responses to an open-ended question on the use and availability of ICTs in the participant's community.

As is evident from these responses, accessibility to affordable infrastructure and usability were important considerations in the minds of the participants in the research. Kwake, Ocholla and Adigun also mention the importance of appropriate content, both in terms of language and subject matter, as well as the need to significantly reduce the hindrances to accessibility, either before or during the provision of the technology.

2.4 Multiple dimensions of the digital divide

According to Harris (2002), in a study of ICT for poverty alleviation in a global context, the elimination of problems due to the digital divide requires more than merely providing access to technologies. The provision of telecommunications infrastructure is necessary, yet is an insufficient means of promoting economic development. The author states: 'the digital divide goes beyond access to the technology and can be expressed in terms of multiple dimensions. If societies wish to share the benefits of access to technology, then further provisions have to be implemented in order to address all the dimensions of the digital divide' (Harris, 2002:4).

Harris proposes a set of dimensions and associated proposals to overcome issues of the digital divide. Those dimensions are summarised in Table 2.2 below. The mention of 'sufficient and appropriate content' is particularly pertinent to this study.

Table 2.2: Dimensions of the Digital Divide (Harris, 2002:5)

Dimension	Explanation
Service availability	The services made available through the use of ICTs should be freely available to all who might wish to make use of them.
Awareness	All stakeholders should be aware of how they might be able to use ICTs for their own benefit.
Opportunity to learn and use new media	All community members should have the opportunity to attain computer literacy.
Mastery of technologies	Stakeholders should understand which tools are best suited for which tasks.

Experience	All stakeholders should be able to accumulate sufficient experience with the use of ICTs to enable them to fully exploit their potential.
Skills	All stakeholders should have the right skills for performing ICT- related tasks.
Support	All stakeholders should have access to appropriate assistance when required so as to support them in using ICTs effectively.
Attitudes (motivation)	Everyone is encouraged to participate in the sharing of benefits available from equal access to ICTs.
Content	Sufficient and appropriate content should be available to enable everyone to gain benefit from ICTs.
Cultural	The other dimensions are adapted as required to the cultures of all potential users.
Disability	The other dimensions are adaptable as required, so that disability is not a barrier to equal enjoyment of the benefits of ICTs.
Linguistic	The other dimensions are adaptable as required, so that language is not a barrier to equal enjoyment of the benefits of ICTs.
Gender	The other dimensions are adaptable as required, so that gender is not a barrier to equal enjoyment of the benefits of ICTs.
Empowerment of civil society	Structural, political, and governance factors should not impede equal enjoyment of the benefits of ICTs.

This holistic view of the digital divide and associated provision of ICT in the context of a complex social environment is echoed in the study by Snyman and Snyman (2003), 'Getting information to disadvantaged rural communities: the centre approach', in which the researchers investigate ICT factors in multi-purpose community centres (MPCCs) and tele-centres in South Africa. In the study, numerous social, technical and operational problems emerge. They highlight an important point that 'the assumption in many tele-centre projects, that providing ICT equipment will automatically mean that useful information will be made available to those who need it, is increasingly being questioned' (Snyman & Snyman, 2003:105). A thorough understanding of context, as well as of usage of ICT infrastructure is necessary for effective ICT4D; merely providing technology is not sufficient.

2.5 The Indian 'Hole-in-the-Wall' project

As mentioned in Gush and de Villiers (2010), in 1999, Dr. Sugata Mitra of the National Institute of Information Technologies in India (NIIT) commenced a project known as the 'Hole-in-the-Wall' experiment (HITW), based around the following hypothesis:

> *'The acquisition of basic computing skills by any set of children can be achieved through incidental learning provided the learners are given access to a suitable computing*

facility, with entertaining and motivating content and some minimal (human) guidance' (Mitra 2000:3).

Mitra and Rana (2001) placed a computer in a specially constructed hole in the wall between the NIIT headquarters and the neighbouring slum, in the Kalkaji region of New Delhi. The computer ran on a Windows operating system and was connected to the Internet. A touch-pad, but no keyboard functionality, was provided. The objectives of the experiment, as stated by the researchers, were to find out :

(i) whether potential users would use a PC-based outdoor Internet kiosk in India without any instruction; and

(ii) whether a PC-based Internet kiosk could operate without supervision in an outdoor location (Mitra & Rana, 2001:224).

They observed that the site was visited mainly by children aged 5 to 16 years old, most of whom did not attend school, and had no previous exposure to computers. The adult women of the slum never used the computer, citing reservations about not knowing the language, or how to use the computer (Mitra & Rana, 2001:226). The contrast between these two groups, both of whom had no prior experience of computing, is notable and indicates a greater openness to technology on the part of children. Various qualitative observations of user behaviour around the computer were recorded by those researchers, including the following:

- Basic browsing and drawing skills were picked up within a few days, with the more advanced skills (such as cutting and pasting) becoming evident within a month.
- Adults did not attempt to learn or use the kiosk.
- The most commonly used applications were MS Paint and Internet Explorer.
- Children understood the functionality of items such as the mouse pointer and the hourglass, and invented their own vocabulary for them.
- In an exhibition of peer tutoring and learning, children taught each other what they had learned.
- Parents saw the benefit of the kiosk, though primarily as a benefit for their children, rather than themselves.
- Children were strongly opposed to the idea of its removal.

What does it mean to be 'computer literate'? In the HITW experiment, a computer literate child was defined as one who could switch on a PC; draw a picture using a paint application; perform basic computer functions such as using folders, short-cuts, copy and paste; navigate web pages; and send and receive email (Mitra, 2000).

Following the Kalkaji experiment, a second kiosk was installed in the town of Shivpuri (Central India) leading to observations similar to those at the first kiosk, as well as differences between the two (Mitra & Rana, 2001:227; Mitra, 2000). Some key comparisons between the first two Indian sites in the HITW study, relevant to the present study, are listed in Table 2.3.

Table 2.3: Key comparisons between two HITW sites, Kalkaji and Shivpuri (extracted and summarised from Mitra, 2000)

Kalkaji	**Shivpuri**
Kiosk installed in a wall facing a New Delhi slum	Installed in a school, but accessible to those outside the school as well
Internet, but no keyboard was included	No Internet, some keyboard use was possible when caretaker was present
Children of both genders used the kiosk, but mostly boys aged 6-12	Due to unsavoury area (with a reputation for gambling activities), girls did not use the kiosk. Regulars are male teenagers aged 13-19
Children used the kiosk regularly, both for playing and learning new things	Kiosk was used for entertainment purposes mostly and as a substitute for expensive computer courses
Priority was placed on web browsing, playing games, navigating stories and cartoons, painting, music	Kiosk was used for playing music, movies, file navigation, and some creative use (e.g., FrontPage)
Peer tutoring occurred, primarily with the most computer-literate user teaching the others	Peer tutoring took place
Mostly independent work; users asked for help from caretaker/observer only when the latter had been identified as an authority	Tendency to ask caretaker/observer for help at every step

Following the Kalkaji and Shivpuri installations, HITW kiosks were set up in multiple locations around India to further assess the viability of this type of informal educational method to teach basic computer literacy skills. In subsequent years, over 100 new sites were installed around India (Inamdar & Kulkarni, 2007:171). The original Kalkaji HITW kiosk was later relocated to a local school (Trucano, 2010).

Table 2.4 from Mitra (2003), highlights the key observations at the Kalkaji and Shivpuri sites, as well as results from subsequent HITW experiments, conducted up to July, 2002.

Table 2.4: Key observations at the Kalkaji and Shivpuri sites (Mitra, 2003:369)

Place	Location	Number of computers	Duration of study	Key observations
Kalkaji	Slum, south east of Delhi	1	January 1999, ongoing	First observations of self organised learning. Peer tutoring. Lack of correlation with social or economic factors as far as child learning is concerned.
Shivpuri	Small town in Madhya Pradesh, central India	1	May 1999 – July 1999	First observations of the actual process of discovery and peer tutoring among children. Kalkaji results successfully replicated.
Madantusi	Village in Uttar Pradesh, north eastern India	1	June 2000, ongoing	All results replicated. Self learning of English language observed. First comments from adults about the occurrence of desirable behavioural changes in children. Equal numbers of boys and girls.
Madangir	Resettlement colonies, south east of Delhi,	30	November 2001, ongoing	First instances of adult vandalism at kiosks. Location and orientation as important factors for kiosk safety and usage. The need for remote monitoring technology.
Sindhudurg	Fishing and other villages in Maha-rashtra, western coast of India,	10	April 2002, ongoing	All results replicated rapidly. Sometimes more girls than boys. English is not a barrier. Games and painting dominate usage in the absence of the Internet. Local teacher reports 10% of the curriculum completed without assistance in one month.
Future plans	All over India	66	August 2002 – 2004, planned	To provide final verification of all hypotheses of minimally invasive education (MIE).

Following the development and implementation of an icon test by colleagues of Mitra in which children were given icons to identify, so as to establish the degree to which computer learning had taken place, Mitra proposed a tri-part pedagogy for learners to acquire the necessary competence. Two of these three bands did not require the direct intervention of a knowledgeable teacher, and were achievable through technology access and peer learning

alone (Mitra 2003). This 'minimally invasive education' (MIE), 'self-assisted learning' and 'peer-assisted learning' approach forms the core educational method on which both the HITW and the DD projects are based.

The following photos of HITW sites (Figures 2.1 and 2.2) were taken by the researcher of this present study, on an academic visit to India in 2003.

Figure 2.1: Users at a 'Hole-in-the-Wall' site, India

Figure 2.2: 'Hole-in-the-Wall' site, 40 minutes drive from Jaisalmer, India

Following the initial successes of the HITW project, *Hole in the Wall Education Limited* (HiWEL) was formed as a cooperative effort between NIIT and the International Finance Corporation. As of 2010, over 300 learning stations had been deployed by HiWEL throughout India, retaining the MIE) approach.

The HiWEL initiative faces some serious social-, educational-, and long-term sustainability challenges, as Arora (2010) points out in a study entitled 'Hope-in-the-wall? A digital promise for free learning':

> *'While the HiWEL initiative is commendable, it raises some challenging questions. Is collaborative learning a natural or a taught process? Is informal and public learning inherently more equitable and democratic? What kinds and depths of learning are achievable? What, if any, is the role of the teacher and/or mediators in this process? What are the benchmarks for success and failure, and how do these differ from those in conventional learning? And is this approach sustainable?' (Arora, 2010:691).*

These questions are posed in the light of two failed HITW sites in the Central Himalayas. In particular, the exact role of schools as custodians of the sites, is questioned, as well as the kinds of content, instruction, and curriculum material that should be allowed to 'seep into these relatively free spaces without compromising on the underlying trends of innovative pedagogy' (Arora, 2010:700).

Table 2.5 below summarises further research papers that have been published on the HITW project. The research clearly indicates that the HITW sites helped with children's computer literacy education, as well as contributing positively to wider learning (e.g., mathematics).

According to de Boer (2009), a knowledge of user behaviours in a typical environment could be used to optimise the kiosks in that area. Optimisation would be achieved through the customisation of educational games and software, either for group or for solo work. In addition, it would involve the creation of community action plans for kiosk usage, based on site demographics.

A further aspect mentioned by de Boer is the effect that media attention and researcher intervention have on kiosk users, contributing to increased interest and sustained use by users.

Applying de Boer's point to the present study, however, it is not possible to maintain media and researcher involvement at all of the 200+ DD sites in South Africa. For this reason, the quantitative data retrieved from sites, independently of direct researcher intervention, has great value in analysing what is happening at the sites in a naturalistic environment 'when no one is watching'.

Table 2.5: Summary of research papers published on the HITW project

Title and authors	Key Findings
'Computer skills development by children using Hole-in-the-Wall facilities in rural India', *by Parimala Inamdar, 2004*	Children who had learned at the HITW kiosk were able to complete the computer science curricular examination without being taught the subject.
'Acquisition of computing literacy on shared public computers: children and the Hole-in-the-Wall', *by Sugata Mitra, Ritu Dangwal, Shiffon Chatterjee, Swati Jha, Ravinder S. Bisht, Preeti Kapur, 2005*	Groups of children were able to use computers and the Internet on their own, irrespective of upbringing or location. Group self-instruction is as effective as classroom instruction, while being less expensive and independent of teachers.
'Self organising systems for mass computer literacy: Findings from the Hole-in-the-Wall experiments', *by Sugata Mitra, 2005*	Following a nine month computer literacy focus group testing study at HITW sites, it became apparent that children were able to master basic computer skills irrespective of upbringing or location.
'Public computing, computer literacy and educational outcome: children and computers in rural India', *by Ritu Dangwal, 2005*	Various tests including the icon test clearly demonstrated that learning had taken place. Danwal uses the term 'playground computing'.
'Impact of minimally invasive education on children: an Indian perspective', *by Ritu Dangwal, Swati Jha, Preeti Kapur, 2006*	MIE provides an alternative educational approach in contemporary times, especially in developing nations. An important aspect is peer group learning which enhances the goal setting behaviour among children at the kiosk.
'Hole-in-the-Wall computer kiosks foster mathematics achievement – A comparative study', *by Parimala Inamdar, Arun Kulkarni, 2007*	A comparative study was conducted, investigating the impact of HITW kiosks on achievement in school examinations. Kiosks were loaded with educational games and videos in the subjects of Mathematics, English and Science. Comparative tests were carried out between kiosk users and non-kiosk users, before kiosk installation and 2.5 years after installation. A significant impact was found on examination results in the subject of Mathematics.
'The relationship between environmental factors and usage behaviours at Hole-in-the-Wall computers', *by Jennifer deBoer, 2009*	Some behavioural patterns emerged from a study involving multiple HITW sites. Typical urban children were dedicated independent users of kiosks, while rural children were more likely to use the computers in groups. Both communities displayed different kinds of sustained interest in the kiosks. The largest category of users was aged between 11 and 12 years old, and there were more boys than girls at the kiosks (girl-boy ration of 0.83). The average age of girls was younger than that of boys (11.37 versus 12.37). As the girls matured, they became reluctant to visit the kiosks where older boys were present.

2.6 A place for constructivism

A number of broad philosophically-based views have been proposed to help educators better understand how learners learn. Three major learning paradigms are behaviourism, cognitivism, and constructivism. On a scale of didactic learning theory through exploratory learning theory (didactic being more authoritarian instruction), the constructivist ethos would be situated in the extreme exploratory zone, while behaviourism would be in the extreme didactic zone, and cognitivism somewhere in the middle (de Villiers, 2005:352). The one most closely aligned with unassisted learning kiosks is constructivism.

According to de Villiers (2006), constructivist philosophy as it relates to e-learning, exhibits the characteristics of personal knowledge construction and interpretation, active learning, anchored instruction, and multiple perspectives. Constructivist mechanisms include problem-based learning, open-ended learning environments, and flexible learning within ill-structured domains. There is no direct instruction in constructivism. Rather, the learner is active in a user-centric environment aimed at promoting active involvement and situated learning that can be applied in the real world (de Villiers, 2006:4). 'The knowledge that students finally acquire is only the knowledge they have actively constructed themselves, not the information transmitted to them ready-made' (Salomon & Almog, 1998).

Constructivism is a recognised approach to education in the HITW initiative. As Mitra and Rana (2001) state: 'One of the foundational premises is that children actively construct their knowledge rather than simply absorbing ideas spoken at them by teachers. It posits that children actually invent their ideas. They assimilate new information to simple, pre-existing notions, and modify their understanding in light of new data. In the process, their ideas gain in complexity and power, and with appropriate support they develop critical insight into how they think and what they know about the world' (Mitra and Rana, 2001:4).

Application to the Digital Doorway

The DD uses a predominantly constructivist approach to education. For this reason, users are left to discover for themselves applications and resources on the DD. Users discover new aspects of computers as they interact with the device, and build up their own 'reality' of how computers function and what they can be used for. 'Constructivism emphasizes the learner exploring, experimenting, doing research, asking questions, and seeking answers' (Alessi & Trollip, 2001:33). The analysis of usage and user interactions at the DD sites in this study will provide insight into these areas.

2.7 Other initiatives aimed at providing computer training in impoverished areas

Computer training in impoverished areas may be achieved through various initiatives, including: the establishment of school computer labs, the building of computer centres and Internet kiosks, and the distribution of individual low-cost computers to selected individuals. In a paper 'An overview of ICT innovation for development projects in marginalised rural areas', Wertlen (2007) highlights a number of development projects, both local and international, including the DD, HITW, One Laptop Per Child (OLPC), and BingBee.

One Laptop Per Child

The OLPC project, launched in 2005, was started by Nicholas Negroponte of MIT's Media Lab. The goal of the project was to provide laptops to children in poor and remote areas of the world, thus granting them access to quality educational resources while engaging their own capacity for learning (Buchele & Owusu-Aning, 2007).

In a study on the applicability of the OLPC project to the country of Ghana, Buchele and Owusu-Aning (2007) note the following aspects:

- Laptops are distributed to the governments of interested countries in large-scale orders (250,000+ units) and cost US$176 each (2007) with prices expected to fall over time.
- The founder of OLPC, Negroponte, insists the project is educational, not a laptop project. However, critics point out that by focusing on the provision of technology, rather than educational content, it is more of a laptop project than an educational project.
- The project is constructivist in nature; children learn by doing, and are free to explore and discover, rather than being 'force-fed' information.
- OLPC aims to saturate a community with laptops rather than provide limited numbers of school labs.
- As children own the laptops, they are able to use them during and after school hours.
- The OLPC approach has a strong emphasis on peer-to-peer teaching and learning.
- Criticisms levelled at the OLPC project include concerns related to the worth of pouring large quantities of money into laptops when basic commodities such as food, water and medical care are lacking. Other critics question whether laptops are an appropriate technology for mass education.
- These laptops are designed to withstand rain and dirt, and can be used in low and erratic power conditions, and in direct sunlight. Laptops have no moving parts and can communicate with each other via Wifi connectivity and allow external devices to be connected via USB ports.

- The software running on the laptop is open source and employs an operating system known as Sugar, which occupies very little memory. Collaborative functions between laptops are possible due to the Wifi connectivity.
- Applications on the laptop include word processing, a web browser, email, a chat facility, media player, drawing tools, basic language programming, encyclopaedia, and calculator.
- Various hardware and software additions are included to prevent theft of the device

Application to the Digital Doorway

While the hardware and business approaches of the OLPC project are very different to the DD, several of the philosophical goals are the same: providing computer literacy and information literacy skills to impoverished communities; allowing users to explore and learn in their own time and at their own pace, in a constructivist manner; maintaining an open source software policy; accessible hardware and infrastructure provision, in areas where it is lacking; and forging specific learning opportunities where they had previously not been available.

The DD, however, is designed to be a fixed point of learning and social activity in a community centre, library or school, where members of the community come together and learn, both individually and together with peers. Security of the infrastructure is achieved through the appointment of a site champion. Also, the robustness of the housing, and the fact that the device is heavy and bolted to the ground, provide additional safety features. The primary goal of the DD is to provide basic computer skills training, enabling users to become familiar with a computer keyboard and touch-pad, opening and closing programs, navigating menus etc. Secondary goals include the provision of information for school projects, adult learning, providing entertainment, and stimulating creativity.

BingBee

This is an information kiosk designed to be deployed in marginalised communities in South Africa, with the aim of improving educational levels of street children. The device is fully contained behind a shop front window and incorporates various innovative technologies, such as ‘fabric distortion’ finger tracking (Slay, Wentworth & Locke, 2006). The secure design of the BingBee kiosk makes it ideal for deployment at locations that are susceptible to vandalism (Thinyane, Slay, Terzoli & Clayton, 2006). A test site of ten kiosks has been operational in Fingo Village, Grahamstown, South Africa, since 2006, and has successfully met the expectations of the developers (Wentworth, 2010).

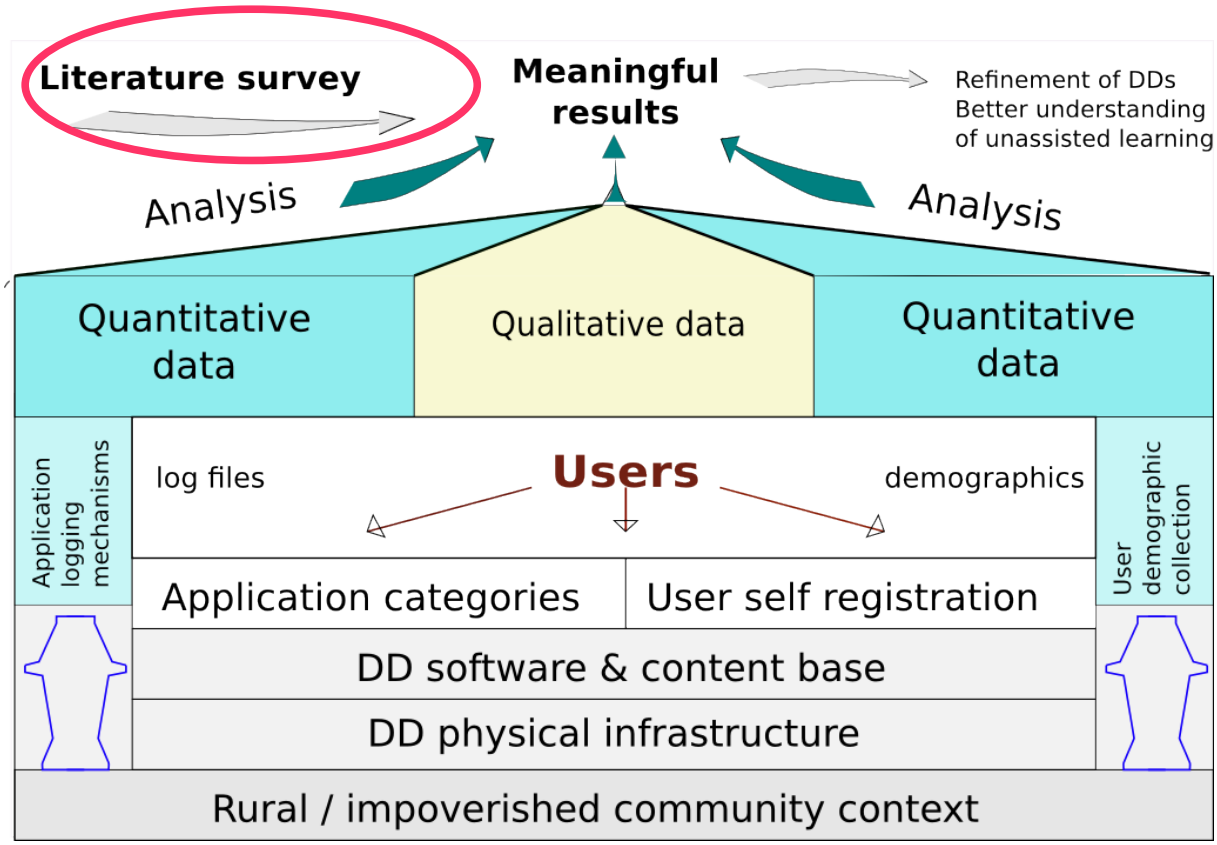
2.8 Summary of chapter

This chapter addressed aspects of ICT4D, that are applicable to this study, including community informatics and digital exclusion. The chapter also presented the multiple dimensions of the digital divide, as well as the need for adequate contextual understanding in infrastructure deployment. The Indian HITW project and associated studies, were presented in some detail. The educational philosophy of constructivism was mentioned and other computer training initiatives were discussed.

The following chapter (Chapter 3), extends the literature survey by addressing relevant studies involving users and software application usage.

– 3 –

Literature study of users and software application usage



3.1 Introduction

Many studies have been conducted on the differences in computer use, and attitudes towards computers, by users of different ages and genders, in a variety of contexts. The studies most closely linked to this research study are those of the Indian HITW project, as mentioned in the previous chapter. Studies on computer usage in South Africa amongst users in remote unsupervised locations, where usage is completely user-controlled, have not hitherto been conducted. However, lessons from related studies can prove valuable in analysing general trends in software usage in different contexts.

The studies from the United Kingdom and Australia described in Sections 3.2 and 3.4, while dating back seven to eight years, are still insightful, given that impoverished communities in South Africa are at least eight to ten years behind first world countries, in terms of technological advancement such as access to ICT and the Internet. E.g. see Barton, Amory-Mazaudier, Barry et al. (2009).

3.2 Related studies

Colley and Comber (2003) examined changes in computer experience and attitudes over a period of time between 11–12 year-old, and 15–16 year-old males and females in schools in the United Kingdom. According to their research findings, females have less experience in computers and are less favourable towards them than males. In 1990, boys exhibited a more favourable attitude towards computers, holding the perception that they were more suitable for males than for females. Males used them more than females at home, for a range of applications including word processing, maths, programming, graphics and games. Mention is made of a study examining computer use and attitudes among college students with enhanced access to computers (Mitra A. et al., 2001, cited by Colley and Comber, 2003). Females held a less positive view of computers than males, and used them less, despite excellent access for both genders.

Results from a second study by Colley and Comber (2003), showed that more boys than girls had access to, and were owners of, console game computers (e.g., Sony Playstation). Boys also rated themselves more highly in terms of computing ability than girls. Regarding application category preferences, boys were seen to prefer music technology and computer games. Amongst the 11–12 year-olds, graphics applications were used more frequently by girls than boys, whereas the 15–16 year-old boys used graphics applications more frequently than girls of that age. Overall, computer games were used more frequently among younger

users than older users, and word processing usage was more frequent among older users than younger users, due to its introduction into school use. The study also found that boys remained more self-confident in the use of computers, and liked computers more than girls (Colley & Comber, 2003).

Table 3.1 portrays the results observed by Colley and Comber, comparing usage of various categories of applications by girls and boys of different ages. The table shows the mean ratings of frequencies of computer usage, and significant ANOVA results. 'The participants were asked to indicate whether they had used each on a scale of 0–3, for which 0 = 'never', 1 = 'once or twice a year', 2 = 'every one or two months' and 3 = 'at least once a week' ' (Colley & Comber, 2003:158).

Table 3.1: Mean ratings of frequencies of use of computers for different purposes (Colley & Comber, 2003)

	Year 7 students		*Year 11 students*		*Gender*	*Age*	*Gender × age*
	Girls	*Boys*	*Girls*	*Boys*			
Home use	2.83	2.92	2.85	2.93	9.31**		
Word processing	2.42	2.34	2.69	2.62		19.97***	
Music	0.94	1.04	1.09	1.63	8.12**	10.97**	3.85*
Programming	0.94	0.96	0.58	1.00			
Maths	1.06	1.03	0.92	1.22			
Graphics	2.19	1.89	1.52	1.68		22.90***	6.30*
Games	2.52	2.69	1.83	2.75	56.41***	18.86***	26.56***
Internet	1.89	1.69	2.35	2.49		39.36***	
E-mail	1.53	1.24	2.18	2.31		60.17***	
CD-ROM	2.52	2.37	2.19	2.64			12.69***

Note: Higher ratings correspond with greater frequency of use.
* $p < 0.05$;
** $p < 0.01$;
*** $p < 0.001$.

According to the study, 'More age than gender differences were found. Boys used computers more at home, and used computers more frequently for music and games than girls. Older students used computers more than younger students for word processing, music, accessing the Internet and for e-mail. Younger pupils used computers more than older pupils for graphics and for games.' (Colley & Comber, 2003:159).

In a related study by Colley, entitled 'Gender differences in adolescents' perceptions of the best and worst aspects of computing at school', the author examined gender differences in perceptions of various aspects of computing, by early- and late stage secondary school learners at school. Both age-related and gender-related differences were found. Boys

displayed a greater affinity for games, while girls indicated a more work-oriented approach, and liking for e-mail (Colley & Comber, 2003).

In a study on 'Content creation for ICT development projects: Integrating normative approaches and community demand', Roman and Colle (2003), emphasise that the term information and communications technologies (ICTs), relates more to the actual information transfer and communication that takes place, rather than to the computer, the Internet or telephone lines. The authors stress the importance of relevant content in community development and poverty alleviation. Roman and Colle (2003), further report on a needs assessment study conducted in three villages in India where tele-centres were to be installed. Preliminary results from the study indicated differences in information uses and patterns depending on gender, age and occupation of participants. With regard to content, the study indicated a need for agricultural information by farmers in the village, as well as the need for children's education and health information by women in the villages. In addition, youth of the villages indicated an interest in information on employment opportunities.

Dangwal (2005) reports on results of studies conducted on school children in rural India, where a HITW kiosk was situated. Evaluation was conducted on the children's ability to learn to operate the computer. Measures were made of the effect of such 'playground computing' on educational outcome. Various measurement tools were employed by the researchers, including the icon association inventory (IAI) where children had to identify the function of software icons before and after a period of using the kiosk. Results indicated a dramatic increase in the percentage of icons correctly identified after a period of nine months, supporting the hypothesis that minimally invasive education, through exposure to the kiosks, could improve computer literacy in users.

3.3 'Census at school' results, 2009

The following figures from the results of the 2009 'Census at school' conducted by Statistics South Africa (2010), provide insight into the need for DDs in South Africa and indications about preferred subjects (by gender and grade). These results are relevant to this study, as they help explain the observed differences in application accesses (application 'hit-counts') discussed in later chapters.

Figure 3.1 indicates that almost 35% of South African schools do not have electricity; approximately 25% have a school library; 53% have a computer (but not necessarily computer classes); and a very low percentage (approximately 15%) have email and Internet.

In Figure 3.2 (top seven favourite subjects by genders), we observe that, within the grade 3 to 7 group (age group 9–13), mathematics is the favourite subject of both boys (17.3%) and girls (14.8%) and this by a significant amount, even more so if the numeracy figures are included in this grouping. This is followed by preferences for languages (5–7%) and literacy subjects (5–6%) with similar ratings by boys and girls.

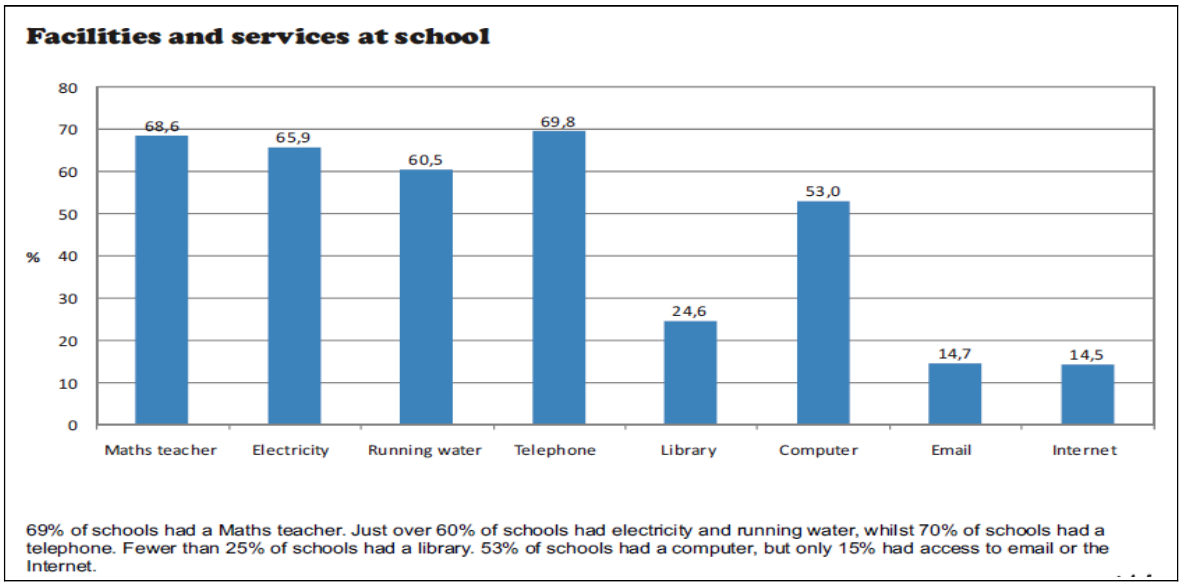


Figure 3.1: Facilities and services at schools (Statistics South Africa, 2010:22)

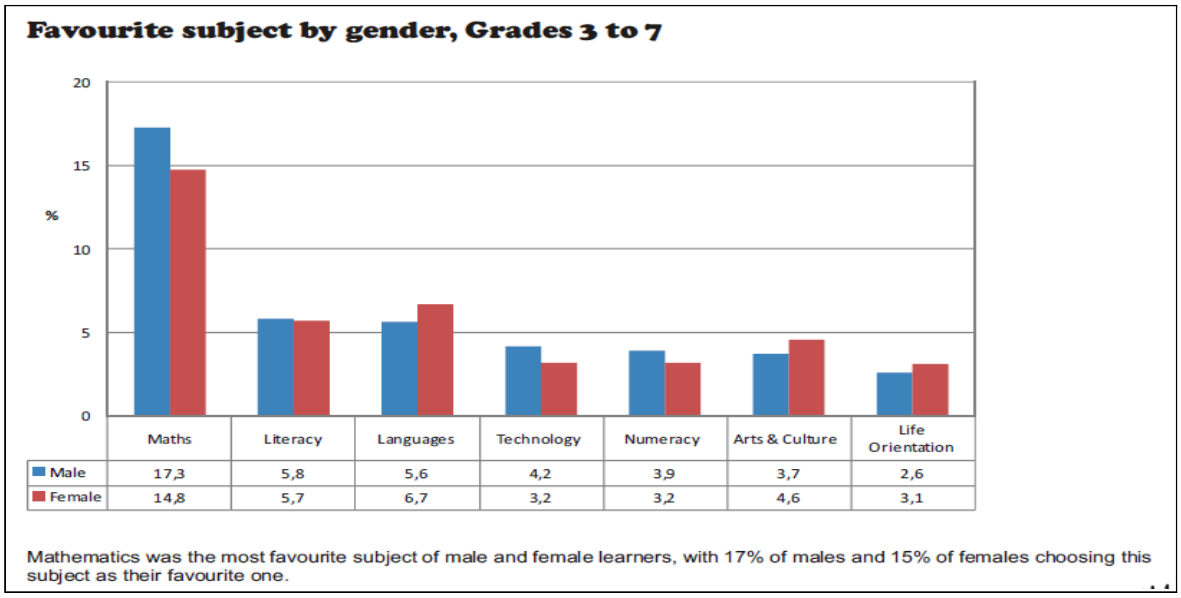


Figure 3.2: Favourite subject by gender, grades 3 to 7 (Statistics South Africa, 2010:37)

Figure 3.3 highlights favourite subject by gender for students in grades 8 to 12 (age group 14–18). In this age group, language studies is the most popular subject, followed by mathematics. Girls are considerably more interested in languages than boys. It is interesting to note that for older learners, mathematics has been replaced by languages as the favourite subject, both for boys and girls.

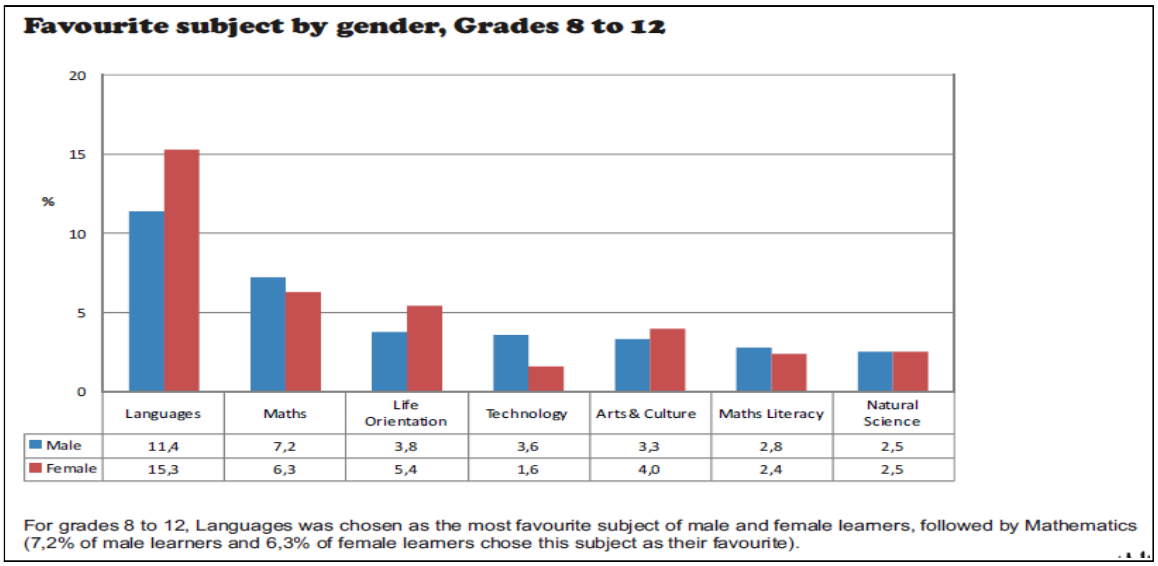


Figure 3.3: Favourite subject by gender, grades 8 to 12 (Statistics South Africa, 2010:38)

Figure 3.4 highlights the difference in access by South African learners to various services in their community, between 2001 and 2009. Access to Internet services climbed from a very low figure of 7% to a low figure of 20%; access to a computer doubled from 15% to 30%; while access to a library only increased from 33% to 34%.

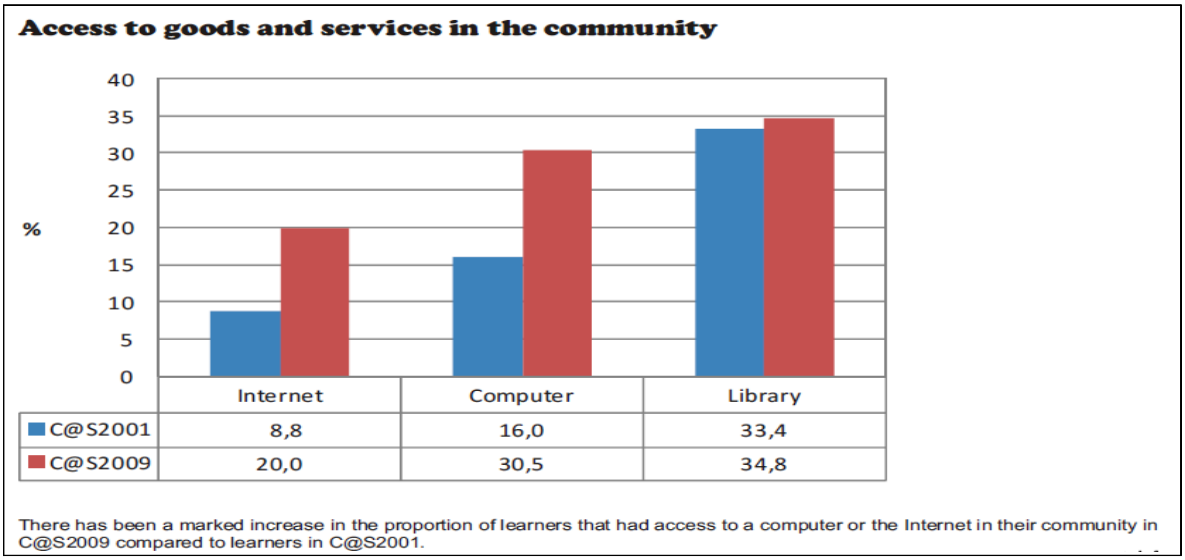


Figure 3.4: Access to goods/services in the community (Statistics South Africa, 2010 :38)

From the above figures, we notice that access to computer and library facilities is low, both for schools and members of the community in general.

3.4 Related work in Australia, 2001-2002

In a paper entitled 'Virtual kids of the 21st century: understanding the children in schools today' (Yelland & Lloyd, 2001), the authors report on a study they conducted involving ownership, use and views of computer and video games by 934 children aged 10 to 13 years, in urban state primary schools in Australia. The study was based on questionnaires administered to students in the schools, as well as ten interviews conducted with students at one of the research sites. Questions were centred around computer and video game ownership, usage and genres as well as various other social interaction aspects. Several findings from this research are pertinent to the present study:

- More boys than girls had a video game system at home (75% versus 57%).
- While the systems were mainly purchased by parents (who also determined where they should be located within the house), more boys than girls reported that they owned the system (36% versus 15%), i.e., boys were more likely to assume ownership of the device, while more girls than boys reported that the system was owned by the family.
- More boys than girls reported that they used the systems the most in their family (60% versus 32%), while girls reported that family members used them more than they did.
- A much higher percentage of boys than girls paid for computer games personally.

The report by Yelland and Lloyd also discusses genres of computer games, and compares differences in preferences of one genre to another between boys and girls. Regarding preferences of one type of game over another, boys were more likely to enjoy games they perceived as 'cool', 'fun' or 'exciting', while girls indicated a preference for games that were challenging or made them think. 38% of boys indicated that they played games every day of the week while this percentage was much lower for girls, at 19%. Most students indicated that they spent between 0 and 7 hours a week playing computer/video games.

Yelland and Lloyd (2001) stress the need for more in-depth information on computer and video game usage in order to better understanding the thinking of students and their use of new media, helping 'inform educators about ways of learning in school and out, and informal learning contexts that have so much to offer in terms of engagement with ideas and high levels of motivation' (Yelland & Lloyd, 2001:191).

In another publication emanating from Australia, Downes (2002) reports on three studies concerning children's and families' use of computers in Australian homes, in particular the interactions and lived experiences of children with computer technologies. The goal of the studies was to inform the work of educators wishing 'to provide effective instructional

environments that draw on children's starting points and the positive aspects of their home computing environments' (Downes, 2002:182). Downes cites the Australian Bureau of Standards statement that the main barriers to computer ownership are primarily the cost, and a lack of interest. Another interesting point made by Downes, is the danger certain families and cultural groups associate with computer usage, seeing it as an isolating activity that removes children and adults from combined family activities.

The three research studies covered by Downes, were conducted between 1995 and 2000 in a capital city in Australia and drew on surveys, discussion groups, diaries and in-depth interviews with children (all ages) and parents on the subject of interactions with computer technologies. Some results and discussion points from the study are highlighted below:

- All the children who participated in the study had at least one computer at home.
- The hardware and software available to children defined its possible use either as a 'toy' (games machine) or a 'tool' (work machine).
- In poorer communities, the lack of a printer or Internet access, limited the use of the computer as a tool, and increased its use as an entertainment device.
- Young children informally observed and modelled their use of the computer on that of their older siblings and parents.
- When initially learning to use the computer, children were guided by their siblings or parents. Those family members with the greatest experience 'scaffolded' the use of computers for family members with less experience.
- Certain parents regarded the child as the technology expert in the family.
- Young children enjoyed socialising around the computer and enjoyed talking about what they were doing with family and friends. 'One early childhood teacher stated, "I think the value they get out of it is actually in the interaction that happens at the computer between two or three kids"' (Downes, 2002:187).
- The resident computer expert was usually the father or an older brother and the least involved with the device was usually female.
- Both boys and girls regularly played games at least once a week; girls preferring platform, educational and strategy games, with boys preferring combat and sports games.
- Girls were more likely to engage in non-game playing activities exclusively, such as word-processing, illustrating and decorating texts, using clip-art, finding information and chatting.
- Gender differences in 2002 were not as marked as in previously published research.

- Seventy-four percent of children participating in the survey, attributed their improved school performance to having a computer at home, specifically in relation to researching information, thinking skills and reading, and mathematics skills.
- The studies revealed a positive linear correlation between frequency of computer use and age, with older children using the computer more frequently and for longer periods than younger children.
- Children in upper secondary school tended to use computers about four or five times a week.
- Children preferred to use a computer at home than at school, citing familiarity with the home computer, more control and choice at home, not having to share with others, and less time restrictions on usage at home.
- All the children expressed a positive attitude and high comfort level with computer use.
- Main computer activities mentioned by users were game playing, writing, editing, decorating texts, completing projects, and locating information.
- The boundary between play and work was often blurred and younger children's descriptions of activities often included the word ‘play’, e.g., ‘play the encyclopaedia’. Children would switch between periods of playful activity and purposeful tasks (e.g., homework).
- Game playing decreased significantly at the beginning of high school and task-oriented activities increased (e.g., making presentations or web pages for school).
- Children who regularly used a computer at home for entertainment and work activities were ‘predisposed to exploratory learning and learning by doing, at least when using computers’ (Downes, 2002:193).
- Some key aspects contributing to successful experiences with exploratory learning in the home computer environment were: sufficient time for self-directed exploration, a relaxed atmosphere, some degree of control, the level of expertise in the home, social interactions, and the blending of playful and purposeful activities.
- ‘One parent summarised the lack of congruence between school and home environments by saying that “they are freer to explore and discover at home, which is hugely beneficial, whereas at school, it's a pretty tight sort of context, and so their learning will be fairly restricted”’ (Downes, 2002:194).
- The use of digital resources is a social activity that encourages risk-taking and challenges children's thinking through the process of exploratory learning.

Stillman (2007), in a study entitled 'The Digital Doorways Project', recognises the importance of content, amongst other factors, to support change in communities: 'In Australia, the potential for ICTs in remote communities to support change in communities has been recognised, but an issue has been the problem of ethical community engagement, content, and backend support' (Stillman, 2009:7).

Application to the Digital Doorway

The isolating factor of computers, highlighted by Downes, mentioned earlier, would be different in the DD context as follows: Children may be taken away from other family-oriented activities by spending time on the DD, however, the multi-terminal group interaction around the DD system would prevent individual isolation of users, and encourage social interaction between peers and possibly between users of otherwise unrelated backgrounds.

The sentiment mentioned by Downes, of the importance of children engaging with computers is echoed in an essay by Mizuko Ito (2006), entitled 'Interaction, collusion, and the human-machine interface'. Ito states that 'The interface is also the site at which children form relationships with machines. While certainly different, in both depth and range, from interpersonal relationships, relationships with computational media are important factors in the learning and identity formation of many children' (Ito, 2006:238). Users of DDs in impoverished South Africa, are no exception.

Returning to the meta-study by Downes (2002), his justification for the need to understand the computer activities of children is relevant to research in the DD context. He states: 'If educators are to adequately prepare all children for a technological workplace, they need to develop an understanding of the extent to which children engage in computing activities at home and at school, the nature of use and outcomes of such use. In order to develop this understanding, a rich and accurate picture of how children incorporate computers into their lives, how they are shaped by their interactions with computers and how they reshape the computer to their own ends within their world, is needed' (Downes, 2002:184). This 'rich and accurate picture' is something that needs to be built up in the DD context as well.

3.5 Summary of chapter

This chapter has discussed related studies involving the analysis of computer software application usage amongst users of different ages and genders. Important findings from the 'Census at school, 2009' results were highlighted, including aspects of context, school subject

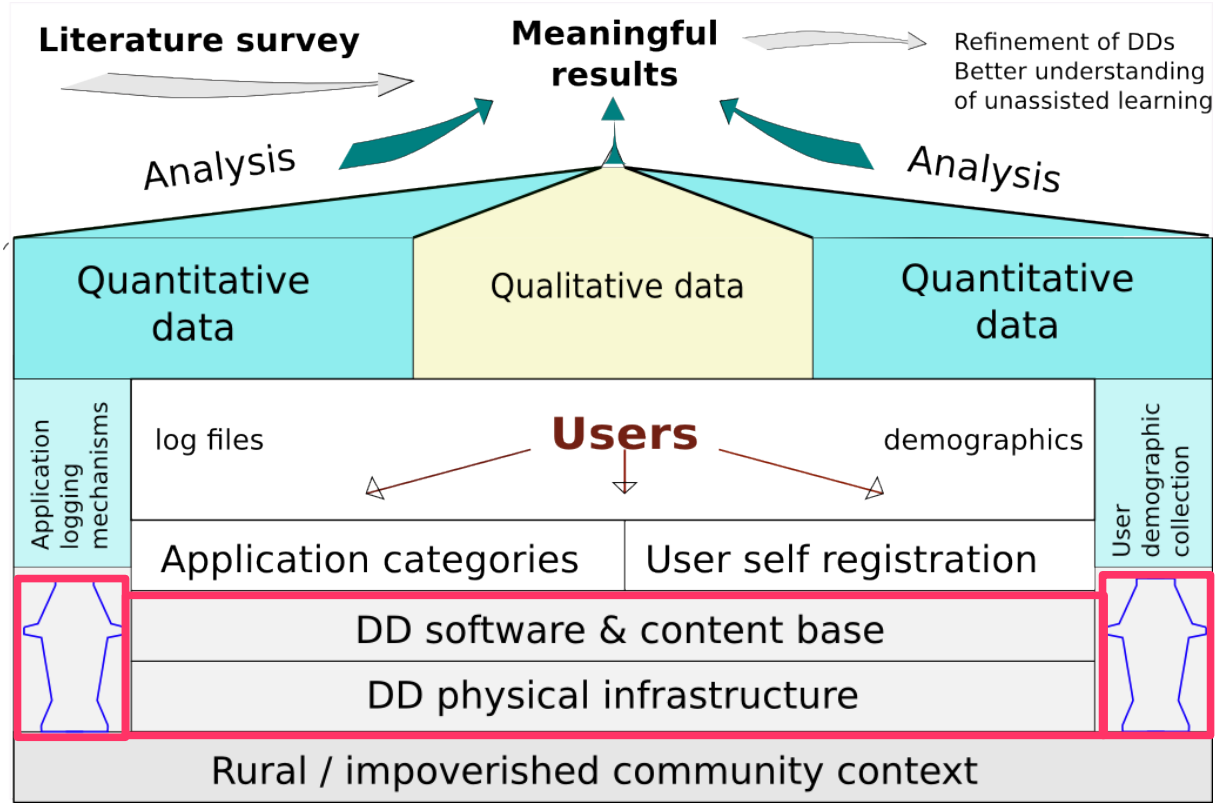
preference and access to services. Related studies involving computer usage in Australia were presented, including their applicability to the DD project.

In the following chapters, we move from a general perspective of ICT4D and unassisted e-learning projects in South Africa and abroad, to the specifics of the DD project. Chapter 4 describes DDs and their context, followed by an explanation in Chapter 5 of the research design and methods used. Chapters 6 to 8 describe the quantitative and qualitative studies on application usage.

– 4 –

The Digital Doorway intervention – background information

'Today's students have not just changed incrementally from those of the past, ...A really big discontinuity has taken place. One might even call it a 'singularity'– ...This so-called "singularity" is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.'
(Prensky, 2001:1)



'ya oh! i nealy forgot... your science is absolutely great there are many things i can say about your computers thnx a lot.' – Digital Doorway User, May 2007

4.1 Introduction

This chapter provides background information to the Digital Doorway project, including details of the first installation at Cwili, subsequent installations around South Africa, the research approach, design improvements over the years, pedagogical goals, hardware and software design, and the typical context of use.

4.2 Cwili installation

The first South African DD was placed at Cwili, in the Eastern Cape, in 2002 (see Figure 4.1). It was inspired by Mitra's 'Hole-in-the-Wall' work (Mitra & Rana, 2001) which began in 1999 and is described in Chapter 2. Termed the Digital Doorway to distinguish it from the Indian project and to avoid confusion with the nearby 'Hole in the Wall' resort, the project employed a single-terminal computer kiosk running Microsoft Windows operating system and software. A back-end server (located in a nearby office) was connected to security camera observation equipment. The kiosk was placed outside a community hall in the Cwili village. No explicit instructions on how to use the system were provided, but users were encouraged to 'play' with the computer, explore its functionality, and 'learn by doing' and experimenting. The Cwili DD was funded by the South African Department of Science and Technology (DST) with the purpose of ascertaining whether unassisted learning was a viable means of teaching basic computer literacy skills in impoverished, rural South African communities.

Figure 4.1: Official launch of the Cwili DD, 2002

Apart from a number of PCs locked away in a school lab, unused because of a lack of a qualified computer science teacher, this DD was one of the first computers in the area. News of the newly installed device quickly spread to the local community. Children crowded around

the DD, jostling for position and a chance to play with the device. The photograph in Figure 4.1 was taken at the official launch of the DD, while the photographs in Figure 4.2 were taken shortly after installation, and illustrate a typical scene at the Cwili site.

Figure 4.2: Collaborative usage amongst users, both young and old, at the Cwili site.

4.3 Subsequent Digital Doorways

The high acceptance of the Cwili DD led to the establishment of a second site, in Mamelodi, Tshwane, Gauteng, in 2003. A decision was taken to move away from the MS Windows operating system and to embrace open source software, in particular Linux. For the Mamelodi site, Debian Linux was installed on the computer. Open source and free software were obtained from various sources (including the Internet and the researcher's colleagues) to make up most of the applications and software content on the DD. The purpose of this software was to encourage users to spend time improving basic computer literacy skills while exploring the content. As in Cwili, security camera footage was recorded at the Mamelodi site, and used to observe social interactions at, and with, the DD.

The DD project proved to be a remarkable success in the opinion of the communities and those who heard about the project; from government officials – particularly the DST – to international visitors, including Dr Mitra (founder of the HITW project), who visited South Africa to visit the DD installations. This led to increased funding from the DST both for deployment of further systems and for directed research to ascertain the viability of such a mechanism to help improve computer literacy in impoverished communities in South Africa through unassisted learning. The number of DD installations increased steadily between 2003 and 2010 (see Section 4.8), employing a design-based research approach, as explained in Section 4.4. Section 4.6 continues this discussion on expansion of the DD project by highlighting improvements to the design that resulted from following this approach.

4.4 Design-based research approach

The following excerpt from the book 'ICTs for Global Development and Sustainability: Practice and Applications' addresses the underlying research design of the DD:

> *'What is the underlying research design of the Digital Doorway? The answer to this question is intrinsically related to the DD's main purpose. Is it an implementation of the emergent discipline of community informatics (CI) or is it first and foremost an educational system? If the former, then its research design requires a theoretical foundation that integrates and directs CI's double agenda of information systems (IS) problem solving and practical community problem solving (Stillman & Linger, 2009). If, on the other hand, it is primarily a technology to support learning, then it requires grounding in a research methodology that emanates from the educational sciences. A study by de Villiers (2007) on interpretive research models for informatics takes cognisance of Walsham's (1995) work on interpretivism and addresses design- and development research which, de Villiers posits, are implemented in IS as design-science research and in educational technology as design-based research' (Gush et al., 2011:103).*

When the DD project commenced in 2002, no explicit research methodology was identified. However, as the project progressed, it became clear that this development was a true implementation of design research (DR) – also known as design-based research (DBR) in the context of education. The main characteristics of DR as laid out by Wilson (2004:82) in an article entitled 'Designing E-Learning Environments for Flexible Activity and Instruction' are:

- Locally situated within a professional or learning context.
- Responds to difficult problems encountered in practice rather than seeking to validate theory.
- Typically, examines whole systems rather than narrow slices of concern.
- Is eclectic in research method.
- Is more concerned with external use and relevance rather than control of internal sources of error.
- Is respectful of practitioner expertise and practices.
- Is somewhat grounded in theory, with theory exploration perhaps a part of the research questions.
- Is aimed to yield knowledge that can be appropriated by practitioners.
- Is concerned about values, equity and justice, not just technical efficiency.

Digital Doorway context and development in the light of Wilson's design research characteristics.

The DDs are indeed locally situated within the learning context, which may be a school, library, community hall or similar site, the idea being to bring technology and content to areas otherwise overlooked in this regard. The project responds to the difficult problem of enabling impoverished communities to acquire computer literacy skills by tackling the problem directly (through actual interventions) rather than seeking to merely validate theory. DDs are concerned with social, technical, and educational challenges. Researchers examine these challenges holistically through various methods such as observation, interviews, and log file analysis. The DDs rely on the expertise of the designers and engineers to achieve a successful installation and are indeed concerned with external use of the systems within a community environment. The theory that under-girds the project is one of unassisted learning and peer-assisted learning, both of which continue to be explored as the project progresses. The knowledge gained from this project can be appropriated by practitioners in other initiatives seeking to increase computer literacy skills in a similar fashion. Finally, by seeking to assist the most impoverished communities in South Africa, it is clear that the DD project is concerned with equity and social justice.

Predictive versus design-based research approaches

Figure 4.3, from Amiel and Reeves (2008:34), highlights the differences between the predictive and design-based research approaches. The third and fourth blocks in the DBR process – iterative cycles of testing and refinement of solutions and practice, and reflection – are particularly appropriate to the DD development and dissemination, which employed, and continue to employ, iterative cycles of design, installation, testing and analysis, reflection, refinement and redesign.

The research and implementation process can be simply described as follows: ‘The project followed an iterative process of design, implement, observe/evaluate, analyse, modify, redesign, implement, observe, ...as the practices of the DD progressed further to meet real-world needs, the iterative research processes became a series of cycles. The underlying research paradigm moved beyond classic action research to become an example of design-based research (DBR)’ (Gush et al., 2011:104). This is shown in Figure 4.4 below.

‘DBR fosters cross-disciplinary work – for example, in the DD project, engineers, educational researchers and sociologists were involved. This collaborative approach leads to insights in unpredictable real-world settings (Kelly, 2003). In complex and ill-structured environments, the design of artefacts and the development of theories proceed concurrently, informing each

other. DBR aims to influence practice with real changes at local level and to develop tangible applications that can be adopted elsewhere' (Gush et al., 2011:105). The valuable learning that has emerged from the DD project is as a result of the typical DD setting: environments with real-world 'messiness' (Kelly, 2003).

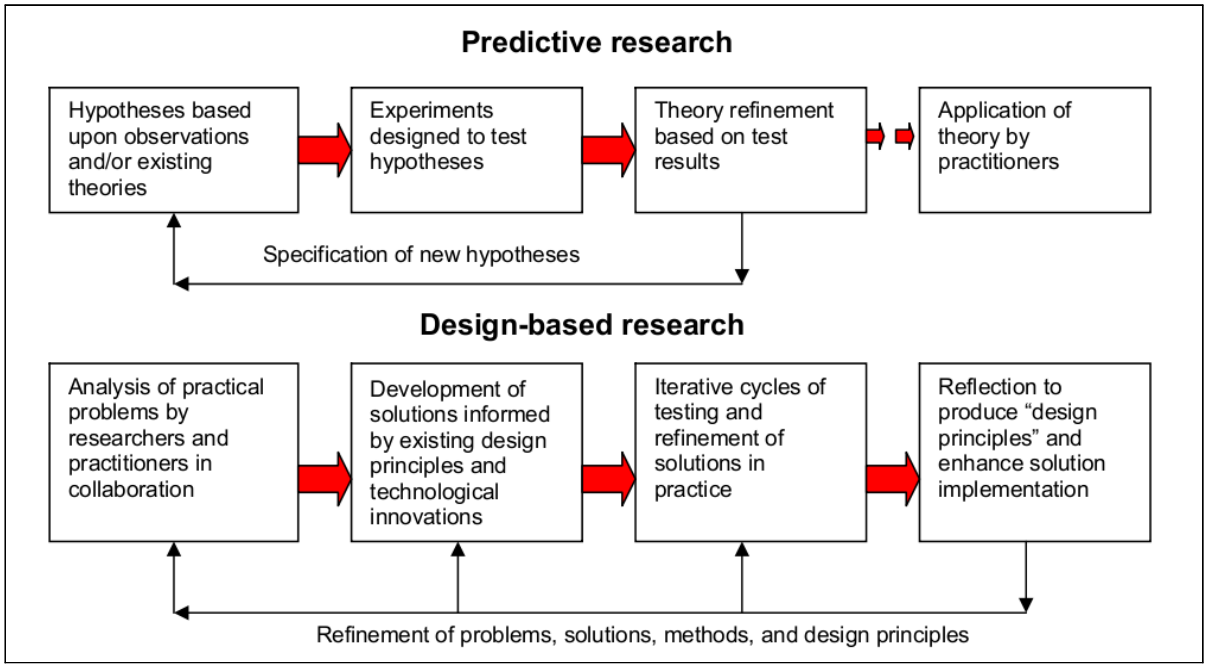


Figure 4.3: Amiel and Reeves (2008:34) diagram: predictive versus DBR

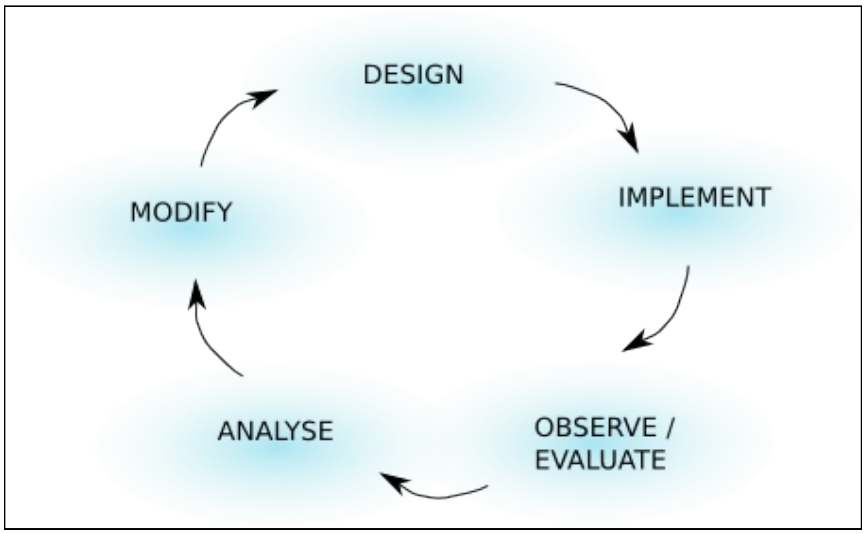


Figure 4.4: Simple representation of the research and implementation process (Gush et al., 2011:104)

Table 4.1 (Gush et al., 2011:107) summarises design-based research model features and their association with Digital Doorway implementations. The features are summarised from studies by Cobb, Confrey, diSessa, Lehrer, and Schauble (2003), The Design-Based Research Collective (2003), Barab and Squire (2004) and Wang and Hannafin (2005) .

Table 4.1: Summary of design-based research models and associated DD features (Gush et al., 2011:107)

Features of DBR models	**Elaboration**	**As implemented in Digital Doorway**
Real-world complex problems	Design theory addresses complex problems in collaboration with practitioners/educators.	Complexities: remote and rural locations; lack of infrastructure; school teachers not computer literate. DD enthuses some of them and they in turn encourage learners to use it.
Problem solutions grounded in pre-existing theories,	Where appropriate theories/principles pre-exist, design should be theory-driven, along with technological affordances, to propose solutions to the problems.	Minimally invasive education/ unassisted learning in India through the 'Hole-in-the-Wall' experiment has been shown to be successful (Mitra, 2000). Children's natural curiosity motivates learning. Peer learning is a valid form of learning (Boud, Cohen & Sampson, 1999). Both curiosity and peer learning are clearly in evidence in the use of DD. Requests by users have contributed to extensions to DD features, making the users co-researchers and 'co-developers'.
Innovation	Underlying innovative approach (Kelly, 2003). DBR should investigate less-common practices and generate technological support; design of innovations, novelty, interventionist approaches.	Solution is unique to Africa in terms of rugged, vandal-proof computer housing when compared to typical lab-based computers. Multi-terminal – social interaction occurs alongside learning. Fully Open Source Operating System and Content. Hardware and Software innovations as detailed elsewhere.
Engineering	Systematic methodology that involves designing and studying means or artefacts of learning.	Usage tracking tools implemented to study learning that has taken place. Statistics gathered on a site by site basis, hard data available. Subjective, qualitative data accumulated through interviews and observation.
Iterative design	Cycles of design, enactment, analysis, redesign.	Following on from first installation in Cwili, hardware and software underwent numerous design changes and improvements based on user co-participation via interviews. Further feedback obtained from observation of user interaction. Sites upgraded when major software releases are available.
Context and environment	Research studies in context, i.e., in naturalistic settings; use of artefacts/ interventions in the real-world; theories also to be contextualised; Responsive to emergent features of the setting (Kelly, 2003).	DDs are located in designated communities where a need is identified. Data gathered on site. Participative workshops involve community-based stakeholders, who offer suggestions. Authentic use in real communities.

Empirical research	Studying tangible, real-world products, which ideally, should be usable elsewhere, i.e., influence on teaching, learning and training practice. Data collection and analysis.	Data collection through observation of learners and video data, interviews and surveys. Instruments: automated logging/recording of usage statistics. Knowledge obtained from these systems transferable to similar installations elsewhere.
Participants as collaborators	Participants are not merely subjects, but can be co-participants in the research.	In day- or half-day workshops, community leaders and, in some cases, other community members joined Meraka researchers as co-participants to discuss aspects of DD implementation and usage.
Refining the artefact/system	Using formative evaluation to derive research findings; design and explore artefacts, environments, etc. with rigorous inquiry methods to refine them and define new design principles.	Hardware progression from single terminal to 4-terminal to space-saving 3-terminal. Further work led to a DD for disabled users and a desktop variety. Software refined based on experience gained from previous versions. Content increased to meet the needs of the users.
Output products: Useful real-world products Development of theory	Real-world products: technical and methodological tools; frameworks; interventions; curricula. These offer immediate value in the environment of use. Theories that are generated, evaluated and refined in a reflective cycle. They provide a set of theoretical constructs that can be transferred and adapted beyond the initial environment.	Success of initial prototypes led to roll-out of more DDs. Poor electricity supply at some sites and unsuitable venues led to solar-powered DD container. Desktop-unit, single-terminal DD. Production of a DD Software DVD. Teachers (e.g., Gatang high school) realised the value of the DD as an information resource, sending pupils there to do homework research. Theories developed around effective and ineffective systems (deployment strategies) and dealing with the rural context in the design of technology.
Pragmatic	The theories developed should do real work and be supported by evidence-based claims about learning.	The success of the DD in teaching basic ICT literacy has resulted in the deployment of multiple machines, nation-wide. Evidence seen in the feedback received, and social assessment of users.
Synergy	Design and research; theory and practice; are advanced concurrently.	Project has a deployment and research phase, mutually feeding into and affecting each other.

4.5 Evaluation

Validation is ‘the process of testing whether the program meets its goals in the real learning environment’ and ‘the true test of a program occurs when it is exposed to a large number of learners in their natural setting for learning’ (Alessi and Trollip, 2001:553).

What has been said about validation of software, can be applied to the entire Digital Doorway solution and its evaluation, or to rephrase Alessi by replacing certain terms: the true test of a Digital Doorway occurs when it is exposed to a large number of users in their natural setting.

Four levels of evaluating instructional multimedia, initially proposed by Donald KirkPatrick, are mentioned by Alessi and Trollip (KirkPatrick, 1998, cited in Alessi and Trollip, 2001). These levels for training in general, are:

1) Assessing reaction and attitude – how much do users like it?
2) Assessing learning – are users learning what was intended?
3) Assessing behaviour change in the intended environment – are learners using what they have learned?
4) Assessing results and return on investment – was the system worth all the effort?

The present study into application usage, is a major component in the current assessment of DDs (see Figure 4.4). It provides insight about reactions to, and attitudes towards, the DDs, as well as insight into usage of content. In addition, usage analysis is an important cog in the DBR approach, where one of the goals is to improve the inbuilt software applications in terms of relevance and effectiveness, through an iterative process.

While DBR is the research paradigm underlying the *general* cyclic development, evaluation, and progression of the DD, the *particular* methodology of the present study is a mixed-methods approach, comprising a quantitative study and a qualitative study (see Chapter 5, on research design and methodology).

'The computer tool most overlooked for evaluation is the learning program itself. A program may have built-in collection of data that will assist in its own evaluation' (Alessi & Trollip, 2001:557). Chapter 6, on quantitative analysis of log files, demonstrates the value of using the 'program' itself for evaluation. This study, together with Gush (2008), forms the first comprehensive study of application and user logs. The qualitative studies discussed in Chapter 7, provide further insight into application usage.

4.6 Digital Doorway design improvements

Table 4.2 highlights some of the issues and problems that became evident after installation, as well as corresponding improvements that were implemented in subsequent designs. The issues encountered, ranged from social to technical. Solutions were informed by observations and feedback from actual implementations and evaluations in the field, as described in Section 4.4 (see Figure 4.4), making this a true case of on-site learning.

Table 4.2: Design improvements

	Issue/Problem	Improvement
1	Difficulty experienced by non-English speaking users in understanding the log in procedure and supporting tutorials	Catering for multiple languages through the translation of on-screen instructions and tutorial menus.
2	Difficulty experienced by system maintainers in performing remote management and monitoring on the proprietary operating system (MS Windows). Inability to customise closed (non open source) code.	Improvement of remote monitoring and management of systems as well as customisation facilities for the software, by moving from a proprietary (MS Windows) operating system with closed (non-modifiable) code, to an open source operating system with open (modifiable) code.
3	Crowding around DD terminals, and the restrictions resulting from many users at a single terminal.	Progression from a single terminal device to a multi-terminal device.
4	Damage and wear-and-tear to the keyboards over time, due to frequent use in an unsupervised context.	Progression from low-quality plastic keyboards, through 'industrial' keyboards, to final establishment of expensive metal vandal-proof keyboards with touch-pads.
5	Lack of direct feedback from he community. The need for cleaning and turning on and off the DD.	Appointment of site champions.
6	The need to obtain user experience feedback/suggestions/requests	Implementation of a software feedback mechanism where users can input text into a form that gets sent back to a central server.
7	Content not always relevant to users in rural areas.	Provision of additional content focused on the needs of rural areas (e.g., agriculture, finding employment, HIV-AIDS information).
8	Physical location of the DD (e.g., enclosed room versus open verandah); the impact of this on who used the DD.	Discerning selection of physical locations of DD housing, taking into account each particular context and environment.
9	Desktop and file system liable to become 'cluttered' due to extensive use of the same guest accounts over weeks and months.	The use of scripts to restore guest user accounts on a daily basis.
10	The need to understand application usage and demographic information of users.	The implementation of user detail logging and application usage logging for improved understanding of user demographics and application usage.
11	Requests from users for functionality to enable them to save their work or content from the DD on a personal device.	The provision (at certain sites) of external USB ports to allow external access to information on the DD.
12	Slots or openings on the housing would attract bubble gum or other detritus.	The provision of wireless (bluetooth) dongle and software to enable downloading of information to cell phones.

13	Typical multi-user, time-limited interactions at DDs made it difficult for users to study complex material in depth	The addition of content (e.g., short video clips and reference material) more suited to a public kiosk environment where long-term in-depth study is not feasible.

Figure 4.5 below (Gush et al., 2011) demonstrates the progression of the digital doorway hardware configurations over time. This depicts the researchers' and developers' responses to the issues outlined in rows 3 and 4 of Table 4.2.

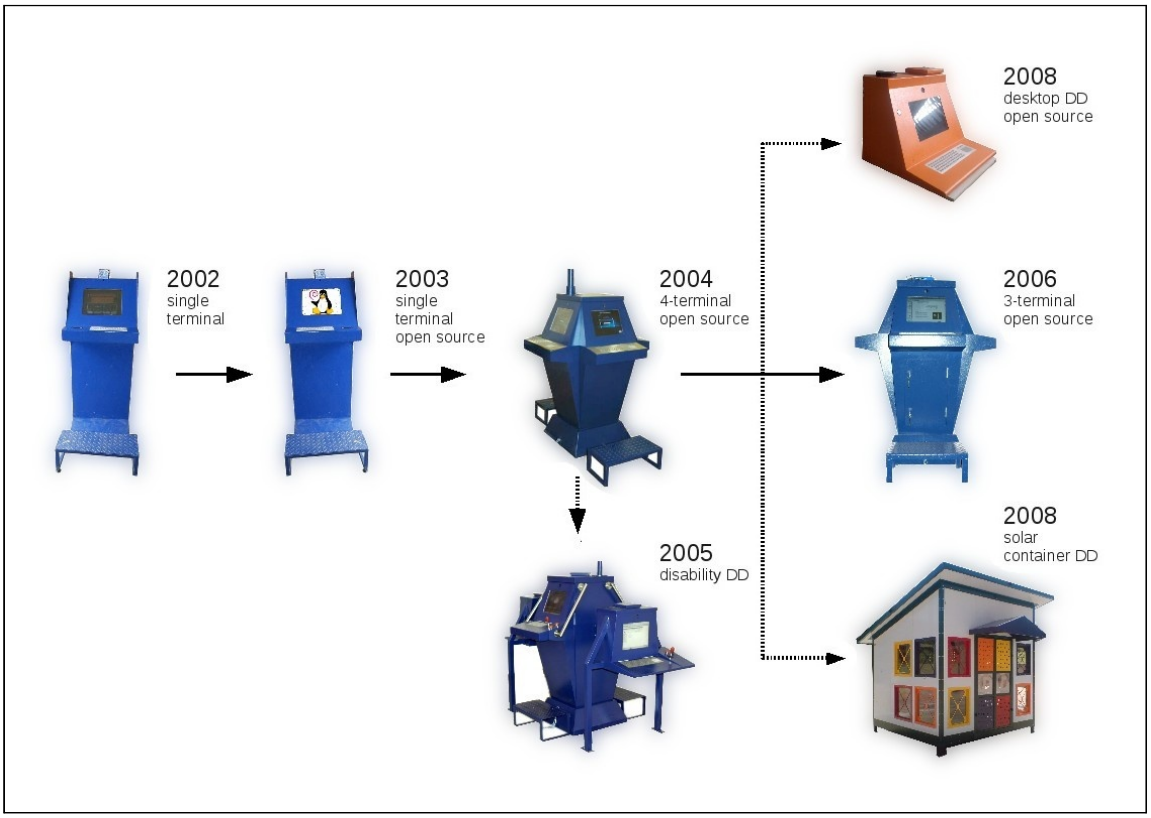


Figure 4.5: Digital Doorway hardware variations

As mentioned earlier, the DD began, in 2002, as a single-terminal Windows-based DD, changing to open source operating system and content in 2003. The plastic keyboards were upgraded to vandal-proof metal keyboards. The need to cater for more users simultaneously, prompted the design of a multiple-terminal 'thin-client' device in 2004. Furthermore, in 2005, a DD was designed specially for disabled users, with wheel-chair access, grab handles and the touch-pad being replaced with a joystick and large buttons. In 2006, a multi-terminal 'fat-client' solution was developed and the terminals reduced to three, for purposes of cost saving and to allow the DD to be installed in more space-limited environments. In 2008, a desktop single-seater DD was developed, as well as a 3-terminal solar powered 'container DD' able to operate in remote locations without requiring an external electricity supply.

Table 4.3, from Gush, de Villiers et al. (2011), highlights the key milestones of the DD project from initial catalyst to current deployment status.

Table 4.3: Digital Doorway time line (Gush et al., 2011:99)

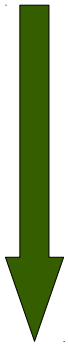
Year	Digital Doorway milestone
1999	Dr Sugata Mitra of NIIT, India trials a mechanism to observe 'unassisted learning' of a computer system in his 'Hole In The Wall' (HITW) project
2000-2001	Mitra's MIE concept proven to be successful in India (Mitra, 2000)
2002	Digital Doorway project commences in South Africa with introduction of single-terminal device (Gush, Smith & Cambridge, 2004)
2002-2004	Similar findings on the success of unassisted learning validated in South Africa
2003	Migration to fully open source software begins with the introduction of the Debian operating system (Gush, 2004)
2004	4-terminal DD housings introduced, together with improved open source based operating system
2005	Project expanded to 24 diverse sites around South Africa for comparison purposes
2006	Xubuntu 3-terminal disk-less 'fat client' solution developed
2007	Project expansion to 100+ three-terminal sites, software refinement, initial wireless network integration prototypes
2008	Further scaling up (deployment of over 200 units) and system refinement. Additional single-terminal desktop system designed. Prototype solar-powered standalone container system developed
2009	Solar powered container systems deployed in rural locations. Formulation of an independent entity to manage installation and maintenance of DDs commences.

As was stated earlier, the development process was one of design-implement-analyse-improve-implement, and followed the design research (DR) approach, which in the context of educational technology is termed design-based research (DBR) (see Section 4.4).

4.7 Progressive expansion of Digital Doorway pedagogical goals

The primary goal of the DD is to provide a technological enabler that moves the learner from a state of ignorance of computers and their use (novice user), to a state of competence (experienced user). No time frame is specified for this process as the user is self-taught and self-directed. This goal may be broken into a discrete set of progressively more involved pedagogical sub-goals, as illustrated in Table 4.4.

Table 4.4: Progressively more involved pedagogical goals of the DD

Experience Level	Development	Detail
Novice user	Exposure to a computer system	User becomes aware that computers exist and include various hardware components
	↓	
	Basic screen, keyboard and touch-pad functionality	User makes an association between touch-pad activity and mouse cursor movement on screen
		User makes an association between typing on the keyboard and corresponding letters appearing on the screen
		User is able to log in to the system following on-screen instructions or peer-observed behaviour
	↓	
	Basic menu and desktop navigation	User is able to navigate the menu system using the touch-pad; opening applications by clicking on menu items and desktop icons
	↓	
	Development of touch-pad hand-eye coordination, improving keyboard skills and moving from random exploration to deliberate usage	User is able to play games, launch videos and edutainment software, explore office applications
	↓	
	Development of information literacy skills	User is able to use content as material reference for personal study or school project research
	↓	
	E-learning by means of the curriculum-based and non-curriculum-based education software	User is able to locate specific educational content and engage with that content in such a way that the material is assimilated
	↓	
Experienced user	Creation of meaningful content, providing feedback and downloading information for subsequent use away from the DD	Users have reached the point where they are able to generate their own content, provide informed feedback of their experience on the digital doorway and be able to take self-generated and other content away with them

In addition to the pedagogical goals outlined above, the ongoing high-level objectives of the project (Gush et al., 2011) are to:

- Narrow the digital divide;
- Provide technology for social inclusion;
- Prepare users, both young and old, for the information society;
- Expose users in previously disadvantaged areas to computer technology;
- Provide meaningful software and content to underprivileged communities; and
- Provide support structures and relevant information for learners undertaking formal education.

4.8 Massification Phase

By 2010, a total of 210 South African installations (Figure 4.6) and 30 international installations (Uganda, Lesotho, Ethiopia) had been rolled out. This study is concerned with a typical subset of the South African sites and the analysis of data accumulated over a number of years from these sites. The criterion-based selection of participatory sites and the research methods are described in Chapter 5. The map below (Figure 4.6) indicates the location of all the South African sites in 2009 – see Digital Doorway website (2010).

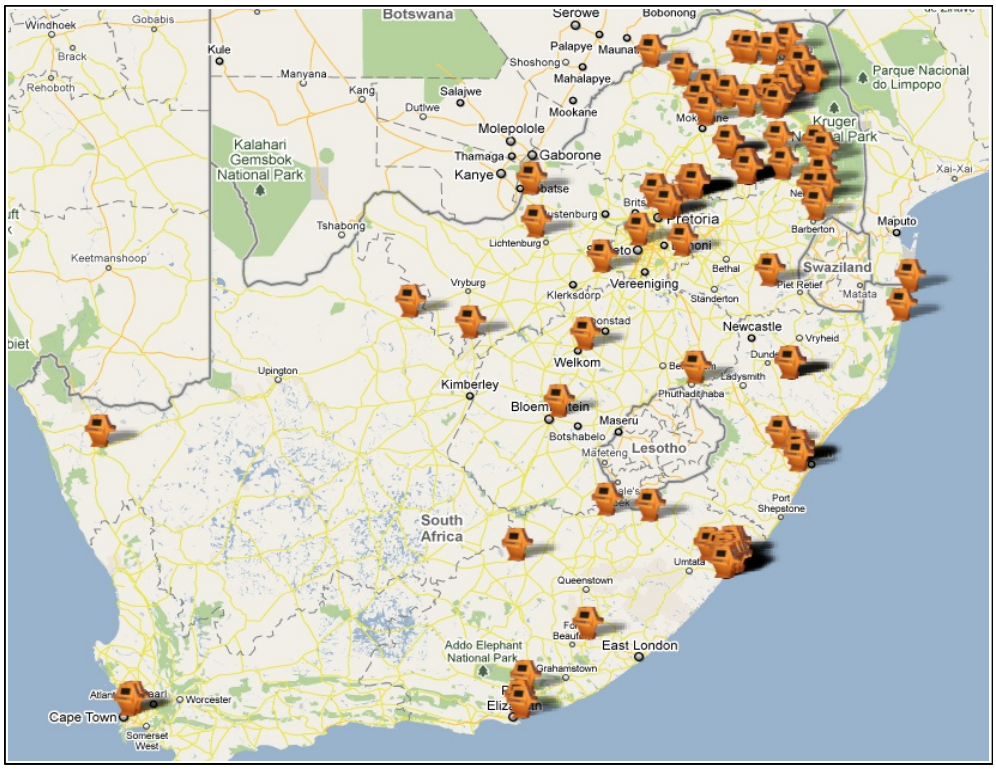


Figure 4.6: Digital Doorway sites as of March 2009.

4.9 Hardware and software specifications

The current DD sites consist of a variety of hardware configurations, from single-terminal to 4-terminal systems (see Figure 4.5). The installations selected for this study, are 3-terminal systems, with the following characteristics :

- A server/client combination powered by a customised Ubuntu Linux operating system running the lightweight XFCE windows manager. (The splash screen, login screen and desktop are all themed to a Digital Doorway theme.)
- Three terminals, made up of the server and two 'fat clients' which use the server as a file server, but with the applications running in the memory of the client machines (reducing the load on the server CPU).
- Applications and resources accessible to all three terminals, each terminal able to be used independently of the other.

Figure 4.7 and 4.8 present a hardware breakdown of the 3-terminal DD. The first figure includes a list of the hardware components making up the housing, the server, and the client. The second figure shows a top view of the 3-terminal system.

Hardware:

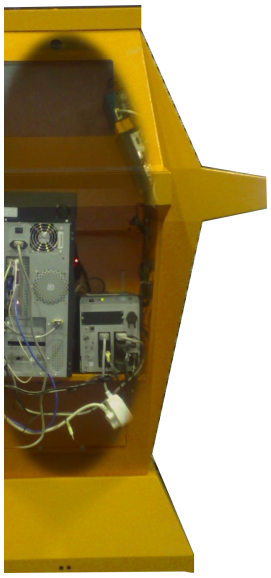
- 1 server and 2 clients per housing
- 15 or 17" LCD screens with protective acro-glass
- Metal keyboards with inbuilt touch-pad
- UPS
- Switch
- GPRS modem
- Mindset server
- Satellite dish
- Cooling fan

Server:

- 2.2 GHz CPU
- 1 Gig Ram
- 250G Hard drive
- Web-cam
- Speakers
- Bluetooth adapter

Client:

- 1.5 Ghz CPU
- 512 Meg Ram
- Web-cam
- Speakers
- No hard drive



Cross section, showing server and UPS inside housing

Figure 4.7: Digital Doorway physical characteristics

By default, no external USB port is installed in the device due to its vulnerability to damage, however some of the installations (4 or 5 machines) have had them installed on request.

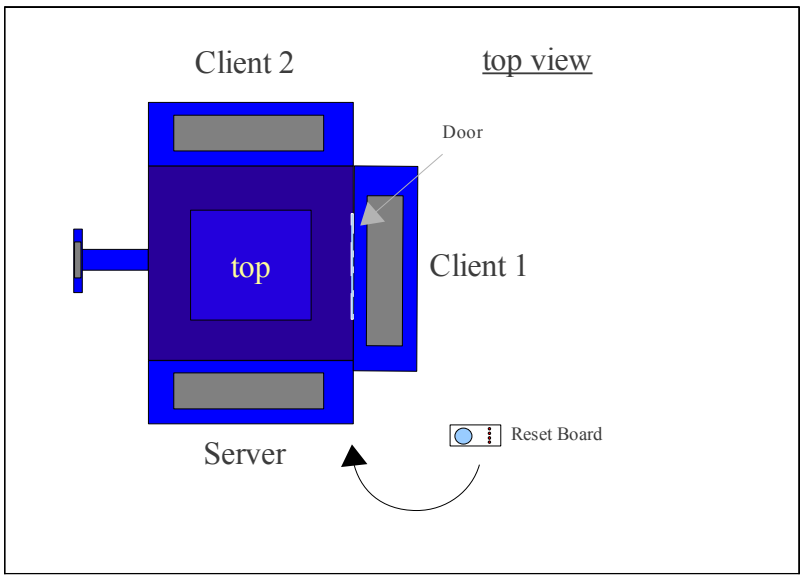


Figure 4.8: Top view, showing the server and client positions

4.10 Software applications used as content

Relevant and engaging software is essential to any meaningful computer experience. Since its inception, the DDs have seen numerous iterations of software applications. Figures 4.9 and 4.10 list the types of content available on the DDs under investigation in this study. Only the first-tier menu structure is shown. A full list of applications is available on the attached CD. Each of the applications on the DD is assigned to a broad general category, and to a specific category for more meaningful analysis. This categorisation step is outlined in Chapter 5.

The following icons are present on the user desktop (not shown here), and visible after logging in:

- DD Tutorials (Flash-based demonstration tutorials of basic interactions that a user can perform on the DD);
- Themba's Journey (A locally produced life-skills game);
- WhatWhat Mzansi (A locally produced quiz game).

The rest of the applications and content are accessible from within one of two task-bar menus: the first is the ‘programs menu’ (Figure 4.9 and Table 4.5); the second is the ‘resources menu’ (Figure 4.10 and Table 4.6).

The ‘Digital Doorway Home’ or *DDhomepage,* presents users with information about the DD project, and links to various content resources. In addition, a user feedback mechanism allows users to key in opinions of the DD experience and suggest additional content to be included. This feedback is logged, and transmitted to the DD developers.

Figure 4.9: First-tier 'Programs' menu

Figure 4.10: First-tier 'Resources' menu

Table 4.5: Programs menu, first-tier items and categories

DDhomepage	Information on the project, user feedback form and links to popular resources
File-manager	Application to allow navigation of all files on the DD
Web-cam	Simple web-cam viewing application
Edutainment/	Sub menu containing edutainment applications
Office/	Sub menu containing office applications (e.g., word processor, spreadsheet)
Games/	Sub menu containing games
Internet/	Sub menu containing Firefox browser and applications for inter-DD comms
Science/	Sub menu containing science simulations and various science applications
Run Custom Program	Quick launcher for any program whose name is known to the user

Table 4.6: Resources menu (first-tier)

Mindset	Curriculum-based content (grades 10-12)
Simulations	Science simulations, direct link
Wikipedia	Encyclopaedia, direct link
Agriculture/	Sub menu of agricultural documents
AudioBooks/	Sub menu of audio clips
Computers/	Sub menu of computer-programming documents
Crafts/	Sub menu of craft related documents
Fun/	Sub menu of various fun documents and movies
Health+Safety/	Sub menu of electricity safety and health information
Literature/	Sub menu of literature resources
RealWorld/	Sub menu of documents related to employment and policies
Science/	Sub menu of science documents and videos

4.11 Context of use

This section describes the environmental factors and requirements present at a typical DD installation site. Environmental requirements – context of use – of a human-computer system are described by Sharp, Preece and Rogers (2007), and comprise four components, namely:

i) Physical environment;

ii) Social environment;

iii) Organisational environment; and

iv) Technical environment.

These are used as sub-headers to structure the discussion following.

4.11.1 Physical environment

The physical environment in which a DD is located is typically on a verandah of a public building (such as a library, school or post office), and therefore exposed to dust and high temperatures on hot days. The area immediately around the device may become crowded (see Figure 4.11, captured from a security camera video) and noisy, affecting usage, both in terms of content choice and the ability of a user to absorb information.

Figure 4.11: Space is at a premium at the single terminal device.

The plexi-glass protective screens over the LCD screens pick up dirt and scratches over time and result in reduced screen visibility. Certain terminals facing outwards from a verandah are effected by sunlight reflecting off the screens during the day, reducing visibility and

consequently the physical usability of the content. This impacts negatively on usage and on the ability of users to control their DD experience,

The image in Figure 4.12 below shows an extreme case of poor visibility affecting usage and usability, while Figure 4.13 shows the wear and tear on the keyboard and touch-pad after a number of years in the field. Figure 4.13 is also a good indication that the DD is being well used. The four arrow keys, enter key, and left touch-pad button are the most worn, while the blue powder coating around the edge of the keyboard has been worn off by hands repeatedly rubbing against it.

Figure 4.12: Visibility of content reduced by reflections off a scratched and dirty screen.

Figure 4.13: Wear and tear on touch-pad

4.11.2 Social environment

The social environment, especially during the first few weeks of installation of a new DD, is typically one of crowded, interested collaboration. Younger users tend to jostle each other for position and an opportunity to use the device. Older users are more cautious and likely to request instruction from a site administrator (or researcher).

In Figure 4.14 we observe how children (mostly females in this instance) crowd around the single terminal device in Cwili, while the official site champion (or caretaker), looks on and provides some verbal assistance.

Figure 4.14: Children and community champion interact at the single terminal device

Figures 4.15a and 4.15b show both the crowded interactions around a multi-terminal DD, and the collaboration that takes place between users. These two static pictures are extracted from video footage. On the video, it was observed that the users in the white cap and brown hat communicated with each other, exchanged terminals and at one point even exchanged hats! Moreover, it was evident that they were demonstrating various aspects to each other that they had discovered in their process of exploration.

Figure 4.15a: Interaction around a multi-terminal DD: notice users in brown and white hats

Figure 4.15b: These users have swapped hats as well as learning!

4.11.3 Organisational environment

Most DD are characterised by a low level of organisation. Training is through self-instruction and peer-instruction and is supplemented by the software tutorials available on the device itself. Users are free to come and go at will and use the device in their own time and in their own way. Certain sites where administrators are involved, display periods of greater organisation, e.g., a teacher sends learners to find specific information from the DD. In the case of one primary school, teachers arranged sessions during the school timetable, for different classes to use the DD.

Reliance on a site champion or site administrator to provide information regarding DD damage or malfunctioning to maintenance contractors, has proved problematic in the past. Lost telephone numbers, site champion moving location, and general apathy, have all been factors in the past.

4.11.4 Technical environment

In the most rural and impoverished communities, the technical environment of a DD installation presents users with technological complexities not previously encountered. On arrival at the DD for the first time, users are required to grasp the functionality of a screen, keyboard and touch-pad, if they are to interact with the device. The site administrator is not expected to train users, but is required to understand the technicalities of switching the device on and off, as well as resetting it if necessary. In addition, a set of indicator lights beneath one of the terminals allow the administrator to report back on the status of power to the device as a whole, the UPS, each of the three terminals, and the communications server. Electricity is a requirement at the site, but one of the greatest challenges in some communities is the continuous provision of stable electricity to the DD.

4.12 Effective versus ineffective installations

Gush, de Villiers, Smith, and Cambridge (2011), in the book 'ICTs for Global Development and Sustainability: Practice and Applications', describe effective and ineffective installations:

Ineffective installation

'In an ineffective system, (Figure 4.16 in this dissertation), the device is installed in the community and, possibly following some apprehension from some of the community members about the purpose of this strange new box, excitement builds up about having access to a computer for the first time. In the weeks and months after installation, the community

becomes familiar with the device and if there is no updating of content – possible via a satellite download – then users become bored and interest wanes. If there is no hardware maintenance, eventually a component will fail and the community is left with a white elephant. The resulting disillusionment of community members leaves the community in a state worse than before the device was installed. ' (Gush et al., 2011:117).

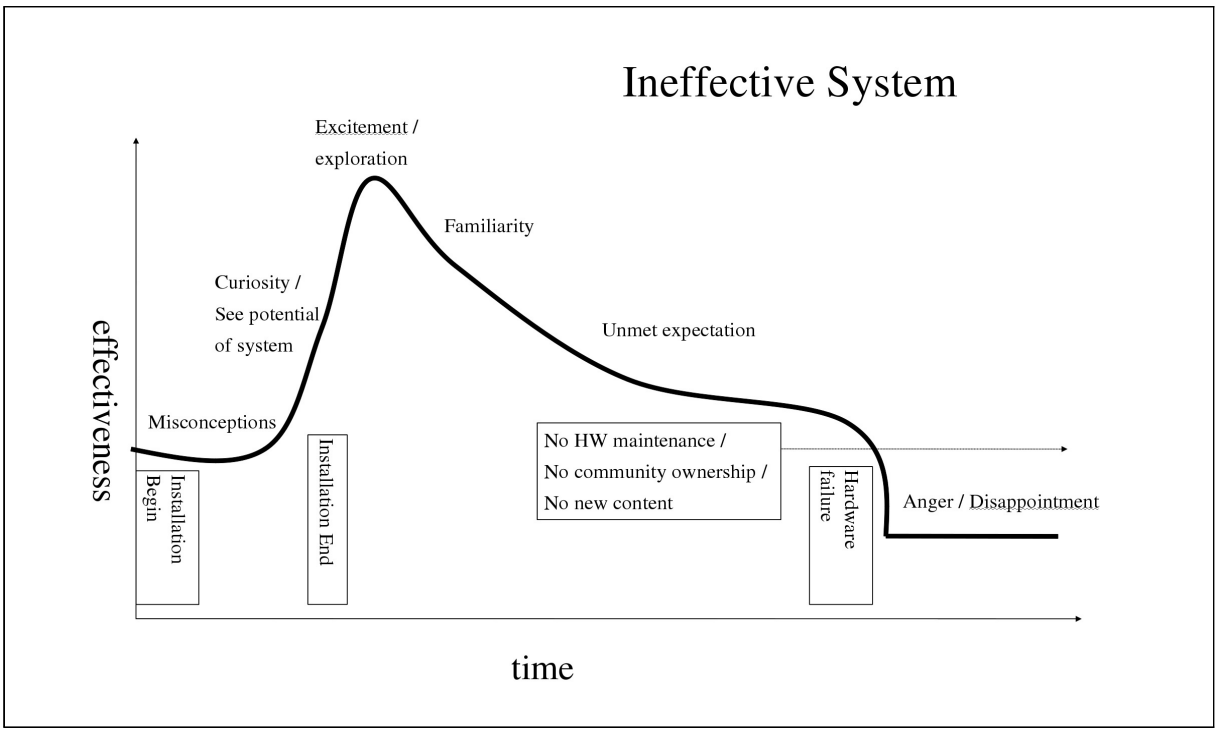


Figure 4.16: Ineffective system (Gush et al., 2011)

Effective installation

'In an effective system, (Figure 4.17 in this dissertation), the content is updated regularly, and proper system maintenance is carried out. Failing components are repaired or replaced within a few days of failure. The community is involved from the outset and users take ownership of the equipment (cleaning the device and surrounding area, advertising the fact that the DD exists, informing maintenance teams of failures). The level of computer literacy of users increases. Users regularly use the device both for learning and fact finding. Peer learning takes place as knowledge is transferred between users. Proficient users are eventually able to generate their own content and the device is an undisputed boon to the community. Experience has shown that the DD sites which become ineffective over time, do so due to two main reasons: firstly, hardware failure - due to a lack of adequate system maintenance and a lack of community 'ownership' of the unit - and secondly, lack of new and stimulating content. On the other hand, where community ownership, proper system maintenance and relevant content updates are present, the site grows in popularity and becomes effective in terms of ICT literacy and community engagement. ' (Gush et al., 2011:118).

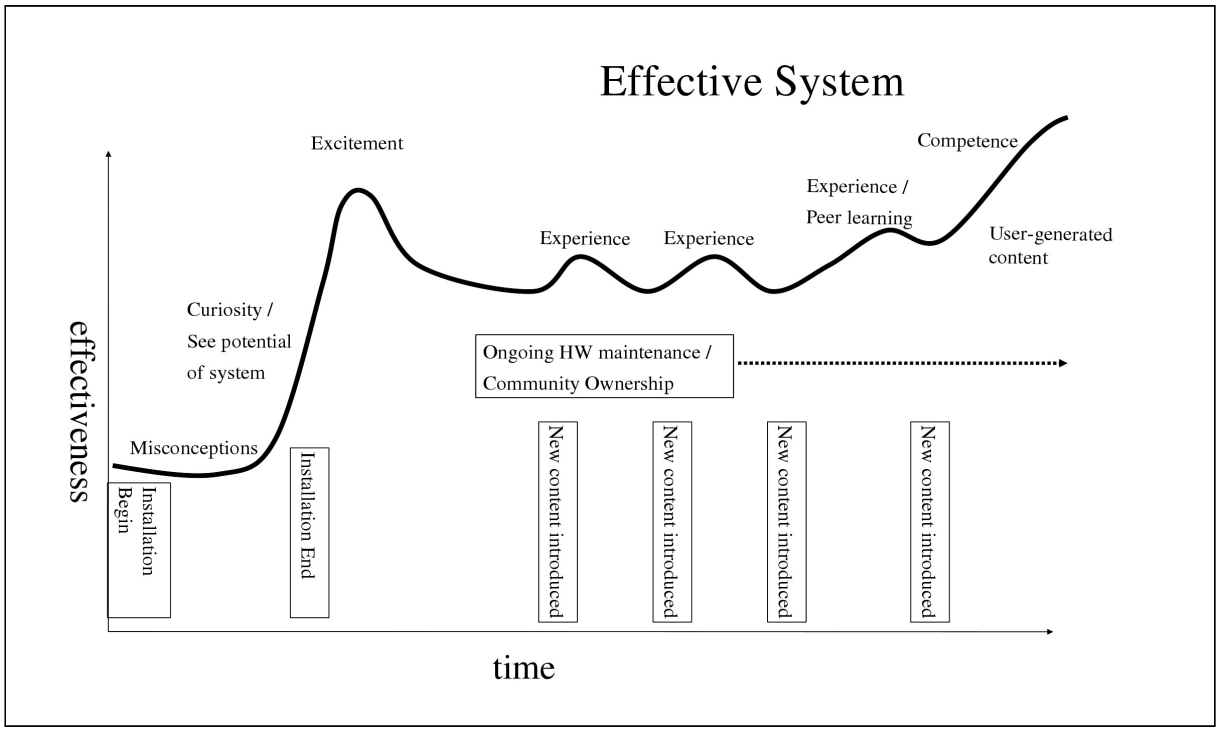


Figure 4.17: Effective system (Gush et al., 2011)

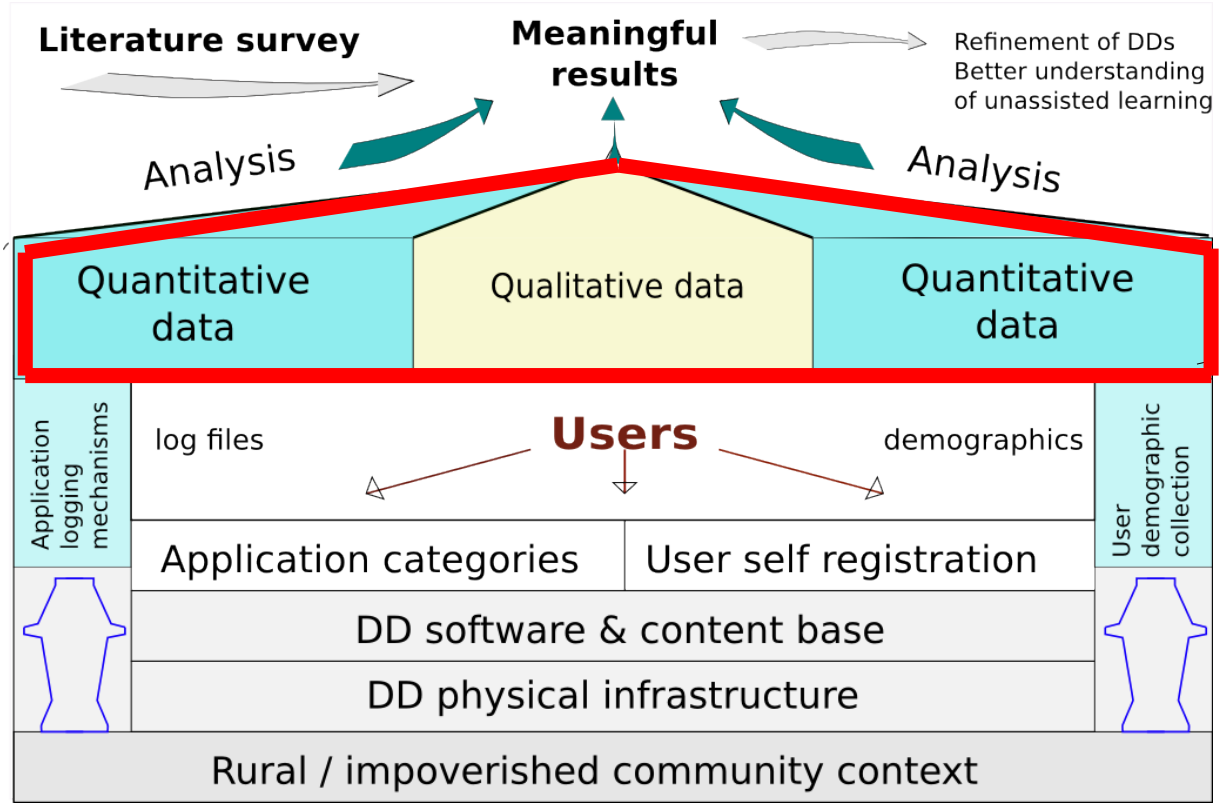
This study aims to assist in the assessment of application usage, establishing its nature and relationship to user demographics and site location, in order to better inform the provision of future content. In this way, the study can contribute to more effective DD installations in the longer term. The following chapter provides a broad overview of the research design and methodology employed to reach this aim.

4.13 Summary of chapter

This chapter provided background information to the Digital Doorway project, from the first installation in Cwili, to the massification phase. The underlying approach of design-based research to the DDs life-cycle from its inception onwards, was discussed, and various design improvements highlighted. The chapter looked at the different pedagogical goals of the DD from those for novice users through to experienced users. Hardware and software specifications were presented, and the typical context of use described, including the physical, social, organisational and technical environments. Finally, graphs of effective versus ineffective installations were included and discussed. The chapter sought to provide a rich contextual background to the quantitative and qualitative studies of software application usage discussed in subsequent chapters.

– 5 –

Research design and methodology



I keep six honest serving-men

(They taught me all I knew);

Their names are What and Why and When

And How and Where and Who.

– Rudyard Kipling

5.1 Introduction

This chapter addresses the research design of the current study, detailing aspects of: overall research design and process; research methods and methodologies; data collection methods for both quantitative and qualitative components of the mixed-methods approach; site selection for quantitative log file analysis; site and participant selection for qualitative studies; categorisation of data; data cleaning approaches; and an overview of the data analysis approaches. Sections 5.2 and 5.3 provide an overview of the research design, processes and methods. Section 5.4 tabulates where, within the study, the research questions are addressed directly. Section 5.5 outlines the quantitative study, while Section 5.6 outlines the qualitative study.

5.2 Overall research design and process

The underlying research model of the study was presented in Section 1.4.2 (See Figure 1.4), and is repeated here as Figure 5.1.

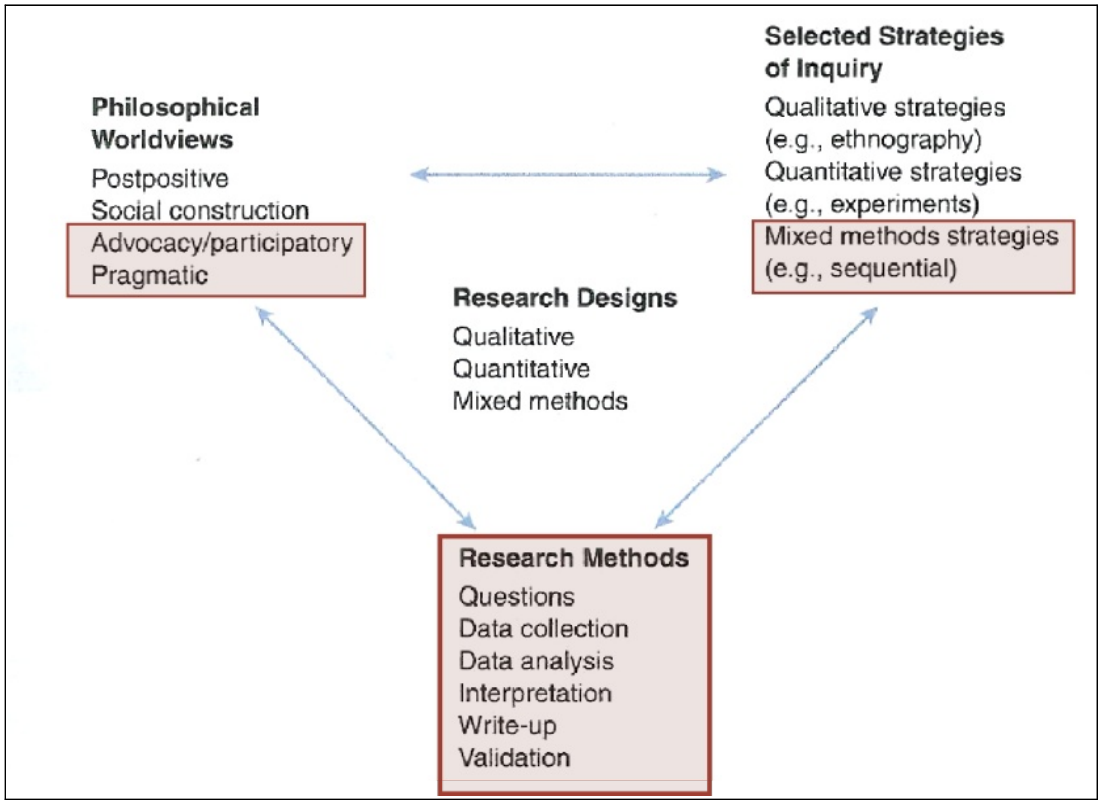


Figure 5.1: Research design, adapted from Creswell (2009:5)

Using this framework as a guide, it emerges that this study contains the following elements:

Philosophical worldviews: The philosphical worldview could be described as advocacy/ participatory as well as pragmatic. It is of an advocacy/participatory nature in that there are

issues of social justice that need to be addressed (inadequate education in impoverished communities). This is in line with Creswell's description of research that 'contains an action agenda for reform that may change the lives of the participants, the institutions in which individuals work or live, and the researcher's life' (Creswell 2009:9). The social issue of inequality is being addressed and the worldview is concerned with focusing on the needs of marginalised individuals, bringing about change in practices, helping self-development and self-determination in a practical way.

It is pragmatic in that the research results from 'actions, situations and consequences' (Creswell, 2009:10), in that it emphasises the research problem (lack of computer literacy) and uses all approaches available to understand the problem by using a mixed-methods approach.

Selected strategy of enquiry: This is a mixed-methods approach, comprising both qualitative and quantitative strategies. Details of the quantitative component (a multi-site survey, with log-files as data) are covered in Chapter 6, while the qualitative component (a case study consisting of four cases) is covered in Chapter 7.

Research methods: The research methods involve initial research question formulation; various data collection methods involving log file analysis, interviews, naturalistic observation, and questionnaires; data analysis; interpretation; write-up; and validation.

The research process was presented in Section 1.4.3. A simplified representation of the various processes (Figure 1.5), is repeated below as Figure 5.2, and illustrates the stages up to quantitative and qualitative data analysis.

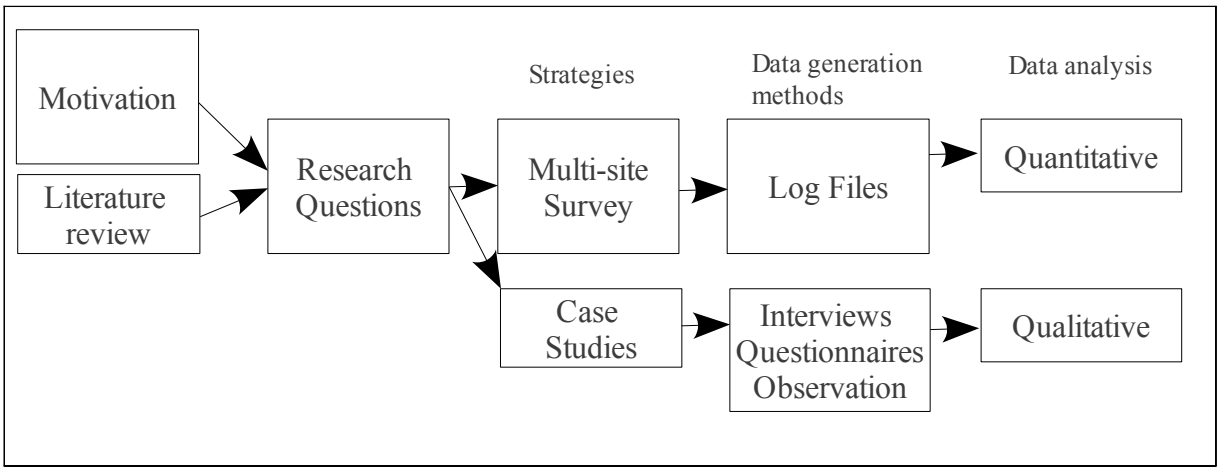


Figure 5.2: Research process, adapted from Oates (2006:33)

According to Oates (2006:35), a survey 'focuses on obtaining the same kinds of data from a large group of people (or events), in a standardised and systematic way. You then look for

patterns in the data using statistics so that you can generalise to a larger population than the group you targeted'. That is the approach used in the quantitative section of this study, where the log files make up the survey data, collected from a large group of people and events in a standardised and systematic way.

A case study 'focuses on one instance of the 'thing' that is to be investigated... the aim is to obtain a rich, detailed insight into the 'life' of that case and its complex relationships and processes' (Oates, 2006:35). Individual DD sites were used as case studies for the qualitative section of this study. At each site a number of individuals were interviewed or asked to complete questionnaires in order to obtain a rich detailed insight into usage at those sites.

5.3 Research methods and methodologies overview

A mixed-methods approach to research (Creswell, 2009) uses both quantitative and qualitative methods to arrive at conclusions about a particular subject of interest. Creswell describes quantitative and qualitative research as follows: 'Quantitative research is a means for testing objective theories by examining the relationship among variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures. Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem' (Creswell, 2009:4).

The research is primarily quantitative, with subsequent qualitative methods being used to support and enrich the quantitative methods, i.e., 'QUANT → qual' (Creswell, 2009, see Figure 5.3).

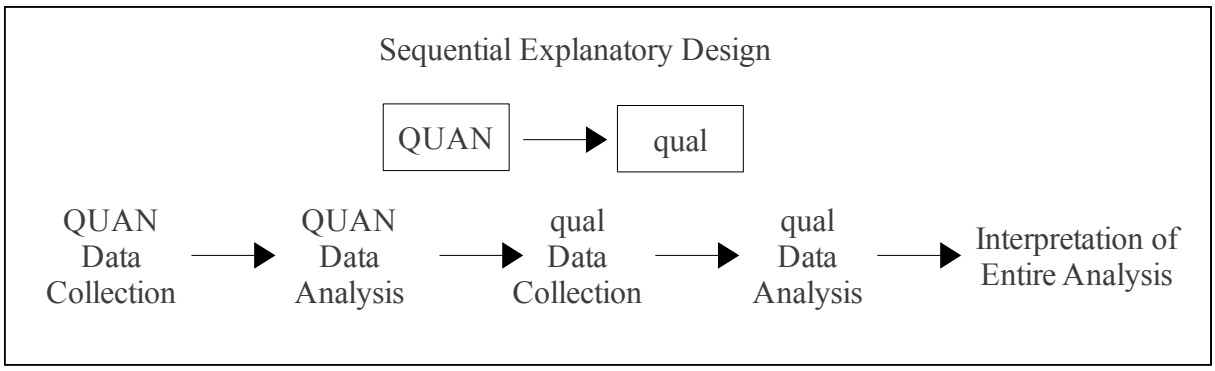


Figure 5.3: Mixed-methods, sequential design (Creswell, 2009)

Computing research may have either a technical, social or philosophical goal. Research with a social goal is best performed by means of literature surveys, surveys, case studies or

experiments, while research with a technical goal is best performed by means of literature surveys, models, languages, mathematical proofs or algorithms (Olivier, 2004:12).

While the primary research goal is a social one (determining relationships between users and usage) the study includes important technical secondary goals to achieve the primary goal. These involved the upfront design and deployment of data processing algorithms and scripting tools to extract crucial information from the log files.

According to Oates (2006) the main research strategies used in IS and computing are surveys, design and creation, experiments, case studies, action research and ethnography, while the main data generation methods are interviews, questionnaires, observation and documents. Applying Olivier's and Oates' concepts, Table 5.1 below illustrates the relationship between the various research methods employed in this study, as shown in Figure 5.2.

Table 5.1: Appropriate research methods for research goals, adapted from Olivier (2004)

	Research Method	Type	Data	Tech-nical	Social	Philo-sophical
Primary Goal *(determine relationships between users and usage)*	Literature Survey		Secondary		x	
	Log files	Quantitative	Primary		x	
	Observations Questionnaires Interviews	Qualitative & quantitative	Primary		x	
Secondary Goal *(data extraction)*	Algorithms (scripting)			x		

The research paradigm of the Digital Doorway project as a whole, in particular its developmental progress and evaluation over time, may be described as one following an action research or design-based research (DBR) strategy (Reason & Bradbury, 2008; Wilson, 2004) – see Section 4.4. However, the research strategy employed in the present research, which represents one cycle in the overall DBR process (see Figures 4.3 and 4.4), is a mixed-methods approach, and can be classified as follows:

- The actual quantitative collection and analysis of data, described in Chapter 6, is a form of survey, involving electronic log files and self-administered online templates. A survey aims to obtain 'the same kinds of data from a large group of people (or events), in a standardized and systematic way' (Oates, 2006).

- The strategy described in Chapter 7 (involving site visits and qualitative data analysis), is one of case studies involving naturalistic observations, researcher-administered paper-based interviews, and self-administered questionnaires.

We use scripting, simple statistical methods, data visualisation, interview and document analysis, to extract the desired information from the raw data, the intended outcomes of the data analysis being:

1. Descriptions and visualisations of typical application usage findings (trends, broad overview).
2. Descriptive case studies of instances of specific application usage (drilling down to key observed aspects).
3. The building up of a clearer picture of user behaviour and environmental aspects at selected DD installations.

5.4 Research questions revisited

Table 5.2 revisits the research questions and the main sections where they are answered:

Table 5.2: Research questions revisited

Number	Research Question	Answered in Section
1	**Given free access to computer infrastructure containing a variety of software applications and content, what categories of applications are used by various age groups on Digital Doorways?**	6.7 8.3
	• What are the general trends amongst all users regarding application usage?	
	• Are there notable relationships between the ages of users and the categories of applications accessed?	
2	**Does gender have an impact on extent of use and on application usage?**	6.8 8.4
	• What are the general trends amongst males and females regarding application usage?	
	• Are there notable relationships between the gender of users and the categories of applications accessed?	
3	**How does the physical situation of the DD installation affect the types of applications accessed?**	6.9 7.5 8.5
	• Does the physical situation of the device (e.g., in a library, a school, a community centre, etc.) affect the types of application that are accessed?	

	• Which applications are underutilised by the intended target groups?	
	• Are there noticeable differences in behaviour around, and usage of, DDs at varying localities?	
	• What is the impact of the site environment on the physical usage?	
4	**What is the relevance and applicability of these results to future unassisted learning terminals?**	6.10 7.6 8.6 8.8
	• Do the results of RQ1, RQ2 and RQ3 help in better understanding the desires and needs of target users?	
	• What lessons are learned for future development, selection and presentation of applications?	

5.5 Quantitative study

This section details the steps taken, and tools created, to do quantitative data analysis on application usage on the DDs. Section 5.5.1 gives a broad overview of the process and outlines the main steps necessary to process the available log files. Section 5.5.2 explains the data collection process, and Section 5.5.3 describes the categorisation of data elements. Section 5.5.4 highlights the process of selecting specific sites to investigate in this study Finally, Section 5.5.5 overviews the key elements in the quantitative analysis of the data.

5.5.1 Quantitative data processing, overview

Over the years, large quantities of DD data on user demographics and application usage have been recorded by various means, including electronic log files and user-generated information. A huge volume of information is available from the 200+ sites, most of it formally extracted since 2007 or 2008 (see Table 6.4), although many sites have been in operation considerably longer. In addition to the complexity of processing thousands of lines of log files, a further complexity was presented by the heterogeneity due to varying types and structures of data stored in these logs.

The log file analysis set out to quantitatively answer the first three research questions of the study, listed in Section 5.4 – regarding application usage data and its relation to user demographics, as well as provide data to help answer Research Question 4. The purpose is to better understand both the user base and interaction with the systems. The quantitative study also aimed to draw out further research questions that could subsequently be answered through the qualitative research covered in Chapter 7. However, before the data could be effectively used, various sub-processes had to be conducted.

The main steps of the data collection and analysis processes were to:

1) Design and implement shell scripts to systematically process raw data and extract salient information from the quantitative log files.
2) Retrieve all available raw data on users, age, gender and application usage from all sites currently installed and communicating.
3) Do data cleaning (refer to Section 6.3 later).
4) Categorise and combine data elements (see Section 5.5.3).
5) Identify subset of sites with large quantities of usable data (see Figure 6.9).
6) Narrow site selection down to ten sites, representative of different areas (school, library, community centre).
7) Do analysis of the ten sites.
8) Perform statistical analysis where appropriate.
9) Visualise significant relationships between categorised data.

Figure 5.4 illustrates the main steps in moving from copious amounts of raw data to meaningful visualisations. Data-processing tools were employed, or newly custom-built by the researcher, to filter, categorise, combine and analyse data – see Chapter 6, Section 6.4.

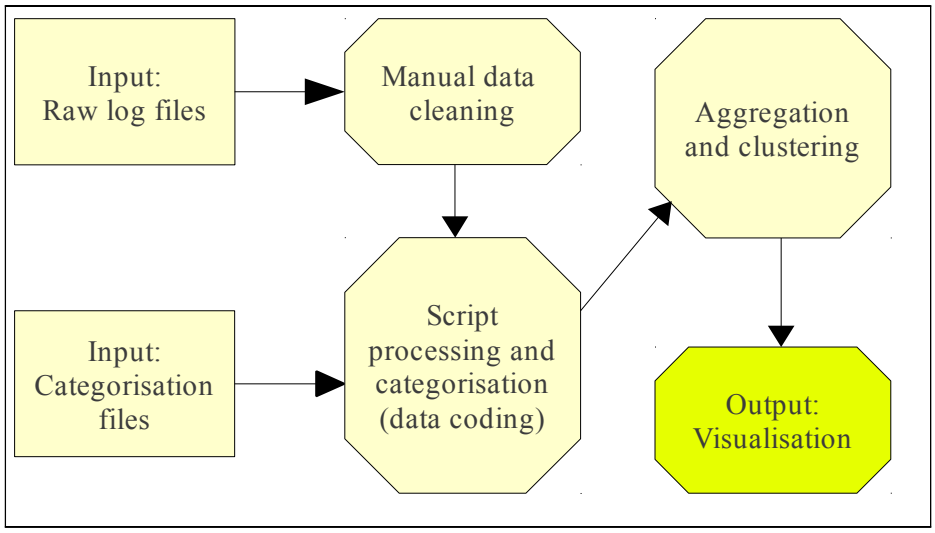


Figure 5.4: Process from raw data to visualisation

The study focused on usage of the embedded applications, not on usability of the DD. Usability of certain DD applications is described in Adebesin, Kotze and Gelderblom (2010). Usability tests and evaluations are focused on specified scopes, participants, interactions, locations and durations (Hilbert & Redmiles, 2001), while this research addresses the utility and usage levels of the subject matter. In addition to Hilbert and Redmiles' (2001:1) question

of *'Where should scarce design, implementation, testing, and usability evaluation resources be focused in order to produce the greatest benefit for users?'* one can also enquire: *'Where should Digital Doorway content resources be focused to produce the greatest benefit for users?' (Gush and de Villiers, 2010).* This study will assist in the focusing of such resources, for the future benefit of users.

5.5.2 Quantitative data collection

As explained in the previous subsection, data for the quantitative study was retrieved from log files of a subset of ten of all current sites. Each DD has mechanisms for the collection and transfer of log files of user details and application usage statistics. This user demographic information is collected through a 'self-registration' procedure, whereby a user can create a unique user name and enter details of name, age, gender, home language and preferred language, into a registration template. Users are also able to log in as 'guest users'. All user-created files saved by guest users are erased daily, however, all application logs, including hits by both guest- and registered users, are stored for later retrieval. Application log files for guest users are many times larger than those for registered users, however, unlike the latter, guest files are not linked to age and gender data, and therefore cannot be used for analysis involving age and gender. Guest logs are still valuable for analysis involving location.

Each application on the Digital Doorway is launched from a wrapper script that records the time of launch and user name of the person launching it. This information is stored in a text file on the server. All log files are compressed and transmitted daily via GPRS (cellular) backbone to a central server. This collection of compressed log files from all sites can be analysed to provide insight into application usage, especially with regard to general trends and preferences (Gush, 2008). Section 6.2 provides greater detail on the data collection process.

5.5.3 Categorisation of quantitative data

According to Olivier (2004), the creation of categories, in and of itself, is a form of interpretation. In total there were over **5300** registered users and over **one million** application launches (hit-counts) by users, distributed over all of the DD sites, in the two years for which data was logged. To make the large quantities of data manageable, applications and ages were grouped into categories, and a selection (of the total possible sites), chosen for this study.

Application categories

A total of 992 different possible applications or content items were identified in the DD software, not all of them available at all the installations. These were each assigned a **general category** and a **specific category** (finer-grained subdivision), in order to cluster items of similar genre into the same category. In total, **seven** general categories were created, namely edutainment, education, system, office, reference, games, and video/audio (Table 5.3), and **26** specific categories were identified (See Table 5.4, which expands Table 5.3). Each specific category is a subset of a general category, and in some instances the entire category comprises only one single application.

Table 5.3: General application categories

Category	Description
Education	Software created purely for educational purposes
Edutainment	Games with educational elements incorporated
Games	Software for pure entertainment
Office	Office suite including word processor, spreadsheet and presentation software
Reference	Encyclopedia or document reference material
System/DDHome	Includes file navigation and DDhomepage
Video/Audio	Audio and video clips (mostly recreational), and web-cam application

Table 5.4: Specific application categories

	General Category		Specific Category	Description
1	**Education**	1	Education, maths	Maths related education materials
		2	Education, mindset	Educational curriculum-based content
		3	Education, science	Science related education applications
2	**Edutainment**	4	Edutainment, computers	Computer-related edutainment
		5	Edutainment, gcompris	Educational suite of games for young children
		6	Edutainment, graphics	Graphics-related edutainment applications
		7	Edutainment, language	Language applications (e.g., spelling game)
		8	Edutainment, localgames	A locally produced quiz and life-skills game
		9	Edutainment, maths	Maths-related edutainment applications
		10	Edutainment, science	Science-related edutainment applications

3	**Games**	11	Games, gamesother	Entertainment software – all other games combined
		12	Games, orientation	Orientation games (e.g., ktron)
4	**Office**	13	Office, openoffice	Open Office Suite
5	**Reference**	14	Reference, agriculture	Agriculture-related documents
		15	Reference, books	Project Gutenberg and other literature
		16	Reference, fun	Fun reference materials (e.g., hand shadows)
		17	Reference, science	Science-related reference material
		18	Reference, wikipedia	An open encyclopaedia
		19	Reference, life-skills/health	Health related documents
6	**System/ DDHome**	20	System, comms	Simple inter-terminal communication
		21	System, ddhomepage	The main homepage
		22	System, file-manager	File navigation and OS commands
7	**Video/audio**	23	Video_audio, audiobooks	A number of audio stories
		24	Video_audio, fun	Fun video clips
		25	Video_audio, science	Science related video clips
		26	Video_audio, web-cam	A simple web-cam display

Appendix D illustrates the assignment of applications and resources to particular general categories. Each category is colour-coded according to the colours in Appendix Table D1. Table 5.4 shows the 26 specific categories, listing them within their general categories.

Age groupings

Rather than perform data analysis on individual ages (in years), certain age groupings were established to assist with identification of general trends. These age groupings are defined in Table 5.5. The groupings are in line with, though slightly more fine-grained than, those of Costanzo and Shaw (1966:269) who conducted a study involving children undergoing psychiatric evaluation. In their research, children were grouped into ages 6–9, 10–13 and 14–18.

Data associated with an indicated age of under 6 years or over 60 years old, were excluded from this study for two reasons, namely, the very low frequency of visitors to the DD falling outside the 6-60 age group, and the likelihood of users choosing either very low or very high ages when not being willing to record their actual age. Many users indicated an age of 0 years. While research into the user activity of a 60+ age group, may provide some interesting results, that is not the focus of this study which is dependant on aggregation to de-emphasise outliers and concentrates more on general trends amongst typical users (ages 6–60).

Table 5.5: Age groupings and age codes

Description	Age range
Typical junior primary school learners	6–9
Typical senior primary school learners	10–13
Typical secondary school learners	14–17
Post-school and tertiary level (FET College) learners	18–21
Young adults	22–25
Older adults	26–60

Gender groupings

There are three gender groupings: male, female and unspecified. The user registration form had unspecified as the default value, and users had the option of either specifying a gender or not.

Location groupings

Four location groupings were selected, namely: schools; libraries; FET Colleges; and public locations (MPCC, informal market etc.). See Section 6.6.1.

5.5.4 Selection of sites for quantitative study

The analysis of complete sets of logged data from multiple sites and multiple end-users affords opportunities to identify aggregated trends and occurrences (Gush and de Villiers, 2010). The overall aim of the log file analysis was to gain a representative snapshot of the nature and extent of usage of the software applications provided with DD terminals and to investigate how usage relates to user demographics. To this end, a small, but heterogeneous and representative, set of locations and sites was selected for in-depth quantitative investigation. The sites were selected using purposive sampling (Oates, 2006), chosen to provide a representative sample of sites that were likely to generate valuable data. With this goal, the following criteria were established to select ten sites from the approximately 210 operational DD sites in South Africa (see Section 6.6.1):

- Site diversity in terms of type of venue (library, community centre, school etc.);
- Numbers of registered users per site – sites with the highest numbers;
- Hit-counts per user – highest hit-counts;
- Region – both rural and township;
- Geographical – multiple provinces.

Using the above criteria, the ten sites listed in Table 5.6, and in more detail in Table 6.2,were chosen, and formed the base from which quantitative analysis for this study was performed.

Table 5.6: Ten sites selected for quantitative analysis

Elandskraal, KwaZulu-Natal	Emjindini, Mpumalanga
Kagung, Northern Cape	Letaba FET College 2, Mpumalanga
Soshunguve, Gauteng	Msunduzi, KwaZulu-Natal
Kwam-Hlonipha, Mpumalanga	Vezebuhle, Mpumalanga
Letaba FET Giyani, Limpopo	Kanyamazane, Mpumalanga

5.5.5 Quantitative data analysis

Figure 5.5 overviews the quantitative data analysis process. Key aspects are:

- Collection of the raw data – 1;
- Choice of appropriate categories for sites, applications and ages groups – 2;
- Integration of the raw data into manageable datasets and assignment of each data element to its appropriate category – 3;
- Calculations and visualisation of categorised data within these datasets, including statistical analysis to determine significant relationships – 4.

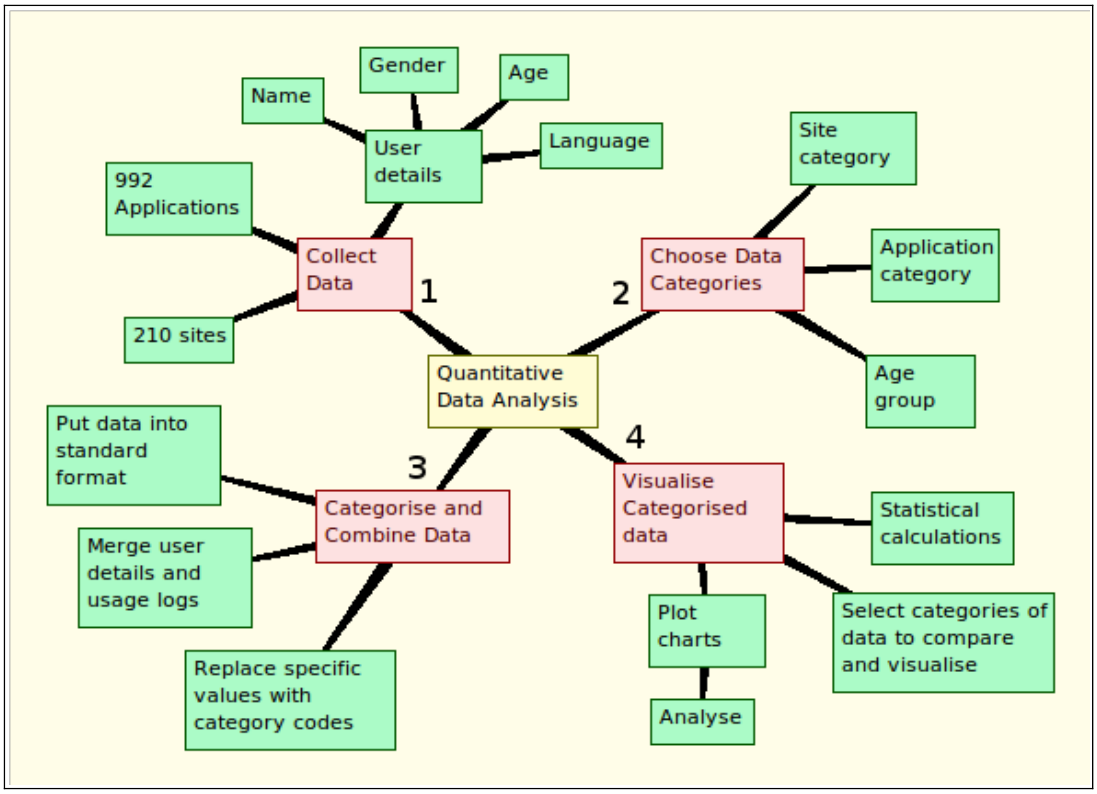


Figure 5.5: Main components of quantitative data collection and analysis

5.6 Qualitative study

This section details the steps taken to do qualitative data collection and analysis on application usage and user behaviour at selected DDs. The qualitative data from these case studies, involving naturalistic observations, interviews and questionnaires, was used in conjunction with quantitative data from the log files, to form a detailed holistic view of application usage at the sites. Section 5.6.1 gives an overview of the research methods used in the qualitative study. Section 5.6.2 discusses the selection of sites and participants, while Section 5.6.3 presents the methods used in data collection. Finally, Section 5.6.4 covers the qualitative data analysis approach.

5.6.1 Research methods for qualitative data, overview

'Qualitative research is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data' (Creswell 2009:4).

The present qualitative study entailed performing site visits to selected DD installations, and completing semi-structured interviews and researcher-assisted questionnaires, with users of DD terminals, in order to get first hand reports of application usage. Naturalistic observation was used to supplement findings from the other methods.

A further purpose of the site visits was to clarify certain issues arising from the quantitative log file analysis, and to serve as a means of validating particular demographic data (e.g., average age of users) obtained from the log files. Furthermore, the study provided valuable information on the physical environments, and situations encountered by users on a day-to-day basis.

A further source of qualitative data was the user comments from the online feedback mechanism mentioned in Section 4.10. These are included in Section 7.6.

5.6.2 Selection of sites and participants for qualitative study

Four heterogeneous sites were selected using both convenience sampling (site 1), and purposive sampling (sites 2, 3 & 4) (Oates, 2006). Participants were selected using a combination of convenience sampling, and snowball sampling (Oates, 2006) as participants, in turn, found other users in the area who also came to the site and took part in the study.

The following four sites were chosen for the qualitative study (see Section 7.3):

- Site 1: Gatang High School, Mamelodi, Gauteng;
- Site 2: Soshanguve Fablab, Gauteng;
- Site 3: Emjindini Library, Mpumalanga;
- Site 4: Msunduzi Customer Care Centre, KwaZulu-Natal.

5.6.3 Qualitative data collection

At each site, a combination of semi-structured interviews, questionnaires, and observation, was used to obtain data of user experience at the DDs.

According to Oates, (2006:188), in semi-structured interviews: 'You have a list of themes to be covered and questions you want to ask, but you are willing to change the order of questions depending on the flow of the conversation and you might ask additional questions if your interviewee brings up issues you had not prepared for. The interviewees are able to speak with more detail on the issues you raise, and introduce issues of their own that they think relevant to your themes'.

A questionnaire, on the other hand, is 'a pre-defined set of questions assembled in a pre-determined order... providing the researcher with data that can be analysed and interpreted' (Oates, 2006:219). A researcher-administered questionnaire is a form of structured interview.

The intention at the sites was to conduct semi-structured interviews with administrators and users of the DDs, based on a set of questions in an interview question template.

Observation at each involved the taking of field notes and photographs on site, with particular attention to user activity and environmental factors (such as site position, locality, proximity to schools, time of day, operational conditions, distractions/interferences etc.). These notes and photographs were used to formulate the general site descriptions in Section 7.5.

Researcher notes from interviews, questionnaire data, and general observational data at the sites, were used to build up a case study of four cases, one for each site. Data was collated into a spreadsheet for ease of comparison.

5.6.4 Approach to the analysis of qualitative data

According to Creswell, qualitative data analysis involves a number of stages, namely: preparing the data for analysis; analysing the data in different ways; reaching deeper and deeper understanding of the data; representing the data in some way and finally interpreting

the larger meaning of the data (Creswell, 2009). Various qualitative analysis approaches exist, and are outlined in the next paragraph, followed by an explication of the approach followed in the present study.

Grounded theory has systematic steps that involve generating categories of information (open coding), selecting a particular category and placing it within a theoretical model (axial coding), and then developing a story from the interconnection of categories (selective coding) (Creswell 2009). Case study and ethnography research involve a detailed description of the environment or individuals, followed by the analysis of the data for themes and issues. (Creswell, 2009). In their paper entitled 'Theory building from cases: opportunities and challenges', Eisenhardt and Graebner provide the following description: 'Case studies are rich, empirical descriptions of particular instances of a phenomenon that are typically based on a variety of data sources' (Eisenhardt & Graebner, 2007, citing Yin, 1994). The central idea of case study research is to use cases as a basis from which to develop theory. The researcher recognises patterns of relationships within and across cases and from these patterns, theory emerges. Case studies 'emphasize the rich, real-world context in which the phenomena occur' (Eisenhardt & Graebner, 2007:25). Other qualitative analysis methods include phenomeno-logical research and narrative research.

This study involves qualitative analysis, inspecting the data to identify the occurrence of themes, and reporting on those themes as they relate to the research questions. Since four distinctive sites were chosen, the analysis is a type of case study research. The particular 'cases', or sites, were selected both to highlight individual differences between sites, and find commonalities in usage behaviour across sites.

Creswell emphasises the process of moving from specific details to more general observations, involving multiple levels of analysis, highlighted in Figure 5.6.

As mentioned earlier, raw data was obtained through observation, questionnaires and interviews. The data was recorded through photographs, in field notes and on the question templates themselves. All this data was collated and consolidated in a spreadsheet and word processor for comparison and analysis. Answers to questions were grouped into categories (e.g., age-related, gender-related, usage-related). The data was analysed for specific themes that emerged within each category. The themes and descriptions from the text were then related to the research questions, and interpreted in the light of the study as a whole, including lessons learned for future software configurations and installations.

The process was not completely linear, and the researcher revisited descriptions and themes as others emerged, refining them as new information came to light, as is done in grounded

theory, paying attention to validity (checking for the accuracy of the findings) and reliability of the data (ensuring that the analysis approach was consistent across different researchers and different sites). Reliability procedures included ensuring that different researchers transcribed the data to a spreadsheet in a standard way, and checking that the captured data was correctly transcribed.

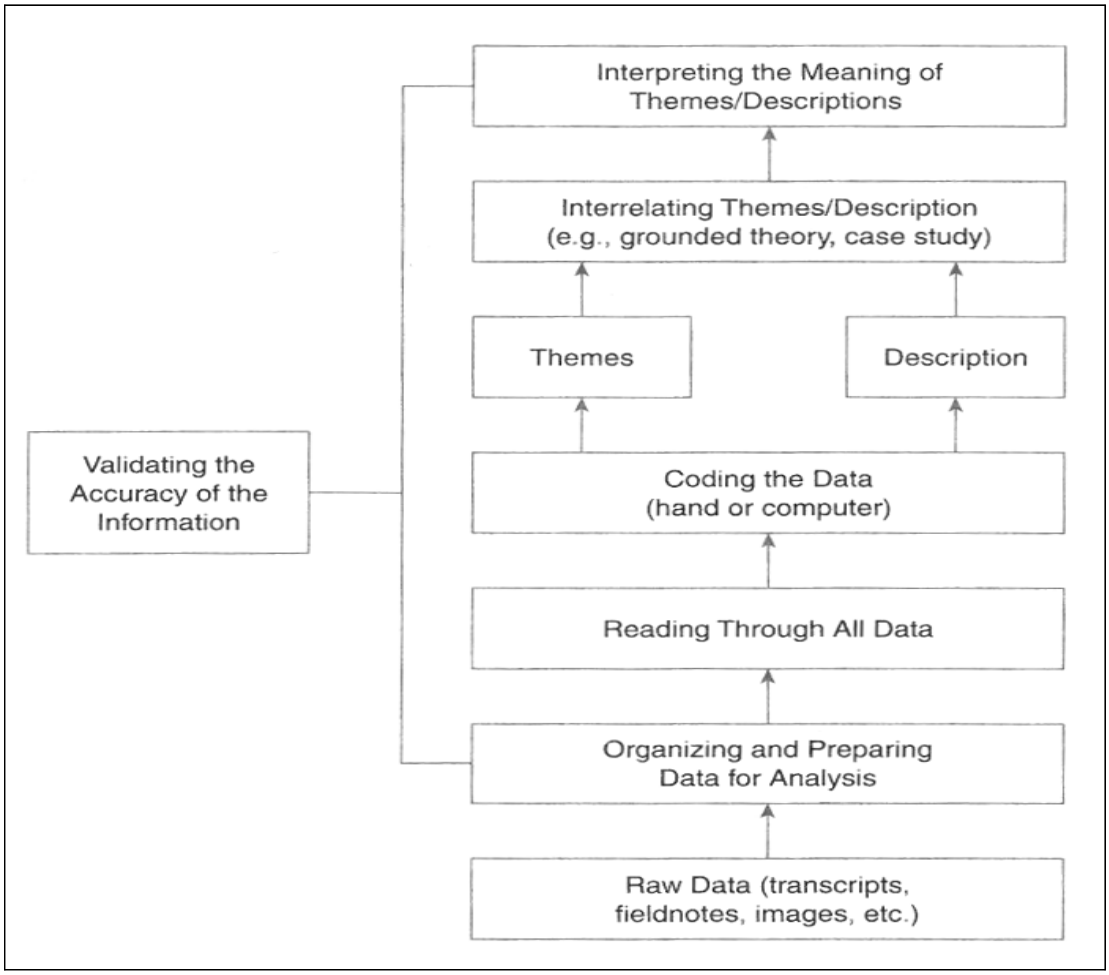


Figure 5.6: Data analysis in qualitative research (Creswell, 2009:185)

Validity strategies mentioned by Creswell (2009), include:

- Triangulating different data sources;
- Member checking, taking reports back to participants;
- Using rich, thick descriptions to convey findings;
- Clarifying the bias the researcher brings to the study;
- Presenting negative or discrepant information that runs counter to the themes;
- Spending prolonged time in the field.

Of the strategies mentioned above, those most pertinent to this study were: triangulation – through the use of multiple case study sites and participants; the use of rich, thick descriptions (Section 7.5); and presenting negative and discrepant information. Participants were encouraged to be as open and honest as possible, and the researcher attempted to present the information as objectively as possible, thus minimising 'researcher-bias' in presenting the results.

In his 'Introduction to case study', Tellis (1997), describes a study involving the 'examination of managerial and economic aspects of the rapid acquisitions of information technology' (Tellis, 1997:2), in the context of academic instructional and research computing. According to Tellis, case study is a research method most strongly associated with the field of sociology and must incorporate the views of the 'actors' in the case under study and satisfy the 'three tenets of the qualitative method: describing, understanding and explaining' (Tellis, 1997:4). This is the aim of the descriptions in Section 7.5.

Creswell presents an alternative conceptualisation to the coding (topic identification) of qualitative data (Creswell, 2009:187, citing Bogdan and Biklen, 1992). Possible codes to look for in this suggestion include:

- Setting and context codes;
- Subjects' perspectives and ways of thinking about people and objects;
- Process and activity codes;
- Relationship and social structure codes.

The approach in this study was to use a combination of predetermined and emerging topics. The former arising from the research questions, the latter emerging from the data after the site visits were completed.

The analysis approach to this part of the study was mainly interpretivist in nature. A good summary of the interpretivist paradigm is found on the website of the Robert Wood Johnson foundation (RWJF, 2008):

'The interpretivist paradigm posits that researchers' values are inherent in all phases of the research process. Truth is negotiated through dialogue.

- *Findings or knowledge claims are created as an investigation proceeds. That is, findings emerge through dialogue in which conflicting interpretations are negotiated among members of a community.*

- *Pragmatic and moral concerns are important considerations when evaluating interpretive science. Fostering a dialogue between researchers and respondents is critical. It is through this dialectical process that a more informed and sophisticated understanding of the social world can be created.*
- *All interpretations are based in a particular moment. That is, they are located in a particular context or situation and time. They are open to re-interpretation and negotiation through conversation.*
- *Interpretive approaches rely heavily on naturalistic methods (interviewing and observation and analysis of existing texts).*
- *These methods ensure an adequate dialogue between the researchers and those with whom they interact in order to collaboratively construct a meaningful reality.*
- *Generally, meanings are emergent from the research process.*
- *Typically, qualitative methods are used.'* (RWJF, 2008)

According to Miles and Huberman (1994), qualitative analysis consists of three main activity flows: data reduction (the simplification and transformation of available data); data display (assembling the information in an organised way to enable conclusion drawing); and conclusion drawing and verification (deciding what the data means).

Further details on the qualitative data collection process and site selection, as well as results from the analysis of data from the site visits, are presented in Chapter 7.

5.7 Summary of chapter

This chapter presented an overview of the research design and process of the current study, highlighting a mixed-methods strategy of enquiry and various primary goals. The research questions were revisited and the research methods for quantitative and qualitative data analysis discussed. The chapter explained site selection criteria and presented ten sites chosen for quantitative data analysis and visualisation. The process of categorising the quantitative data into manageable categories was explained, and the various elements in each category laid out. Finally, research methods, and data collection and analysis approaches for qualitative data were discussed.

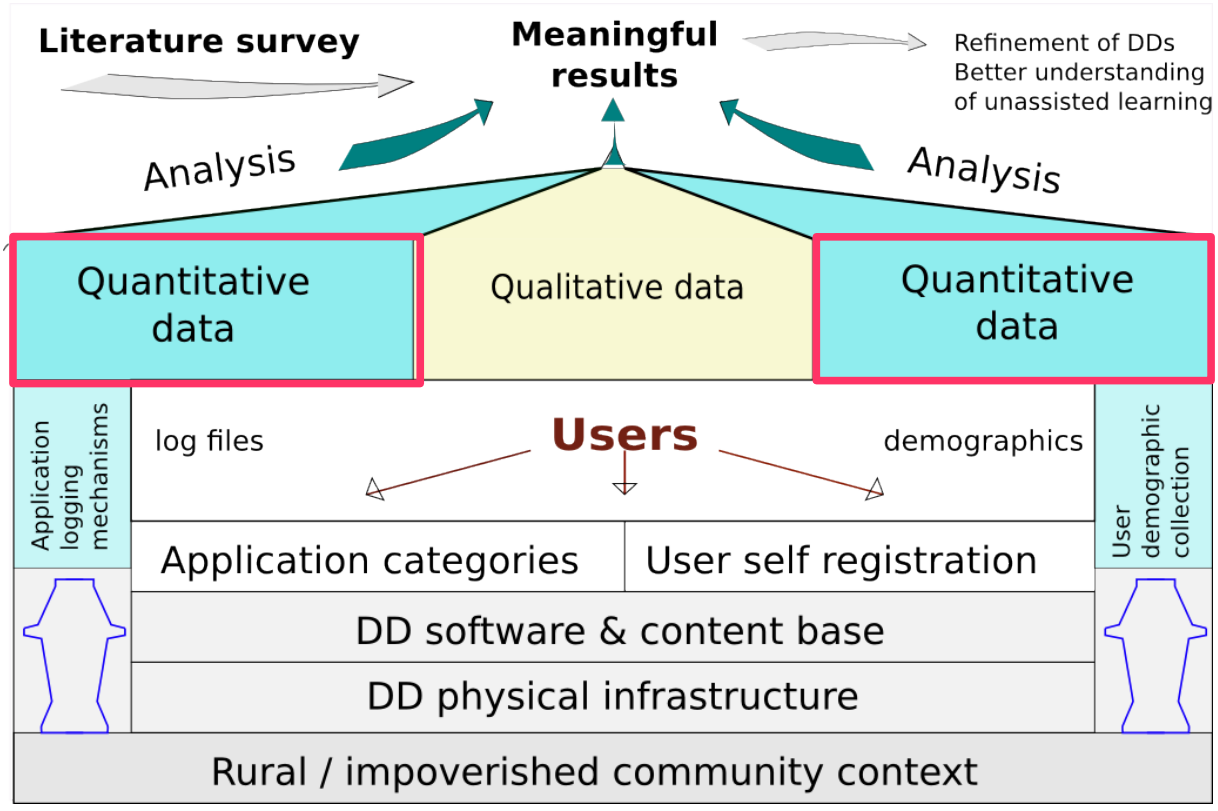
The chapter sets the foundation for Chapters 6 and 7 which, respectively, discuss the quantitative and qualitative studies. The mixed-methods strategy is consolidated in Chapter 8, where pertinent discussions and findings from the study as a whole, are presented.

– 6 –

Quantitative data collection and analysis

'hi guyz i enjoy using your computers. it so fun playing games and i find many information in dis computers. thank u guyz. we'll like if u put some more information 4 us'

– Digital Doorway User, June 2007



6.1 Introduction

This chapter provides details of the quantitative analysis of the data from each of the ten selected sites, with a view to comparing sites of varying physical situation for similarities and differences in demographic and application usage statistics. The chapter is arranged as follows: Sections 6.2 to 6.5 include details of the quantitative data collection process, data cleaning process, design of a log file interrogation tool, and log file processing. This technical information elaborates on points mentioned briefly in Section 5.5.1, and is necessary to explain some of the complexities involved in generating uniform data for this study. Section 6.6 contain general findings from the quantitative data, applicable to the study as a whole. Sections 6.7 to 6.10 present detailed analysis of quantitative data as it relates to each of the four research questions.

6.2 Data collection process and format of raw data

In order to collect raw data on user demographics and application usage statistics, two data collection mechanisms and one data transfer mechanism were implemented at each Digital Doorway site.

6.2.1 Data collection mechanism 1

On software start-up, each DD terminal boots into a customised login screen, displaying textual information and an input form for entering a user name, as depicted in Figure 6.1. The textual information displays the following message in English, Afrikaans, Zulu and Xhosa: *'Type: **new** to create a new account. Guest users are dd1 to dd5'*

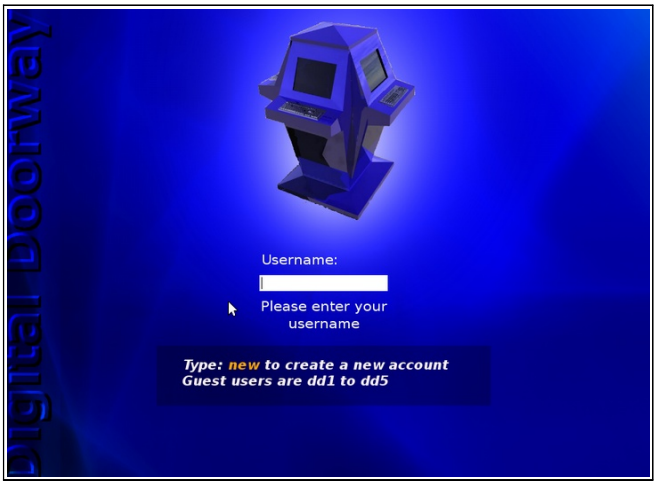


Figure 6.1: DD login screen

Users proceed to take one of three possible courses of action:

1. Login as a guest user;
2. Login with a previously created user account;
3. Create a new user account.

In the first scenario, logging in as a guest user, no user demographic information is collected, and the user is taken directly to the guest desktop environment. In the second scenario, users enter their login name and password, and are then directed to their own desktop environment. The desktop environments for users and guests initially look identical, however, any changes that the user makes to their own desktop are permanent, while guest desktops are restored to their default state each evening, all saved files within the guest home directory being erased.

The third scenario takes the user to a screen for creating their own user name and specifying various demographic details, as shown in Figure 6.2.

Figure 6.2: User registration form

The following information is requested in the template: full name; user name; password; age; gender; home language; and preferred language. This information is stored as a text file on the DD server, and later transmitted to a central server.

6.2.2 Data collection mechanism 2

Each software application on the DD menu is embedded within a script that records:

- Which application was accessed.
- The name of the user accessing the application.
- The time and date of access.

Application log file data is accumulated per user name, and each evening the various log files are compressed into a single file, named with the current date. In a case where the Mindset server has been down for more than a day, log files from previous days are compressed with log files for the current day. Examples are included in Appendix A.

6.2.3 Data transfer mechanism

Each evening, provided the communication server (Mindset server) connectivity was up, the user registration file was uploaded to the Mindset server, and transmitted via the GPRS modem to a central server, accessible to the DD researchers. Thereafter, the file resided under a sub-directory named after the DD site name. The process is depicted in Figure 6.3.

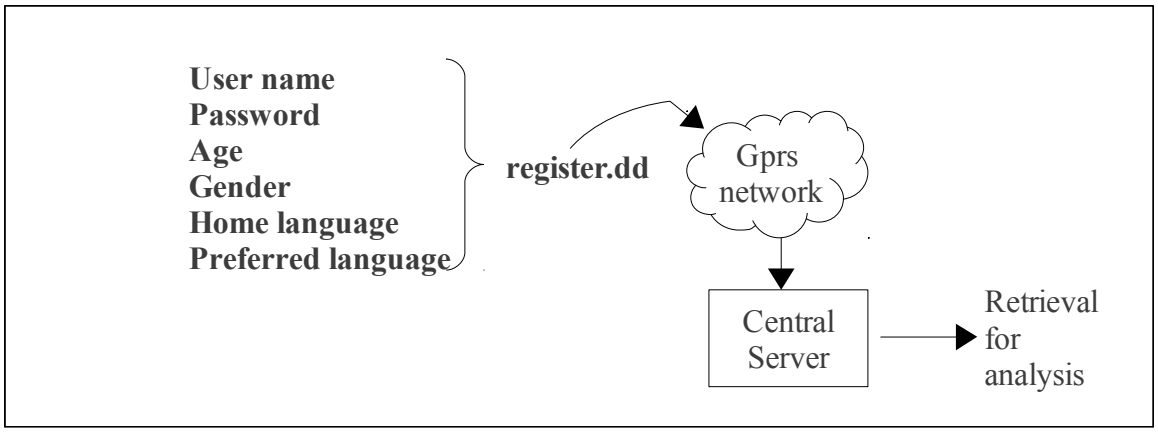


Figure 6.3: Data transmission

6.2.4 Data extraction

Using shell scripts written by the researcher specifically for this study, the data in Table 6.1 was extracted from the raw data for each of the 210 DD sites. This data could then be used for site selection (see Section 6.6.1), and further analysis.

Table 6.1: Data extracted from log files

- number of sites
- location information for each site
- number of sites with data
- number of days of data per site
- number of registered users per site
- start and end dates of data per site
- total number of application launches per site
- total number of registered user application launches per site
- number of registered females per site
- number of registered males per site
- age grouping per site
- overall age grouping
- application usage per age group (overall)
- application usage per age group (site specific)
- application usage per gender (overall)
- application usage per gender (site specific)
- categorised application usage per site and overall for each age group
- categorised application usage per site and overall for each gender

Demographic data (e.g., age and gender) is linked to registered user application logs, but not to guest application logs, therefore, in the analysis to follow:

- Registered user application logs were used for age versus application usage analysis.
- Registered user application logs were used for gender versus application usage analysis.
- All application logs (guest + user) were used for location (context) versus application usage.

It is important to distinguish between registered user logs (where age, gender and language information available could be associated with the logs) and guest user logs (where no such association was possible).

6.3 Data cleaning

Prior to processing, the raw data from every connected site was cleaned. Sites with multiple entries and subdirectories in the database were combined into one subdirectory. Sites without log files were removed, and sites not applicable to this research were removed (for example the demo units in the Meraka research lab). After the cleaning process, a total of 156 sites from the original 210, were available for potential analysis. Table C1 in Appendix C shows the original material available from the ftp site and those sites that were removed or combined in the cleaning process. The selection process of ten sites, chosen for detailed analysis, was discussed in Section 6.6.1).

The log files for each site contain application accesses for guest users – dd1 to dd10 – and self-registered users. For analysis involving age and gender, only *self-registered* user application accesses were extracted. The versatility of Linux command line scripting was employed to achieve this. A simple *egrep* command (find and replace) allowed us to remove all lines with guest users, leaving only self-registered users.

A further cleaning step involved the removal of superfluous user entries in many of the 'register.dd' files of sites. These duplicate user entries were present due to their existence before the imaging process of site hard drives, before site installation, resulting in the same user registrations being imaged to multiple sites.

Due to the open-ended nature of the user registration template that the user was required to complete (a design limitation corrected in later versions of the software), fields could be filled in, in more than one way. For example, when specifying an age of 20, a user could enter any one of the following (Figure 6.4):

20	(Standard Numerical Format)
twenty	(Non-standard Formats)
20 years	
twenty years old	
1989-01-01 (date of birth)	
2o	
etc.	

Figure 6.4: Non-standard age entries

This required a standardisation step to be performed, involving manual inspection and reformatting of all data in a non-standard format. A useful consequence of the open-ended format was the discovery of some interesting entries (Figure 6.5). The first two entries illustrate attempts by different groups of children to indicate that the group consisted of members of various ages, while the last two are more for the psychology department.

12-13
13 14 13
old
15 for life

Figure 6.5: Interesting age entries

A further complexity occurred fairly frequently when the same user attempted to create multiple user names. Although the system only allows for one unique user name, the log files still record the attempts to generate additional accounts using the same user name. In order to reach a more accurate figure for the number of unique users who generated user names at each site, duplicate user names were eliminated from the registration data. As mentioned earlier, age data over 60 and under 6, was ignored, due to high number of obviously incorrectly specified ages.

6.4 Log file interrogation tool

Key to the visualisation and analysis of application usage data from the sites was the design by the researcher, of a **log file interrogation tool** for **customisable category-specific extraction of data.** For various reasons, a customised tool was chosen rather than a standard database and queries. The manipulation of plain text files by means of Linux bash scripting allowed for greater flexibility in terms of both the manipulation parameters and the output. Multiple queries could easily be combined into a single script and left to run overnight in the case of very large quantities of data. Linux bash scripts provide a powerful set of find and

replace commands (e.g., regular expressions) for string manipulation within a file. A simple pictorial representation of the tool is shown in Figure 6.6:

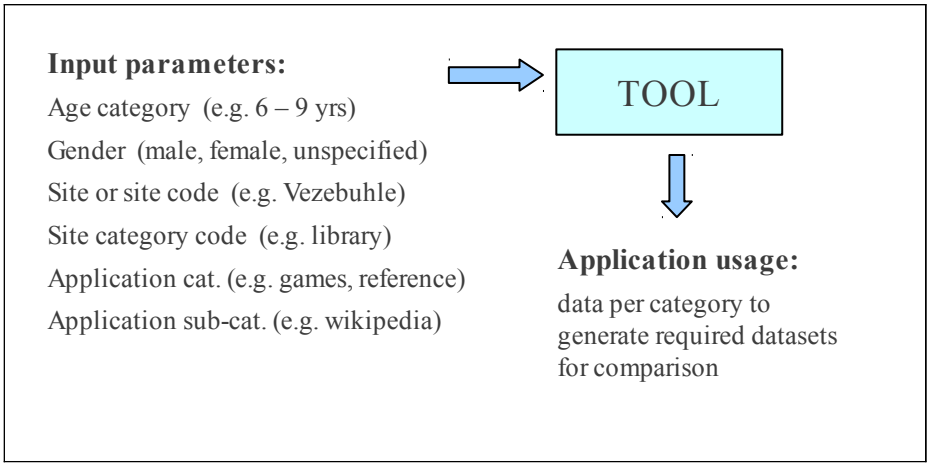


Figure 6.6: Log file interrogation tool (simple representation)

The primary steps to realising this log file interrogation tool were as follows:

- Ensure uniqueness of each user name by appending site name to user name in log files (e.g., Vezebuhle.John).
- Associate application usage data logs with user details (age, gender etc).
- Define application categories (see Section 5.5.3, Tables 5.3 and 5.4).
- Define age categories (see Table 5.5).
- Replace individual ages in log files with age category code.
- Add site category code to each line of log files.
- Replace individual application launches with application category codes.
- Merge all log files into one large log file, that can be queried using the Linux 'grep' command and custom scripts.

6.5 Extraction of 'per user' log files

This section, though somewhat technical, is included to show the main steps that were taken to arrive at meaningful data. It includes some areas of concern with regards to data validity.

6.5.1 Steps taken to arrive at meaningful data

In order to meaningfully process and analyse the application usage data, the compressed log files were uncompressed, and all log files for each user at a particular site were aggregated

into a single large log file per user, per site. The full script to perform this operation (written in the bash scripting language) is included in Appendix B, under the name: **getapps_peruser2**. Note Code_segment 6.1 below, where the .log extension is stripped from each file in the directory to retrieve the user name of that file, and then the *sed* command is called within each log file, replacing the user name with 'sitename.username'. This was essential to differentiate users at different sites who had the same name.

```
username=${file2%\.*}
sed -i -e s/$username/$dir.$username/g $file2
cat $file2 >> ./appsperuser/$dir.$file2
```

Code_segment 6.1: Script example – unique user names

Further processing of the log files involved a significant amount of work on the part of the researcher, but ultimately made it possible to extract the results presented from Section 6.6 onwards. The result of the various log file integration steps was a single file named *FINAL.txt,* which combined logs from all ten sites.

Extracting meaningful data from the results then became a process of applying carefully constructed scripts to *FINAL.txt*, using Linux file sub-string manipulation and line-count operators. To illustrate the data collection process, three examples of programming code follow in Code_segments 6.2 to 6.4. For example, to find the total number of application launches in each age group, one would apply the lines of code in Code_segment 6.2 below, to *FINAL.txt* file (where TOT(acX) denotes the total number of application launches in age category X).

```
TOT(ac0) = grep ",ac0," FINAL.txt | wc -l
TOT(ac1) = grep ",ac1," FINAL.txt | wc -l
TOT(ac2) = grep ",ac2," FINAL.txt | wc -l
TOT(ac3) = grep ",ac3," FINAL.txt | wc -l
TOT(ac4) = grep ",ac4," FINAL.txt | wc -l
TOT(ac5) = grep ",ac5," FINAL.txt | wc -l
```

Code_segment 6.2: Script example - application launches per age category

And to find the total number of application launches in the 'edutainment' category one would apply the lines in Code_segment 6.3 below.

```
SUBT(ac0,edutainment) = grep ",ac0," FINAL.txt | grep "edutainment" | wc -l
SUBT(ac1,edutainment) = grep ",ac1," FINAL.txt | grep "edutainment" | wc -l
SUBT(ac2,edutainment) = grep ",ac2," FINAL.txt | grep "edutainment" | wc -l
SUBT(ac3,edutainment) = grep ",ac3," FINAL.txt | grep "edutainment" | wc -l
SUBT(ac4,edutainment) = grep ",ac4," FINAL.txt | grep "edutainment" | wc -l
SUBT(ac5,edutainment) = grep ",ac5," FINAL.txt | grep "edutainment" | wc -l
```

Code_segment 6.3: Script example - application launches in edutainment category per age category

To determine the percentage of application launches in the edutainment category with respect to the total application launches for a specific age grouping, one would apply an operation as in Code_segment 6.4.

```
PERCENT(ac0,edutainment) = SUBT(ac0,edutainmnet) / TOT(ac0)
```

Code_segment 6.4: Percentage edutainment application launches versus total application launches in age category zero

For the next example, assume one wanted to retrieve the number of application launches for females in the 14–17 age category (ac2) at the Vezebuhle site in the games category, as illustrated in Figure 6.7. The Linux script to do this is shown in Code_segment 6.5.

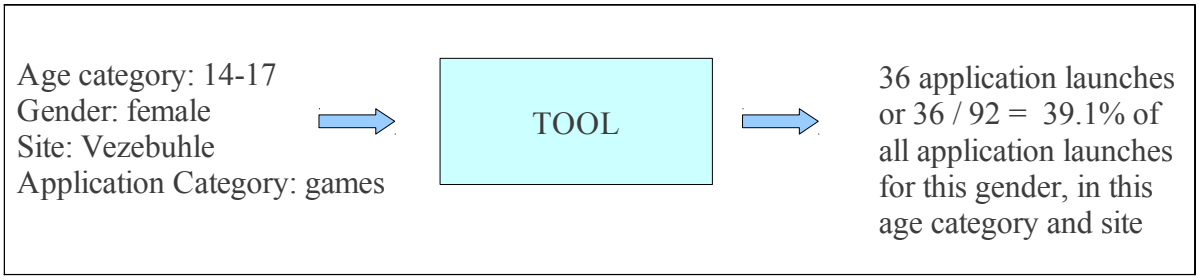


Figure 6.7: Vezebuhle application launch example

```
cat FINAL.txt | grep ",ac2," | grep ",female," | grep "Vezebuhle" | grep ",games," | wc -l
```

Code_segment 6.5: Vezebuhle application launch code

The final example indicates how one would determine the overall percentage of system use by females, as illustrated in Figure 6.8. The Linux script to do this is shown in Code_segment 6.6.

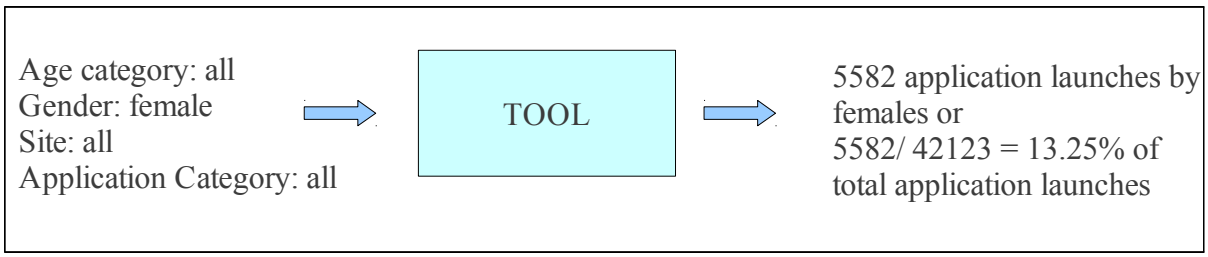


Figure 6.8: Overall usage by females

```
cat FINAL.txt | grep ",female," | wc -l
```

Code_segment 6.6: Determining overall usage by females

The above examples serve to illustrate the versatility of the Linux command-line scripts when performing calculations on thousands of lines of data. In addition to this scripting method, calculations and visualisations in this chapter were achieved using spreadsheets.

6.5.2 Data validity

Data validity point 1

Where users on separate terminals, at the same site, log in with the same user name, at the same time, application logs from both users are combined in the same log file, potentially causing confusion in deciphering the log file. This is unlikely to happen much in the case of user generated logins, as each user has their own password. For it to occur, a user would have to give personal login details to a friend, and the friend would need to simultaneously log in on a different terminal, using those details.

Data validity point 2

Data showed inaccurate time readings at some sites, due to the system clock time of either server, or clients, or both, being incorrect. This would affect the reliability of determining the exact time of day that an event occurred, but would still allow reliable comparisons of start times between the launching of one application and the next, where log files were for logged-in users (not guests). Fortunately, accurate application launch times were not a requirement in comparing figures for age, gender or location versus application usage.

Data validity point 3

Users were permitted to choose 'unspecified' for their gender. A fairly high percentage of gender results, namely 28%, fall into this category and could thus not to be meaningfully used in the gender versus application usage analysis (see Section 6.8.1). In retrospect, this should not have been an option. Users should have been forced to choose either male or female. This is a feature incorporated in the latest release.

6.6 Sites, application hit-counts, and users

6.6.1 Site selection

Tools to facilitate site selection

Shell scripts (see the ***processor*** script in Appendix B) were written by the researcher to extract information from all potential sites in the study. This information was collated in a spreadsheet table. For each site, the following data was extracted:

- logged_days – number of days that had log files and user activity;
- nolog_days – number of days with log files (machine was up) but no user activity;

- lines_feedback – number of lines of user-generated feedback;
- application_accesses – number of total application launches;
- user_accesses – number of total application launches by registered users;
- first_log – date of first recorded log file;
- last_log – date of last recorded log file;
- num_users – total number of registered users at a site;
- male – users who registered themselves as male;
- female – users who registered themselves as female;
- undefined gender – users who did not specify a gender on registration;
- accesses per user – average number of application launches per user.

Figure 6.9 is an example extracted from this spreadsheet. For full data, refer to the CD in the thesis pocket. Data was logged for different time periods, depending on when the site was installed. However, the end date for the raw data extracted for this study, was 02 October 2009, for all sites.

sitename	logged_days	nolog_days	lines_feedback	application_accesses	user_accesses	first_log	last_log	uptime_days	num_users	male	female	undefined	accesses per user
elandeskraalmpcc_003018B0C936	212	66	947	49777	21749	07/02/11	08/05/07	451	301	166	46	89	72.26
mamosebo_combined	69	71	12	2398	2289	08/11/11	09/05/07	177	40	27	4	9	57.23
ntshongweni_003018B0C932	170	62	85	29437	109	07/02/24	08/01/10	320	2	2	0	0	54.5
ladygrey_003018B05899	11	2	28	2773	260	07/02/15	07/11/18	276	5	1	2	2	52
kagung_informal	19	3	12	6152	1899	08/07/30	09/06/19	324	50	30	2	20	37.98
kitsongfablab_003018B0CA35	6	0	8	7407	302	07/08/03	07/12/11	130	9	4	1	4	33.56
soshanguvefablab_003018B0CA0F	190	5	202	41701	4628	07/01/13	08/03/18	430	171	105	22	44	27.06
kwam_hlonipa	36	1	136	11290	2144	07/10/12	09/03/20	525	81	44	14	23	26.47
ngubezulu_sss	44	7	4	8259	47	07/10/31	08/02/12	104	2	1	0	1	23.5
matlala_003018B057EE	94	14	31	6955	65	09/03/10	09/06/28	110	3	3	0	0	21.67
letabafetgiyani_003018B0C92D	55	0	76	11481	7716	07/01/17	07/09/25	251	377	227	58	92	20.47
emjindini_library	72	25	181	21330	12647	07/02/01	09/06/26	876	733	359	203	171	17.25
ben_mali	8	1	13	2796	1311	07/11/08	08/10/29	356	89	45	32	14	14.73
kwam_sizweni	51	51	298	4765	445	07/05/26	07/11/16	174	31	18	2	11	14.35
wozamoyaschool_003018B05866	91	18	60	15284	43	07/03/29	07/10/04	189	3	1	0	2	14.33
soshanguve_fablab	24	2	14	6063	543	09/02/23	09/04/18	54	38	27	4	7	14.29
letabafetcollege2_003018B0C994	294	172	33	15814	1017	07/01/16	09/02/22	768	73	37	13	23	13.93
vulindlela_mthatha	4	2	8	2712	91	07/10/21	07/12/05	45	7	3	3	1	13

Figure 6.9: Log details for sites – example segment

Using this spreadsheet, and the criteria listed in Section 5.5.4, it was possible to do meaningful and representative site selection. By looking at figures for ‘number of registered users’ (num_users), ‘accesses per user’ (user_accesses), location information and geographical location; a diverse range of sites (where there had been the most user activity), could be identified.

From the initial 210 sites, ten were chosen for detailed quantitative analysis (Figure 6.10).

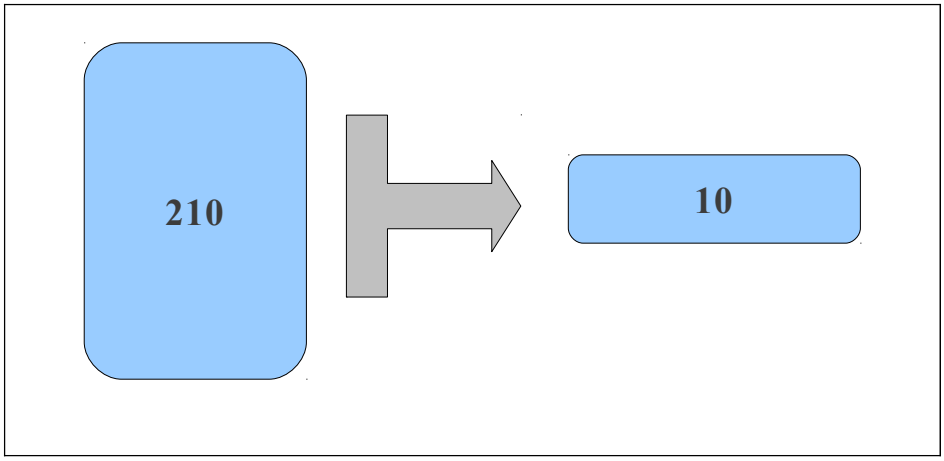


Figure 6.10: Subset 10 selection

The ten sites chosen for quantitative analysis, are listed in Table 6.2. Figure 6.11 indicates the geographical location of the ten sites (orange icons). The grey icons represent the remainder of the sites.

Table 6.2: The ten sites selected for detailed analysis

	Site Name	**Location**	**Province**
1	Elandskraal	MPCC	KwaZulu-Natal
2	Kagung	Informal Market	Northern Cape
3	Soshunguve	Fablab	Gauteng
4	Kwam-Hlonipha	Secondary School	Mpumalanga
5	Letaba FET Giyani	Tertiary FET College	Limpopo
6	Emjindini	Library	Mpumalanga
7	Letaba FET College 2	Tertiary FET College	Mpumalanga
8	Msunduzi	Cust. Care Centre	KwaZulu-Natal
9	Vezebuhle	Secondary School	Mpumalanga
10	Kanyamazane	Library	Mpumalanga

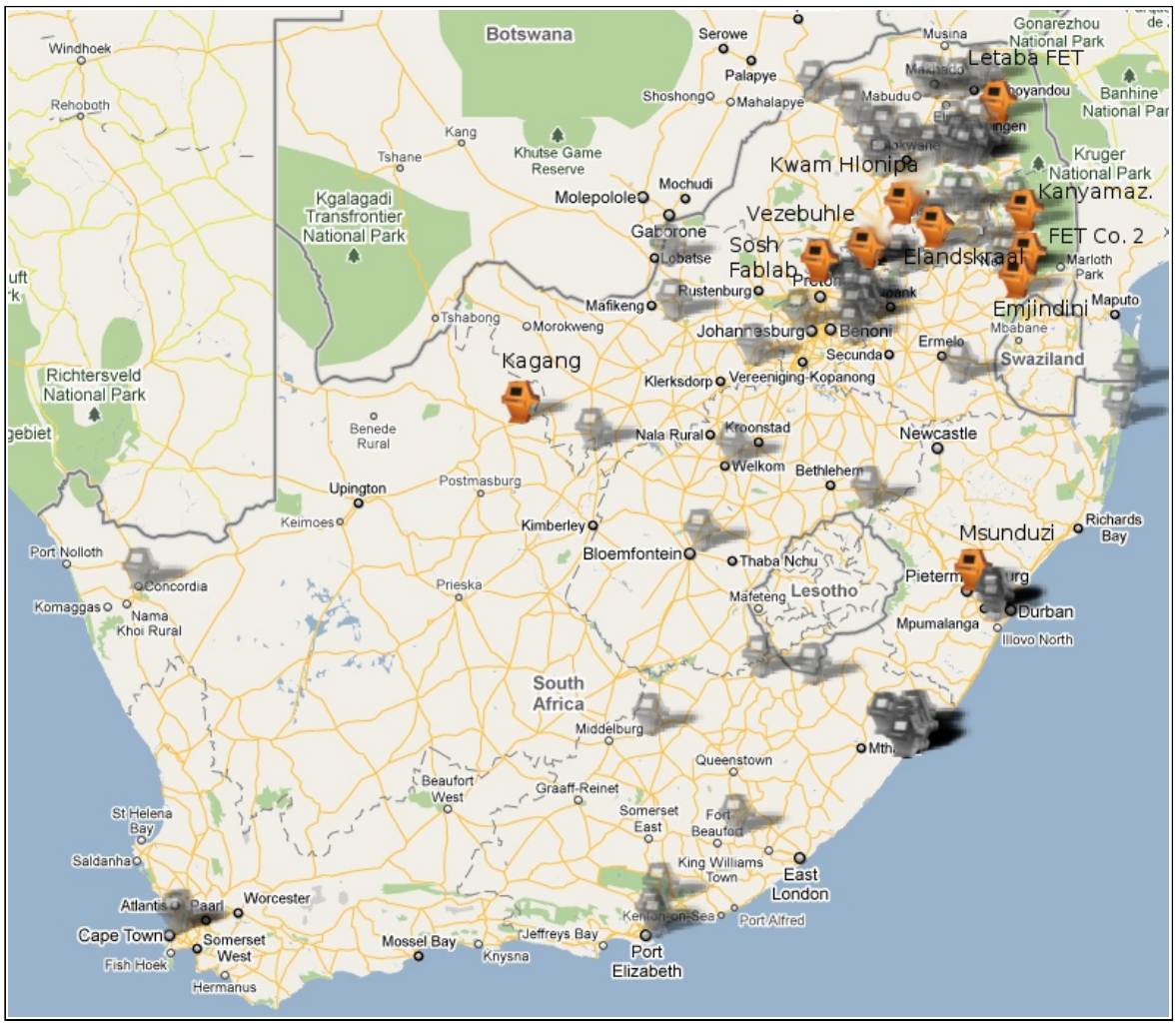


Figure 6.11: Selected Digital Doorway sites

6.6.2 Site details

Table 6.3 lists the types of the ten sites chosen for this study. The sites represent four subdivisions or location categories, namely schools, FET colleges, libraries, and general public facilities.

Table 6.4 expands on Tables 6.2 and 6.3, indicating the number of registered users per site, subdivided into male, female and unspecified; as well as the number of application hits by guest users and self-registered users; and the periods over which data was collected. This important table is used extensively in the quantitative data analysis.

Some pertinent figures in Table 6.4 are highlighted in red font, and discussed in this section.

Table 6.3: Site location categories

	Site type	Location category
1	School 1	Schools
2	School 2	
3	FET college 1	FET colleges
4	FET college 2	
5	Library 1	Libraries
6	Library 2	
7	1 MPCC	General public facilities
8	1 Fablab	
9	1 Informal market, and	
10	1 Customer care centre	

Following the detailed aggregation and processing described in Sections 6.6.1, the data is now manageable, and consists of:

- 6 age groupings;
- 7 application category groupings;
- 3 gender groupings;
- 10 sites in 4 site groupings;
- a total of 2150 users: 1190 male, 365 female, and 595 unspecified.

From Table 6.4 we see that the total number of registered users was 2150, with the highest numbers in Vezebuhle school (690), followed by Emjindini library (474) and Letaba FET College Giyani (306). Emjindini library had the greatest number of of application launches (hit-counts) by registered users (12634), understandable considering the data collection period for this site was the longest (28 months).

Two of the sites with the highest registered user count, Emjindini and Letaba FET Giyani, recorded more registered user hits than guest user hits, indicating extensive use by self-registered users.

Guest users were more than three times as likely to launch an application than registered users (134415 versus 42123 hits). This could be due to the fact that logging in as a registered user is a more complex task, requiring the initial creation of a user account and subsequent remembering and entering in of a password (See Section 6.2.1). The motivation for logging out of the guest account and logging back in as a user, was perhaps not sufficiently strong.

Table 6.4: The ten sites chosen for this quantitative study, in seven different location categories

	Location	Site name	Prov.	Township or rural	Site category	Tot. reg. users (m, f, u)	Guest user hits	Reg. user hits	Data collection period	Months
1	School	**Kwam-Hlonipha**	LIM	Rural	Education	69 (35, 12, 22)	9133	455	Apr2008–Apr2009	12
		Vezebuhle	MP	Rural	Education	690 (382, 90, 218)	16081	8937	Mar2007–Sep2007	6
2	MPCC	**Elandskraal**	LIM	Rural	Public	258 (150, 50, 58)	17557	2759	Feb2007–Jun2008	16
3	Library	**Emjindini**	MP	Township	Public	474 (250, 118, 106)	8683	12634	Feb2007–Jun2009	28
		Kanyamazane	MP	Township	Public	46 (25, 6, 15)	5319	421	Feb2008–Jun2008	4
4	FET College	**Letaba FET College 2**	LIM	Township	Education	66 (34, 9, 23)	14798	951	Jan2007–Feb2009	13
		Letaba FET Giyani	LIM	Township	Education	306 (187, 50, 69)	3765	7598	Jan2007–Sep2007	8
5	Cust. Care Centre	**Msunduzi**	KZN	Rural	Public	101 (38, 17, 46)	17752	1841	Feb2007–Sep2008	19
6	Fablab	**Soshunguve**	GAU	Township	Public	100 (64, 12, 24)	37074	4628	Jan2007–Mar2008	14
7	Informal Market	**Kagung**	NC	Rural	Public	40 (25, 1, 14)	4253	1899	Jul2008–May2009	10
**excludes names registered multiple times, m=male, f=female, u=unspecified* *LIM=Limpopo, MP=Mpumalanga, KZN=KwaZulu-Natal, GAU=Gauteng, NC=Northern Cape*						**2150*** (1190, 365, 595)	134415	42123		

6.6.3 Self-registered users versus age

Table 6.5 lists the number of self-registered users per age group. The greatest numbers are in the 10–13 group (726 users) and the 14–17 group (749), with a high number aged 18–21 (583). This finding, which indicates extensive usage by both primary, and secondary school learners, is most satisfactory. The fact that high numbers of young people are using the DD sites at *public* locations such as libraries, as well as in schools, seems to indicate that the youth are more open to embracing new technologies than older people.

Table 6.5: Age category, and number of registered users per category

	Description	Age range	Reg. Users
1	Typical junior primary school learners	6–9	57
2	Typical senior primary school learners	10–13	726
3	Typical secondary school learners	14–17	749
4	Post-school and tertiary level learners	18–21	583
5	Young adults	22–25	243
6	Older adults	26–60	279
7	The rest (incl. many obviously false ages)	0-5, 61+	389
	*includes duplicate registrations		**3026***

Less pleasing data from Table 6.5 is that, from the subset of 10 sites, the logs record 3026 registered users of which 3026 – 2150 = 876 are duplicates. Of the 2150 unique names, only 1153 have a hit-count of 1 or more (see Section 6.6.4), leaving 997 user names that were created and never used, suggesting either a lack of understanding of the purpose for creating a user name, or an inability to remember the user name and/or password combination.

6.6.4 Account usage

With this background it was appropriate to drill down and determine how registered users accessed their accounts. Figure 6.12 plots hit-count (x-axis) versus number of users (y-axis). Figure 6.13 plots cumulative hit-count (x-axis) versus number of users (y-axis), i.e., the number of users that had a hit-count of at least X, where is X is the value on the x-axis.

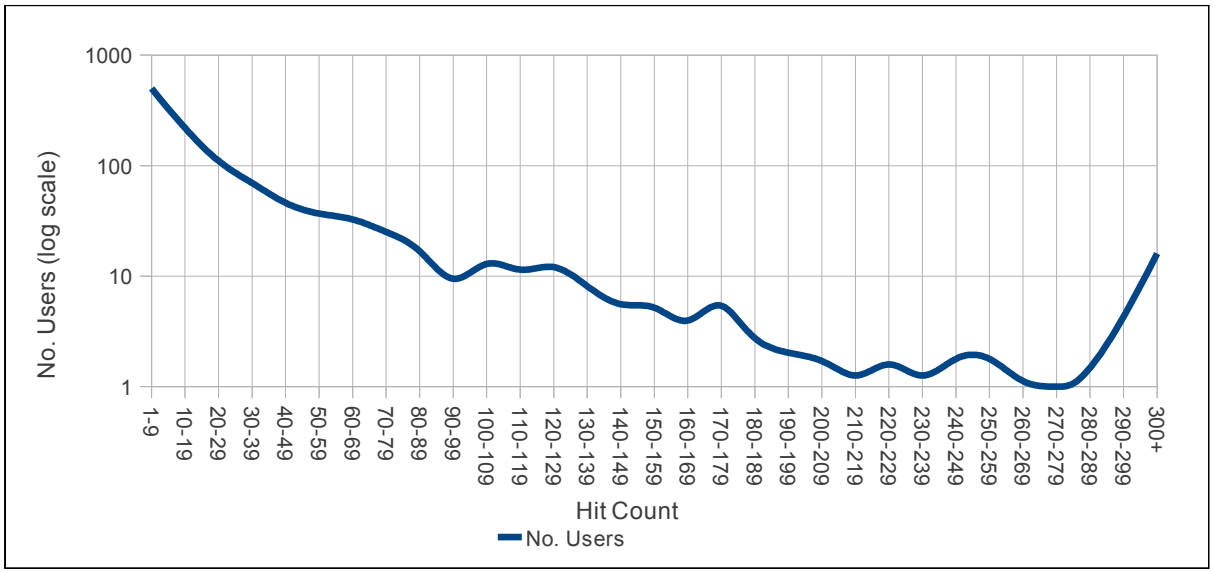


Figure 6.12: Number of users versus hit-count

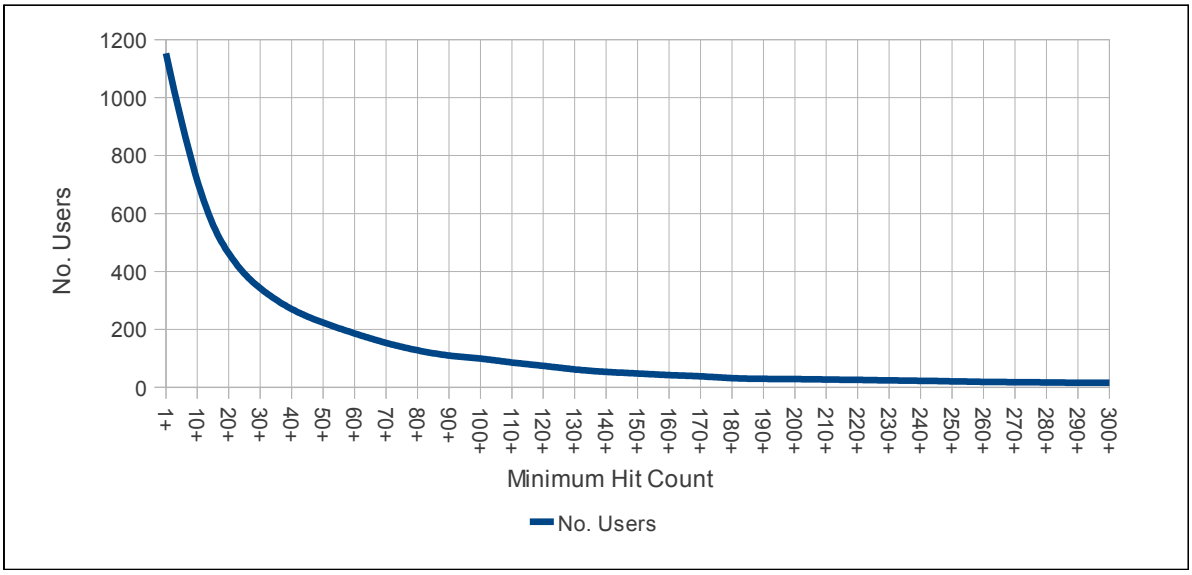


Figure 6.13: Number of users versus hit-count cumulative

These figures show that a large proportion of users registered a user name, but spent very little time logging in and using the account. By contrast, other users made extensive use of DD terminals. Some observations from the above graphs are listed below, relating to the 1153 users who used their accounts at least once (Section 6.6.3):

- 500 users (almost 50%) launched only 1 application.
- 9% of users (101 of the 1153) used their registered accounts to launch 100 applications or more, indicating extensive use.
- Over 200 of the 1153 users (17%) registered 50 application launches or more, indicating fairly extensive use.

Figure 6.12 shows that a notable number of users (the exact figure is 500), registered accounts and used them only for between 1 and 9 application launches. What does this tell us? Various possibilities exist:

- A user logged in with their newly created account, launched a few applications and did not return.
- A user logged in with the newly created account, launched a few applications and did not log in again with that user name, possibly logging in as a guest user from then on.
- A user forgot his/her password or just decided to create a new user name.

Suggestions for encouraging users to create and use their own accounts, are presented in Chapter 8 (see Section 8.8). These suggestions could contribute to alleviating the data issues identified in this study and described in this section.

6.7 Quantitative analysis for Research Question 1

This section analyses the data as it relates to Research Question 1 (RQ1):

Given free access to computer infrastructure containing a variety of software applications and content, what categories of applications are used by various age groups on Digital Doorways?

- What are the general trends amongst all users regarding application usage?
- Are there notable relationships between the age of users, and application usage in the various general and specific categories?

As previously mentioned, applications are categorised according to seven general categories and 26 specific categories (Section 5.5.3), and ages are divided into seven groupings.

6.7.1 Percentage total registered users per age group

To set the context for answering the question, we first address the question: What percentage of total registered users does each age group comprise?

The figures in Table 6.6 show the numbers of registered users across the ten sites, according to age group. This is depicted graphically in Figure 6.14.

From the available data, it is evident that the highest percentage of registered users was in the 14–17 age group (23.62%), closely followed by the 10–13 age group (23.29%) and the 18–21 age group (20.18%). The other age groups showed considerably lower figure for total registered users.

Table 6.6: Percentage registered users per age group

Age group	Registered users	% of total
6–9	42	1.95%
10–13	501	23.30%
14–17	508	23.63%
18–21	434	20.19%
22–25	181	8.42%
26–60	202	9.40%
0–5, 61+	282	13.12%
	2150	

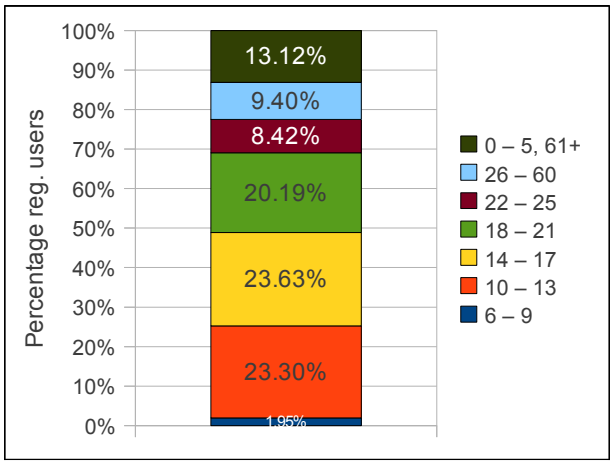


Figure 6.14: Registered users per age group

Figure 6.15 (from Gush et al., 2011) shows data not collected as part of the present study, but is included here for comparison with the ten sites in this study. The graph displays the number of registered users versus age for 75 DD sites around South Africa, with data up to January 2008. It shows a distribution similar to that of the present study. The single age with the most registered users was age 14, followed by ages 12, 13 and 15 respectively. There was a noticeable trend of declining registrations from the early teens, through to older adults.

As in the present study, user registrations in the 6–9 age group were extremely low, as were registrations in the 26+ age group.

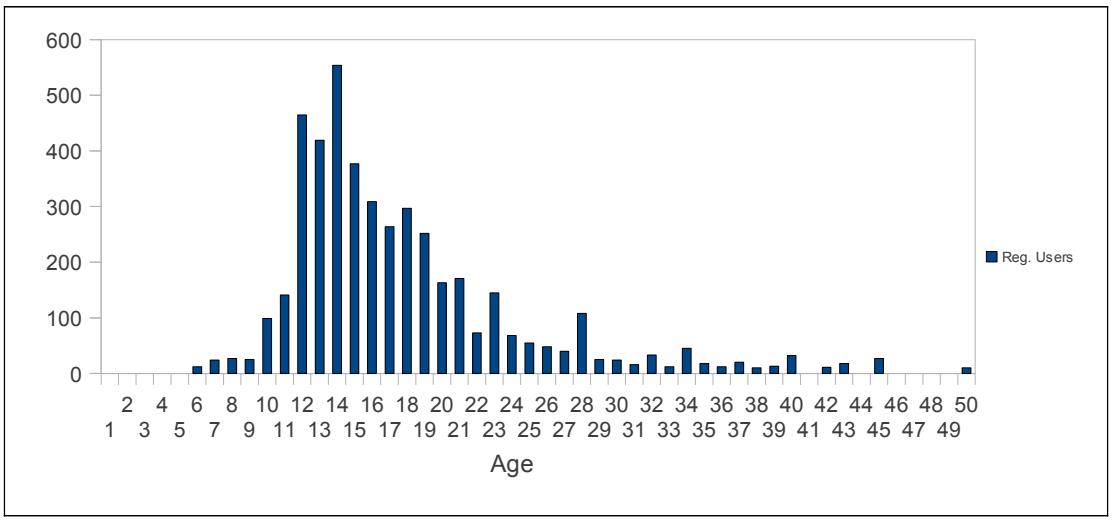


Figure 6.15: Age distribution of registered users (75 sites)

Section 6.7.3 presents the stereotypical profiles of the ages of users at each of the ten sites, enabling a site-by-site comparison of age distributions, per age grouping.

6.7.2 Percentage of total hits per age group

Age groups that are using the Digital Doorways most to launch applications

Figure 6.16 displays the percentage of total application hits, per age group (all categories). From these figures, it is clear that most application launches are by users in the 14–17 age group (29.2%), followed by the 10–13 age group (22.3%) and the 18–21 age group (21.9%).

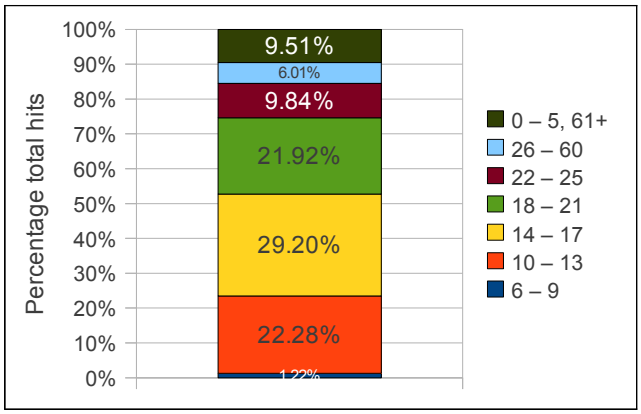


Figure 6.16: Percentage of total hits per age group

6.7.3 Comparison of age distributions per site

Figures 6.17 to 6.25 illustrate the age distribution per age category for each of the ten sites. These figures are based on the number of registered users at each site and help build up a picture of user activity at that site, as defined by age.

Kwam-Hlonipha, Secondary School

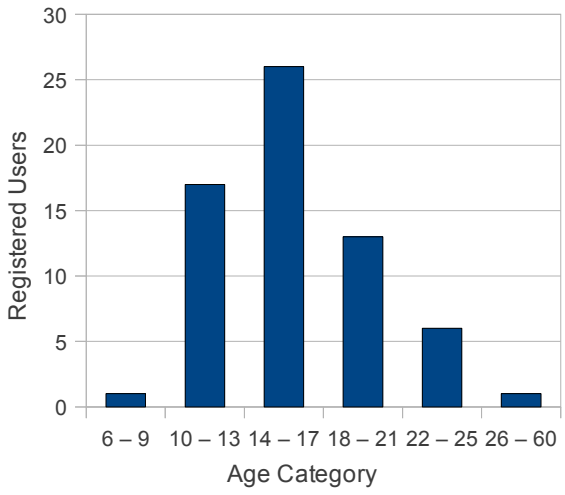


Figure 6.17: Kwam-Hlonipha, Limpopo

Most registered users were in the 14–17 age group, as is to be expected at a secondary school.

Vezebuhle Secondary School

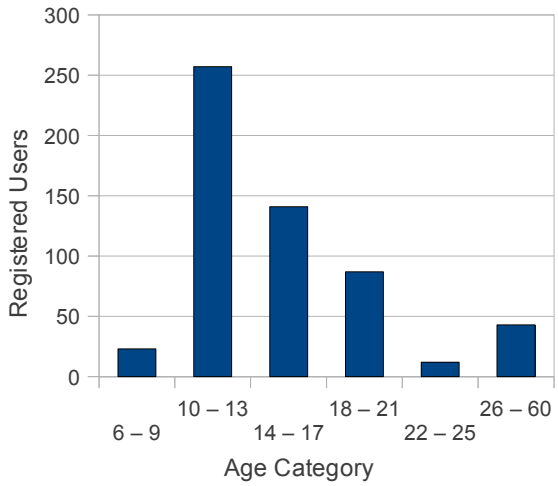


Figure 6.18: Vezebuhle, Mpumalanga

Most users were in the 10–13 age group, followed by the 14–17 age group, as is expected at a school.

Elandskraal, MPCC

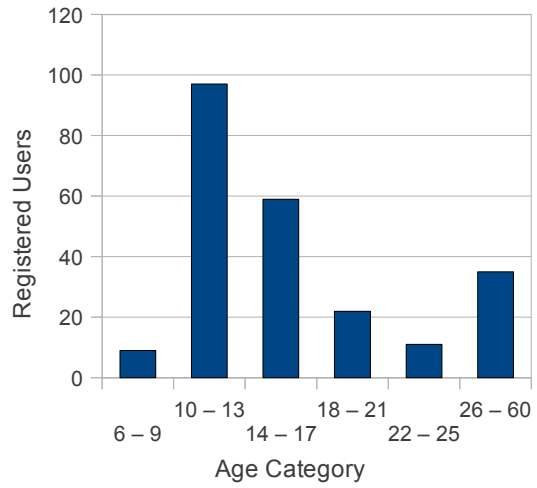


Figure 6.19: Elandskraal, Limpopo

Multi-purpose community centre, situated near schools, mostly used by the 10-17 ages, with some use by the over 26 age group.

Emjindini, Library

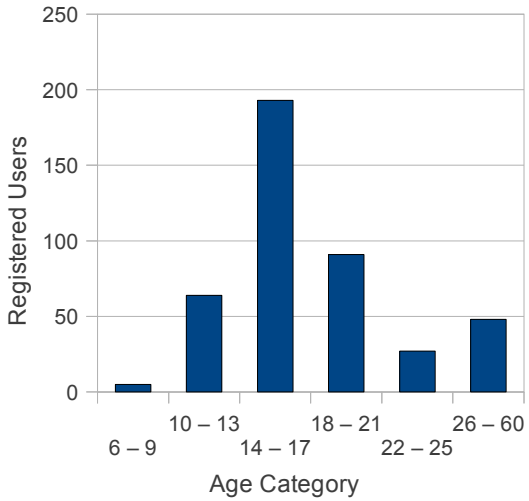


Figure 6.20: Emjindini, Mpumalanga

Most use by users in the 14–17 age groups, followed by the 15-21 age group. These are mostly students going to the library to study, as confirmed in the qualitative study (see Chapter 7, Section 7.5.3).

Kanyamazane, Library

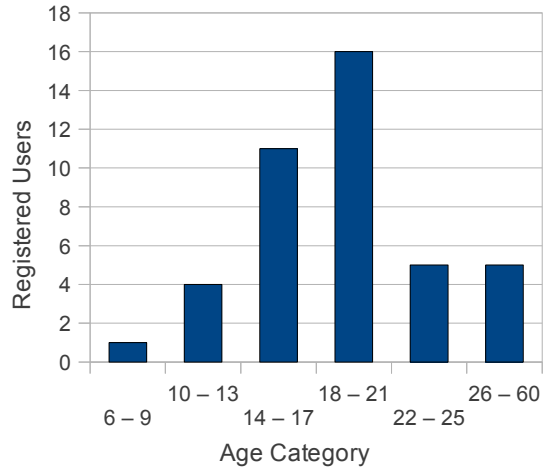


Figure 6.21: Kanyamazane, Mpumalanga

At this library, the highest values are in the 14–17 age group and the 18–21 age group.

Letaba FET College 2, FET College

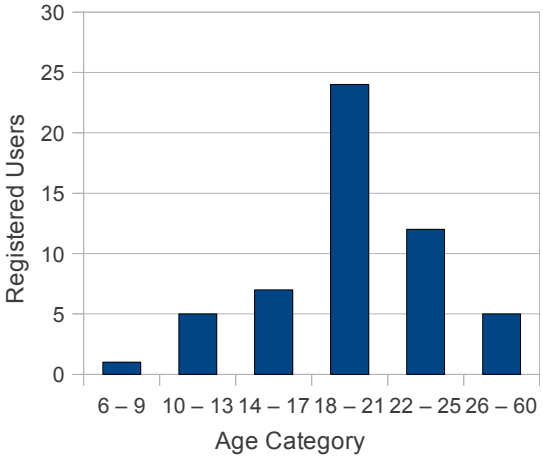


Figure 6.22: Letaba FET 2, Limpopo

Highest values are in the 18–21 age group, and second highest in the 22–25 age group, as is to be expected at an FET college.

Letaba FET Giyani, FET College

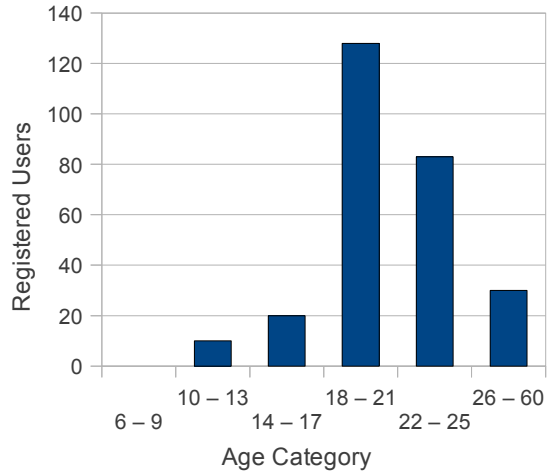


Figure 6.23: Letaba FET Giyani, Limpopo

High values in the 18–21 and 2nd highest in the 22–25 age group is to be expected at an FET college. It is interesting to note a number of users between 10 and 17 also using the FET college DD.

Msunduzi, Customer Care Centre

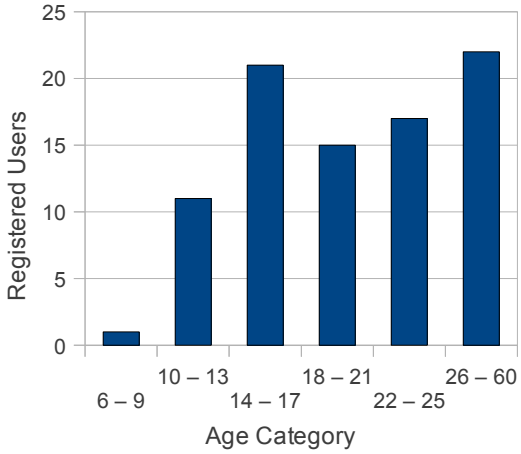


Figure 6.24: Msunduzi, KwaZulu-Natal

Registered user values indicate usage across a wide distribution of age groups, reflective of a mixture of students and adults coming to the customer care centre for administrative purposes (amongst other facilities, a post office is situated in the centre).

Soshunguve, FabLab

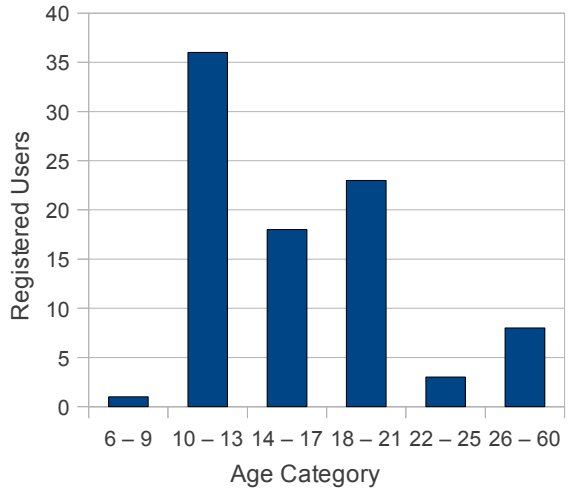


Figure 6.25: Soshunguve Fablab, Gauteng

Highest values in the 10–13 age group, with 2nd highest in the 18–21 age group. Site is located near schools.

Kagung, Informal Market

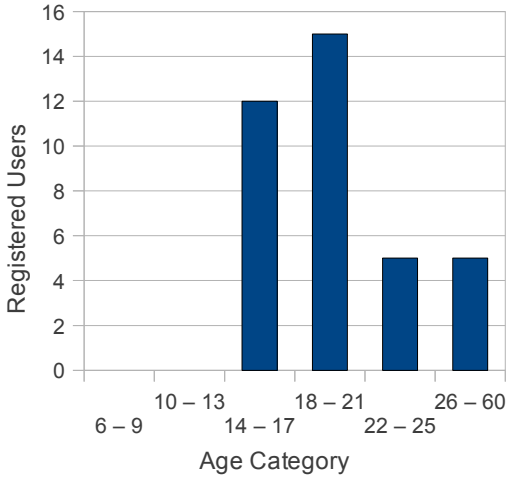


Figure 6.26: Kagung, Northern Cape

High values in the 14–17 age group and the 18–21 age group. No registered users under 14 years old. The total number of registered users is low.

6.7.4 Usage statistics per age group, per site

Table 6.7 (page following), presents a useful overview of the age distributions at the ten sites, as well as details of hit-counts, which indicate the extent to which the DD is being used (when related to the data collection periods in Table 6.4). Key values are highlighted in red.

Kwam-Hlonipha school has the highest hit-count in the 14–17 age group (37.6%), while Vezebuhle school, Elandskraal MPCC and Soshanguve Fablab have their highest hit-counts in the 10–13 age group (42.8%, 33% and 30.1% respectively). Emjindini library displays high usage in the 14–17 age group (over 50%). Kanyamazane library, the two FET colleges, and Kagung informal market, all display highest usage in the 18–21 age group (59.6%, 72.7%, 42.2% and 60.1% respectively). Msunduzi Customer Care Centre has the highest usage in the 22–25 group (23%).

6.7.5 Usage findings - general categories

To what extent is each of the general categories used by each age group? The seven general categories were described in Section 5.5.3, and are listed below:

- Edutainment;
- Education;
- Games;
- Office;
- Reference;
- System/DDhomepage;
- Video/audio.

Table E1 in Appendix E, depicts the actual hit-counts per general category, per age group, for males, females, unspecified and all users respectively. Table E2 in Appendix E, depicts the hit-counts per age group, as a percentage of total hit-counts per age group, for each general category. The data is displayed for males, females, unspecified and all users respectively.

Gender independent data from Table E2 (Appendix E) is illustrated in Figure 6.27, enabling comparison both of general category application usage within the same age group, and of differences in application usage between different age categories.

Table 6.7: Per-site hit-count, per age group

	Location	Site Name	Age Groups														All age groups	
			6–9		10–13		14–17		18–21		22–25		26–60		Other			
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total	%
1	*School*	**Kwam-Hlonipha**	0	0.0%	120	26.4%	171	37.6%	61	13.4%	73	16.0%	14	3.1%	16	3.5%	**455**	100%
		Vezebuhle	231	2.6%	3821	42.8%	1954	21.9%	901	10.1%	270	3.0%	275	3.1%	1485	16.6%	**8937**	100%
2	*MPCC*	**Elandskraal**	202	7.3%	910	33.0%	874	31.7%	117	4.2%	110	4.0%	411	14.9%	135	4.9%	**2759**	100%
3	*Library*	**Emjindini**	49	0.4%	1782	14.1%	6392	50.6%	1530	12.1%	406	3.2%	800	6.3%	1675	13.3%	**12634**	100%
		Kanyamazane	0	0.0%	8	1.9%	74	17.6%	251	59.6%	70	16.6%	12	2.9%	6	1.4%	**421**	100%
4	*FET College*	**Letaba FET2**	2	0.2%	93	9.8%	28	2.9%	691	72.7%	82	8.6%	13	1.4%	42	4.4%	**951**	100%
		Letaba FET Giyani	0	0.0%	804	10.6%	427	5.6%	3205	42.2%	2385	31.4%	332	4.4%	445	5.9%	**7598**	100%
5	*Cust.Care Centre*	**Msunduzi**	0	0.0%	366	19.9%	369	20.0%	218	11.8%	424	23.0%	140	7.6%	324	17.6%	**1841**	100%
6	*Fablab*	**Soshunguve FL**	28	0.6%	1391	30.1%	1525	33.0%	1067	23.1%	95	2.1%	388	8.4%	134	2.9%	**4628**	100%
7	*Informal Market*	**Kagung**	0	0.0%	0	0.0%	402	21.2%	1141	60.1%	229	12.1%	127	6.7%	0	0.0%	**1899**	100%
All sites aggregated			**512**	1.2%	**9295**	22.1%	**12216**	29%	**9182**	21.8%	**4144**	9.8%	**2512**	5.96%	**4262**	10.1%	**42123**	

RESULTS_Hits_AgeGroups_vs_Sites.ods

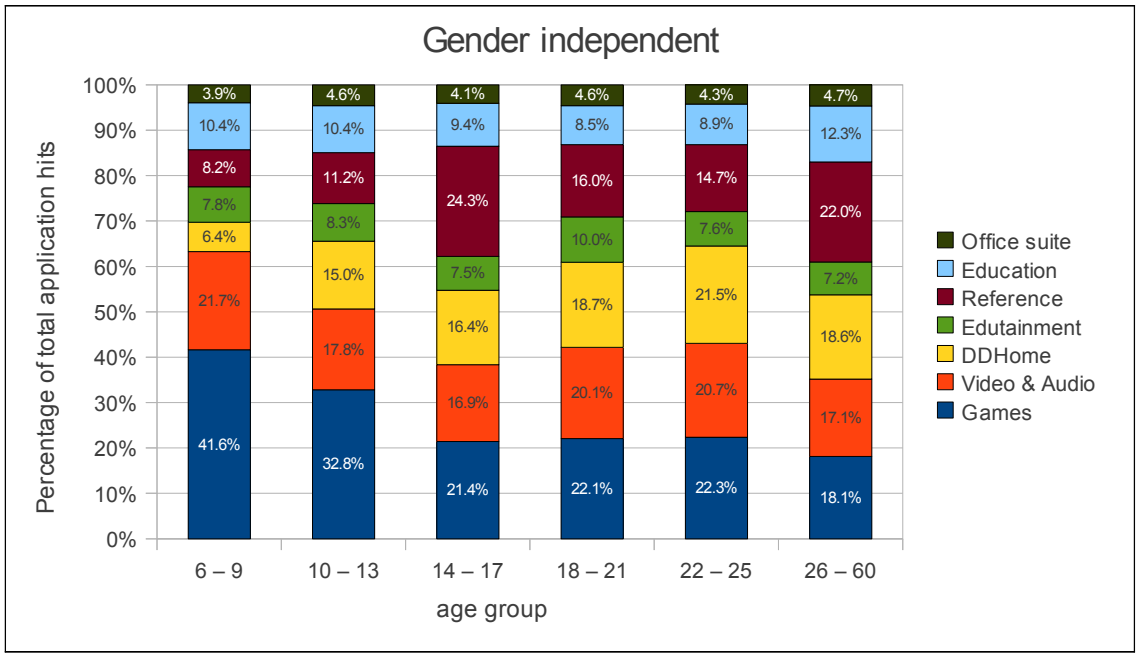


Figure 6.27: Application hits per age grouping and category (gender independent)

In Figure 6.27, we notice a downward trend in the usage of games with increasing age, declining from over 40% of usage time for 6–9 year-olds to 18% for users over 26 (see statistical analysis in Section 6.7.6). However, games remain the top- or second-most popular activity among all age groups. Education has low usage levels, less than 10.5%, except in the 26–60 group, where it is slightly higher at 12.3%. However, when education and reference are combined, a different picture emerges, with the 14–17 age group and the 26–60 age group showing equivalent usage levels at 33.7% (9.4 + 24.3) and 34.3% (12.3 + 22.0) respectively, followed by the 18–21 age group at 24.5% (8.5 + 16).

The low use of the office suite applications (open office word processor, spreadsheet etc) is notable. This is possibly due to the relative 'dryness' of these applications relative to games and video, but a further major issue is the absence of a printer at DD terminals. Requests for printing services are frequently made by users (see Chapter 7), however, the logistics of managing supplementary consumables in remote unsupervised areas have prevented the installation of printing facilities at any of the sites in this study. Moreover, DDs are explicitly not intended to be clerical service points. Such usage would run counter to the envisaged fundamental purposes. The DD project may, however, for sustainability reasons, require future expansion to provide the dual functionality of computer training and service delivery.

Noticeable in Figure 6.27 are the high percentages in the reference category of users in the 14–17 age group (24.3%), as well as those in the 26–60 age group (22%). The high usage of DDhomepage/navigation category in the 22–25 age group (21.5%) is also noteworthy.

6.7.6 Significance of relationship between application usage and age category

Pearson's Chi-square test

Pearson's Chi-square test for a (row x column) frequency table is used to determine the degree of statistical significance between age category and application category usage. Table E3 (in Appendix E), displays application usage hit-counts versus age categories for all users regardless of gender. In addition, Table E3 displays the cell Chi-square values for each entry. Data for users in the 0–5, 61+ category were excluded from the analysis. The resultant Chi-square calculation is:

Table 6.8: Chi-square for age versus application usage

Statistic	DF	Value
Chi-Square	30	1325.6277

Sample Size = 37852

The Pearson's Chi-square statistic with a value of 1325.63 is statistically highly significant. The probability associated with the Chi-square statistic is less than 0.001, which indicates significance on the 0.1% level of significance. Statistical significance in this instance means that the two variables that are represented by the rows and columns of the frequency table (age and user application, Table E3) are statistically significantly dependent. (The null hypothesis examined with Chi-square tests of this nature always states that the two variables are independent of one another). Dependence implies that application use is dependent on age, or changes with age. Stated differently, dependence implies that, for a specific age group (row), the distribution of application-use over the various applications (all columns) for that age group differs from another/ or some other age group usage distributions. The distribution of usage-proportion differs.

Since the cell-Chi-square value-entries of individual cells in Table E3 add up to the Pearson Chi-square statistic above, the individual cell-chi-square values can assist in identifying usage-distributions that differ significantly for different age groups. For example, age groups 6–9 and 14–17, differ with respect to the use of games versus referencing applications – 41% of total application use of 6-9 year-olds is devoted to games, and 8% to referencing applications; as compared to 21% games and 24% referencing usage by 14–17 year-olds. Another example would be the 10–13 year group compared to the 26+ group: their games application usage and reference application usage patterns differ significantly. A final example would be comparing the 6–9 and 10–13 year age groups, where usage patterns on games, DDhomepage, and referencing, differ statistically.

Trend tests

The same reasoning can be followed to compare how, over age categories, usage of two or more applications differs. For Table E3, this approach was taken one step further by comparing the usage ratio of pairs of columns in Trend tests. The purpose of these specific tests is to determine whether trends in application usage over age, differ statistically significantly between applications. The specific type of test is referred to as the Cochran-Armitage Trend test. Three separate, pairwise tests are presented in Table 6.9, to investigate trend differences over age between,

- Games and video/audio;
- Games and DDhomepage;
- Games and reference.

The first section of Table 6.9 presents the usage frequencies and percentages, and the second section, the test statistics and significance measures.

Interpretation of Table 6.9

Significance on the 0.1% level of significance is associated with the three Chi-square statistics of 192.05, 401.24, and 880.84, for the three age versus 2-factor application usage frequency tables respectively. This implies that there are statistically significant relationships (dependencies) between the frequency usage of games and video/audio; games and DDhomepage; and games and reference.

The second test, the Cochran-Armitage trend test, confirms the statistical significance of the dependencies, but also indicates the type of relationship that exists between the frequency proportions of paired applications. The trend test examines the statistical significance of a trend in binomial proportions over the levels of age categories. If a statistically significant trend is established (as has been done in the three instances), this implies that the proportion of row frequencies (frequency proportions between column 1 and total row frequencies) in column 1 (the first usage variable in this instance, which will be ‘games’) either decrease or increase over classification categories (increase in age). At the same time, proportion of row frequencies of column 2 – the paired application category usage–will decrease or increase adversely. The value of the Cochran-Armitage trend test statistic assists in this respect: if the value is negative, the proportions trend over the column 1 variable is decreasing, and the row-proportions trend of the second column variable is increasing.

Since all three trend test statistics were negative in this instance (and highly significant with associated probabilities of less than 0.0001), statistically significant decreasing age-related trends were established for the pair-wise tests of games versus video/audio, DDhomepage and referencing. In other words: over ascending age categories;

- There is a statistically significant decreasing trend in games utilisation and increasing trend in video/audio utilisation;
- There is a statistically significant decreasing trend in games utilisation and increasing DDhomepage utilisation trend;
- There is a statistically significant decreasing trend in games utilisation and increasing referencing utilisation.

These trends can be visualised by referring back to Figure 6.27.

Table 6.9: Cochran-Armitage age-trend tests on three pairs of application usage variables

Age cat. Frequency Cell Chi-Sq. Row %	**Games**	**Video/ audio**	**Total**	**Games**	**DD home**	**Total**	**Games**	**Refer ence**	**Total**
6-9	213 4.1518 65.74	111 5.5443 34.26	324	213 33.593 86.59	33 47.075 13.41	246	213 28.175 83.53	42 39.191 16.47	255
10-13	3047 48.09 64.83	1653 64.22 35.17	4700	3047 79.806 68.60	1395 111.83 31.40	4442	3047 187.68 74.52	1042 261.06 25.48	4089
14-17	2606 1.4698 55.84	2061 1.9627 44.16	4667	2606 4.2175 56.06	2043 5.91 43.94	4649	2606 121.95 46.88	2953 169.64 53.12	5559
18-21	2018 14.835 52.48	1827 19.811 47.52	3845	2018 15.245 53.50	1754 21.363 46.50	3772	2018 0.0142 58.02	1460 0.0198 41.98	3478
22-25	919 8.6646 51.89	852 11.571 48.11	1771	919 20.765 50.22	911 29.098 49.78	1830	919 1.1407 60.26	606 1.5867 39.74	1525
26-60	454 5.0236 51.47	428 6.7085 48.53	882	454 13.465 49.13	470 18.869 50.87	924	454 29.436 45.13	552 40.945 54.87	1006
Total	9257	6932	16189	9257	6606	15863	9257	6655	15912
Test statistics									
Pearson's	Chi-square = 192.05, Pr <0.0001***			Chi-square = 401.24, Pr <0.0001***			Chi-square = 880.84, Pr <0.0001***		
Cochran-Armitage trend test	Z-statistic= -12.31 One-sided Pr < Z is, <0.0001***			Z-statistic= -17.76 One-sided Pr < Z is, <0.0001***			Z-statistic= -15.42 One-sided Pr < Z is, <0.0001***		

Significance legend: * : Significance on the 5% level of significance (probability is less than 0.05)
** : Significance on the 1% level of significance (probability is less than 0.01)
*** : Significance on the 0.1% level of significance (probability is less than 0,001)

6.7.7 Usage findings - specific categories

As mentioned in Section 5.5.3, 26 *specific application categories* were identified, as a more fine-grained set than the *general categories*. The initial goal was to ascertain the application hit-counts per specific category for each of the age groups. The script '*counter_per_age*' (See Appendix B) was designed to calculate the hit-count per specific category, per age group, and output this to a file, from which the following results in Table 6.10, of age group versus specific category, were obtained. In the first column, category entries are listed in the format 'general category, specific category'. Specific categories with the ten highest hit-count totals are highlighted in red font. These are:

- Games, other – 5892 hits. These games include card games and the likes of *khangman*, *atomix* and *klickety*.
- Games, orientation – 4620 hits. The bulk of hits were on *gnibbles* and *ktron*.
- Reference, Wikipedia – 3819 hits. The use of this open encyclopaedia is very high in the 14–17 age group, with a hit-count of 1946.
- System, DDhomepage – 3570 hits. Comparatively high hit-counts in the 18–21 and 22–25 age groups. Prominence of position of this item in the menu structure, may also have contributed to the high usage (See Section 6.9.5).
- Video_audio, fun – 3541 hits. Multimedia content is consistently popular with users.
- System, file-manager – 3446 hits. The high use of the file-manager is indicative both of the prominence of position in the menu structure (Section 6.9.5) and the desire of users to explore the DD file system.
- Education, science – 3083 hits. Interactive Java science simulations, solar system exploration, and physics facts, make up most of these hits.
- Video_audio, web-cam – 3057 hits. The novelty of seeing themselves on camera for the first time, make this application very popular amongst users. The web-cam is also used to customise the user desktop with a custom image.
- Office, openoffice – 1831 hits. Despite the lack of a printer, usage of the office-related applications such as word processor and spreadsheet was quite high.
- Reference, life-skills – 1043 hits. This category includes health information such as HIV/AIDS awareness literature.

The low hit-counts for the *gcompris* edutainment application (highlighted in blue font), in the 6–9 and 10–13 age groups is disappointing, as this application contains a wealth of interactive content, specifically targeted at younger users. Making this application more prominent to younger users may encourage them to spend more time exploring the various activities that are available. The edutainment category is further addressed in Section 6.9.4.

Table 6.10: Hit-count for specific categories (per age group)

Category	Age Category Hit-count							
	6-9	10-13	14-17	18-21	22-25	26-60	Other	Total
Education, maths	5	37	50	48	27	11	11	**189**
Education, mindset	8	168	249	168	54	98	146	**891**
Education, science	40	757	849	565	286	200	386	**3083**
Edutainment, computer	3	23	52	24	12	5	10	**129**
Edutainment, gcompris	13	282	227	162	88	19	63	**854**
Edutainment, graphics	6	96	139	99	65	32	36	**473**
Edutainment, language	5	34	45	65	27	15	22	**213**
Edutainment, localgames	0	99	178	349	9	70	15	**720**
Edutainment, maths	11	191	203	165	96	33	85	**784**
Edutainment, science	2	44	65	48	17	7	24	**207**
Games, orientation	112	1666	1106	666	275	168	627	**4620**
Games, other	101	1381	1500	1352	644	286	628	**5892**
Office, openoffice	20	427	496	422	175	117	174	**1831**
Reference, agriculture	2	72	135	130	57	37	42	**475**
Reference, books	10	134	253	221	86	61	84	**849**
Reference, fun	7	63	108	86	54	16	26	**360**
Reference, life-skills	8	183	294	177	154	105	122	**1043**
Reference, science	8	120	217	196	105	54	106	**806**
Reference, wikipedia	7	470	1946	647	150	279	320	**3819**
System, comms	0	27	58	45	13	8	4	**155**
System, ddhomepage	22	574	1021	884	519	261	289	**3570**
System, file-manager	11	794	964	825	379	202	271	**3446**
Video_audio, audiobooks	4	104	191	224	108	55	53	**739**
Video_audio, fun	74	839	969	750	367	180	362	**3541**
Video_audio, science	3	106	114	61	38	14	39	**375**
Video_audio, web-cam	30	604	787	802	339	179	316	**3057**
	512	**9295**	**12216**	**9181**	**4144**	**2512**	**4261**	**42121**

RESULTS_Specific_category_Hitcounts.ods

Table 6.11, while similar to Table 6.10, places the emphasis on the percentage of usage per specific category, for each age grouping. Each column adds up to 100%. The table allows comparison of one category with another, to determine the percentage of usage of the applications in that category, for a certain age group. The table may also be used to compare the percentage of usage in a particular category, between one age group and another. The percentages were calculated by dividing the hit-count in a cell (Table 6.10), by the total hit-count for that age group (512, 9295, …, etc.). This enables age by age comparison, irrespective of differences in total hit-counts between age groups. As in Table 6.10, the specific categories with highest usage overall, are highlighted in red font. The table is presented in graphical form in Figure 6.28.

Table 6.11: Hit-count percentages (per age group)

Category	Age Category Hit-count						
	6-9	10-13	14-17	18-21	22-25	26-60	Other
Games, other	19.7%	14.9%	12.3%	14.7%	15.5%	11.4%	14.7%
Games, orientation	21.9%	17.9%	9.1%	7.3%	6.6%	6.7%	14.7%
Video_audio, fun	14.5%	9.0%	7.9%	8.2%	8.9%	7.2%	8.5%
System, ddhomepage	4.3%	6.2%	8.4%	9.6%	12.5%	10.4%	6.8%
Education, science	7.8%	8.1%	6.9%	6.2%	6.9%	8.0%	9.1%
Reference, wikipedia	1.4%	5.1%	15.9%	7.0%	3.6%	11.1%	7.5%
System, file-manager	2.1%	8.5%	7.9%	9.0%	9.1%	8.0%	6.4%
Video_audio, web-cam	5.9%	6.5%	6.4%	8.7%	8.2%	7.1%	7.4%
Office, openoffice	3.9%	4.6%	4.1%	4.6%	4.2%	4.7%	4.1%
Reference, life-skills_health	1.6%	2.0%	2.4%	1.9%	3.7%	4.2%	2.9%
Education, mindset	1.6%	1.8%	2.0%	1.8%	1.3%	3.9%	3.4%
Reference, books	2.0%	1.4%	2.1%	2.4%	2.1%	2.4%	2.0%
Reference, science	1.6%	1.3%	1.8%	2.1%	2.5%	2.1%	2.5%
Edutainment, gcompris	2.5%	3.0%	1.9%	1.8%	2.1%	0.8%	1.5%
Edutainment, maths	2.1%	2.1%	1.7%	1.8%	2.3%	1.3%	2.0%
Video_audio, audiobooks	0.8%	1.1%	1.6%	2.4%	2.6%	2.2%	1.2%
Edutainment, localgames	0.0%	1.1%	1.5%	3.8%	0.2%	2.8%	0.4%
Edutainment, graphics	1.2%	1.0%	1.1%	1.1%	1.6%	1.3%	0.8%
Reference, agriculture	0.4%	0.8%	1.1%	1.4%	1.4%	1.5%	1.0%
Reference, fun	1.4%	0.7%	0.9%	0.9%	1.3%	0.6%	0.6%
Video_audio, science	0.6%	1.1%	0.9%	0.7%	0.9%	0.6%	0.9%
Edutainment, language	1.0%	0.4%	0.4%	0.7%	0.7%	0.6%	0.5%
Education, maths	1.0%	0.4%	0.4%	0.5%	0.7%	0.4%	0.3%
Edutainment, science	0.4%	0.5%	0.5%	0.5%	0.4%	0.3%	0.6%
Edutainment, computers	0.6%	0.2%	0.4%	0.3%	0.3%	0.2%	0.2%
System, comms	0.0%	0.3%	0.5%	0.5%	0.3%	0.3%	0.1%
	100%	100%	100%	100%	100%	100%	100%

RESULTS_Specific_category_Hitcounts.ods

In the 6–9 age group, the two games categories are the most used (19.7% and 21.9% respectively), followed by the video_audio, fun category (14.5%); science education (7.8%); and video_audio, web-cam (5.9%).

In the 10–13 age group, games are most popular (14.9% and 17.9%); followed by video_audio, fun (9%); file-manager (8.5%); and science education (8.1%).

In the 14–17 age group, the Wikipedia reference material has the highest usage (15.9%); followed by games categories (12.3% and 9.1%); DDhomepage (8.4%); video_audio, fun and file-manager (both 7.9%).

In the 18–21 age group and above, we see a marked decline in the orientation games category (games such as *gnibbles* and *ktron*), while usage in the other games category (e.g., card games) remains high. For the 18–21 age group, usage is also high in the DDhomepage; file-

manager; web-cam; and video_audio, fun categories; (9.6%, 9%, 8.7% and 8.2% respectively). Similar results are observed in the 22–25 age group.

In the 26–60 age group, we see high usage in games, other (11.4%); Wikipedia (11.1%); DDhomepage (10.4%); file-manager (8%); and science education (8%). Interestingly, Wikipedia usage in this category, is second only to that in the 14–17 age group. Games use, while still high, is the lowest of all age categories. Combining percentages for Wikipedia and science education (19.1%), we notice that these educational resources are being well used by adults, despite the low numbers of adults using the DDs.

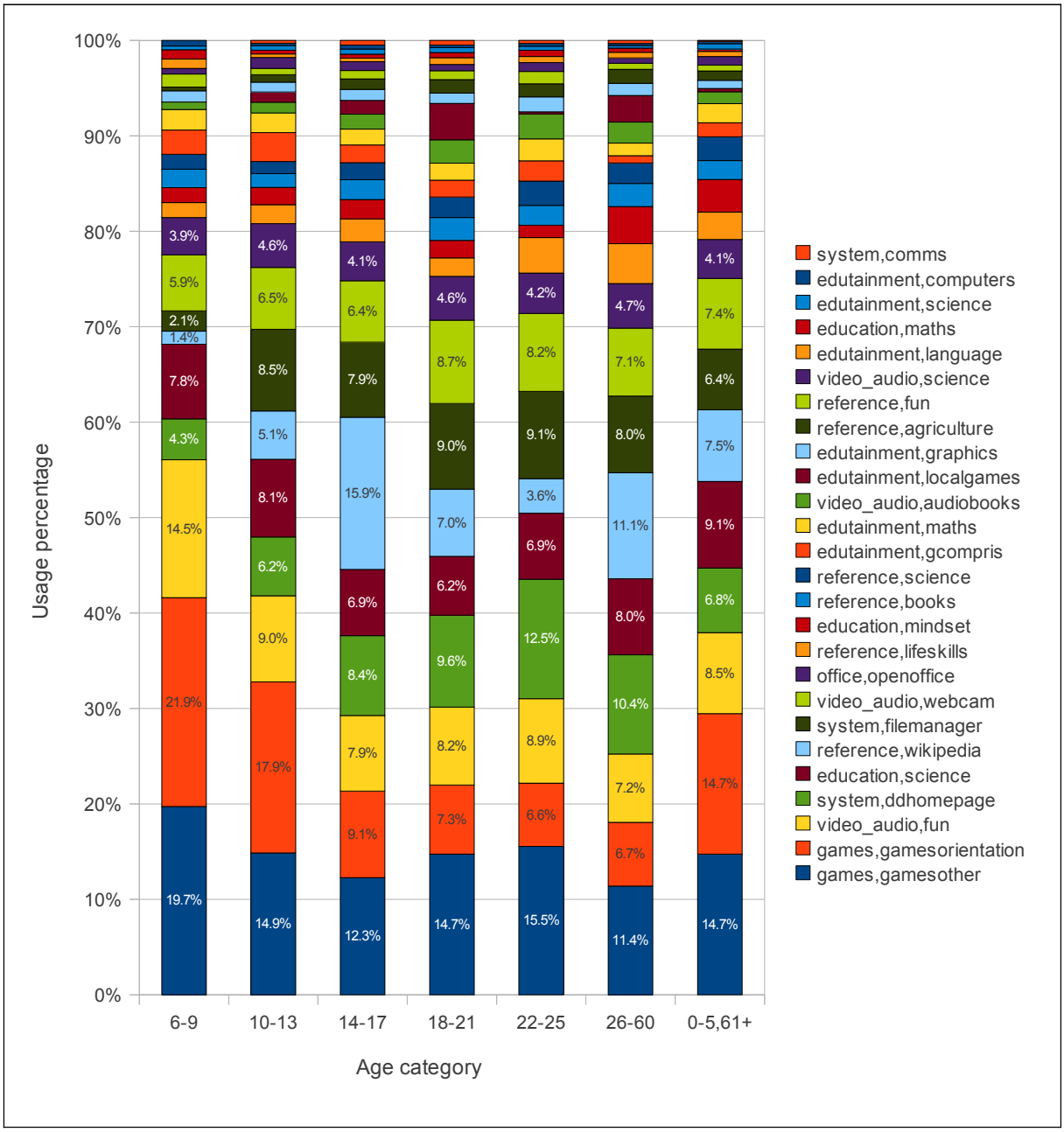


Figure 6.28: Specific category usage (percentages) per age group

Figures E1 to E4 in Appendix E, show similar information to Table 6.10, Table 6.11, and Figure 6.28, regarding specific categorised application usage by the various age groups. The figures show both actual hit-counts, and percentages of total usage per age group. The assignment of specific categories to general categories is indicated by means of colour boxes. The results again indicate high games, multimedia and reference usage, but disappointingly low usage of edutainment and certain reference materials, which were deliberatively placed in DDs for their value in education.

6.7.8 Discussion

Coming back to our sub questions, 'what are the general trends amongst all users regarding application usage?', and 'are there notable relationships between the age of users and the categories of applications accessed?' we see that there are noticeable trends in the general categories of games usage, reference application usage and system/DDhomepage usage.

High registrations and hit-counts were recorded in the 10–21 age group. On a per-site basis, ages of registered users varied according to location, as well as being influenced by the site surroundings (e.g. see Figure 6.19, Elandskraal MPCC, where high values of youths between 10 and 17 are as a result of nearby schools). Registrations at some sites were markedly higher than at others (see Table 6.4).

There was a noticeable downward trend in games usage, with increasing age. Office applications and educational resources were underutilised among all ages.

In the statistical analysis of the data, it became clear that age does statistically significantly affect application choice, and that the most significant trends were observed between the games category usage and video/audio, DDhomepage, and reference applications.

Specific category findings highlighted high usage of applications in the orientation games, other games, Wikipedia, DDhomepage and fun video/audio categories; with some noticeable variations when analysed per age category, e.g., high use of the Wikipedia in the 14–17 age group (Table 6.10).

The low overall use of applications by adults (e.g. 26+) is a cause of concern. However, we have an interesting duality in this 26–60 age group. Firstly, total registration and usage is low – a negative finding, see Figure 6.14 (9.39% of total registered users), and Figure 6.16 (6.01% of total hit-counts). Nevertheless, much of the usage that occurs is focused on knowledge acquisition – a positive finding, emphasised in the discussion of Figure 6.27. Recommendations for addressing the challenge of low usage by adults, are suggested in Section 8.8.

6.8 Quantitative analysis for Research Question 2

This section analyses the data as it relates to Research Question 2 (RQ2), namely: **does gender have an impact on extent of use and on application usage?** Specifically, the following points are addressed:

- What are the general trends amongst males and females regarding application usage?
- Is there a relationship between the gender of users and the categories of applications accessed?

6.8.1 Gender-related registration findings

Proportion of registered accounts belonging to males, females, and those not willing to say

The following table (Table 6.12) and chart (Figure 6.29) display the number of male, female and unspecified gender users who registered a user name for themselves at one of the ten sites. Table 6.12 indicates that, of total registered users, 1190 were male (55%), 365 female (only 17%), and 595 (27.7%) did not specify their gender. This gives a female:male ratio of only 4:13. At the popular Emjindini library site, the ratio of girls to boys, namely 118:250 (See Table 6.4), was substantially higher than the overall averages and ratios. The qualitative study of Emjindini library in Section 7.5.3, highlights some environmental and behaviour aspects that explain this high ratio.

Table 6.12: Registered users per gender

	Registered Users	Percentage
Male	1190	55.3%
Female	365	17%
Unspecified	595	27.7%
Total	2150	100%

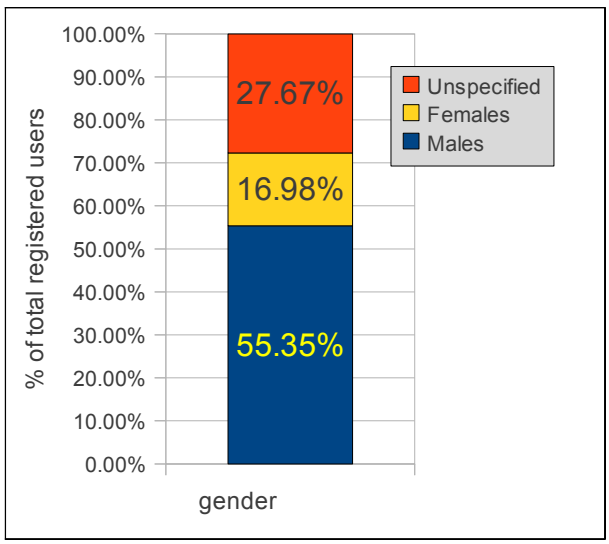


Figure 6.29: Percentage of registered users per gender

While HITW sites in India also displayed usage behaviours of more boys than girls (de Boer, 2009), the difference is even more marked in South Africa. The low usage by females at the majority of sites, is a cause of concern.

Recommendations for addressing gender imbalances are suggested in Section 8.8.

Proportion of registered accounts belonging to males, females, per age group

Table 6.13 and Figure 6.30 display the number and percentages of registered users, per gender, per age group. Percentages are calculated separately for males and females (vertically, columns total 100%). We observe that for males, the most account registrations were done in the 10–13 age group, and for females, in the 14–17 age group.

Table 6.13: Registered users per gender, per age group

Age	Males		Females		Unspecified	Total
	No.	%	No.	%	No.	No.
6–9	18	1.5%	13	3.6%	11	42
10–13	291	24.5%	73	20%	137	501
14–17	275	23.1%	96	26.3%	137	508
18–21	267	22.4%	70	19.2%	97	434
22–25	118	9.9%	34	9.3%	29	181
26–60	123	10.3%	46	12.6%	33	202
0–5, 61+	98	8.2%	33	9%	151	282
total	**1190**	**100%**	**365**	**100%**	**595**	**2150**

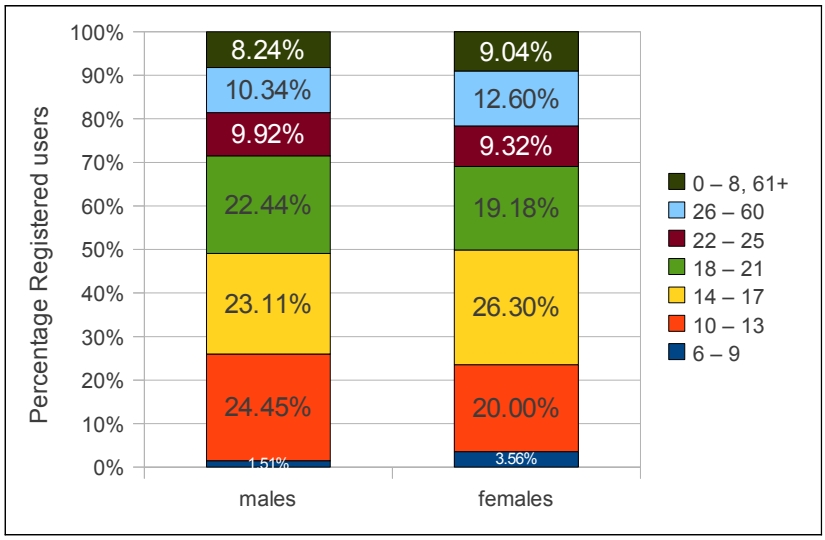


Figure 6.30: Percentage of registered users per age group (males and females)

Table 6.14, and Figure 6.31 display the number and percentages of registered users of males and females, per age group. Percentages are calculated per age group, as a proportion of total male and female registered users in that age group (horizontally, rows total 100%). This enables us to see the proportional difference between genders, per age group, in terms of user registrations.

The results are indicative of the many young people (under 21 years old) accessing the DDs, but highlight both the difficulty that users under the age of 9 have in registering personal user accounts, as well as the high proportion of males to females registering accounts, across all age groups. Of the registered, specified-age users, only 24% overall (in red font) are female.

Table 6.14: Percentage registered males and females, per age group

Age	Males		Females		Total	
	No	%	No	%	No	%
6 – 9	18	58%	13	42%	31	100%
10 – 13	291	80%	73	20%	364	100%
14 – 17	275	74%	96	26%	371	100%
18 – 21	267	79%	70	21%	337	100%
22 – 25	118	78%	34	22%	152	100%
26 – 60	123	73%	46	27%	169	100%
0 – 5, 61+	98	75%	33	25%	131	100%
total	**1190**	76%	**365**	**24%**	1537	100%

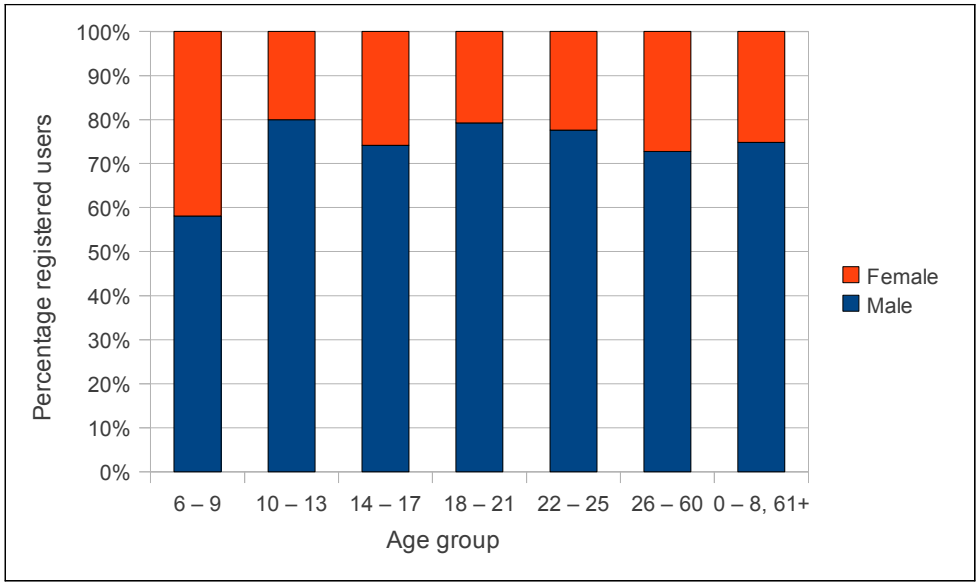


Figure 6.31: Percentage registered males and females, per age group

6.8.2 Gender-related hit-count findings

Percentage hits per gender

Whereas the previous section presented results for numbers of accounts registered to users in each gender, this section focuses on actual hit-counts of registered users.

Figure 6.32 shows the percentage of application hits by gender, based on every instance of an application being launched by a particular user. It portrays a situation similar to Figure 6.29, but with the male hit-count percentage being 62% in comparison with a male registration percentage of 55%. This indicates that not only do more males register, but also that, once registered, they make more extensive use of the facility than do female registered users (See Figure 6.34).

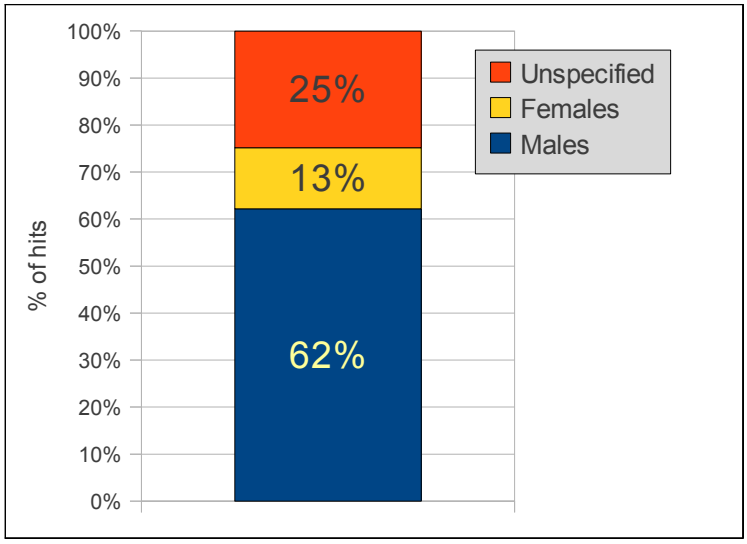


Figure 6.32: Percentage of total hits by gender

Distribution per age group, of application hit-counts (male versus female, all categories)

Table 6.15 below, and Figure 6.33, show the totals and percentages of application hits, per gender, according to age group. Highest usage by both males and females is in the 14–17 age group (in red font), followed by the 10–13 and 18–21 age groups . Usage in the 6–9 age group is the lowest for both males and females (1.15% and 1.50% respectively). Usage in the 26–60 age group is low for both males and females (6.23% and 9.49% respectively) indicating a disappointingly low use of DD by older users, however, it is noteworthy that in this age group (26–60), proportional usage is higher for females than for males, i.e., proportionally more older females (compared to younger females) use the DD than is the case for males.

Figure 6.33 (of hit-counts) depicts a similar distribution to Figure 6.30 (of registered users), but emphasises the great extent of actual DD sessions in the 14–17 age group.

Table 6.15: Total hits per gender, per age group

Age Group	Males		Females		Total*	
	No.	%	No.	%	No.	%
6–9	300	1.15%	84	1.50%	512	1.22%
10–13	5828	22.27%	1235	22.12%	9295	22.07%
14–17	7795	29.78%	1522	27.27%	12216	29.00%
18–21	5697	21.77%	1145	20.51%	9182	21.80%
22–25	3144	12.01%	440	7.88%	4144	9.84%
26–60	1632	6.23%	530	9.49%	2512	5.96%
0–5, 61+	1779	6.80%	626	11.21%	4262	10.12%
	26175	**100.00%**	**5582**	**100.00%**	**42123**	**100.00%**
**includes values for unspecified gender*						

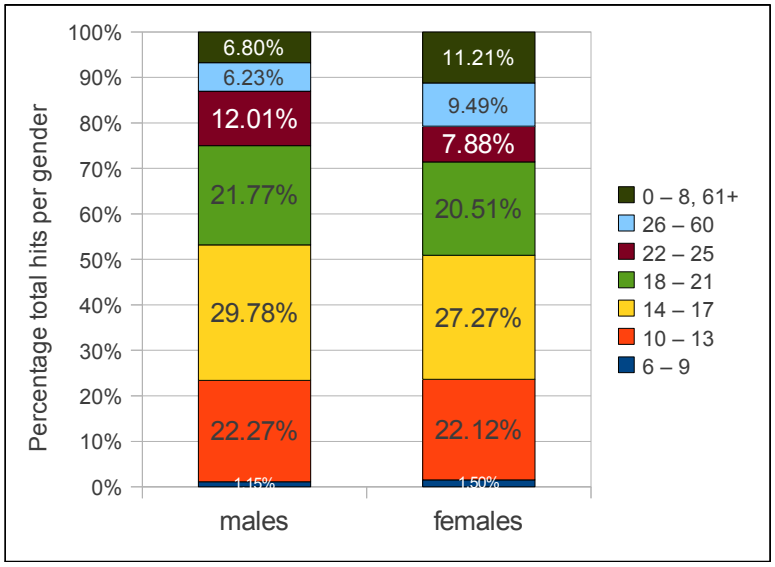


Figure 6.33: Percentage of total hits per age group (males and females)

Calculating the values for percentage hits divided by percentage registered users, for each age group (Table 6.16), indicates account usage, with a higher value representing greater usage per registered account, lower value representing less usage per registered account. Low values reflect few hits, but many registered users, i.e., low usage per user, as occurs among males in the secondary school 14–17 category, where (% hits ÷ % registered) is only 0.78. High values reflect many hits, but less registered users, i.e., high usage per user.

We notice an interesting anomaly from Table 6.16, in that the youngest users (6–9), and the oldest users (26+) in both genders, representing small user groups (Table 6.6), made the most use of the accounts that they had registered (values of 1.32 and 1.66 for males, 2.37 and 1.33 for females). This also indicates that the females in those groups who did register, showed commitment. Usage in the 10–25 age group was less per personal account, most likely due to increased competition for a position and time at the DD.

Table 6.16: Account usage indicators

Gender	Age group	% hits ÷ % reg
Males	6–9	1.32
	10–13	1.1
	14–17	0.78
	18–21	1.03
	22–25	0.83
	26–60	1.66
Females	6–9	2.37
	10–13	0.9
	14–17	0.96
	18–21	0.93
	22–25	1.18
	26–60	1.33

Average application hits per user

Figure 6.34 displays the average application hits per registered user, for males, females and all users, at the ten sites under observation. For males, the value is 22, for females, it is 15.2, and for all users it is 19.6. There is a notable difference between males and females, (29.5%), indicating that, in general, males make greater use of their personal accounts than females. Possible explanations for this difference may be inferred from the answers to the questionnaires in the qualitative study (see Chapter 7).

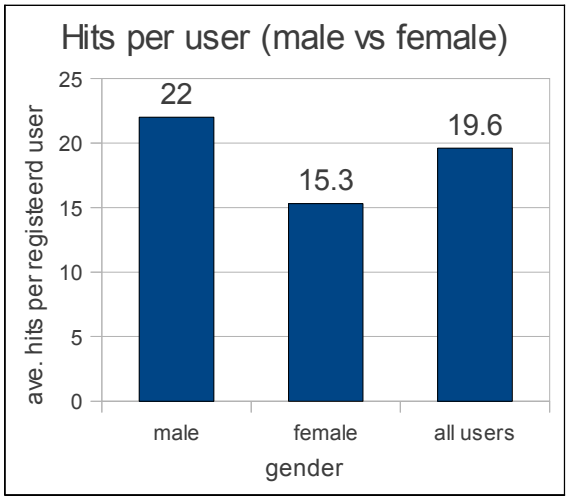


Figure 6.34: Average hits per user, male and female

Table 6.17 further decomposes the above values, according to individual sites. In Vezebuhle, hits per female are more than hits per male (peach background). At all other sites, the opposite is true, with the greatest differences being observed at Kwamhlanga (kwa), Letaba FET Giyani (lfg), Kagung (kag), Elandskraal (ela), Msunduzi (msu) and Kanyamazane (kan). These are highlighted with a yellow background.

In order to determine whether the values for males and females in Figure 6.34 are statistically significant, the Chi-square value for the table of gender (male and female) versus hit-count and registered users (Table 6.18), is calculated.

Table 6.17: Hits per user, per site

	site	hits male	hits female	hits all	reg males	reg females	reg unspec	reg all	hits per male	hits per female	hits per user (all)
1	lfc	623	152	951	34	9	23	66	18.32	16.89	14.41
2	kwa	289	53	455	35	12	22	69	8.26	4.42	6.59
3	lfg	4974	736	7598	187	50	69	306	26.60	14.72	24.83
4	vez	4420	1055	8937	382	90	218	690	11.57	11.72	12.95
5	emj	7893	2562	12634	250	118	106	474	31.57	21.71	26.65
6	kag	1757	0	1899	25	1	14	40	70.28	0.00	47.48
7	sos	2594	469	4628	64	12	24	100	40.53	39.08	46.28
8	ela	2232	333	2759	150	50	58	258	14.88	6.66	10.69
9	msu	1044	188	1841	38	17	46	101	27.47	11.06	18.23
10	kan	349	35	421	25	6	15	46	13.96	5.83	9.15
				42123				2150			

Table 6.18: Gender versus hit-count and reg. users

Gender	Users		
Freq Cell Chi-Square	Hit-count	Registered	Total
Male	26175	1190	27365
	0.29	5.97	
Female	5583	365	5948
	1.35	27.49	
Total	31758	1555	33313

Statistic	DF	Value	Prob
Chi-Square	1	**35.1**	<.0001***

Sample size = 33313

The Chi-square statistic of 35.1 is statistically highly significant (on the 0.1% level of significance). The deduction can thus be made that the 'distribution pattern' of males and females differ statistically significantly, both over 'hits' and over 'registered users'. Since only two variables are evaluated over gender, the distribution pattern can be expressed in terms of the ratios of the two variables, namely, 'hits' to 'registered users' for male and females :

26175/1190 = 22, and 5583/365 = 15.3

The Chi-square test established that both these ratios differ statistically significantly from one another. These ratios furthermore represent the average number of hits per male or female user – thus confirming the original answer that male respondents use significantly more applications than female respondents (even though the magnitude of usage data differed between genders. Furthermore, the number of registered users is significantly higher for males than females.

6.8.3 Gender-related usage of general categories

Figures 6.35 and 6.36 are representations of the values in Table 6.19, and show the percentage of males and females accessing the various general categories (Gush and de Villiers, 2010). Values for registered users of unspecified gender, are excluded. Figure 6.35 (from column 3 of Table 6.19), shows the values for each gender as a percentage of the total values for that gender, attempting to determine if different genders show a preference for different general categories of applications. The greatest difference between values for males and females is noticeable in the reference and DDhomepage categories, where the ratios of male to female usage of these categories are approximately 3:4 and 13:10 respectively, indicating that females allocated a proportionally greater amount of their time to reference, than males; while males allocated a proportionally greater amount of their time to exploration of the file system, than females. The difference in edutainment, is predominantly due to the popular 'TuxMaths' game, which (from detailed log file analysis) males prefer over females. Figure 6.36 (from the last two columns of Table 6.19), shows the values for each gender as percentage of the total values (both genders combined), i.e., highlighting the greater use by males than females.

Table 6.19: Percentage of males and females accessing each category

General Application Category	Usage of applications according to gender (M=male,F=female)					
	Totals per gender		% of app. usage per gender		% of total usage (M+F) of ALL applications	
	M	F	M	F	M	F
Games	6035	1396	23.5%	25.1%	19.3%	4.5%
Reference	4328	1247	16.8%	22.4%	13.8%	4.0%
Video/audio	4757	1060	18.5%	19.1%	15.2%	3.4%
DDhome and nav.	4650	768	18.1%	13.8%	14.9%	2.5%
Education	2527	525	9.8%	9.4%	8.1%	1.7%
Edutainment	2282	334	8.9%	6.0%	7.3%	1.1%
Office suite	1119	226	4.4%	4.1%	3.6%	0.7%
					82%	**18%**
Total	**25698**	**5556**	**100%**	**100%**	**100%**	

While useful trends and generalisation can be extracted from the categorised data above, a complete understanding of the usage patterns is only possible when referring to the composition (in terms of applications) of each category. Nevertheless, it is clear from Table 6.19 that for males, games are most popular, followed by video and audio and the DDhomepage and navigation applications; with females, games are seen to be the most popular, followed by reference material and video and audio content. Figure 6.36 reinforces the finding of low usage by females of content in general, compared to males.

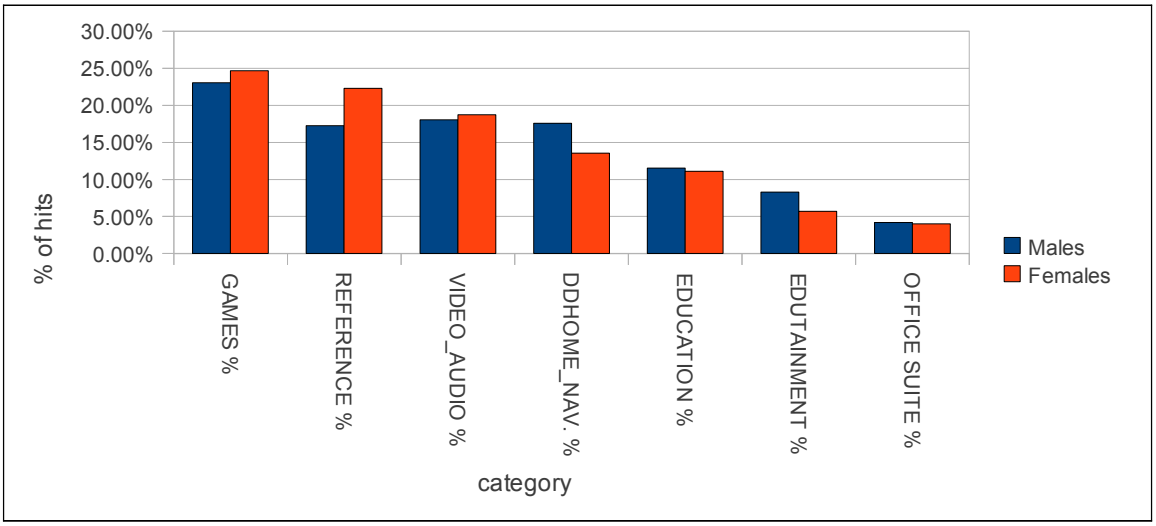


Figure 6.35: Percentage of male hits for a particular category versus total male hits, and percentage of female hits per category versus total female hits

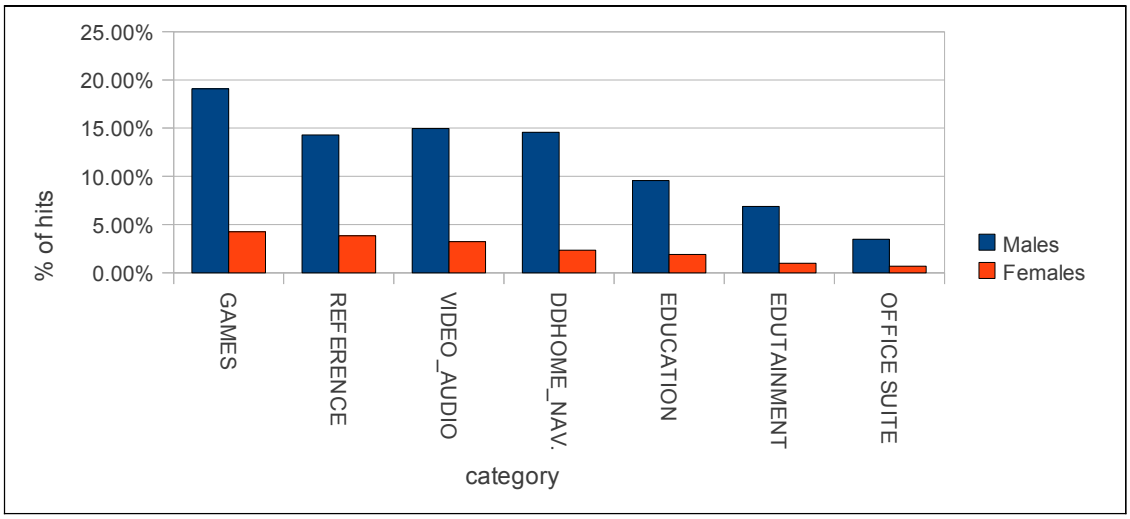


Figure 6.36: Percentage of male and female hits for a particular category versus total hits

The data can be further analysed by investigating general category usage by males and females in each of the age groups. Data for males and females from Table E2 (Appendix E) is illustrated in Figures 6.37 and 6.38 below.

In the 6–9 age group, games usage by females is considerably higher than by males (56% compared to 31.7%). Video and audio application usage is similar (29.5% and 25.7%) while applications in the education category were used more by males (14.7% compared to 2.4%).

In the 10–13 age group, games usage is approximately equal at around 29%, while females made greater use of the video/audio, and reference applications (23.5% versus 17.1%, and 17.4% versus 12.6% respectively). Males made greater use of the DDhomepage and navigation applications (18.6% versus 10.6%).

In the 14–17 age group, females made greater use of the reference materials than males (31.2% for females, compared to 24.4% for males), the difference being even greater than that of the 10–13 age group. Games usage for both males and females was down from younger ages (19.4% and 23.4% respectively).

In the 18–21 age group, comprising predominantly college students, a number of categories displayed distinctive differences between males and females. Games usage was higher for males, at 21.2% versus 16.7% for females. Video and audio application usage was similar for both genders, while females displayed higher usage of the DDhomepage and navigation applications (20.7% versus 17.9%) as well as reference materials (27.5% versus 14.3%). Edutainment, education, and office suite applications were all used more by males than females.

In the 22–25 age group, males displayed greater use of reference materials than females (15.9% versus 11.6%). In each of the other age categories above age 10, females displayed higher usage of reference materials than males. DDhomepage and navigation was also higher for males (20% versus 15%), while in this age group, females were more actively involved in playing games (27.3% versus 22%).

In the 26+ age group, the most noticeable difference between males and females was in the reference category (27.5% versus 18.6%).

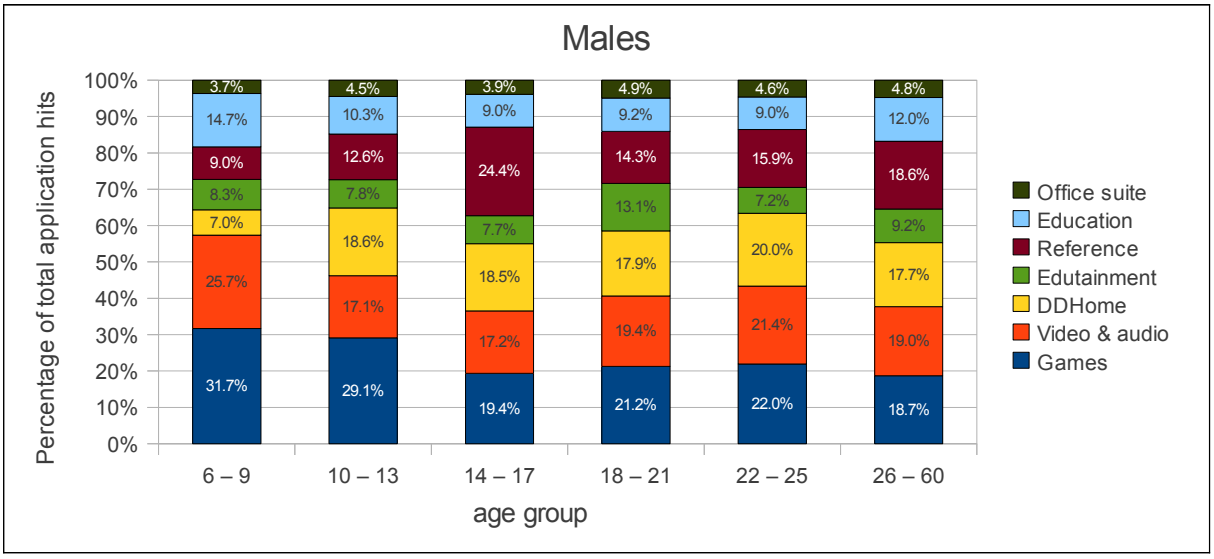


Figure 6.37: Application hits per age grouping and category (males)

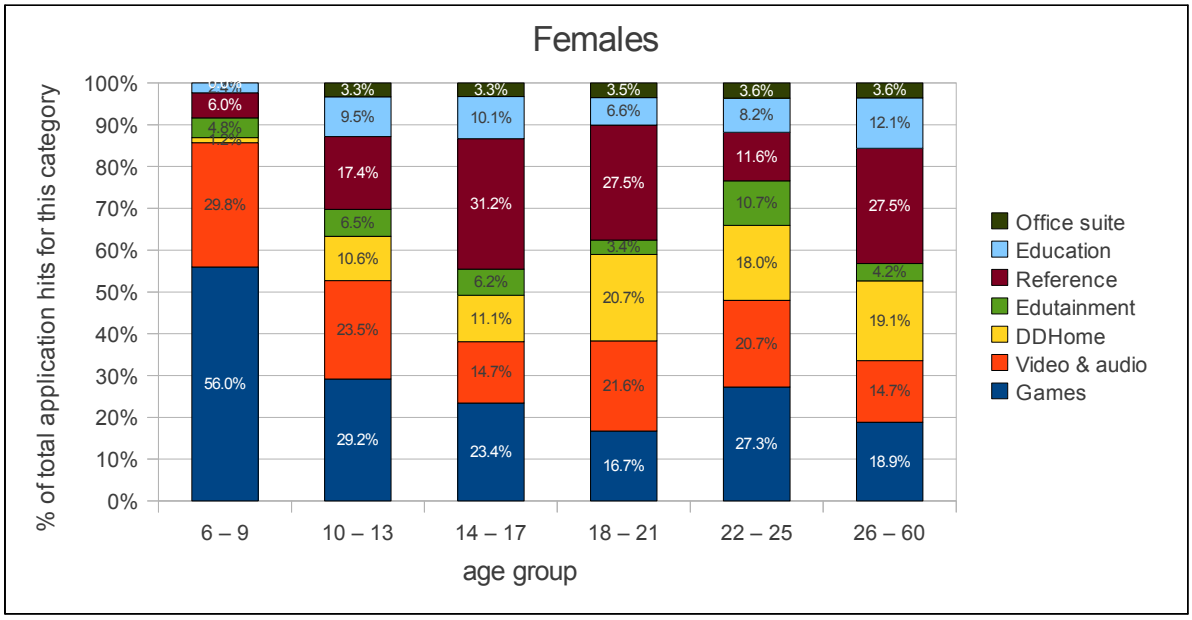


Figure 6.38: Application hits per age grouping and category (females)

6.8.4 Gender by applications: Pearson's (c x r) Chi-square

Pearson's Chi-square test for a (row x column) frequency table is used to determine the degree of statistical significance between gender and general application category usage (hit-counts). Table 6.20 displays application usage hit-counts versus gender (male and female). In addition, the table displays the cell Chi-square values for each entry.

Table 6.20: Gender versus application category, cell Chi-square values

Gender	Application category						
Hit-counts Cell Chi-Sq. Row %	Games	Video & audio	DDhome	Edutain-ment	Refe-rence	Edu-cational	Office Suite
Male	6170 0.6999 23.57	4812 0.1697 18.38	4771 8.592 18.23	2294 7.5574 8.76	4453 14.157 17.01	2553 0.1015 9.75	1121 0.1045 4.28
Female	1396 3.2818 25.01	1061 0.7955 19.01	777 40.288 13.92	334 35.437 5.98	1263 66.38 22.63	525 0.4758 9.41	226 0.4901 4.05
Total	7566	5873	5548	2628	5716	3078	1347

Statistic	DF	Value	Prob
Chi-Square	6	178.5291	<.0001

Deductions

The Pearson's chi-square statistic with a value of 178.53 is statistically highly significant. The probability associated with the Chi-square statistic is less than 0.001, which indicates significance on the 0.1% level of significance. Statistical significance in this instance means

that the two variables that are represented by the rows and columns of the frequency tables (gender and application hit-counts) are statistically significantly dependent. (The null hypothesis examined with Chi-square tests of this nature always states that the two variables are independent of one another). Dependence implies that application use patterns differ between genders. Stated differently, and viewed from a row-wise approach, dependence implies that for a specific gender group (row), the distribution of application-use over the various applications (all columns) differs significantly between male and female. That is, the distribution of usage-proportion differs.

Since the cell-Chi-square value-entries of individual cells add up to the Pearson Chi-square statistic, the individual cell-Chi-square values can assist in identifying those applications that cause application usage patterns to differ statistically significantly between males and females. Thus, row wise comparisons indicate, for example that females tend to spend – proportionally – statistically significantly less time on DDhomepage and edutainment than males, and more time on accessing reference-related applications. The latter point reinforces that, while overall usage by females is low, the usage that does occur demonstrates more committed use of educational reference material such as encyclopaedia access.

6.8.5 Discussion

Returning to our sub-questions on gender and application usage, we note that the general trend is for significantly more males than females to register user accounts (approximately 3:1 ratio). Greatest number of registrations by males was in the 10–13 age group, while greatest number of registrations by females was in the 14–17 age group. Actual hit-count figures were greatest for both males and females in the 14–17 age group.

While the dominance of users in the 10–21 age groups is understandable, considering that many of the sites are at, or near, schools or colleges, the issue of gender imbalance at DDs is a cause for concern, since the intention is for them to be equally beneficial to both genders.

Recommendations to address this are suggested in Section 8.8.

Some important findings regarding gender-related application usage per general category were made in Section 6.8.3. These could assist in a more targeted content-presentation mechanism in future DD software releases.

6.9 Quantitative analysis for Research Question 3

This section analyses the data as it relates to Research Question 3 (RQ3), namely:

How does the physical situation of the computer kiosk affect the types of applications accessed?

In particular, the first two sub-questions of RQ3 are addressed:

- Does the physical situation of the device (e.g., in a library) affect the types of application that are accessed?
- Which applications are underutilised by the intended target groups?

6.9.1 Libraries, schools, FETs and public locations (a comparison)

To compare the application usage data between the categories of sites, namely the two libraries, the two schools, the two FET colleges and the four public locations in the sample of 10 sites (displayed in Table 6.21), data for each site in a category is combined.

Table 6.21: Site categories

Site category	Site name
School	Kwam-Hlonipha
	Vezebuhle
Library	Emjindini
	Kanyamazane
FET College	Letaba FET College 2
	Letaba FET Giyani
Public location	Elandskraal
	Emjindini
	Msunduzi
	Soshunguve
	Kagung

i.e., for each category, the sites in that category are totalled, so that:

Sch(total) = KwH(total) + Vez(total); **Lib(total)** = Emj(total) + Kany(total) etc.

For this section, data from both registered users and guest users was used in the analysis. Guest user logs could be used in this case, as location information was not dependent on the demographic logs from registered users. All users logs at a particular site (whether for guests or registered users) could be used to differentiate activity at that site from that at a different site. The results to follow are first presented according to general category groupings (seven categories), and then according to specific category groupings (26 categories).

6.9.2 General category usage per location grouping

Figure 6.39 is a visual representation of the percentages found in Table E4 (Appendix E), and displays the percentage category usage per location for each of the seven general categories.

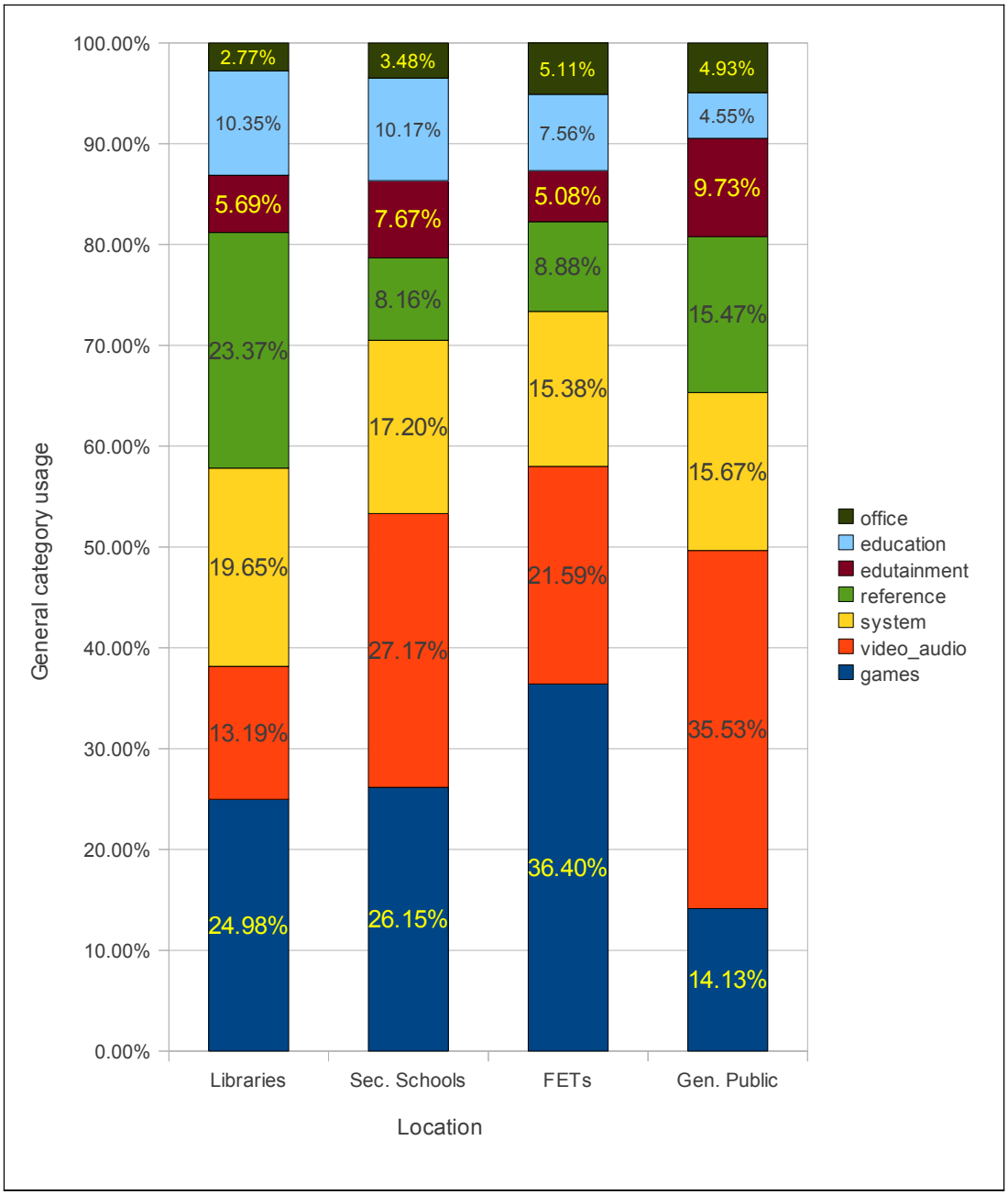


Figure 6.39: General category usage percentages, per location grouping

Sites in the library category displayed almost equal values for games usage and reference (24.98% and 23.37% respectively), followed by system-related applications (navigation /DDhomepage etc. at 19.65% usage), video and audio applications (13.19%), education (10.35%), edutainment (5.69%) and office applications (2.77%). The reference category

percentage (predominantly composed of the Wikipedia open encyclopaedia) was greatest for libraries than any other location category. While the graphs of age group versus application usage (Figures 6.27 and 6.28) indicated proportionally high usage of reference and Wikipedia material by the 14–17 age group, Figure 6.39 provides the additional insight that reference and Wikipedia use within that age group is predominantly by school students visiting libraries, and much less so by students using the DDs in schools (8.16%). Further insight into usage of library DDs, is given in the subsequent qualitative analysis (Section 7.5.3).

Sites in the secondary schools category displayed high usage in the games category and the video/audio applications (26.15% and 27.17% respectively), followed by system-related applications (DDhomepage/file-navigation etc., at 17.20% usage), education applications (10.17%), reference (8.16%), edutainment (7.67%) and office applications (3.48%). While the DDs at schools were used, to some extent, for school reference (confirmed during site visits), the numbers indicate that users at schools were more interested in using the DD for entertainment and exploration than reference. Further insight into usage at schools is given in the subsequent qualitative analysis (Section 7.5.1).

It is of note that FET colleges showed highest usage in the games category (36.4%), higher than any other location category. Second highest is video and audio (21.59%), followed by system/DDhomepage (15.38%), reference (8.88%), education (7.56%), office (5.11%) and edutainment (5.08%). While still low, office application usage is higher at FET colleges than any other location category, despite there not being printers attached to the DDs. The low use of reference applications indicates that the reference resources on the DD are inadequate, or inappropriate, for FET college level students.

Sites in the general public category displayed highest usage in the video/audio category (35.53%), followed by system and navigation (15.67%), reference (15.47%) and games (14.13%). On the lower end were edutainment (9.73%), education (4,55%) and office applications (4.93%).

The popularity of multimedia content (video/audio) in public locations such as community centres and informal markets could be exploited by delivering content targeted at these locations, in this format.

Educational resources are under utilised (4.55%, less than half the usage levels for secondary schools and libraries). Exploration through the use of the file navigation and DDhomepage facilities is still a strong element of user activity in public locations, with reference materials being used considerably more than both secondary schools and FET colleges.

6.9.3 Significance of relationship between application usage and location

As in the case for application usage versus age, Pearson's Chi-square test for a (row x column) frequency table is used to determine the degree of statistical significance between location category and application category usage. Table E7 in Appendix E displays application usage hit-counts versus location categories. In addition, the table displays the cell Chi-square values for each entry (highlighted in red). The resultant Chi-square calculation is presented below (Table 6.22):

Table 6.22: Chi-square for location versus application category

Statistic	DF	Value
Chi-Square	18	16112

Sample Size = 176336

The Pearson's Chi-square statistic with a value of 16112 is statistically highly significant. The probability associated with the Chi-square statistic is less than 0.001, which indicates significance on the 0.1% level of significance. Statistical significance in this instance means that location and user application usage are statistically significantly dependent. Dependence implies that application usage is dependent on location, or, stated differently, that for a specific location category, the distribution of application-use over the various applications (all columns) for that location, differs from other location usage distributions.

Since the cell-chi-square value-entries of individual cells in Table E7 add up to the Pearson Chi-square statistic above, the individual cell-Chi-square values can assist in identifying usage-distributions that differ significantly for different locations. For example, libraries and FET colleges, differ with respect to the use of games versus referencing applications, with FET colleges displaying proportionally higher use of games, and lower use of reference material, than libraries.

Knowing that location and application usage are significantly dependent, provides a motivation for customising content on a location-specific basis. Considering DD location, in addition to the previous factors of age and gender, will allow for more effective content development and sourcing. More fine-grained analysis of significant correlations between location and software applications, would be valuable in assessing the impact of location-targeted content (e.g. school curriculum-based materials in schools).

6.9.4 Specific category usage by location grouping

While Sections 6.9.2 and 6.9.3 relate to the seven general categories of software applications, this section focuses on the specific categories as defined in Section 5.5.3. Figures 6.40 and 6.41 are based on the percentages in Table E5, in Appendix E (with actual values in Table E6). The graphs display the percentage usage for each of the 26 specific categories, for the four location categories (libraries, secondary schools, FET colleges and general public locations). Each location category's percentages are calculated independently of the other location categories (see Table E5), making allowance for differing total hit-counts per category, while enabling comparison between categories; e.g., all values in the 'libraries' category add up to 100%.

Figure 6.40 is 'category-prioritised', displaying percentages as horizontal bars on a specific category by specific category basis. Each location is represented by a different colour. Figure 6.41 is 'location-prioritised', each stacked bar chart representing a location category, and different colours representing different specific application categories. This Figure is a fine-grained version of Figure 6.39, allowing for more specific analysis of the categories of applications being accessed in each location grouping.

Games usage in both the games categories is higher at the FET colleges than any of the other location categories (21.87% and 14.53% of total application usage at the colleges). Comparing this to Figures 6.27 and 6.28 which compare age group to application usage, reveals that users in FET colleges (mostly in the 18–21 age group, see Figures 6.22 and 6.23) are more likely to use the DD for playing games than other users of their age outside FET colleges.

The fine-grained resolution of Figure 6.40 (as compared to Figure 6.39), allows us to better understand which of the specific category items are being used, and to what extent. Clearly the Wikipedia application (*reference,wikipedi*a) is being used extensively in libraries. Health and life-skills content (*reference,lifeskills/health*), though not extensively used, is used more at libraries, FET colleges and public locations than at schools (3.18%, 2.95%, 3.52% and 1.92% respectively).

We notice users at secondary schools making the greatest use of entertaining video clips (*video_audio, fu*n) and the web-cam. The one- to two-minute science-related video clips (in *video_audio, science* category) were used to a far greater extent by users at public locations than at any other (6.83% versus approximately 1%). Fun videos and the web-cam were also used extensively at these public locations.

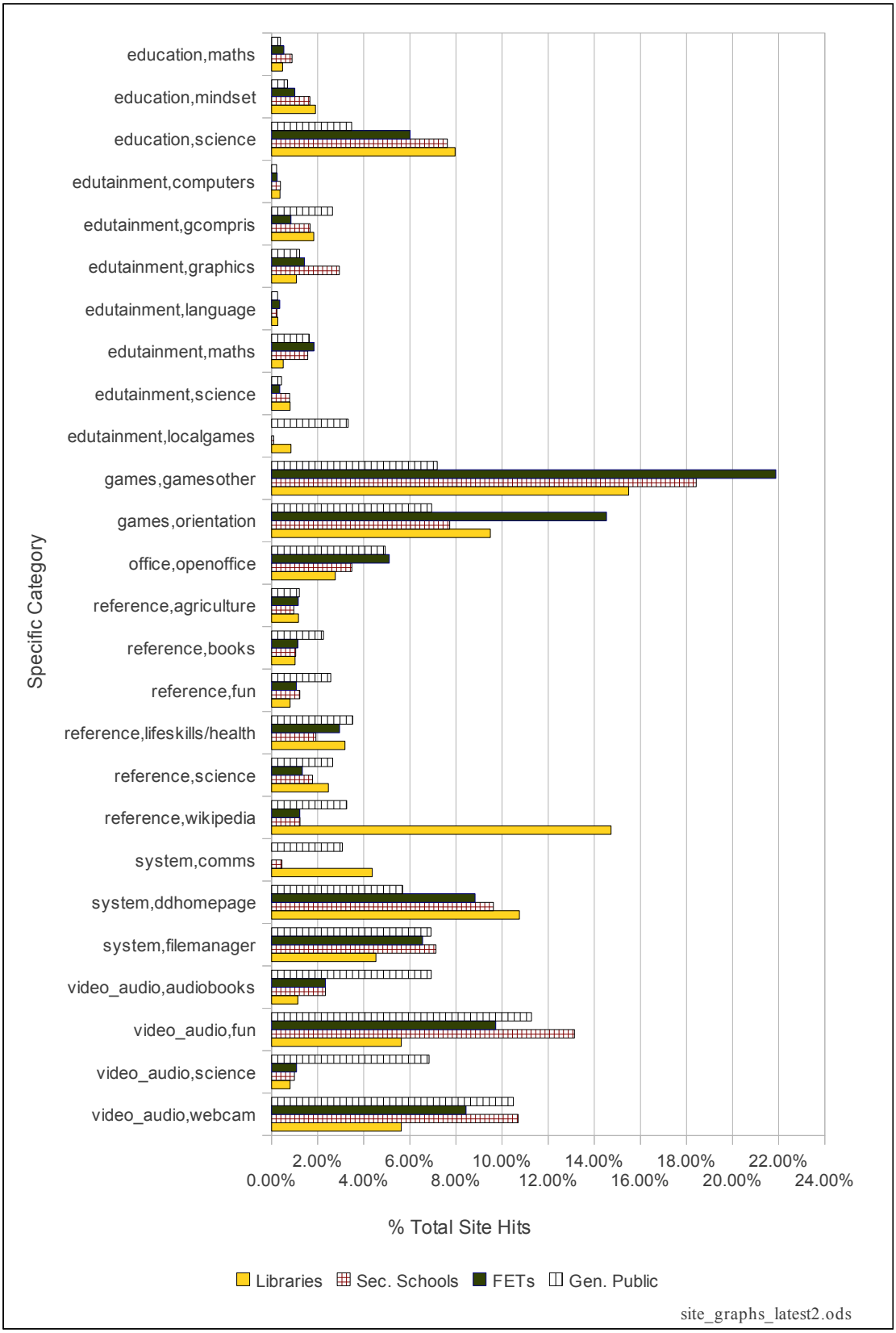


Figure 6.40: Specific application versus location

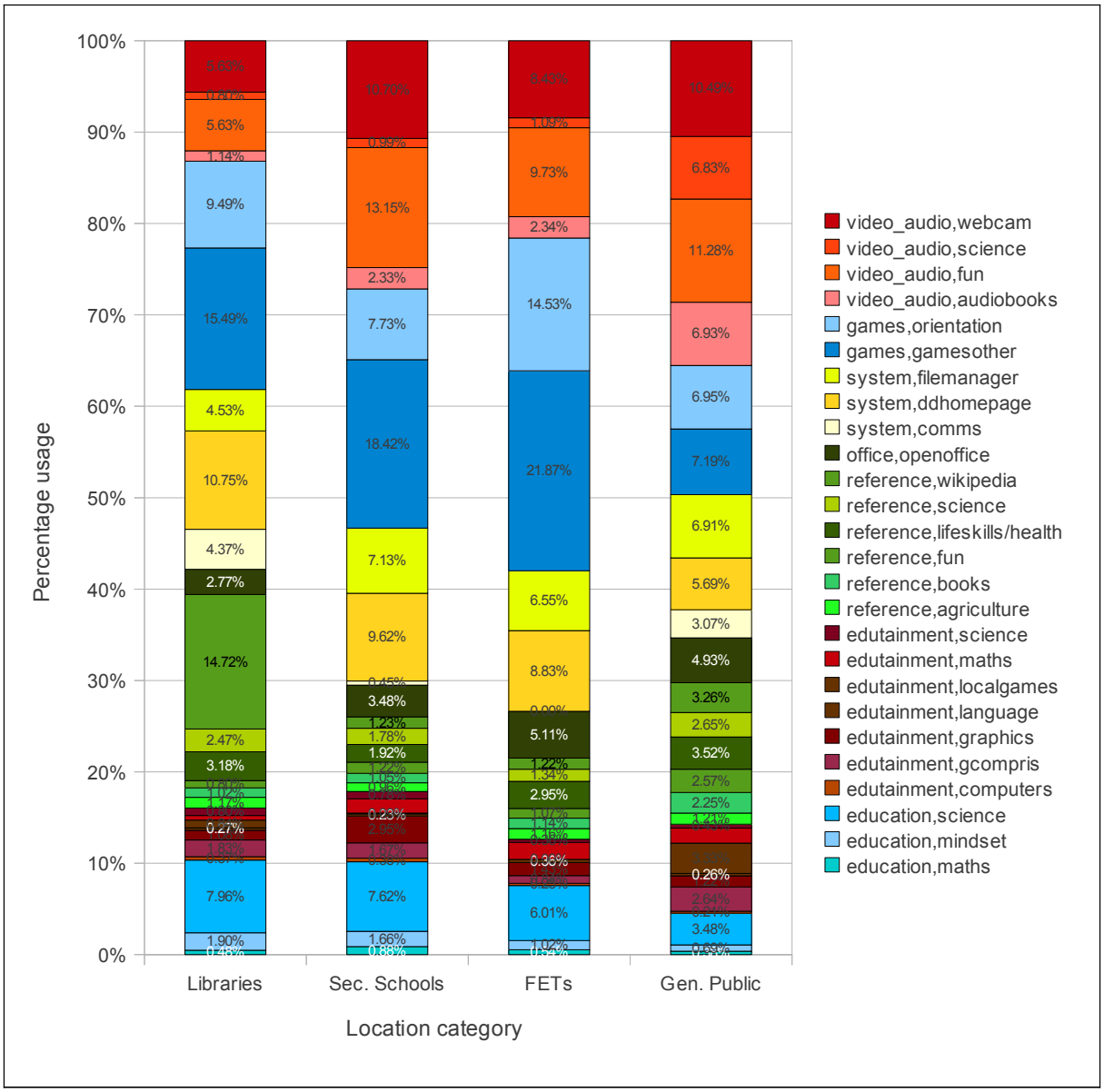


Figure 6.41: Specific application categories versus location, stacked

Figure 6.41 extends Figure 6.39 to fine-grained detail using a similar colour-coding notation. It presents the same data as Figure 6.40, while giving a better impression of usage on a per-location basis. The extent of video_audio category usage at general public locations is noticeable (red/orange coloured blocks), as well as games usage at FET colleges (upper set of blue coloured blocks). Reference material usage (green) is highest for libraries, followed by general public locations. The low use, across locations, of applications in the edutainment categories (lower dark red blocks) and education categories (lower light blue blocks) is evident. Fairly uniform block distribution in the general public category suggests more random usage at these locations, while uneven distribution and some large blocks in the other locations suggest a more targeted approach to usage, consistent with a fairly static user base, i.e., many of the same users returning to the DD to perform similar tasks as before.

Local games in the edutainment category

An important point, not evident from the above graphs, concerns hit-counts in the edutainment category. It is noted in Figure 6.41, that the general public location category displays a usage percentage of 3.33% for the *edutainment, localgames* collection, while the other locations display little-to-zero usage for this specific category. The two entries comprising the local games category are 'WhatWhat Mzansi', a local quiz game, and 'Themba's journey', an interactive life-skills game, set in Johannesburg. Both were introduced to the DDs later than the other content reflected in this study, and in just five of the ten sites, so their usage figures do not show the true current status. They became extremely popular as indicated in red font in Table 6.24.

On analysis of data from all 156 DD sites (those of the 210 with usable data, see Section 6.3), the usage hit-counts in the edutainment category are proportionally much higher than in the results for the ten sites in this study (See Table 6.23 and Figure 6.42). This is directly attributable to the introduction of the two local games mentioned above, as can be seen in Table 6.24 and Figure 6.43, where the individual applications making up the edutainment category are shown, and local games' hit-counts are highlighted in red.

Table 6.23: General category hit-counts for 156 sites

General category	Hit-count
Games	**290972**
Audio and video	**199448**
System and navigation	**182282**
Edutainment	**177771**
Reference	**111390**
Education	**82446**
Office suite	**53589**

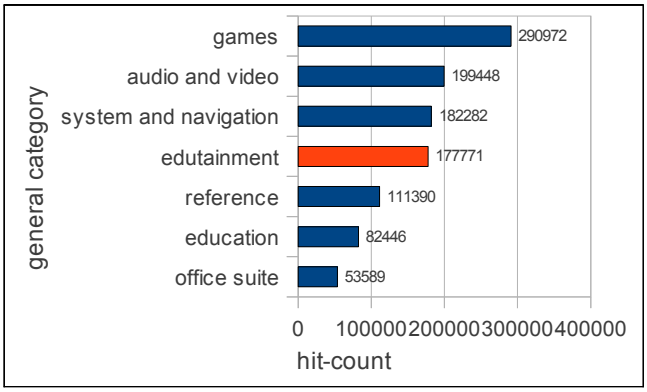


Figure 6.42: Hit-counts for 156 sites

Table 6.24: Edutainment breakdown

Specific application	Hit-count
Whatwhat	39672
Tuxmaths	30756
Themba	30959
Science	5049
Music	2282
Life-skills	939
Language	4680
Graphics	22652
Gcompris	33718
Fractals	4366
Computers	2698

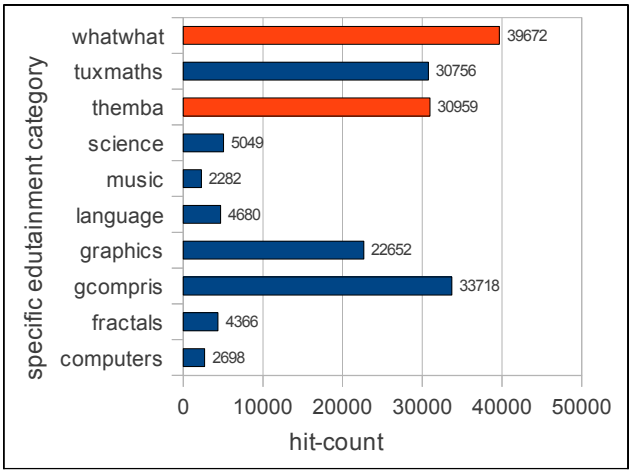


Figure 6.43: Hit-counts for edutainment category

At sites without these two local games, hit-counts in the edutainment category amount to approximately 11% of total hit-counts for those sites, (Table 6.25). At sites where the two local games have been introduced, hit-counts in the edutainment category more than double, to over 23%. This is extremely important, as it emphasises what has been said earlier about the importance of presenting educational content that is relevant to the user, and in a way that is entertaining and engaging.

Table 6.25: The effect of local games on edutainment category hit percentage

	Edutainment Hits	Total Hits	Percentage
Sites without local games	41605	380966	10.92%
Sites with local games	144715	629013	23.01%

6.9.5 *Which applications are underutilised by the intended target groups?*

This section presents information adapted from Gush and de Villiers (2010), supplemented with additional findings.

It is evident from the hits portrayed in Figure 6.40 that, despite the large selection of resources available on each DD, usage of just a few applications and application categories comprises the bulk of the hits. On the launch menu, both the DDhomepage item and the file-manager (navigation) item are at the primary positions at the top of the menu (Figure 4.9), and could thus be likely choices for new users exploring the content in an undirected way. To the contrary, games which are embedded under a second-tier menu, are the most popular selections, even though they require purposive exploration to reach them. In addition, users at both schools and libraries tend to access and return to the web-cam, fun video clips, the DDhomepage and science education (predominantly interactive graphical simulations). Reference materials for agriculture, books, science, etc are little used. Edutainment of all varieties, excluding local games, is underutilised.

An interesting discrepancy between usage at libraries and at schools is the percentage of hits to the free encyclopedia, Wikipedia, which is accessed more than other reference media. Figure 6.40 shows high use of Wikipedia in libraries, which is due both to a desire by library users for information acquisition, and to the presence of a librarian to facilitate information seraches. Usage in libraries is of great importance in analysing DD usage. Among the registered users (Table 6.4), the number of library users in the stereotypical sites selected for this study is second only to the secondary school users. Moreover, library visitors were almost twice as likely to access health-related information as school users. High usage of Wikipedia

by 14–17 year-olds is heavily influenced by the fact that Emjindini Library has the largest base of registered users, over 50% of which are in this age group, and who use Wikipedia regularly. At other venues too, (e.g., Gatang high school, not featured in the quantitative study) users are explicitly required by teachers to source information for school projects from the DD.

A site visit to the Emjindini library provided further insight into the behaviour of users and the relationship between the users and the librarian, and how that relationship influenced application usage patterns (see Section 7.5.3).

At FET colleges, games usage in both games categories was very high, as was usage of the web-cam and fun video applications. This indicates that students were using the DDs primarily for recreation, rather than for educational learning and reference. These latter underutilised categories could be bolstered through the addition of content that is more engaging to young adults, and more appropriate in terms of educational level. Further research studies, specifically targeted at college students, could prove valuable in this regard.

6.10 Applicability to Research Question 4

This section investigates the relevance and applicability of the previous quantitative results, to future unassisted learning terminals, exploring the following sub-questions:

- Do the results of RQ1, RQ2 and RQ3 help in better understanding the desires and needs of target users?
- What lessons are learned for future development, selection and presentation of applications?

6.10.1 Do the results of RQ1, RQ2 and RQ3 help in better understanding the desires and needs of target users?

The results of research questions 1, 2 and 3, do indeed help us to better understand the desires and needs of target users. The results of Research Question 1 help us understand the following:

- The registration procedure needs to be simplified and made more accessible.
- Younger users need better guidance on creating and using self-registered accounts.
- There needs to be more on-screen guidance for self-registered account creation, and logging in, to encourage user account usage over guest accounts.

- Terminals would benefit from tutorials and vocalised multilingual guides, providing direction to new users, and informing about content available at the DDs
- Games are most popular with younger users and college students.
- Older users are keen to explore and navigate their own way through the system.
- There are too few users in the 26–60 age group, perhaps indicating that they are not being adequately catered for. However, much of the usage that does occur in this age group is for reference and other educational content.
- Encyclopaedia reference material is a valuable addition to the DD content, and is being extensively used by many younger- and, to a lesser degree, older users.

The results of Research Question 2 help us understand the following:

- Many more males than females are coming to the DDs and registering their own accounts.
- At certain sites, the female to male ratio is considerably higher than at other sites.
- Females that register accounts, are not using the DDs as much as males.
- Gender influences general application category usage to some extent (i.e., there is statistically significant association between gender and certain categories, e.g., reference).
- There is proportionally more use by females than males of reference material.

The results of Research Question 3 help us understand the following:

- Location has an effect on the ages of users as well as the types of applications accessed.
- There is a high usage of entertainment and multimedia content at all locations.
- There is a need for content customised to the type of location where the DD is located.
- Local content that is both educational and engaging is very popular. Content of this nature provides an ideal opportunity to combine education and entertainment, in a meaningful manner. These is a need for creative designers to rise to this opportunity.
- Many content resources on the DD are underutilised, requiring interventions to increase usage.
- Given the popularity of recreational video content, this format should be further exploited for the presentation of educational and informational content relevant to the target users at a location.

6.10.2 What lessons are learned for future development, selection and presentation of applications?

From analysis to date of the carefully-selected sample of log files, it emerged that DDs are being used by thousands of users from a variety of age groups, with the bulk of users being males between 10 and 21. Usage by females is approximately 25% to 30% of total usage, which is inadequate. The interface and content needs to be made more female-friendly, and supporting structures put in place to encourage female users.

The DD experience is aimed to be self-directed and enjoyable for all community users. It results in valuable peer-assistance (noted in previous observation studies), implicit learning and computer literacy. However, it became clear that useful educational material and sources of knowledge enrichment are underutilised.

Given the lack of facilities at many schools, such as a school library, computer classes, or even electricity (see Section 3.3), any additional resource that can help educate school-going learners should be used to its maximum potential. The results above indicate that in most instances, the usage of DDs is biased in favour of games usage. There is great potential for using games to deliver educational content, however, the low use of the edutainment software appears to indicate that more could be done in this regard and that content on future DDs should perhaps be adjusted to reduce the amount of purely recreational games, and increase the number of edutainment type games.

Considering the results that emerged from the census 2009 survey involving students' favourite subject at school, it was noted that maths was favoured by students in grade 3 to 7, followed by languages, while students in grades 8 to 12 favoured language subjects, followed by maths subjects (Figures 3.2 and 3.3). Future DD installations would benefit from the addition of relevant language-related content.

Should the content on the DD be tailored to the favourite subjects of the majority of users, or should engaging content be used to direct user's attention to less known subjects that may enrich the users' lives? Either way, users should be encouraged to explore and engage with the full spectrum of available content.

Figure 3.4 indicated that community access to library services in South Africa, did not increase much between 2001 and 2009. The high use of the Wikipedia encyclopaedia application at Emjindini library demonstrated the potential for a DD to supplement traditional library services, particular information provision for school projects. In communities where a library is not present, a DD may provide a low-cost, alternative information resource.

Given that much of the educational material and information resources on the DD are being underutilised, how should these issues be addressed?

First, efforts could be made to explicitly encourage use of the direct educational material. Without changing the ethos of unassisted, non-invasive learning, supportive signposting measures could be sought. Users might benefit from clear visual guides explaining the various types of content available, either in the form of an online document (immediately accessible on logging in) or eye-catching laminated posters attached to the unit itself, recommending use of particular applications and customised to the type of site. It is also important that the best-practice efforts used at particular venues such as Emjindini library (see Section 7.5.3) should be explicitly documented and advocated to facilitators elsewhere such as school principals, teachers and community librarians.

Second, modifications could be made to existing underutilised software, and new applications could be incorporated or developed, with a view to integration of educational aspects into game or audio/video presentation formats, which are the most popular. Reference material could be made prominent in the user interface to stimulate greater usage. Content choice and design would benefit from such efforts. The position of items within the menu system influences the number of launches, therefore sequencing should be carefully designed to cater for novice users. In such processes, the findings of the CSIR's Meraka group investigating DD usability (Adebesin, Kotzé & Gelderblom, 2010), should be noted and applied.

Finally, developers could investigate the feasibility of deploying different software releases, depending on location, and typical user demographics at that location, e.g., one version for schools, and another for public places, and another for libraries.

6.11 Summary of chapter

This chapter provided details of the quantitative analysis of data from ten selected sites, with a view of comparing sites of varying physical situation for similarities and differences in demographic and application usage statistics. The chapter provided technical information necessary to explain some of the complexities involved in generating uniform data for this study. Details were included of the quantitative data collection process, data cleaning process, design of a log file interrogation tool, and log file processing. In addition, the chapter provided general findings from the quantitative data, applicable to the study as a whole, and discussed the analysis of quantitative data as it relates to each of the four research questions.

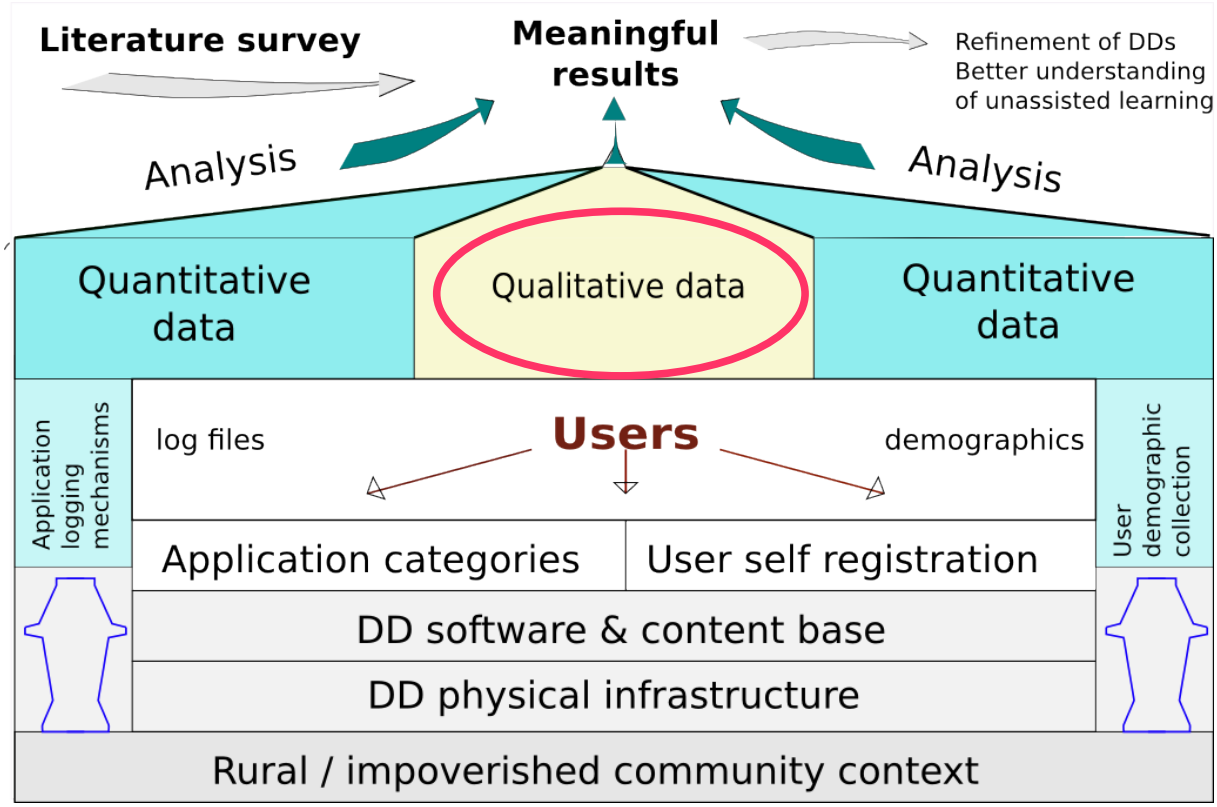
– 7 –

Qualitative study – on-site interactions and analyses

'it's me again this time i want to here from u' – June, 2007

'the digital doorway is de best cus we get 2 c other parts of de world' – May, 2007

'i would love to know more about java world.to get to produce my own catoon and themes, get to make drawings come alive and to know which movement to attach to them' – March, 2009



7.1 Introduction

This chapter details empirical data obtained from visits to a selection of DD sites. The visits were conducted to build up a rich supporting picture of user activity and perceptions at the sites, based on qualitative methods, with some quantitative data emerging in the process.

One of the strengths of qualitative data collection is that it focuses on naturally occurring, ordinary events in natural settings, presenting a good picture to the researcher of what the 'real life', 'lived experiences' of people in that setting, are like (Miles and Huberman, 1994). Creswell describes the most important characteristics of qualitative research: it occurs in natural settings; the researcher is a key instrument; there are typically multiple sources of data; data analysis is inductive; participants' meanings are most important; the research process is emergent (not tightly prescribed); researchers often use a theoretical lens (e.g., gender or culture); inquiry is interpretive; the study is holistic in its approach (Creswell, 2009).

In addition to collecting first-hand data to provide insight into the main focus points of the research questions (age and application usage; gender and application usage; location and application usage; and applicability of the data to future DDs), some valuable insights concerning the DD environment, and its effect on usage, emerged. The descriptions and anecdotes that emerged from the site visits relate to particular instances, and thus cannot be generalised, however, they do serve to illustrate situations that impact on the usage experience.

Following the three activity flows of Miles and Huberman (1994) touched on in Section 5.6.4, data reduction and display is performed in Section 7.5; while conclusion and verification is performed in Section 7.6 and Chapter 8.

7.2 Data collection methods

As mentioned in Section 5.6.1, data for this section of the study was retrieved from semi-structured interviews, naturalistic observation and questionnaires, at actual sites. Semi-structured interviews, researcher-assisted questionnaires, and observation, were used at three of the sites, while semi-structured interviews and observation were used at the fourth site. Interviews were conducted with administrators based on the question template in Appendix G. End-users were either guided through the question template by the researcher, or filled it in independently as a questionnaire. While the bulk of the data was qualitative, certain quantitative data (e.g., age, gender) was also collected and analysed.

7.3 Site and participant selection for interactions

Sites for the qualitative study were selected using both purposive sampling and convenience sampling (Oates, 2006). The following four sites were chosen for the interview and questionnaire process, with the intention that they would help the researcher understand the problems at specific sites, and contribute to answering the research questions:

- Site 1: Gatang High School, Mamelodi, Gauteng;
- Site 2: Soshanguve Fablab, Gauteng;
- Site 3: Emjindini Library, Mpumalanga;
- Site 4: Msunduzi Customer Care Centre, KwaZulu-Natal.

These sites provided heterogeneity in terms of age groups and location (school, library, Fablab and customer care centre). There was diversity of the aspects of setting, actors, events and process, as mentioned by Creswell (2009:178). The four sites are displayed in orange in Figure 7.1.

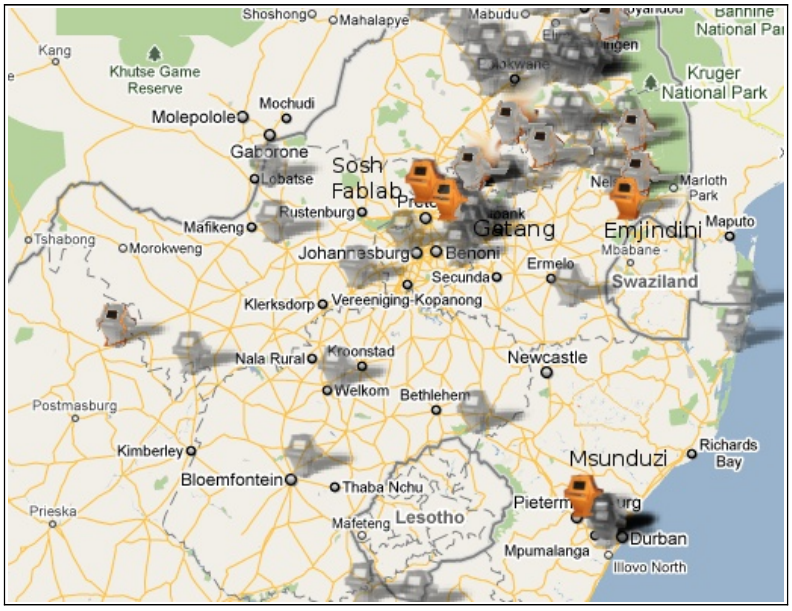


Figure 7.1: Sites selected for qualitative study

Site visits were not by prior appointment. In this way the researchers were able to do naturalistic observation, both of the users, and of the real-world situation at the DDs. Participants at the sites were selected using a combination of convenience sampling, and snowball sampling (Oates, 2006), whereby participants located further participants to take part in the study. At each of the first three sites, between 10 and 30 users were selected, or volunteered to participate in the study. At the fourth site, two site administrators were interviewed, to obtain a further perspective. Participants were required to complete a consent form (Appendix F), agreeing to participate in the study.

These four sites provide valuable insight into user activity and application usage at DDs, however, the sample is too small to be able to generalise these findings to DD sites in general.

7.4 Design of questions

Users were asked to respond to a set of pre-determined questions – either verbally (in interviews), or in written form, by completing the interview template independently, as a questionnaire. The researchers provided assistance where required. Questions were chosen to address issues of age, gender, environment, and application usage. Topics are included below, broken down per research question in this study. The template is given in Appendix G.

Relevant to all or most research questions:

- Is the Digital Doorway useful?
- What is your favourite Digital Doorway game?
- What is your favourite Digital Doorway program (other than games)?
- Why is it your favourite program?
- Tell us what you like to do on the Digital Doorway (e.g., play games; school work; reference; video/audio; DDhomepage; educational programs; office programs;
- What other software (programs) would you like on the Digital Doorway?
- What other information would you like on the Digital Doorway?
- What else would you like on a Digital Doorway?
- Has the DD helped you learn how to use a computer?

Relevant to RQ 1 – age versus categories of applications:

- How old are you?
- How long have you been using the DD?
- What time of day do you normally use the DD?
- How many times a week do you normally come here?
- How long do you spend per session?

Relevant to RQ 2 – gender versus usage:

- Male/Female?
- Who uses the Digital Doorway the most, boys, girls or don't know?
- Why is this, do you think?
- Are there enough programs for girls? Yes or no, please comment;

Relevant to RQ 3 – location versus usage:

- Site name;
- What language do you speak at home?
- What language would you prefer to use on a computer?
- What are your favourite games and programs?
- What additional programs, information, content, would you like on the DD?

Relevant to RQ 4 – future DDs:

- What other software (programs) would you like on the Digital Doorway?
- What other information would you like on the Digital Doorway?
- What else would you like on a Digital Doorway?
- Has the DD helped you learn how to use a computer, yes or no?
- Do you use the DD on your own; or together with friends (size of group?);
- Do you prefer to learn a computer on your own; or with friends; or at school?

7.5 Results

The results below attempt to describe, understand and explain user activity at each of the sites visited, and are presented as follows:

- Section 7.5.1: Gatang High School;
- Section 7.5.2: Soshanguve Fablab;
- Section 7.5.3: Emjindini Library;
- Section 7.5.4: Msunduzi Customer Care Centre.

Each site section contains a site description, an activity description, participant details, general usage findings, gender and age issue, and user requests. Comparisons between sites are tabled in Section 7.5.5.

The discussion in Section 7.6 revisits some of the findings from each of the sites, highlighting a number of external and internal factors influencing application usage. Finally, noticeable themes from user comments in the online feedback mechanism, are presented.

7.5.1 Site 1: Gatang high school

Site description

GPS coordinates: 25˚ 43'18.5 S, 28˚ 23'43.14 E

Environment: A large, noisy, urban high school (1000+ pupils), in an impoverished district of Mamelodi, an urban settlement north of Pretoria. The school is located near informal settlements (see Figure 7.2).

Principal researcher was assisted by: Ms. Mmamakanye Pitse Boshomane.

Figure 7.2: Satellite view of the school – base image © Google Maps

Activity description

Date and time of visit: 15 September 2010, 12:00.

Two researchers from the CSIR drove to Gatang High school to commence with the study. On arrival at the school, it was noted that only one DD terminal out of three, was fully functional. One terminal had a black screen, and one terminal had a malfunctioning keyboard.

The screens were scratched and visibility was poor due to light reflecting off the screen. No-one was using the DD on arrival, however, after the researchers commenced with the study, user activity around the single operational terminal picked up rapidly.

The DD was located on a verandah next to a classroom. During break periods between classes, the corridors were crowded, with large numbers of talking and laughing students, relocating to their next class. Class periods were quiet, with little to no student activity in the corridors.

The researchers spoke to a senior staff member and science teacher, explaining to him their purpose and methods. He offered to fetch users from various classes, and proceeded to find pupils who he knew had previously used the DD. The participant sample was randomly picked from various age groups, genders and school classes. They gathered around the DD (Figures 7.3, 7.4). As users were capable of completing the questions independently, the researchers handed out questionnaires and explained what needed to be done, assisting where required. A consent form was signed by the teacher on behalf of the students, since it was not realistic for pupils to return to their homes to obtain consent from a parent or guardian.

No monetary rewards for participating in the study were given, however, token gifts were handed to participants. When it became apparent that all participants received a pen and a chocolate, other users offered to take part in the study. A few appropriate users were added to the initial number picked by the science teacher, resulting in a total of 28 participants.

Figure 7.3: Participants at Gatang

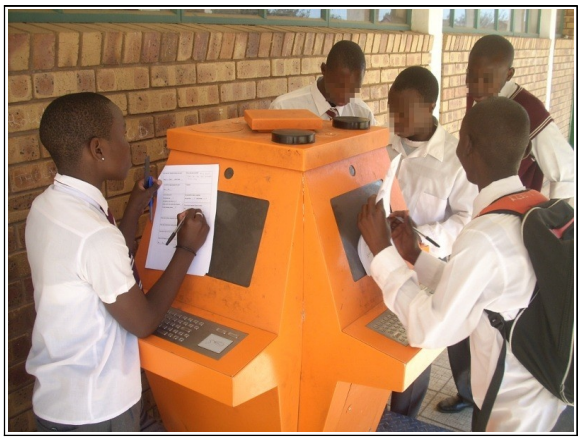


Figure 7.4: More participants at Gatang

Gatang questionnaire results

Recording of responses

Questionnaires were numbered 1 to 28 to identify them. A spreadsheet was drawn up (see attached CD) to tabulate the responses for extracts of statistics for certain quantitative aspects (e.g., age and gender), and the cells populated for Gatang.

Participant details

The 28 participants ranged in age from 13 to 19 years old (Figure 7.5), and included 19 males and nine females. Fifteen of them (54%) were 17 or 18 years old.

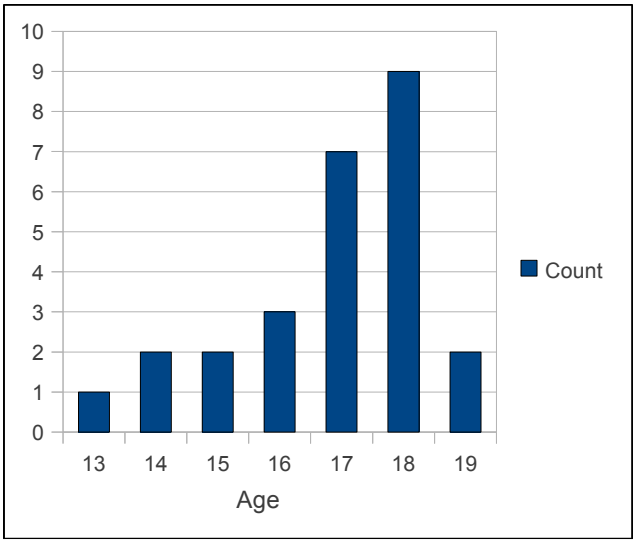


Figure 7.5: Age distribution of participants, Gatang

While participants spoke various non-English languages at home, all 28 indicated a preference for interacting with a computer in English. Only 7 of the 28 participants had access to a computer at home. A slightly larger number had access at a friend's house. Only three indicated access to a MPCC or Internet Café and 17 indicated they had access to the school computer lab (the computer lab is completely separate from the DD terminal, and only available to certain classes, at predetermined times of the day).

Usage findings

All 28 participants responded positively to the question 'is the DD useful', indicating a willingness to embrace the technology, and acceptance of the DD as a useful addition to their lives. Approximately 80% of them had been using the DD for at least a year. The DD was mostly used at break time and after school in the afternoon. Two users indicated using the DD before school in the morning. Twenty three of the 28, indicated that they used it three to five times a week. Durations of sessions on the DD ranged from 15 minutes to three hours.

While more users indicated that they *used* the DD together with friends, more than on their own (11:9), more users indicated they would prefer to *learn* a DD on their own, rather than with friends (16:9). Although 17 participants indicated they had access to a school lab, only 8 indicated they had official computer classes. A need for qualified teachers to teach computer classes was mentioned by the school science teacher. Encouragingly, 26 of the participants

indicated that the DD had helped them learn to use a computer, while only one indicated that it hadn't, and one didn't answer this question.

While the quantitative data indicates a strong tendency for users to locate and play games (see Section 6.8.3), the questionnaires and interviews revealed a desire to have access to a wide variety of other resources for personal use and study. There appears to be an interesting juxtaposition between users knowing and requesting what will be beneficial on the DD, and using it purely for entertainment purposes. Once again it should be highlighted that the ideal scenario is to combine educational and information resources in an entertaining and engaging way, effectively addressing both aspects (education and entertainment) at the same time.

Age versus application usage

Regarding application usage differences across the age groups, many younger users indicated a preference for the 'snake' game (*gnibbles*), while many older users indicated a preference for card games, calculator, and maths or science applications. The variety of answers made it difficult to identify further noticeable age-related trends in usage.

Gender differences

Indications were that the DD was mostly used by boys. All 19 of the 19 boys indicated that the DD was mostly used by boys. Five of the nine girls indicated the same thing, while three of the nine girls stated that it was mostly used by girls. One participant indicated that she didn't know. Some of the reasons given for the discrepancy between boys and girls are as follows (Table 7.1):

Table 7.1: Gender perceptions

Of the boys that thought the DD was mostly used by boys, these reasons were supplied:
• *'Boys like to play games';* • *'Didn't see a girl using it';* • *'Girls do not love the DD';* • *'Girls are shy';* • *'Boys know how to use the DD';* • *'Girls don't like the games';* • *'Girls are just boring and they are not that much into the digital electronic life'.*

Of the girls that thought the DD was mostly used by boys, these reasons were supplied:

- *'Boys like exploring';*
- *'Because boys know too much and they like touching and pressing things';*
- *'Because boys like playing games and music'.*

Of the girls that thought (incorrectly) that the DD was mostly used by girls, these reasons were supplied:

- *'Many girls like it';*
- *'I find girls when I get there'.*

We see from the above comments that perceptions differed widely between participants. Two males and one female agreed that games were a definite draw-card for males; while one male and one female agreed that males were more knowledgeable when it came to the DD.

Many of the female users indicated a preference to play card games on the DD, while the boys were more likely to specify action and science games. One of the games found by users was not accessible through the menu system, but required navigation with the file-manager, and locating the games directory within the Linux file structure. This indicated a successful mastery of the file-manager, and confirmed that self-directed learning had taken place.

User requests

Requests for information on the DD covered a wide variety of topics from information on World Wars 1 and 2, and geographical information, through to biology and health (see Table H1, in Appendix H). These requests for information confirmed that users viewed the DD as being more than just a learning station, but also an information repository.

Some notable responses from participants are included below:

- *'Reading how to program, I need to focus on the computer and want to do much better than other people e.g. police and teachers. Many things because I want to study on the computer.'* 16 years old, female.
- *'Basically on the DD, most of the time I am browsing the periodic table to master all the elements because I want to become a future physician so I have to know all the elements and their relative atomic mass.'* 19 years old, male.

7.5.2 Site 2: Soshanguve Fablab

Site description

GPS coordinates: 25˚ 33' 22.7" S, 28˚ 03 '54.67" E

Environment: An AMTS Fablab (small public manufacturing facility, laser cutter, and CAD/CAM terminals) situated in an impoverished, semi-urban township, north west of Pretoria (See Figure 7.6).

Principal researcher assisted by: Ms. Nare Mmonwa, Mr. Charles Mphiwi.

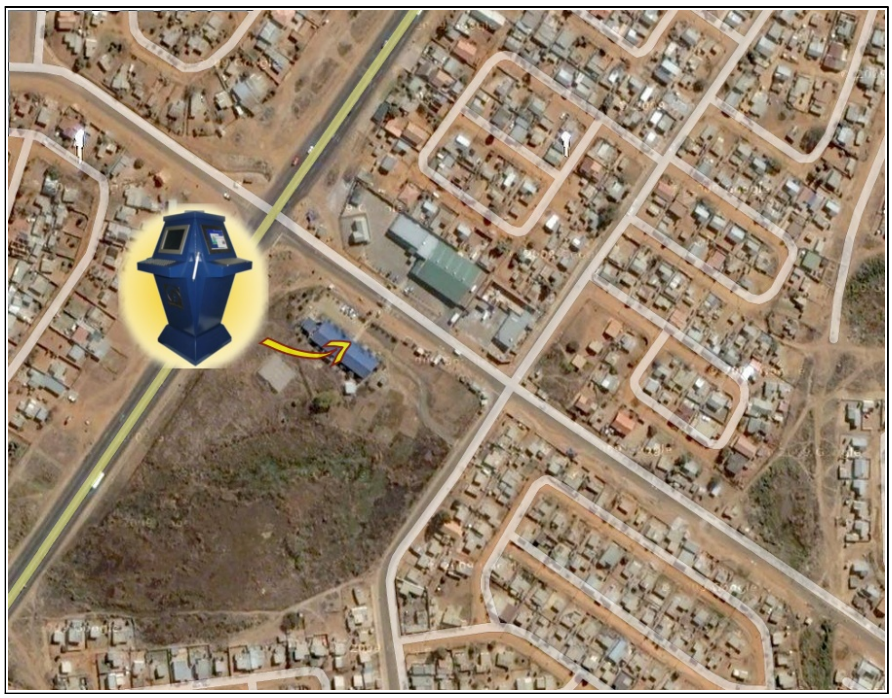


Figure 7.6: Satellite image of Soshanguve FabLab – base image © Google Maps

Activity description and observations

Date and time of visit: 5 October 2010, 11:00.

Three researchers from CSIR travelled to Soshanguve, an impoverished urban township North West of Pretoria. We located the AMTS Fablab, location of the Digital Doorways in question. There were two DDs at this premises, one on the veranda, outside the entrance to the Fablab, and one about 20m away on the verandah outside premises belonging to a different entity. It was determined that these second premises no longer had access to electricity and thus the DD was not functioning. The first DD had been installed approximately three years previously, however, it had been down for a month and had only been repaired that day. On our arrival, various people (mostly young adults and adults) were seen milling around the complex, however, no-one was using the DD at the time.

The Digital Doorway was dusty, and visibility of one screen in particular (terminal two) was extremely poor due to scratched and scuffed perspex sheet covering the LCD screen. Evidence of extensive use was present in the form of touch-pad and keys that had been worn down to the layer below the metallic coating (see Figures 4.12 and 4.13). This was particular marked on client number two (terminal three). Terminal one had been used to the second-greatest extent (based on the evidence of worn keys) and terminal two had been used the least, possibly due to the difficulty of seeing the screen properly during bright sunlight periods (this terminal was most affected by the ambient lighting conditions).

In the course of the afternoon, we interviewed an administrator of the Fablab, and spoke to adults and children on site. Questionnaires were handed to volunteers who completed them with assistance from the researchers. A consent form was signed by the Fablab administrator on behalf of the children. Adults completed their own consent forms.

At approximately 13:15 (after school had finished), some primary school children arrived and proceeded to enthusiastically engage with the DDs, talking to each other and periodically moving to a different terminal to observe what another user was doing before returning to the original terminal, often to find the same application or perform the same activity as the one just observed (see Figure 7.7). Children were seen to use the touch-pad in an unconventional way, keeping their fingers on the touch-pad buttons and using their thumb to work the pad.

Figure 7.7: Users at the Soshanguve DD

While the number of users was few because of the DD having been down for a month, valuable information on usage was obtained through interviews with the Fablab staff and security personnel on the premises as well as the questionnaires that were performed with those children that did arrive. Although adults were present at the site, and participated in the study, no adult users were observed using the DDs.

Twelve questionnaires were completed under the guidance of the researchers, and the following semi-structured interview conducted.

Semi-structured interview – site administrator

Participant: A male volunteer worker at the AMTS Fablab, in his twenties or early thirties.

According to him, users were mostly aged between 7 and 19 years, with the most consistent users being those in grades 10, 11 and 12. The most popular time to use the DD was between 2pm and 5pm, after which the complex was locked, except on occasions where the Fablab staff were under work pressure, in which case the security guard would be required to lock the facilities at a later hour, and users could access the DD for longer periods than usual. The complex was also open every Saturday between 7am and 5pm.

His impression was that users were mainly girls, however, a number of respondents in the questionnaires indicated that more boys than girls used the DD. This agreed with the findings in Table 6.4, of more males than females registering accounts. At the time of the visit, only males were observed using the DD, however, a number of girls were in the area and acknowledged having used the DD before.

The interview respondent believed that there were enough programs for girls especially in light of all the educational resources on the DD, but that there was always a need for further educational resources. He had noticed that the Mindset educational content was popular, and did not know which of the games users preferred. When asked what other programs he thought would be beneficial on the DD, he named a vector graphics program (Inkscape). However, he was unaware that this application was already on the DD.

When asked which additional information he thought users would require on the DD, he mentioned employment resources, typing-skills development, and computer literacy courses. A further request involved linking the DD to PCs within the neighbouring computer school and providing other PCs on the premises (inside the Fablab), with access to the content on the DD. He stressed the need for an external USB port, particular for school learners to be able to save information from the DD.

When asked if he thought the DD helped learners acquire basic computer skills he responded in the affirmative, adding that there was value in acquiring ‘science and technology knowledge’ and ‘promoting debate amongst learners’; referring to the collaborative nature of learning at the DD terminals.

Regarding awareness of the DDs, he mentioned that teachers at nearby schools had been informed of the DD's presence, and regularly sent school children to the DD to access information. Awareness campaigns promoting the DD had been conducted two years previously, as well as the previous year. These campaigns had involved visits to schools, where teachers were informed of the DD facility.

Soshanguve questionnaire results

Recording of responses

Questionnaires were numbered 1 to 12 to identify them. Additions were made to the previous spreadsheet, and the cells populated for the Soshanguve site, for identifying the particular themes and patterns that occurred there.

Participant details

The twelve participants ranged in age from 9 to 35 years old (Figure 7.8) and comprised nine males and three females. There was a representative distribution across the age spectrum. While all participants were familiar with the DD, and had spent time using it, not all of them interacted with it during the course of the afternoon.

Users in Soshanguve displayed a varied mix of home languages. Nine of the twelve participants indicated a preference to interact with a computer in English. For most users in this case study, the DD was not the only PC they had access to, with eight users having access to a home PC as well. Despite this, all twelve participant indicated that the DD was useful.

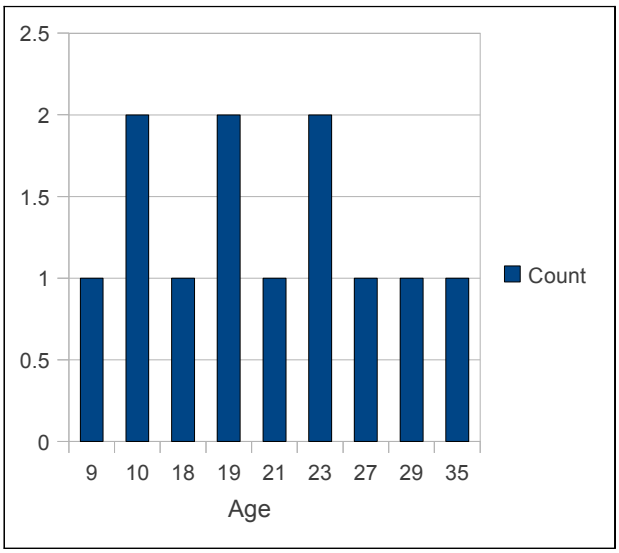


Figure 7.8: Age distribution, Soshanguve

Usage findings

Half the users (six) indicated that they used the DD alone, while five users specified they used it in a group of friends. A high percentage of users (eight of the twelve) displayed a preference for learning computers alone. Only one user indicated the availability of school computer classes.

Ten of the twelve participants indicated that the DD had helped them learn how to use a computer. Of the users who indicated that they played games on the DD, a variety of favourites emerged, from card games to action games and maths and science games. Some older users indicated that they did not play games on the DD, rather using it for searching for information. A number of users showed a preference for using the encyclopaedia (Wikipedia) to find information. Another favourite was watching movies. There seemed to be a general desire to have access to information and to increase their knowledge.

The site administrator displayed enthusiasm regarding the facility, and was particularly interested in the possibility of more advanced customisation of the DD, as he stated: *'Play around with settings, trying to integrate a wireless feature into it. Make sure people can print out information and log into the machine from remote PCs'.*

Gender differences

Participants indicated that the DD was mostly used by boys. One of reasons for this appeared to be that boys dominated the use of the machine and did not allow girls to use it as highlighted by the following comment by a 21 year-old male: *'Girls don't have time to use the DD as it is always being occupied by boys'*. Six users felt that there were enough applications for girls. Five did not specify or indicated that they didn't know. Another user, a 19 year-old female, stated: *'Girls like fun and interesting games. The latest ones'*.

Some further notable questionnaire responses:

- *'Boys do not give girls a chance to use the machine'* 18 year-old male.
- *'Boys like games. Girls will be mostly researching, doing their homework'* 35 year-old female.
- *'Boys play games, girls do homework'* 10 year-old male.

User requests

Requests for applications included Internet, email, social media, graphics applications, audio facilities and more games (see Table H1). The requirement for business information, geography information and local content (councillor-ships and youth organisations in the area) reflected a more mature user base in this interview and questionnaire session, than had been the case at the Gatang location (Section 7.5.1). The proximity to the Fablab might also have affected the demographics of the typical DD user and associated requests for further content.

Awareness

Despite the promotion at schools in previous years, some participants indicated a general lack of understanding of the purpose of the DD, as the following comment highlights:

- *'Most people they don't know that DD is for free. If people can receive pamphlets and information about DD'* 29 year-old male

While many users become aware of the DD through word of mouth, there is an ongoing need for explicit promotion and publicity of the DDs, especially amongst older users (see Section 8.8 on DD awareness).

7.5.3 Site 3: Emjindini library

Site description

GPS coordinates: 25˚ 46' 29.15" S 31˚ 01' 48.44" E

Environment: A satellite library in Emjindini township, outside the small town of Barberton, Mpumalanga. The area is semi-urban, with a combination of RDP houses and more expensive houses (see Figure 7.9).

Principal researcher assisted by: Ms. Nare Mmonwa, Mr. Charles Phiri, Ms. Bonang Tselane.

Figure 7.9: Satellite image of Emjindini library - base image © Google Maps

Activity description and observations

Date and time of visit: Monday, 1st Nov. 2010, 14:00; Tuesday, 2nd Nov. 2010, 09:00.

After a four-and-a-half hour journey from Pretoria, the researchers arrived at the site (see Figure 7.10), which had been the venue for an official Digital Doorway launch some years before (see Figure 7.11). The library had just reopened after the lunch break. One or two young adults were using the library, which was neat and orderly and air-conditioned. The DD, located in a corner of the library, was switched off. The librarian turned on the DD and explained that one of the screens (on the server side) went black after a few minutes. Both client terminals worked as expected. After approximately ten minutes, the server screen did indeed go off, and we noted that this DD was in need of repair.

Figure 7.10: Entrance to Emjindini library

Figure 7.11: Digital Doorway board on site

During the course of the afternoon, many young people from the surrounding areas arrived at the library and were approached to participate in the questionnaire and informal interview process. Most of them agreed. In total, nineteen questionnaires were completed, and additional informal interviews/conversations held with the majority of those participants on an open-ended basis. Library users who did not use the DD were also asked to specify reasons. The librarian assisted the researchers by coordinating users (Figure 7.12).

Figure 7.12: Librarian and users at the DD

Snapshots of user experiences observed

The majority of library users were under the age of twenty. Older users did enter the library, but were not seen to use the DD. On the following morning, the library was very quiet, and the few young adults who came in, all indicated that they had not used the DD before, and were content to locate information in the traditional book-based manner. They also indicated that they were unaware of the benefits of a computer. This implies that a potential opportunity exists to make these users aware of the resources and learning opportunities afforded by the DD.

Mention was made of the DD being potentially noisy when lots of school children were using it, disturbing other users in the library. Options for locating the DD outside the library should be considered for this reason.

Some users were unaware that the information they were seeking was available on the DD, and had to be shown how to access the encyclopaedia and search for a particular topic of interest. One boy requested information on the local area of Barberton. The researcher showed him an encyclopaedia search that did indeed return information on Barberton. The introduction of a prominent content search icon, in later DD releases will help facilitate self-discovery of this important resource.

Another boy (15 years old) indicated that he was 'not interested in computers' although he had access to a computer at home. He indicated that he would use the DD for school research, but did not like the idea of having to copy information from the screen, and requested that printer facilities be included.

Many requests were made for the ability to print documents from the DD. There was a printer in the library, that the librarian could use to print documents from her computer. The option to connect the DD to that printer was viable, given the controlled environment of the library. The librarians were very involved with the young people, helping them find books and research material, and encouraging them to participate in the research study, as well as perform information searches at the DD.

Some of the girls mentioned that boys didn't use the computer but rather picked up books, and that the girls used the computer the most. The quantitative study revealed that the boy to girl user registration ratio was approximately 2:1 (Table 6.4), however, that figure does not reflect day-to-day, or week-to-week changes in behaviour or gender distribution.

Emjindini questionnaire results

Recording of responses

Questionnaires were numbered 1 to 18 to identify them. Further additions and refinements were made to the spreadsheet previously drawn up for the first two sites, and the cells populated for Emjindini.

Participant details

The eighteen participants ranged in age from 10 to 39 years old (Figure 7.13), and included seven males and eleven females.

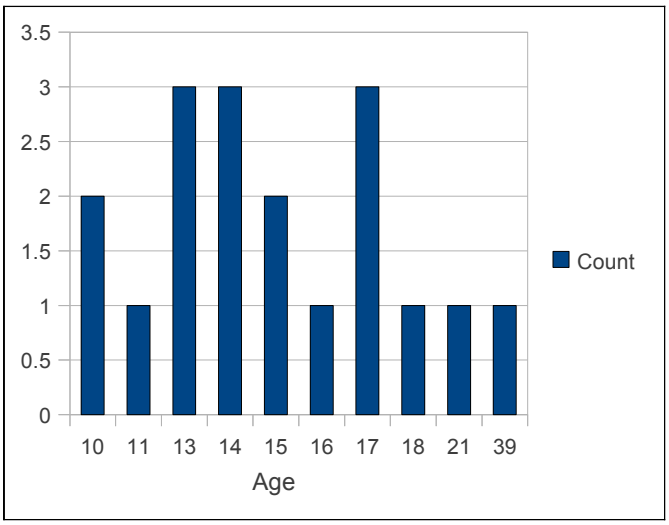


Figure 7.13: Age distribution, Emjindini

While participants mostly spoke Siswati at home, all eighteen indicated a preference for interacting with a computer in English. Nine participants had access to a home PC, while six had access to a PC at a friend's house.

Usage findings

Sixteen participants felt that the DD was useful. Eleven users had been using the DD for over a year. The DD was predominantly used in the afternoon (fifteen of the eighteen users), with eight of the participants using it less than twice a week; five using it three to four times a week; and a further five interacting five or more times a week. Ten users indicated that they spent between one and two hours per session on the DD.

Ten users indicated that they used the DD for homework. This corresponded with a high percentage of users who indicated use of the reference resources and encyclopaedia for finding information. Seven indicated that they had school computer classes, while six other

school-age users did not. Sixteen of the eighteen participants explained that the DD had helped them learn how to use a computer, while only one stated that he had learned elsewhere.

Some users mentioned that the librarian discouraged users from playing games, however, for those that did play games, card games and action games were the most popular. One user mentioned finding the game titled 'X-moto' (not directly accessible via the standard menu).

Users at Emjindini evidenced a preference for using the open encyclopaedia application, Wikipedia, DD resources and the Celestia space simulation application, as well as playing games. The most common response to 'Why is that your favourite application?' was 'It helps me with my homework'. Other user activity included watching movies.

An important issue was addressed with regard to Wikipedia: the researchers determined that it was extensively used, due to users being encouraged to search for information on the DD for school projects, both by the librarians and (according to the librarian) by schools in the area.

Users were enthusiastic about the DD and keen to learn more. Two boys, aged 13 years, showed an eagerness to discover more about the DD. When informed that the software would be upgraded in the near future, they were quick to enquire as to the *exact* date this would happen.

One user (aged 17) indicated that he had not learned to use a computer by accessing the DD, as he had a computer at home. He stated, however, that the DD was useful and entertaining. He used it both to play games and for research. He had discovered a gamed called X-moto that was not accessible from the menu system. On being asked how he had located the game, he mentioned *three* different ways the game could be accessed: through the file-manager, navigating to a games directory; via the 'run custom program' option in the menu; or by opening a terminal window and typing in the name of the game. This indicated that he was indeed computer-literate and had grasped various ways of accessing software applications on the DD, showing resourcefulness in reaching his goal.

The same user requested Internet services and a 3D landscape-generating application.

Gender differences

In contrast to the other sites, indications were that Emjindini library DD was used more by girls than boys. Seven respondents indicated that the DD was used more by girls, while only four believed it was used more by boys. Table 6.4 indicates that, on average over a 28 month period, twice as many males than females registered user accounts, but a 1:2 female:male ratio shows notably higher usage by females than elsewhere.

Some gender-related comments are included below:

- *'Girls use computer boys use books';*
- *'Both gender because they all need to use it for homework and projects';*
- *'Because I think girls like things like beauty';*
- *'Its because boys are the ones who do their homework';*
- *'Because it doesn't have some information that girls usually like the most, like gossiping',* female 16

Twelve respondents indicated there were enough applications for girls.

User requests

Some interesting requests emerged, including the desire for a printer to be hooked up to the DD and the ability for users to take pictures and upload them to the Internet. When asked what additional information would be useful on the DD, responses were varied, from celebrity gossip and music videos to health and nature information (see Table H1). Some notable responses were:

- *'Information about school things and cultural stuff, political information. They also should access TV in the Internet for developing technology but not unnecessary stuff that make children not concentrate on school work. Music is also appropriate in there.'* 17 year-old female;
- *'If you fixed the printer. Because we need information but it is difficult for us to print. Internet also. We need a separate space for DD because we make a lot of noise, others are busy studying inside the library and they complain.'* 13 year-old female;
- *'There are great things here for everyone'* 21 year-old female.

Discussion

The overall impression of the site was one of a well-managed library facility, where visitors were enthusiastic about learning, and willing to embrace whatever technology was available. While the librarians indicated that they required advanced instruction on the use of the DD, so that they could further instruct users, they were enthusiastic about encouraging users to use the DD on their own, to find information.

The researcher felt that some basic instruction on the DD to the librarians would be beneficial. Such instruction would enable them to give users an idea of the content on the DD and the potential for finding information. Thereafter, the users would have enough interest, expertise, and motivation to explore the DD independently.

7.5.4 Msunduzi Customer Centre

Site description

GPS coordinates: 29˚ 39’ 56.25” S, 30° 38’ 11.39” E

Environment: The DD was situated on the verandah of a customer care centre building, surrounded by a collection of municipal offices, a post office, and a library that was situated inside a recycled shipping container. The complex is located within a sprawling rural development in a hilly area of KwaZulu-Natal (see Figure 7.14). The area is named after the Msunduzi river, which flows through the region.

Figure 7.14: Satellite image of Msunduzi DD site – base image © Google Maps

Activity description and observations

Date and time of visit: 11 November 2010, 15:00.

The researcher arrived at the site at approximately 3pm. Contact was made with two staff workers in the municipal complex who agreed to be interviewed. These were a librarian at the container library, and a lady responsible for cleaning of the complex.

The fact that the researcher was from the organisation that had developed and installed the device, had the potential to influenced the interview participants to bias their answers to favourable ones. For this reason, they were specifically asked to provide open, honest responses.

On arrival at the site, it was noted that the DD had been switched off, hence there was no user activity. According to the staff workers, the reason for this was that, up until a few weeks earlier, the library, which assumed responsibility for the machine, had not contributed to the monthly electricity cost of the complex. The machine was perceived to be wasting electricity and thus had been switched off. The librarian mentioned that the library had since begun to contribute to the electricity costs and that the DD could thus be switched on permanently. The cleaner also mentioned that the DD would be left on from that time on.

Once switched on, the DD itself was seen to be in working order, except for the external USB port. This was one of the few DDs with an external USB port, however, the slot had been damaged and was unusable. Damage to external ports and drives was the reason they were not included in the original design, and the system in question illustrates one of the inherent problems with the provision of additional functionality.

While the researcher was interviewing the staff members, two boys aged 8 and 12, arrived to use the computer. They were pleased to find that it was in operation again. Neither boy could speak English, so the researcher did not interview them, but observed some of their behaviour and demonstrated a few activities on the DD. The boys conversed with each other, while interacting at separate terminals of the DD.

The children who arrived at the DD were observed to be playing games, as well as using the Tuxpaint program for drawing. The researcher observed the actions of one young male user, noting how he logged on, after arrival at the DD. The researcher suggested he log on with guest user ‘DD1’, however, he mentioned the word ‘five’ and proceeded to log in with guest user ‘DD5’. Apart from a few English words, he could not speak that language, but had obviously learned how to log in using DD5 from other users, though not with his own user account (see Sections 5.5.2 and 6.2.2). This indicated that he had acquired enough learning to log into the DD, without fully grasping the concept of guest user logins.

Interview participant details

The following participants were selected for the semi-structured interviews:

- African male, early twenties, Zulu home language – librarian.
- African female, thirties, Zulu home language – cleaning staff.

Both staff member were competent in English and indicated a preference to learn computer skills in English rather than Zulu, due to the difficulty of transitioning to an English interface in the work place, if their learning had occurred on a Zulu interface.

Usage findings

The interview was conducted in a semi-structrured way, with both participants being interviewed at the same time, while the researcher took notes. Consent forms were signed by both participants.

The following point were made:

- Many children in the area were aware of the existence of the DD, and made use of it.
- There were approximately fifteen schools in the area.
- Most of the schools were equipped with computer labs and offered computer classes.
- The librarian requested some basic training, in order to be able to teach children how to use the DD effectively.
- The complex was open between 7:00 and 4:30 on week days. It was closed on weekends.
- Usage at that time of year (11 November) was low, since students were writing exams, and were studying in the library.
- The two participants did not know how to use the DD, and thus were unable to show others.
- Neither respondent had a computer at their home or at a friend's home.
- The respondents were unfamiliar with the content on the DD, and thus could not comment on its appropriateness. However, they commented that users mostly used the DD to play games, with some doing research for school purposes.
- They both had access to a workplace computer in the library that was Internet-enabled, but did not indicate how proficient they were at using it.
- Users had to pay to use the Internet in the library.
- If the USB port had been operational, the printer in the library could have been used for print outs. The library charged R3 a page.
- Most users were between 14 and 21 years old, and would converge on the site in the afternoon after school.
- Both boys and girls used the DD.
- The gender balance was most even for users in matric. For younger users, the DD was used more by boys than girls.

- When asked what they thought should be on the DD, in terms of content, the following were suggested: school related content, in particular maths and science material; for older users: email and resources to do with agriculture.
- They both indicated a desire that schools in the area be contacted and made aware of the benefits of the DD. It is interesting to contrast this with the Emjindini library DD, which had held a formal launch and was well known in its community.
- Importantly, a request was made for a poster or chart to be placed on a nearby wall, explaining something of the DD and giving basic usage instructions to help new users. A similar request was made by a user at the Soshanguve site.

Discussion

This case study differed from the previous three, in that no questionnaires were completed, and data was collected by means of observation and interviews only. The site visit highlighted the following aspects with regard to ICT in education in general, and the DD in particular:

- Fifteen schools, thousands of school children and tens of thousands of people are located in a community with a desperate need for better infrastructure.
- The limited effectiveness of only one DD, in a community with such great need, became apparent.
- Technical aspects, and infrastructure provision are just one of a number of challenges accompanying efforts to to promote ICT education in impoverished areas.
- Social and local political structures can have a significant impact on the effectiveness of the DD, particularly with regard to electricity costs, awareness, and staff confidence in the device.
- There is a need for basic training and some catalyst interventions, such as a launch, or awareness programmes, or awareness posters, to maximise the potential of the device.
- The DD is vulnerable to damage of external USB ports.
- There is a need to find a compromise between physical position (e.g., safely installed on a verandah within a municipal complex, or inside a library) and accessibility to users (e.g., next to a busy road). The former being preferred for reasons of security, and management, while the latter holds advantages for creating awareness and offering accessibility.

7.5.5 Comparison tables

Tables 7.2 to 7.3 compare data elicited from the questionnaires and interviews of the site visits to Gatang, Soshanguve and Emjindini. Table 7.2 tabulates participant demographics and usage patterns, while Table 7.3 highlights gender perceptions and usage preferences. Table H1 (in Appendix H), highlights respondents' favourite applications, and additional requests for applications and information.

Table 7.2: Site comparisons 1: demographics and usage patterns

	Gatang	%	Soshunguve	%	Emjindini	%
Participants	28		12		18	
Ages	13–19		9–35		10–39	
Males	19	68%	9	75%	7	39%
Females	9	32%	3	25%	11	61%
Home Language	Ndebele: 2 isiZulu: 7 N. Sotho: 1 Swazi: 1 Tswana: 1 Xhosa: 1 Tsonga: 1 Sepedi: 14		isiZulu: 2 S. Sotho: 1 Tswana: 3 Tsonga: 4 Sepedi: 2		English: 3 Siswati: 15	
Preferred Language	English: 28		English: 9 Zulu: 1 Sepedi: 1		English: 18	
Access to a PC	at home: 7 at friend: 10 MPCC: 3 school lab: 17		at home: 8 at friend: 3 MPCC: 1 school lab: 1		at home: 9 at friend: 6 MPCC: 4 school lab: 1	
Used DD for > 1 yr	21	75%	8	67%	11	61%
Use DD mornings	6	21%	2	17%	0	0%
Use DD afternoons	14	50%	7	58%	15	83%
Use DD anytime	8	29%	2	17%	1	6%
Use 0-2 times a wk	3		6		8	
Use 3-4 times a wk	19		4		5	
Use 5+ times a wk	4		2		5	
Spend < 1 hour	7		2		5	
Spend 1-2 hours	14		6		10	
Spend 3+ hours	5		1		1	

Table 7.3: Site comparisons 2: gender perceptions and usage preferences

		Gatang	%	Soshunguve	%	Emjindini	%
Mostly used by	**boys**	24	86%	9	75%	4	22%
	girls	3	17%	2	17%	7	39%
	both	0	0%	0	0%	4	22%
Enough apps for girls?	**yes**	19	68%	6	50%	12	67%
	no	9	32%	1	8%	3	17%
Use DD	**on own**	9	32%	6	50%	6	33%
	with friends	11	39%	5	42%	7	39%
	both	8	29%	0	0%	8	44%
Use DD for homework		19	68%	5	42%	10	56%
Not for homework		7	25%	3	25%	3	17%
Prefer learning on own		16	57%	8	67%	11	61%
Prefer with friends		9	32%	3	25%	6	33%
School comp classes?	**Yes**	8	29%	1	8%	7	39%
	No	19	68%	3	25%	6	33%
Has DD helped you learn computers?	**Yes**	26	93%	10	83%	16	89%
	No	1	4%	2	17%	1	6%
DD is useful		28	100%	12	100%	16	89%
DD is not useful		0		0		0	

7.6 Discussion

From the various case studies in the qualitative study, it became apparent that usage at each site was different, with some similarities emerging. User activity was highly influenced in positive ways, by the presence of a supervisor, as evidenced by the usage at Emjindini library, where the librarians were closely involved with user activity. At unsupervised sites, boys were seen to dominate usage, and the DD was used mostly for playing games. At supervised sites, such as Emjindini, and to some extent Gatang, usage was more varied, and the use of the reference applications much higher. The majority of users indicated that the DD was mostly used by boys, however, the reasons supplied by respondents, varied considerably. The variety of information and applications requested by users, indicated a hunger for information resources and applications relevant to their needs and interests, and confirmed the value (and potential) of the DD beyond a basic ICT literacy tool and entertainment device.

It was observed that both external and internal factors have an effect on application usage. The following factors were the most obvious:

External factors influencing usage

- Time of day – school and work hours impacted on the time available to use the DD;
- Location – both in terms of physical position (e.g., a busy corridor), and the general site location (school, library etc.);
- Whether DD is switched on – administrative issues, perceived high cost of electricity, or high noise levels, may result in the DD being turned off;
- Whether DD terminals are working – see Figure 4.17 for aspects of an effective installation;
- Glare from the sun – a noticeable problem at the Gatang site;
- Availability of electricity – rural communities often experience regular power failures;
- Restriction of the environment (noise in libraries) – at Emjindini site, games usage was restricted due to high noise levels;
- Extent of crowding at the site – at busy sites, access is limited, and quiet study of DD content is not possible;
- Study demands (exams) – applicable wherever student are present;
- Personal demands (social/domestic commitments) – often affecting older teenagers and adults more than younger users;
- Distance from DD to home – users in certain communities may have to walk a few kilometres to reach the DD;
- Availability of printing facilities – lack of a printer may mean that time taken to complete research activities is increased, as users copy the information from the screen;
- Encouragement/restrictions from authorities – the involvement of a teacher or librarian can influence usage behaviours.

Internal factors influencing usage

- Language barrier – potentially limits the effectiveness of reference material, tutorials and guides, as well as following instructions for basic procedures such as logging in;
- General perception of the content – if material is to be used, it must be perceived to be relevant;
- Motivational factors – e.g., the desire for entertainment versus the desire for learning versus immediate needs (finding a job, health information etc.);

- Previous experience – new users explore content in a random, erratic way, whereas familiarity with the DD typically results in more focused/directed activity;
- Peer pressure or peer encouragement – especially noticeable when groups of users interact around the DD;
- Risk of embarrassment and lack of confidence – especially noticeable amongst older users (26+);
- Level of education – certain resources will be more appropriate than others, depending on the educational level of the user.

Noticeable themes in user feedback comments

An additional useful source of qualitative data consists of comments from the online mechanism (See Section 4.10), collected over a period of two years, 2007 and 2008. These provide further insight into user opinion and perceived needs and desires. Of a random sample of 73 opinionated comments extracted from those received from DD sites throughout South Africa, 66 were positive (90%), and just seven were negative (10%). In addition to this, numerous feedback messages contained suggestions or requests. Examples of each of the above, are included below:

Positive examples:

- *'We love it'* – April, 2007;
- *'Hi i'm enjoying it a lot coz there are many things i've learn. and i using it to find info about how people were living long time ago. & finding out about what happening around us "ya" oh! i nealy fogort your science is absolutly great, there are many things i can say about your computers thnx alot'* – May, 2007;
- *'it is very wonderful to use the digital doorway. i use it to investigate some of the study that i am learning now even though there is no music to listen and it is so boring when we come to that'* – February, 2007.

Negative examples:

- *'i dont feel gaining some skills bcos we dont surf the internet'* – April, 2007;
- *'I'm trying to brows the web but I cant, why is this thing doesn't search the web?'* – April, 2007.

Request examples:

- *'we do enjoy your digital doorway .I wish you could've added some music, it would be better.'* – March, 2007;
- *'Nice!! But where is the Internet?'* – August, 2008;

- *'It's plessure to have this machine at our college. I have knowing many thngs through this machine. I would like you to add the whole informention about South Africa such as how many airports do we have?'* – February, 2007;
- *'i would like you to send me a xbox game on my file'* – August, 2008;
- *'can you help me to get where they talk about the effect of smoking during pregnancy please.'* – March, 2007.

In terms of requests for information and further functionality, the following major themes emerged from analysis of this feedback:

- Numerous requests for the Internet, email, music, movies and games;
- A number of requests for career information, university courses or finding a job;
- A number of requests for health-related content, including HIV/AIDS information;
- A number of requests for information on South Africa and local geography;
- A few requests for help with school projects;
- Various hardware requests, including printing services, external USB port and a radio;
- Miscellaneous requests, e.g., volcanoes/dictionary/glue;
- System-related requests, e.g., logging in, or setting the internal clock.

Finally the following two requests illustrate the need for applications for older people, and social services:

- *'im enjoying using this digital doorway, but you must add things for old persons not for children only e.g games, internet etc'* – January, 2007;
- *'another favour i wanna ask is that may you please find a conseller for us'* – June, 2007.

While the DD is unable to meet every request, or provide answers to every question, the online feedback mechanism is an important means of gauging users' perceptions, concerns, and desires. In addition, it contributes to the sourcing and developing of relevant content for future software releases.

This study has shown that qualitative data has a key role to play in building up a holistic picture of user activity at a DD site, and should be used during the implementation and evaluation of ICT projects of this nature.

7.7 Summary of chapter

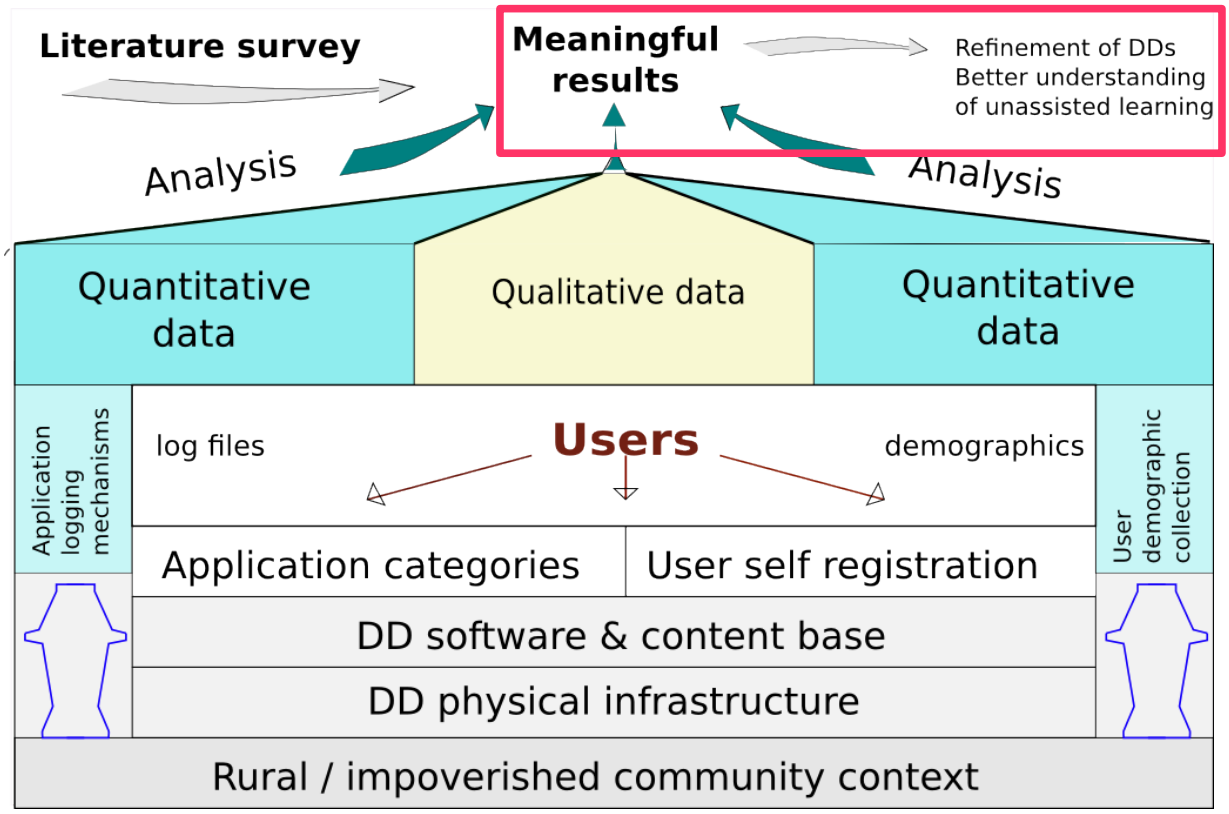
This chapter detailed empirical data obtained from site visits to Gatang High School, Soshanguve Fablab, Emjindini Library, and Msunduzi Customer Care Centre. Descriptions were given of activities during the visits, and results presented from interviews, researcher-assisted questionnaires, and naturalistic observation. Findings highlighted user interactions at the sites, age profiles of users, opinions by participants on gender differences, favourite applications and requested applications. The chapter presented comparison tables between three of the sites, and discussion relating to software application usage and themes that emerged from user feedback.

– 8 –

Discussion and conclusions

'yes it is great, but i have a question. do you have a dictionary?' – January, 2007

'for research and other stuff, i think u r makin a big impact on our community by inpowerin us wit knowledge.' – Febuary, 2007



8.1 Introduction

This chapter brings together and summarises findings from the previous chapters, before presenting a selection of recommendations, ideas for future research, and some concluding remarks. This study employed a mixed-methods approach to answering the four research questions posed in Chapter 1, and revisited in Section 5.4 of the research design chapter.

Following a section of general discussion (Section 8.2), we return to the four research questions, and answer them in Sections 8.3 to 8.6 respectively, by referring to the results and findings in the quantitative study of Chapter 6, the qualitative study of Chapter 7, and the literature studies. The recommendations in Section 8.8, address aspects of user registration and logging in, DD awareness, basic training, and content choice.

8.2 General discussion on DD usage

In Chapter 2, we saw that, with any ICT intervention (such as the DD), the mere provision and maintenance of technology is not sufficient to bring about change in a community. What is needed is a holistic understanding of the community and its problems, as well as behavioural and social aspects that determine use of the technology. This was the motivation for the socio-technical nature of this study.

In light of the low penetration of computer centres in schools (Section 2.3), the DDs are a viable alternative means for users to access computer infrastructure and develop basic computer skills. The record of registered users (over two thousand) in Table 6.4 (Section 6.6.2), is in itself an indication that the DD is accomplishing its goal. The fact that these users have picked up enough basic computer skills to create their own user name and log in, is an indication of success. However, certain sites are more successful than others. The varying numbers of application hit-counts and registrations, over different time periods (from 4 months to 28) is indicative of the degree to which each site is being used. It is apparent that a number of sites are used much more frequently than others.

Mapping Harris's dimensions of the digital divide (see Section 2.4), to the DD project, reveals the following:

- **Services** are being made available to the users through the DDs, and users have the opportunity to learn and acquire computer literacy skills.
- There is insufficient **awareness** of how the ICT intervention might be used for their benefit, particularly in the older age groups.

- As a freely accessible resource, the DD provides all community members with the **opportunity** to attain computer literacy.
- The basic functions are quickly **mastered** by users, however, it appears the full potential of the applications is not being exploited.
- **Skills** to use the DD are acquired and shared between peers.
- Local **support** of the DD infrastructure is vital, and assisting users, while not necessary for learning to take place, can be beneficial in providing direction, as seen in Emjindini library.
- **Attitudes** towards the device vary, but are mostly positive.
- The challenge of finding appropriate **content** is ongoing. The study has helped clarify what users engage with on the DD, and will inform ways of combining their preferences (e.g., for games and multimedia content) with the most appropriate content (e.g., health and education).
- Regarding **cultural** and **linguistic** aspects, there is an ongoing need for material in the user's own language. That being said, the majority of users indicated a preference to interact with the computer in English, despite their home language not being English. This needs to be addressed in light of the importance of preserving languages and promoting content that is culturally relevant.
- Regarding **disability**, while the physical DD does have an accessible version (See Figure 4.5), more could be done with regards to content to increase accessibility. This study did not address usage by disabled users.
- Much can be said with regards to **gender** issues at the DD. Some aspects of usage and behaviour have been highlighted, and these are revisited in Section 8.4 following.
- To a great extent, the DD **empowers civilians** to take control of their own learning with respect to ICT, making use of the opportunities afforded by the availability of infrastructure and resources. The inclusion of additional, locally relevant content, would further empower users, provided they were aware of, and used, that content.

Each of the above dimensions has bearing on application usage, and should inform the design and implementation of content. The wealth of findings from this study highlights the value of building in mechanisms to monitor and log usage in an ICT intervention. These logging and monitoring mechanisms could be further enhanced and refined, to determine how successfully various software interventions are, in influencing these and other dimensions of the digital divide.

We now revisit each of the research questions and sub-questions in turn, presenting notable findings from the study.

8.3 RQ1: What categories of applications are used by various age groups on Digital Doorways?

What are the general trends amongst all users regarding application usage?

Some of the general trends that are apparent across the selected sites are:

- The high use of games applications, especially by younger users;
- The popularity of audio and video content (including use of the built-in web-cam), amongst most users;
- The extensive use of the file navigation application to explore the content;
- The popularity of locally relevant edutainment applications.

Sites with locally relevant and engaging edutainment material, displayed significantly higher usage of applications in the edutainment category, than sites that did not (Table 6.25).

From the qualitative study, it was apparent that participants preferred to interact with a computer in English, rather than their home language, despite the majority of participants having a language other than English as their home language. Results from the log files in the quantitative agreed with this finding.

While the quantitative study found that games, and video and audio content, were very popular on the DD, the various encounters with users, teachers and librarians, during the site visits, revealed an underlying need for access to life-skills resources, from information on university degrees, finding a job, or starting a career; to medical advice, and pregnancy information.

Are there notable relationships between the age of users and the categories of applications accessed?

There is a statistically highly significant correlation between age and categories of applications used (Section 6.7.6). This has implications for future DD content choice and development, and suggests value in age-dependent presentation of information. The comparison of registered users versus age group for individual sites (Section 6.7.3) indicated that, with the exception of the Msunduzi customer care centre, most users were in the 10–13, 14–17 or 18–21 age groups. At Msunduzi, a high percentage of registered users were in the 22–25 and 26+ age group, reflective of older visitors to that DD site, which was located near a post-office and various municipal offices.

With increasing age, we see a significant decrease in the use of games (Section 6.7.6), a fairly steady use of video and audio applications, a general increase in the use of DDhomepage and navigation applications, fairly constant but low use of education and edutainment applications, as well as office applications, and a varying use of reference materials with high use in the 14–17 and 26+ age groups. These two age groups also showed equivalent usage levels when education and reference categories were combined (33.7% and 34.3% respectively). Adults over 26, though few in number, were using it for knowledge-acquisition.

At libraries, usage of reference material was significantly high in the 14–17 age group.

Life-skills and health information showed notably higher usage in the 22–25 and 26+ age groups, than in the younger age groups (see Table 6.11) The majority of the content in this category was not in an engaging multimedia format, explaining the low usage figures overall.

8.4 RQ2: Does gender have an impact on extent of use and on application usage?

What are the general trends amongst males and females regarding application usage?

Colley and Comber (2003) report on discrepancies of computer use between girls and boys, highlighting that boys use computers more than girls. While there is a general tendency for more boys than girls to use computers in equal access environments, such as a computer lab, the DD has the added issue of shared physical location to compound the issue, with girls having to contend with boys for use of the system. The comments obtained by both males and females on the issue of gender (see Table 7.1) provide further insight into the matter.

While earlier sites such as the Cwili installation displayed a high number of girls using the system, confirmed by historical video footage from 2003, the data indicates that female users are very much in the minority at the sites, despite all sites being accessible to users of both genders, and schools and colleges being co-educational. More males than females are using the DDs (approx. 3:1 ratio), and on average, each male is launching more applications (i.e., making greater use of the resources on the DD) than females (approx 7:5 ratio).

A comparison of Indian HITW sites and South African DD sites, yields some similarities. Mitra reports that at some sites in India, the girls complained that the boys didn't let them use the computer and thus were unable to complete their desired objectives (Mitra 2000). At Kalkaji, children of both genders used the kiosk, but mostly boys aged 6-12. At Shivpuri: girls did not use the kiosk. Regulars were male teenagers aged 13-19.

DDs are being underutilised by females both in terms of users registering their own user accounts, and in terms of actual hit-counts (Section 6.8.2). Females that did register an account, used their account less than males used theirs. That is, male respondents used statistically significantly more applications than female respondents, per registered user.

The quantitative study indicated that more males than females were registering accounts and accessing applications; correspondingly, the majority of participants in the qualitative study agreed with this (see Table 7.1). Almost all males, and the majority of females indicated that the DD was mostly used by males. Suggested reasons for this ranged from the opinion that males prefer technology or games, to girls being shy, or not interested in technology. Some users indicated that girls were prevented from using the DD by boys.

Within the games category, females were more likely to play card games, while males were more likely to play action, maths or science games. The competitive nature of boys, especially in light of the typically multi-user activity around the DD, was a determining factor in the choice of games.

Is there a relationship between the gender of users and the categories of applications accessed?

Colley found that, in terms of gender, the most significant differences between boys and girls usage was in the categories of home use, music and games.

While the clustering of individual applications into general categories masks immediately noticeable differences between male and female usage, statistical analysis of gender versus usage revealed a statistically significant association between gender and application hit-count. Notable results from analysis of individual cell-Chi-square values indicated proportional differences between male and female hit-counts in the DDhomepage/navigation category (males > females), the edutainment category (males > females) and, interestingly, in the reference category (females > males). The higher percentage of males to females using the edutainment category of applications, is predominantly due to the high popularity of the TuxMaths application amongst boys where the competitive nature of boys is an incentive to play the game often.

A more fine-grained analysis comparing individual application hits per gender, for a selected applications, would enable more specific differences between the genders to become apparent.

8.5 RQ3: How does the physical situation of the computer kiosk affect the types of applications accessed?

Does the physical situation of the device (e.g., in a library, a school, a community centre, etc.) affect the types of application that are accessed?

Noticeable differences in usage percentages between schools, FET colleges, libraries and public locations (see Figures 6.40 and 6.41), enable us to conclude that the physical situation of the device does indeed affect the types of applications that are accessed.

The high use of reference material at libraries (in particular Emjindini) was both a reflection of the types of users visiting these DDs, as well as a reflection of the supporting infrastructure (librarians who were willing and able to assist users).

As mentioned in Section 6.9, multimedia content (video and audio) was popular in public locations such as community centres and informal markets. This could be exploited by delivering content targeted at these locations, in this format, for instance the delivery of information on a range of topics beneficial to the general public, for example, SARS income tax info; health information such as HIV/AIDS information or sanitary information; domestic safety issues; environmental concerns; and road safety.

The high use of games and low use of educational material at FET colleges was both a reflection of users attitude towards the DD (a source of entertainment and diversion), as well as an indication of content that was inadequate or lacking.

Which applications are underutilised by the intended target groups?

Much of the content on the DD is underutilised by the target groups, as evidenced in Sections 6.7.7 and 6.9.4 Reference materials for agriculture, books, science, etc. were little used, as were office suite applications and edutainment of all varieties, excluding local games. See Chapter 6, Section 6.9.5, for more details.

The sub-section *content choice and presentation of* Section 8.8 provides recommendations to address the underutilisation of certain applications.

Are there noticeable differences in behaviour around, and usage of, DDs at varying localities?

Some of the findings of Chapters 6 and 7 are addressed below.

Varying localities displayed noticeable differences in user demographics, behaviour and usage at the DD terminals. Table 6.4 highlighted differences in overall usage and account registrations, for the ten sites in the quantitative study.

The qualitative study showed that social interactions between users varied from one location to the next, both as a result of different groups of individuals displaying different interactions with each other, and as a result of the location itself. For instance, school pupils compete for usage of the DD during break times, or before or after school, and public location users come to the site for other tasks, and encounter the DD unexpectedly.

Emjindini library stood out with regard to assistance of users by the resident librarians. The high use of reference applications evident in the quantitative analysis (Section 6.7.7) was confirmed during the subsequent qualitative study to be as a result of these supportive interventions (Section 7.5.3).

What is the impact of the site environment on the physical usage?

As in the Indian HITW findings, the caretakers/administrators played different roles, depending on the site. Facilitation ranged from active participation, encouraging and directing the use of resources (Emjindini), or enthusiastic but less-involved authority (Gatang), to uninvolved, or little involved observation (Soshanguve, Msunduzi).

Given the environmental conditions of a typical DD (Section 4.11), aspects to consider in application choice, include:

- Time taken to learn the application;
- The degree to which the application will be suitable for a crowd of users;
- The applicability of the application in high noise-level settings;
- The applicability of the application in sub-optimal visual settings;
- The appeal of the application to casual passers-by and ability to engage these user in a more permanent way;
- The amount of noise the application creates;
- The suitability of the application to users of different ages;
- The ability of the application to engage and be meaningful to novice users, and lead them through to more advanced levels of interaction.

With regard to Section 4.12 (effective and ineffective installations), the important aspect is that content is continually improved, and new and appropriate content added. Online feedback mechanisms should include more content-specific questions, allowing users an easy way to provide information to developers on what content is being used, and what users require. This would require a mechanism to process and follow up on requests where possible. Feedback is also a good way of ensuring that the community remains an integral part of the project.

Obviously the physical state of the DD has an enormous effect on usage. This includes whether the DD is switched on every day (preferably remaining on permanently); whether there is a stable power supply to the DD – constant power outages affect usage, and reliability of the equipment; whether there is damage to one or more of the terminals – potentially affecting both usage levels and user confidence in the solution as a whole; and whether the environment in general is conducive to prolonged use of the device.

8.6 RQ4: What is the relevance and applicability of these results to future unassisted learning terminals?

Do the results of RQ1, RQ2 and RQ3 help in better understanding the desires and needs of target users?

This sub-question was comprehensively covered in Section 6.10.1. The results of Research Questions 1, 2 and 3 assisted in understanding the desires and needs of target users, and clarified issues of:

- User registration;
- The need for greater on-screen guidance;
- Popularity of certain applications such as games and video;
- Gender imbalance and usage differences; and
- The effect that location has on usage.

What lessons are learned for future development, selection and presentation of applications?

Section 6.10.2 of the quantitative study addressed this sub-question in some detail. The recommendations to follow (Section 8.8), in particular the 'content choice and presentation' section, highlight key areas that should be addressed in the development, selection and presentation of content.

8.7 Effectiveness of a mixed-methods approach

As discussed in Section 5.3, this study employed a mixed-methods research methodology, involving both quantitative and qualitative methods. This proved to be effective.

The quantitative approach was beneficial in examining the many complex relationships between the variables in the study (age, gender, application category, location grouping). Visualisations and statistical procedures enabled trends, patterns and pertinent findings to emerge from the data. In addition, the objective nature of the log-files provided a view of what had *actually* transpired in terms of application usage.

The qualitative approach was beneficial in understanding the various complex social and environmental aspects affecting usage at a site. The interviews, questionnaires and observations contributed to the establishment of a far richer picture of site activity, than could have been achieved through quantitative analysis alone.

The quantitative analysis constituted proportionally more to the overall study than the qualitative (approximately 70:30). The quantitative study also preceded the qualitative study. By employing a sequential 'QUANT → qual' approach (Creswell, 2009), a number of issues raised in the quantitative analysis, were explained in the qualitative study, for example, the high use of the open encyclopaedia at Emjindini library. In addition, difficulties not observable in the raw data analysis (such as users battling to register an account) could be discovered during the site visits. The quantitative and qualitative studies thus played both confirming and complementary roles. They served a confirmatory role when similar findings emerged, and a complementary role when the particular features of the method elicited data not possible with the other method.

8.8 Recommendations

As a direct result of the research in this study, a number of recommendations for future DD installations emerge. They concern aspects of user registration and logging in, DD awareness, gender issues, basic training, and content choice.

User registration process, and logging in

Suggestions to improve user-registration and facilitate the login process:

- Provide an audio interface with voice-guided instructions;
- Provide multilingual instruction boxes;

- Provide pictorial representations for non-literate speakers;
- Simplify the user self-registration process through the use of guides and pictures;
- Provide an option for groups of users to sign in;
- After login, customise the user desktop, based on age, gender, language, location, disability of the user;
- After login, prompt new users with audio instructions and guides, if requested;
- Limit input to predefined formats (e.g., 2-digit numerical format for age);
- Restrict user age input to a predefined format and age range;
- Make it mandatory for users to specify either male or female, in the gender option;
- Clearly distinguish between user name creation, guest login, and user login options;
- Check for duplicate user name creation and inform the user accordingly.

From Table 6.4 we saw that users' use of registered user accounts was approximately a third of that of guest accounts. This indicates that more should be done in encouraging users to create and use their own accounts, personalised to their own particular needs, and retaining the information they save. This could be encouraged through greater desktop customisation, personalised greeting of the user on login (through the use of a speech synthesiser) and customised menus and applications suited to the user's age, gender and computing ability. The option to save documents to their personal accounts, should be stressed.

Regarding large numbers of users registering user accounts but not making use of them (Section 6.6.3 and 6.6.4), some suggestions to solve this are:

- Not allowing duplicate registrations;
- Explaining the benefits of user name registration at the login screen;
- Allowing users to recover passwords though a mechanism such as a secret question.

Further suggestions:

- In the user registration screen, an option could be for users to specify visual or hearing impairments, and the user desktop customised accordingly.
- On user login, present users with a choice of desktop interfaces, based on their specified current preference for the DD (e.g., reference machine, games machine, learning station).

DD awareness

Potential users in a community need to be made aware of the existence of the DD, the valuable resources it contains, and how they, personally, could use it.

Efforts could be made to explicitly encourage use of the direct educational material. Without changing the ethos of unassisted non-invasive learning, supportive supplementary signposting measures could be sought. Users might benefit from clear visual guides explaining the various types of content available, either in the form of an online document (immediately accessible on logging in) and/or eye-catching laminated posters attached to the unit itself, recommending use of particular applications and customised to the type of site.

The study has touched on aspects of menu layout that could affect user awareness of an application, and usage thereof. Links to content relevant to a certain location or relevant to a particular user, should be placed in prominent positions in the menu.

How can usage of the DD be maximised with regards to time of day? Adults may be at work while children are at school. Unemployed or retired adults could use the DD in the mornings, however, the technology alone is unlikely to draw them (as it does with children), since observations have shown that adults are more cautious and reserved, and less curious than children. What can be done to encourage more adults to register accounts and use the DD? A community-driven DD awareness campaign, supplemented with some basic training, may be one solution. Greater interaction by the older generation (ages 26+) should be encouraged through awareness campaigns and more content targeted at them.

Gender issues

The following recommendations concern aspects of gender:

- Initiate a (funded) campaign to stimulate interaction by females: This would be in line with the SA government's efforts to promote scientific and mathematical expertise, as well as use of technology among girls and women.
- In controlled environments such as libraries and schools, encourage site administrators to provide help and support to girls, and allow users of both genders equal opportunities to use the DD.
- Encourage the development of a DD Code of Conduct by a representative group of stakeholders from the community, including administrators and users.
- Customise user desktop features and the presentation of content, based on the gender of the user.

- Combine educational and game-related content, taking cognisance of both male and female preference for both of these elements.
- Conduct further qualitative studies, specifically targeted at gender and usage.

Basic training

As Table 6.5 confirmed, most user registrations are being made by primary and secondary school learners. High numbers of registrations also appear in the 18-21 age group. The usage by mostly young people at public locations such as libraries is encouraging, however, the low usage by adults is discouraging, and raises the concern that adults are not embracing new technology or making use of resources that could benefit them. Suggestions for addressing these concerns include making content that targets older users, prominent on login, thus creating more awareness of the benefits of the DDs amongst that target group. Programmes could be instigated at certain sites to introduce the DDs to older users and take them through some of its basic operations. The site visits highlighted that school-going users attend in the afternoon. Unemployed and retired adults could be encouraged to visit the sites in the morning, while sessions could be arranged in the evening for employed adults to use the DDs. A well-utilised DD site might structure usage according to a timetable, such as the following:

- AM, weekdays: Unemployed and retired adult users, some training provided.
- PM, weekdays. School-going learners. Predominantly unassisted learning.
- Evening, weekdays: Employed adult learners: Evening classes with training provided.
- AM, Saturdays: Lessons on computer basics and searching for information. All ages.
- Rest of weekend: Any age group. Unassisted and peer-assisted learning.

The above would depend on funding and resources available to provide the training, and proper management of the site to allow access after hours (in the case of sites that are locked, e.g., libraries).

Facilitators should be trained in practical ways of enhancing utilisation of this valuable resource in their environments. Such training should emphasise the worth of educational resources and interaction by females. Moreover, educators and trainers should advise learners to access DDs in projects and in preparing deliverables.

School teachers should be supported and encouraged to become personally proficient in using the DD, to enable them to provide assistance to pupils who request it, and who are not comfortable with the unassisted learning environment. In addition, this will enable teachers to directly refer learners to relevant subject-related material on the DD.

Further technology

The qualitative study revealed the need for a number of technologies supplementary to the basic functions of the DD. These are: an external USB port, printing facilities, and Internet connectivity, The quantitative study revealed low use of office applications such as the word processor, attributable to the inability to print the documents. In addition, users expressed a desire to print out reference information, and save files to their own devices.

The provision of each of these technologies remains a challenge for DD developers. Damage and vandalism to ports and slots on the DD necessitates expensive maintenance. Printing facilities require dedicated human resources and funds to manage the consumables of paper and ink. Monthly Internet costs are expensive.

While the primary goal of the DD remains a basic computer literacy tool, employing unassisted and peer-assisted learning methods, the value of such supplementary functions should not be ignored. There is scope for developmental projects that tackle the above challenges, and enable realistic, manageable and sustainable solutions.

Content choice and presentation

It has been highlighted that much of the software on the DD is underutilised. Modifications could be made to existing software, and new applications could be incorporated or developed, with a view to integrating educational aspects into game or audio/video presentation formats, which are the most popular. Reference material could be made prominent in the user interface, to stimulate greater usage. Content choice and design has a significant effect on usage, and users would benefit from efforts to merge educational content into readily accessible formats.

In such processes, the findings of the Meraka group investigating DD usability, should be noted and applied. As mentioned earlier, the position of items within the menu system influences the number of launches, therefore sequencing should be carefully designed to cater for novice users.

Following on the success and popularity of games contextualised to the South African situation, more local-content software applications should be developed.

Other recommendations are to:

- Encourage the use of more educational games;
- Reduce the amount of pure entertainment games and add more educational games;
- Increase the quantity and accessibility of reference material;

- Modify the content and develop new applications to stimulate user-interaction with educational resources;
- Identify the most popular games and allow the launching of these games as a reward for completing a learning task;
- Customise the presentation of content for greatest applicability to location and age group; e.g., making links to reference and literature material prominent in libraries; making curriculum-based support material prominent in schools; and health-related applications prominent in community centres and clinics.

8.9 Future research

Following on the findings of the present study, possible future research directions are :

- Studies to determine whether level of usage is translated into academic performance and workplace skills (Gush and de Villiers, 2010).
- Research targeted at college students and older adults, to determine how DDs could best help them acquire ICT skills, and provide meaningful content.
- Studies to determine the extent to which on-screen guidance affects user registration and application usage.
- Comparison of data from a variety of user interface choices, to ascertain to what extent usage behaviour is influenced by menu layout and user-specific prioritising of applications.
- A study investigating the impact that printing facilities have, on usage behaviour.
- Differentiation studies on how purely unassisted learning sites differ from those where supervision or facilitation may influence behaviour (Gush and de Villiers, 2010).

8.10 Conclusion

This study explained the concept of the South African Digital Doorway, and discussed usage of its embedded software applications with relation to aspects of user demographics and type of location.

Both user demographics and environmental aspects have an impact on software application usage on the DD. Each site is a complex social and technical mix. Practitioners need to take a holistic approach in approaching the challenge of providing ICT training, and address both the

environmental and user/content aspects of each DD. Some of these key aspects are depicted in Figure 8.1. The two domains, namely 'users and content' and 'environment', are separate, yet closely interrelated, and thus separated by a broken line.

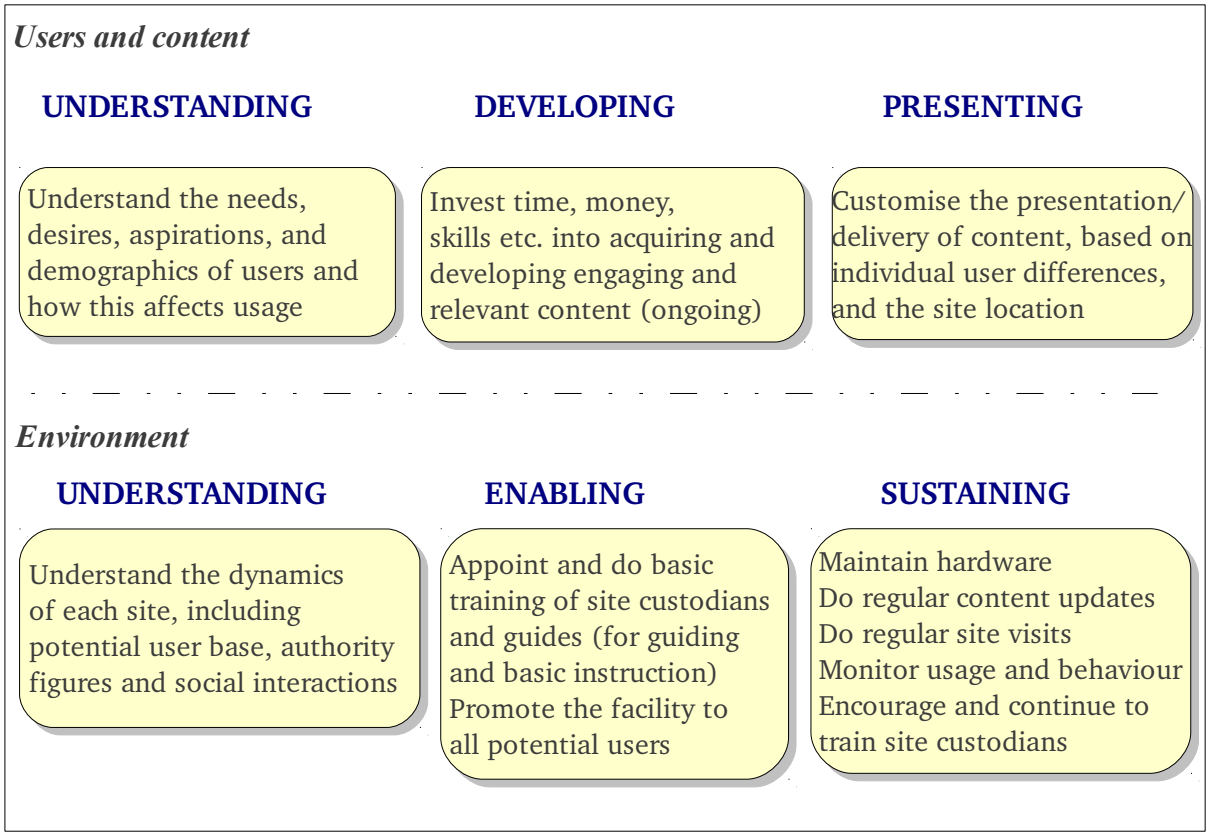


Figure 8.1: Holistic approach to ICT provision

Within the 'users and content' domain, there needs to be an adequate **understanding** of both the user base, and how the demographics of potential users relate to usage patterns. Content should be **developed** in such a way as to keep users engaged, while providing relevant information or skills. Careful attention should be paid to the **presentation** of the content, based on target audience, site location and on individual user differences such as age and gender.

In the 'environment' domain of an installation, it is important to **understand** site dynamics such as the authority figures in the community, the potential user base, and common social interactions. Issues around the physical environment, infrastructure issues such as electricity supply, and human-centred factors such as the social dynamics in the immediate site vicinity, need to be well researched.

Various means of **enabling** the community to better manage and use the DD should be implemented. Site custodians should undergo basic training, and the facility promoted within

the community, through diverse means, such as posters and school visits. Facilitators such as librarians and teachers should be made aware of new content releases and software updates, and encouraged to pass on this information to users.

Finally, emphasis should be placed on **sustainability**, through regular hardware maintenance, software and content updates, ongoing training of site custodians, and continuous monitoring and evaluation of each site.

The Digital Doorway is a collaborative effort between researchers, developers, and community stakeholders. It is hoped that the understanding gained from the many facets of this study will be integrated into subsequent DD developments, and in so doing, will strengthen an already effective ICT intervention. And that, further, the lessons learned from existing DD installations, will contribute to the successful establishment of similar ICT initiatives in the future.

Ultimately, whether through analysis or installation, our goal should be to make a measurable and favourable difference to the lives of impoverished and technologically disadvantaged members of society.

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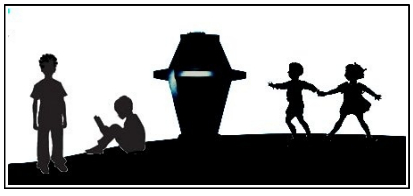
'it is my pleasure to write you the report that our community is happy about the digital doorway because it is helpful for them and their children. Hopeful we can receive a lot more of information from you in the near future. Thank you for exposing our community to such a great empowerment. May God enrich you to do more than what you are doing.' – *Digital Doorway user, March 2007*



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Appendices

Appendix A – Log file extracts

Extract from compressed log file tarball:

log_20070418.tar:

mvotiti.log
sithole.log
dd3.log
dd1.log
dd2.log

Text A1: Example of tar file contents

Extract from user log file dd2.log:

dd2.log:

dd2,/usr/bin/gmplayer,file:///opt/digidoor/DDCONTENT/BOOKS/Fun/Movies/Turing_Test.mpeg,Tue Apr 17 11:55:59 SAST 2007
dd2,/usr/games/ksmiletris,,Tue Apr 17 11:57:59 SAST 2007
dd2,/usr/bin/xfrun4,,Tue Apr 17 12:09:58 SAST 2007
dd2,/usr/bin/firefox,file:///opt/digidoor/DDCONTENT/BOOKS/Fun/Bird_Alphabet/Bird_Alphabet.html,Tue Apr 17 12:16:44 SAST 2007
dd2,/usr/games/gnibbles,,Tue Apr 17 12:17:39 SAST 2007
dd2,/usr/bin/gmplayer,file:///opt/digidoor/DDCONTENT/BOOKS/Fun/Movies/Alien_Song.mpeg,Tue Apr 17 12:27:47 SAST 2007
dd2,/usr/bin/gmplayer,file:///opt/digidoor/DDCONTENT/BOOKS/Fun/Movies/Chameleon.mpeg,Tue Apr 17 12:30:07 SAST 2007
dd2,/usr/bin/gmplayer,file:///opt/digidoor/DDCONTENT/BOOKS/Fun/Movies/Alien_Song.mpeg,Tue Apr 17 12:31:28 SAST 2007
dd2,/usr/games/ktron,,Tue Apr 17 12:33:01 SAST 2007
dd2,/usr/games/ksmiletris,,Tue Apr 17 12:34:53 SAST 2007
dd2,/usr/games/gnect,,Tue Apr 17 12:36:01 SAST 2007
dd2,/usr/games/gnometris,,Tue Apr 17 12:38:00 SAST 2007

Text A2: Example contents of .log file

Example of log file with sitename and username concatenation:

elandeskraalmpcc_003018B0C936.balofrey,17,male,Southern_Sotho,English,/usr/bin/xawtv,,Thu Feb 22 17:49:52 UTC 2007
elandeskraalmpcc_003018B0C936.balofrey,17,male,Southern_Sotho,English,/usr/bin/firefox,http://home.digitaldoorway.co.za,Thu Feb 22 17:55:32 UTC 2007
elandeskraalmpcc_003018B0C936.balofrey,17,male,Southern_Sotho,English,/usr/bin/kalzium,,Thu Feb 22 17:56:42 UTC 2007
elandeskraalmpcc_003018B0C936.balofrey,17,male,Southern_Sotho,English,/usr/bin/firefox,file:///opt/digidoor/DDCONTENT/BOOKS/Science/Theory_of_Relativity/The_Relativity_of_Simulatneity.htm,Thu Feb 22 17:57:03 UTC 2007

Text A3: Example output of concatenated log file

Appendix B – Code listings

processor:

```
#!/bin/bash
# processor
# K GUSH, 2010.
# Process log files and extract various details such as name, age, gender, language into individual files
if [ -f stat_breakdown ]
then
rm stat_breakdown
fi
if [ -f age_breakdown ]
then
        rm age_breakdown
fi
echo "sitename logged_days nolog_days lines_feedback application_accesses user_accesses first_log last_log num_users male
female undefined" > stat_breakdown
for dir in ./*
do
        if [ -d $dir ]
        then
                cd $dir
                pwd
                pwd | egrep -o -e "/[a-Z0-9-]*_[a-Z0-9]*" | egrep -o -e "[^/].*" > z_name.txt
                ls log_* > z_loglist.txt
                ls nologs_* > z_nologs.txt
                ls report* > z_reportlist.txt
                if [  `ls feedback_2* | wc -l` > 0 ]
                then
                        cat feedback_2* > z_allfeedback.txt
                        else echo "no feedback" > z_allfeedback.txt
                fi
                cat z_loglist.txt | wc -l > z_num_logged_days.txt
                cat z_nologs.txt | wc -l > z_num_nolog_days.txt
                cat z_allfeedback.txt | wc -l > z_num_lines_feedback.txt
                egrep -v -e "dd1|dd2|dd3|dd4|dd5|dd6|dd7|dd8|dd9|dd10|HOMELANGUAGE|PREFLANGUAGE" z_all_apps.txt
>               z_all_apps_users.txt
                egrep -v -e "HOMELANGUAGE|PREFLANGUAGE" z_all_apps.txt > z_all_apps_better.txt
                cat z_all_apps_better.txt | wc -l > z_num_lines_allapps.txt
                cat z_all_apps_users.txt | wc -l > z_num_lines_users.txt
                firstlog=`head -n 1 z_loglist.txt`
                echo ${firstlog:4:4}"-"${firstlog:8:2}"-"${firstlog:10:2} > z_first_log.txt
                lastlog=`tail -n 1 z_loglist.txt`
                echo ${lastlog:4:4}"-"${lastlog:8:2}"-"${lastlog:10:2} > z_last_log.txt
                if [ -f register.dd ]
                then
                        grep "NAME=" register.dd | wc -l > z_num_registered_users.txt
                        egrep -e "[a-Z0-9]*[0-90-9]:[a-Z0-9]*" register.dd > z_registered_dates.txt
                        grep "NAME="  register.dd > z_registered_names.txt
                        egrep -e "^AGE=" register.dd > z_registered_age.txt
                        grep "GENDER=" register.dd > z_registered_gender.txt
                        grep "HOMELANGUAGE=" register.dd > z_registered_homelang.txt
                        grep "PREFLANGUAGE=" register.dd > z_registered_preflang.txt
                        grep "GENDER=m" z_registered_gender.txt > z_registered_gender_male.txt
```

```
                grep "GENDER=f" z_registered_gender.txt > z_registered_gender_female.txt
                grep "GENDER=u" z_registered_gender.txt > z_registered_gender_undefined.txt
        else
                echo "0" > z_num_registered_users.txt
                echo "0" > z_registered_dates.txt
                echo "0" > z_registered_names.txt
                echo "0" > z_registered_age.txt
                echo "0" > z_registered_gender.txt
                echo "0" > z_registered_homelang.txt
                echo "0" > z_registered_preflang.txt
                echo "0" > z_registered_gender_male.txt
                echo "0" > z_registered_gender_female.txt
                echo "0" > z_registered_gender_undefined.txt
        fi
        k1=`cat z_name.txt`
        k2=`cat z_num_logged_days.txt`
        k3=`cat z_num_nolog_days.txt`
        k4=`cat z_num_lines_feedback.txt`
        k4b=`cat z_num_lines_allapps.txt`
        k4c=`cat z_num_lines_users.txt`
        k5=`cat z_first_log.txt`
        k6=`cat z_last_log.txt`
        k7=`cat z_num_registered_users.txt`
        k8=`cat z_registered_gender_male.txt | wc -l`
        k9=`cat z_registered_gender_female.txt | wc -l`
        k10=`cat z_registered_gender_undefined.txt | wc -l`
        echo $k1 $k2 $k3 $k4 $k4b $k4c $k5 $k6 $k7 $k8 $k9 $k10 >> ../stat_breakdown
        cat z_registered_age.txt >> ../age_breakdown
        cd ..
    fi
done
if [ -f age_breakdown ]
then
    sort age_breakdown | uniq -c > age_breakdown_grouped
fi
```

getapps_peruser2

```
#!/bin/bash
#getapps_peruser2
# K GUSH, Oct 2009
# This script scans subdirectories for tarred log files files and
# untars them and merges the logs per user into a userxx.siteyy.log file under the appsperuser/users subdirectory as well as
combining all guest logs into ddX.siteyy.log file under appsperuser/guests
#In addition, all user logs are combined into ../all_user_logs_big.txt and ../all_guest_logs_big.txt
# Script should be run from the uploaded directory, containing all the site
# directories in it.
if [ -f all_user_logs_big.txt ]
then
rm all_user_logs_big.txt
fi
if [ -f all_guest_logs_big.txt ]
then
rm all_guest_logs_big.txt
fi
```

```
for dir in *
do
        if [ -d $dir ]
        then
        ls $dir/log* > /dev/null 2>&1
        if [ $? -eq 0 ]
        then
        cd $dir
        if [ -d appsperuser ]
        then
        rm -r appsperuser
        fi
        mkdir appsperuser
        mkdir appsperuser/guests
        mkdir appsperuser/users
        for file in log*
        do
                tar -xvf $file
                for file2 in *.log
                do
                        if [ $file2 != 'jp.log' ] && [ $file2 != 'tom123.log' ] && [ $file2 != 'kim.log' ]
                        then
                        username=${file2%\.*}
                        sed -i -e s/$username/$dir.$username/g $file2
                        cat $file2 >> ./appsperuser/$dir.$file2
                        grep -v "LANGUAGE=" ./appsperuser/$dir.$file2 > ./appsperuser/$dir.$file2.1
                        mv ./appsperuser/$dir.$file2.1 ./appsperuser/$dir.$file2
                        fi
                done
                rm *.log
        done
        mv appsperuser/$dir.dd{1,2,3,4,5,6,7,8,9,10}.log appsperuser/guests/
        mv appsperuser/*.log appsperuser/users/
        cat appsperuser/users/*.log >> ../all_user_logs_big.txt
        cat appsperuser/guests/*.log >> ../all_guest_logs_big.txt
        cd ..
        fi
        fi
done
```

get_userdetails_perline

```
#!/bin/bash
#  get_userdetails_perline
# K GUSH, Oct 2009
# This script adds age, gender, homelang and preflang to each line of all_user_logs_big.txt and all_guest_logs_big.txt
# It scans the file name_age_gender_lang.csv for the first occurance of the username and adds the details if found
# Script should be run from the uploaded directory, containing all the site
# directories in it.
 if [ ! -f all_user_logs_big.txt ]
then
echo "couldn't find all_user_logs_big.txt, please run get_apps_peruser2"
exit 0
fi
if [ ! -f name_age_gender_lang_nodupes.csv ]
```

```
then
echo "couldn't find name_age_gender_lang_nodupes.csv, please create it from spreadsheet"
exit 0
fi
cat "name_age_gender_lang_nodupes.csv" | while read line
do
        # add a comma to the line
        line2=$line,
        # assign first field of the line (and a comma to avoid substring substitutions)
        # to the variable username
        username=`echo ${line} | cut -f 1 -d',',`
        echo $username
        # replace each occurance of username with the entire line incl. age, gender etc
        sed -i -e s/"$username"/"$line2"/g all_user_logs_big.txt
done
```

getuserdetails

```
#!/bin/bash
# getuserdetails
# K Gush, Meraka Institute October 2009
# This script scans subdirectories for register.dd files and
# merges all the user details into a comma seperated file, appending the sitename to the username
# Script should be run from the uploaded directory, containing all the site
# directories in it.
if [ -f all_user_details_name.txt ]
then
rm all_user_details_name.txt
fi
if [ -f all_user_details_age.txt ]
then
rm all_user_details_age.txt
fi
if [ -f all_user_details_gender.txt ]
then
rm all_user_details_gender.txt
fi
if [ -f all_user_details_homelang.txt ]
then
rm all_user_details_homelang.txt
fi
if [ -f all_user_details_preflang.txt ]
then
rm all_user_details_preflang.txt
fi
for dir in ./*
 do
        if [ -f $dir/register.dd ]
        then
        cd $dir
        for file in ./register.dd
        do
                cat $file | grep "NAME=" |
                while read line
```

```
                do
                        echo $line
                        echo $dir.$line >> ../all_user_details_name.txt
                done
                cat $file | grep "AGE=" | grep -v "HOMELANGUAGE" | grep -v "PREFLANGUAGE" |
                while read line
                do
                        echo $line
                        echo $line >> ../all_user_details_age.txt
                done
                cat $file | grep "GENDER=" |
                while read line
                do
                        echo $line
                        echo $line >> ../all_user_details_gender.txt
                done
                cat $file | grep "HOMELANGUAGE=" |
                while read line
                do
                        echo $line
                        echo $line >> ../all_user_details_homelang.txt
                done
                cat $file | grep "PREFLANGUAGE=" |
                while read line
                do
                        echo $line
                        echo $line >> ../all_user_details_preflang.txt
                done
        done
        cd ..
        fi
done
```

line_categorise

```
#!/bin/bash
# line_categorise
# K GUSH, Dec 2009
# This script replaces application name with general and specific category codes for each line in all_user_logs_big_cat.txt and
all_guest_logs_big_cat.txt
# It scans the file applications_and_categories_2.csv and replace each matching line in all_user_logs_big/guest.txt with the
corresponding category
# Script should be run from the uploaded directory, containing all the site
# directories in it.
if [ ! -f all_user_logs_big_cat.txt ]
then
echo "couldn't find all_user_logs_big_cat.txt, please run get_apps_peruser2 and cp all_user_logs_big.txt to
all_user_logs_big_cat.txt"
exit 0
fi
if [ ! -f applications_and_categories_2.csv ]
then
echo "couldn't find applications_and_categories_2.csv, please create it from spreadsheet"
exit 0
fi
```

```
counter=0
cat "applications_and_categories_2.csv" | while read line3
do
echo $counter
counter=$(($counter+1))
        gencat=`echo ${line3} | cut -f 1 -d','`
        speccat=`echo ${line3} | cut -f 2 -d',' ,
        rep=$gencat$speccat
        partA=`echo ${line3} | cut -f 4 -d','`
        partB=`echo ${line3} | cut -f 5 -d',' ,
        partAandB=$partA$partB
        sed -i -e "s!$partAandB!$rep!g" all_user_logs_big_cat.txt
done
```

age_categorise

```
#!/bin/bash
# age_categorise
# K GUSH, Feb 2010
# This script replaces user age with an age category code for each line in all_user_logs_big_cat_age.txt and
all_guest_logs_big_cat.txt
# It scans the file ages_and_agecodes.csv and replace each matching age in all_user/guest_logs_big_cat_age.txt with the
corresponding age code
# Script should be run from the uploaded directory, containing all the site
# directories in it.
# see ages_and_agecodes.csv for list of ages and corresponding codes
# ages : agecode
# 6 – 10 : ac0
# 11 – 14 : ac1
# 15 – 17 : ac2
# 18 – 22 : ac3
# 23 – 30 : ac4
# 31 – 60 : ac5
if [ ! -f all_user_logs_big_cat_age.txt ]
then
        echo "couldn't find all_user_logs_big_cat.txt, please run get_apps_peruser2 and cp all_user_logs_big.txt to
all_user_logs_big_cat.txt then run line_categorise and cp all_user_logs_big_cat.txt to all_user_logs_big_cat_age.txt"
        exit 0
fi
if [ ! -f ages_and_agecodes.csv ]
then
        echo "couldn't find ages_and_agecodes.csv, please create it"
        exit 0
fi
counter=0
cat "ages_and_agecodes.csv" | while read line3
do
        echo $counter
        counter=$(($counter+1))
        agelookup=,`echo ${line3} | cut -f 1 -d','`
        echo $agelookup
        agecode=,ac`echo ${line3} | cut -f 2 -d','`
        echo $agecode
        sed -i -e "s!$agelookup!$agecode!" all_user_logs_big_cat_age.txt
done
```

site_categorise

```
#!/bin/bash
# site_categorise
# K Gush, Meraka Institute April 2010
# This script adds the site category code to all_user_logs_big_cat_age.txt
# It scans the file sites_and_sitecodes.csv adding the site code as appropriate
# see sites_and_sitecodes.csv for list of ages and corresponding codes
# sitename : sitecode
# Kwam_hlonipha : scc0
# Vezebuhle : scc0
# Elandskraal : scc1
# Emjindini : scc1
# Kanyamazane : scc1
# Letaba FET College2 : scc0
# Letaba FET Giyani : scc0
# Msunduzi : scc1
# Soshunguve : scc1
# Kagung : scc1
if [ ! -f all_user_logs_big_cat_age_sc.txt ]
then
        echo "couldn't find all_user_logs_big_cat_age_sc.txt, please run get_apps_peruser2 and cp all_user_logs_big.txt to
all_user_logs_big_cat.txt then run line_categorise and cp all_user_logs_big_cat.txt to all_user_logs_big_cat_age_sc.txt"
        exit 0
fi
if [ ! -f sites_and_sitecodes.csv ]
then
        echo "couldn't find sites_and_sitecodes.csv, please create it"
        exit 0
fi
counter=0
cat "sites_and_sitecodes.csv" | while read line3
do
        echo $counter
        counter=$(($counter+1))
        sitelookup=,`echo ${line3} | cut -f 1 -d',' `,
        echo $sitelookup
        sitecode=,`echo ${line3} | cut -f 2 -d',' `,
        echo $sitecode
        sed -i -e "s/$sitelookup/$sitecode\,$sitelookup/" all_user_logs_big_cat_age_sc.txt
done
```

get_userdetails_perline_persite

```
#!/bin/bash
# get_userdetails_perline_persite
# K Gush, Meraka Institute Oct 2009
# This script adds age, gender, homelang and preflang to each line of z_all_user
_logs_big.txt and z_all_guest_logs_big.txt for each site
# It scans the file name_age_gender_lang_persite.csv for the first occurance of
the username and adds the details if found
# Script should be run from the uploaded directory, containing all the site
# directories in it.
for dir in *
 do
```

```
        if [ -d $dir ]
        then
        cd $dir
        echo $dir
if [ ! -f z_all_user_logs_big.txt ]
then
echo "couldn't find z_all_user_logs_big.txt, please run get_apps_peruser2"
fi
if [ ! -f name_age_gender_lang_persite.csv ]
then
echo "couldn't find name_age_gender_lang_persite.csv, please create it from spre
adsheet"
fi
cat "name_age_gender_lang_persite.csv" | while read line
do
        # add a comma to the line
        line2=$line,
        # assign first field of the line (and a comma to avoid substring substit
utions)
        # to the variable username
        username=`echo ${line} | cut -f 1 -d',',
        echo $username
        # replace each occurance of username with the entire line incl. age, gen
der etc
        sed -i -e s/"$username"/"$line2"/g z_all_user_logs_big.txt
done
cd ..
fi
done
```

counter_per_age

```
#!/bin/bash
# counter_per_age
# For each age group count the number of hits per specific category
if [ -f countresults_cat_perage ]
then
        rm countresults_cat_perage
fi

if [ ! -f all_user_logs_big_cat_age_sc.txt.2 ]
then
        echo "Please generate all_user_logs_big_cat_age_sc.txt.2 first, and then run this script again"
exit 0;
fi
echo "results for subset_10 sites, specific category per cat per age group" >> countresults_cat_perage

echo "rows: ac0, ac1, ac2, ac3, ac4, ac5, ac99" >> countresults_cat_perage
# all gender groupings
for i in 0 1 2 3 4 5 99;
do
        echo ac$i
echo ac$i >> countresults_cat_perage
echo games,ktron `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "games,ktron," | wc -l` >> countresults_cat_perage
```

```
echo games,gnibbles `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "games,gnibbles," | wc -l` >>
countresults_cat_perage
echo games,gnometris `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "games,gnometris," | wc -l` >>
countresults_cat_perage
echo games,gamesother `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "games,games other," | wc -l` >>
countresults_cat_perage
echo reference,fun `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,fun," | wc -l` >> countresults_cat_perage
echo system,filemanager `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep ",system,system," | wc -l` >>
countresults_cat_perage
echo education,science `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "education,science," | wc -l` >>
countresults_cat_perage
echo edutainment,science `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,science," | wc -l` >>
countresults_cat_perage
echo edutainment,graphics `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,graphics," | wc -l` >>
countresults_cat_perage
echo office,graphics `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,graphics," | wc -l` >>
countresults_cat_perage
echo reference,science `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,science," | wc -l` >>
countresults_cat_perage
echo system,ddhomepage `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "system,dd homepage," | wc -l` >>
countresults_cat_perage
echo video_audio,webcam `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "video_audio,webcam," | wc -l` >>
countresults_cat_perage
echo video_audio,science `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "video_audio,science," | wc -l` >>
countresults_cat_perage
echo office,maths `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,maths," | wc -l` >> countresults_cat_perage
echo edutainment,whatwhat `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,whatwhat," | wc -l` >>
countresults_cat_perage
echo edutainment,gcompris `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,gcompris" | wc -l` >>
countresults_cat_perage
echo reference,wikipedia `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,wikipedia," | wc -l` >>
countresults_cat_perage
echo edutainment,themba `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,themba," | wc -l` >>
countresults_cat_perage
echo education,mindset `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "education,mindset," | wc -l` >>
countresults_cat_perage
echo edutainment,computers `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,computers," | wc -l` >>
countresults_cat_perage
echo video_audio,audiobooks `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "video_audio,audiobooks," | wc -l` >>
countresults_cat_perage
echo video_audio,fun `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "video_audio,fun," | wc -l` >>
countresults_cat_perage
echo system,comms `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "system,comms," | wc -l` >>
countresults_cat_perage
echo reference,computers `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,computers," | wc -l` >>
countresults_cat_perage
echo reference,health `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,health," | wc -l` >>
countresults_cat_perage
echo edutainment,language `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,language," | wc -l` >>
countresults_cat_perage
echo reference,agriculture `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,agriculture," | wc -l` >>
countresults_cat_perage
echo reference,lifeskills `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,life skills," | wc -l` >>
countresults_cat_perage
echo reference,news `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,news," | wc -l` >>
countresults_cat_perage
```

```
echo edutainment,music `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,music," | wc -l` >>
countresults_cat_perage
echo reference,crafts `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,crafts," | wc -l` >>
countresults_cat_perage
echo education,maths `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "education,maths," | wc -l` >>
countresults_cat_perage
echo edutainment,maths `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "edutainment,maths," | wc -l` >>
countresults_cat_perage
echo system,download `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "system,download," | wc -l` >>
countresults_cat_perage
echo office,word `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,word," | wc -l` >> countresults_cat_perage
echo office,database `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,database," | wc -l` >>
countresults_cat_perage
echo office,spreadsheet `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,spreadsheet," | wc -l` >>
countresults_cat_perage
echo office,mindmap `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "office,mindmap," | wc -l` >>
countresults_cat_perage
echo reference,books `cat all_user_logs_big_cat_age_sc.txt.2 | grep \,ac$i\, | grep "reference,books," | wc -l` >>
countresults_cat_perage
done
```

Appendix C: Data cleaning as applied to original site list

Table C1: Site names used and not used in quantitative analysis

1	_003018A467D2	removed	test system
2	3gen_server_test_003018A4684E	removed	test system
3	addo_003018B0C89E	used	
4	albini_girls_high_school_003018B0590E	combined	
5	albinigirlshigh_003018B0CADF	used	
6	alice_library_003018B0CA2B	used	
7	alra_park_community_centre_003018B0583B	used	
8	ba-galotlhare_high_school_003018A468B7	used	
9	barkly_east__331-099_003018B0C8C8	used	
10	batlharos_police_station_003018A3DD50	used	
11	ben_mali_sss_331-097_003018B0CAD9	used	
12	ben_matloshe_sec_school_casteel_003018AD9ECD	used	
13	ben_w_mashigo_high_school_003018AD9F7F	used	
14	black_box_@_hbg_003018A3B6AA	removed	test system
15	bloemfontein-fab-lab_003018B0C9A1	used	
16	boitelo_ps_003018A00D1B	removed	no data
17	boitelo_ps_003018A00D41	removed	no data
18	bojelakgomo_primary_school_003018A3DD3E	removed	no data
19	bongani_high_school_003018A3DD3C	used	
20	bulamahlo_003018B0588F	used	
21	buzongoma_jss__331-062_003018B0CA73	used	
22	caguba_jss-331-062_003018B0C97F	used	
23	casteel_mpcc_003018B057B0	removed	no data
24	casteelmpcc_003018B057B0	used	
25	cyrilclarke_003018B0C9FE	used	
26	dabulamanzi_school_003018AD9EBA	used	
27	deben_primary_school_003018B0C9C7	used	
28	dikgatlong_high_school_003018AD9DB9	used	
29	diqhobong_ps_003018A00CDB	used	
30	elandeskraal_mpcc_003018B0C936	combined	
31	elandeskraalmpcc_003018B0C936	used	
32	embhokodweni-setlhakwane_331-057_003018B0CA5F	used	
33	emjindini_library_003018B0CA4F	used	
34	filadelfiagirls_003018B058A2	used	
35	gatang_high_school_003018A00CAE	used	
36	gija-ngove_003018B0CA30	used	
37	groot_mier_primary_school_003018A3DCCB	used	
38	hanover_primary_school_003018AD9E56	used	
39	hlonipa_secondary_school_003018B0CA91	removed	no data
40	ikageng_computer_college_rustenburg_003018B058B5	used	
41	ikhaya_primary_school_003018A81346	used	
42	ikhwezi_lokusa_primary_school_003018AD9FC3	removed	no data
43	immerpan_hp_school_003018B0CA78	used	
44	immerpan-marblehall-056_003018B0CA78	used	
45	innhub_fablab_003018B0CA8A	used	
46	kagung_informal_market_003018A46853	used	
47	kalakengpschool_003018B0C9C7	used	
48	kanyamazane_library_003018B0580F	used	
49	kennen_primary_school_casteel_003018ADA060	used	
50	keurtjiekloof_primary_school_	removed	no data
51	keurtjiekloof_primary_school_003018A694B7	used	
52	kgabang_combined_school_003018A3DCE1	used	
53	kgatang_high_school_mamelodi_003018B0CA51	combined	
54	kgatang_high_school_mamelodi_331-089_003018B0CA51	combined	
55	kgoledi_ya_manka_ps_003018A467DD	removed	no data

63	kwam_vezebuhle_003018B0CAF9	used	
64	ladygrey_003018B05899	used	
65	lalelani_primary_school_003018B0CA1B	removed	no data
66	lalelaniprimarys_003018B0CA1B	used	
67	lebadishang_public_school__003018A00CAE	used	
68	lebadishang_public_school__003018ACBBFB	removed	no data
69	lebadishang_public_school_003018A467E4	removed	no data
70	lebadishang_public_school1_003018A467E4	used	
71	lekanang_h_school_casteel_	removed	no data
72	lekanang_h_school_casteel_003018ADA04B	used	
73	lepellehighschool_003018B0C930	used	
74	lerato_ps_003018A00D41	removed	no data
75	lerato_ps_003018ACBBFB	removed	no data
76	leriana_sec_school_003018B0CA49	removed	no data
77	leriana_sec_sehlakwane_331-065_003018B0CA49	removed	no data
78	letabafetcollege1_003018B0CA7C	used	
79	letabafetcollege2_003018B0C994	used	
80	letabafetgiyani_003018B0C92D	used	
81	letabafetlenyenye_003018A694FD	used	
82	lutaweni_jss-_331-076_003018B0C772	used	
83	m.o_mashigo_primary_school_casteel_003018AD9DD3	used	
84	mabeskraal_community_hall_003018A467D0	used	
85	mabeskraal_community_library_003018A467CE	used	
86	mabeskraal_primary_school_003018A460B4	used	
87	mabeskraal_primary_school_2_003018A00D19	used	
88	machaea_ps_003018A46872	removed	no data
89	machaea_ps_003018AB4268	removed	no data
90	mahubahuba_primary_school_casteel_003018A81351	used	
91	makata_high_school_casteel_003018AD9F19	removed	no data
92	makweleng_primary_school_003018A00C97	used	
93	mamosebo_combined_school__003018A00D1B	removed	no data
94	mamosebo_combined_school_003018A00C9C	used	
95	mamosebo_combined_school_2_003018A00C9C	used	
96	mamoseterata_high_school__2_003018A467DF	used	
97	mamoseterata_high_school_003018A467DF	used	
98	mamosodi_primary_school_casteel_003018AD9FC7	used	
99	mandlalathi_primary_school_003018A00CC3	removed	no data
100	mandlalathi_school_003018A00CC3	used	
101	mandlalathi_school_003018A460B4	combined	
102	mandlalathi_school_003018A467D0	combined	
103	mandlalathi_school_003018A467D8	combined	
104	maoloshe_primary_school_casteel_003018AD9F16	used	
105	marhubeni_jss_331-084_003018B0C9D7	used	
106	mashishing_003018B0580F	used	
107	mathukwane_sec_school_casteel_003018A81352	used	
108	matlala_003018B057EE	used	
109	matlushe_public_school_003018A00D3A	removed	no data
110	matlushe_public_school_1_003018A00D3A	used	
111	matlushe_public_school_2_003018A00C90	used	
112	matutu_middle_school_003018A00C9D	used	
113	mbhande_sehlakwane_331-074_003018B0CAFB	used	

114	meraka_003018A00C90	removed	test system
115	meraka_003018A00C9C	removed	test system
116	meraka_003018A00C9D	removed	test system
117	meraka_003018A00CA6	removed	test system
118	meraka_003018A00CAE	removed	test system
119	meraka_003018A00D19	removed	test system
120	meraka_003018A00D26	removed	test system
121	meraka_003018A00D3A	removed	test system
122	meraka_003018A00D41	removed	test system
123	meraka_003018A460BE	removed	test system
124	meraka_003018A46836	removed	test system
125	meraka_003018A46872	removed	test system
126	meraka_003018A69491	removed	test system
127	meraka_003018A69499	removed	test system
128	meraka_003018A6949E	removed	test system
129	meraka_003018AD9FC3	removed	test system
130	meraka_003018AD9FC6	removed	test system
131	meraka_003018B05873	removed	test system
132	meraka_003018B0C852	removed	test system
133	meraka_331-068_003018B0C909	removed	test system
134	meraka_331-070_003018B0CA47	removed	test system
135	meraka_331-109_003018AD9FC6	removed	test system
136	meraka_331-111_003018A7E64D	removed	test system
137	meraka_331-113_003018AD9F1A	removed	test system
138	meraka_331-131_003018A3DCD6	removed	test system
139	meraka_c248_003018B0C852	removed	test system
140	meraka_dd1_003018A694FC	removed	test system
141	meraka_dsd_62_003018B0C852	removed	test system
142	meraka_dsd_70_003018B0C983	removed	test system
143	merakalab_248_003018A467D2	removed	test system
144	merakalab_248_003018B0C852	removed	test system
145	merakatest__003018A00CAE	removed	test system
146	mmapadi_003018B0C8E6	used	
147	moetlo_primary_school_003018AD9F1A	used	
148	mohlarekoma_331-059_003018B0CADB	used	
149	mokgawane_1_003018A00CA6	used	
150	mokgawane_combined_school__2_003018A00CDB	used	
151	mokgawane_primary_school_003018A00CA6	removed	no data
152	mokgwathi_003018B0CA39	used	
153	mokopanei-com_003018B0C8C7	used	
154	molotsi_primary_school_003018A00D19	removed	no data
155	mooifontein_003018A7E64D	used	
156	moreesburg_003018A46823	used	
157	moseterata_high_school_1_003018A467DD	used	
158	mosipa_sec_school_casteel_003018AD9DB7	used	
159	motlamogale_primary_school_casteel_003018AD9DD6	used	
160	motsisi_primary_school_003018A4687F	used	
161	msunduzi_003018B0C8CA	used	
162	msunduzi_customer_care_centre_003018B0C8CA	used	
163	mthweni_port_st._john_331-086_003018B0CACF	used	
164	mtn_centre_003018B058E7	used	
165	naka_ps_003018A46836	removed	no data
166	namahadi_ps_003018A00CEC	removed	no data
167	ndevu_jss__331-082_003018B0C810	used	
168	new_4_13__248_003018A467D2	removed	no data
169	ngubezulu_sss__331-072_003018B0CA37	used	
170	ngxongweni_jss__331-098_003018B0CAA1	used	

171	nkambako_003018B0C8C6	used	
172	nkandla_1_1_003018A00D14	used	
173	nkandla_1_3_003018AB4265	used	
174	nkandla-3-1_003018A467DC	used	
175	nkqilwini_jss__331-079_003018B0CA83	used	
176	ntshongweni_003018B0C932	used	
177	ntshongweni_customer_centre_003018B0C932	used	
178	ntshongweni_primary_003018B0CA36	used	
179	okiep_primary_school_003018A4688A	used	
180	or_tambo_sec_school_003018B0C909	removed	no data
181	orange_farm_mpcc_003018A451E8	used	
182	oranjezicht_high_003018AD9FC2	used	
183	pampier_003018B05838	used	
184	pe_teachers_centre_003018B0C89B	used	
185	phalane_primary_school_1_003018A00D14	used	
186	pniellandgoed_primer_003018A3DD3A	used	
187	port_st_john_sss__331-083_003018B0C79E	used	
188	Port_St_Johns_331-093_003018B0CAFC_	used	
189	puk_campus_003018B0C905	used	
190	qoqisizwe_high_school_003018A46892	used	
191	qoqisizwe_school_003018A46892	used	
192	reti_sec_school_casteel_003018AD9DF5	used	
193	rhodes_public_school_003018B0CA42	removed	no data
194	rietfontein_combined_school_003018A3DD4F	used	
195	roman_catholic_jss_331-054_003018B0CAF8	used	
196	runnymede_003018B0C8BE	used	
197	runnymedenew_003018B0C8BE	used	
198	sango_combined_school_003018B0CB16	removed	no data
199	shoeshoe_ps_003018A00C90	removed	no data
200	sicambeni_jss__331-073_003018B0CA64	used	
201	sinthumule_003018B05861	used	
202	skhosana_sec_school_003018B0CA66	removed	no data
203	skhosana_sec_setlhakwane_331-061_003018B0CA66	used	
204	soshanguve_fablab_003018AD9FC6	used	
205	soshanguve_fablab_1_003018AD9FC6	used	
206	soshanguve_fablab_2_003018A4683A	removed	no data
207	soshanguvefablab_003018B0CA0F	used	
208	soshanguvefablab2_003018A4683A	used	
209	soshanguvefablb2_003018A00D1B	removed	no data
210	sterkspruit_003018B05873	used	
211	strydenburg_combined_school_003018B058BE	used	
212	suncitycarecernter_003018B0C999	used	
213	teboho_ps_003018AB4268	used	
214	thekwini_jss__331-087_003018B0CB18	used	
215	thlakong_5_003018A00C97	removed	no data
216	tjetje_tech_school_003018B0C882	used	
217	tjetje-sehlakwane331-053_003018B0C882	used	
218	tlhakong_2_003018A4687F	used	
219	tlhwahalang_secondary_school_003018A3DD09	used	
220	tombo_jss_port_st_john_331-063_003018B0C843	used	
221	trompie__001E5830CFEF	removed	no data
222	tshilambuvheprimarys_003018B0C928	used	
223	ubuntu_education_fund_003018B0C931	used	
224	umbumbulu_003018B0CAAD	used	
225	valdezia_003018A00D0F	used	
226	valdezia_003018B0590E	used	
227	vezebuhleovccernter_003018B0CAAC	used	
228	victor_poto_sss_331-095_003018B0C8DC	used	
229	vukundlule_jss__331-058_003018B0CB14	used	
230	vulindlela_mthatha_331-090_003018B0C923	used	
231	wozamoya_high_school_003018B0CA36	used	
232	wozamoyaschool_003018B05866	used	
233	zaaiplaas_hp_school_003018B0CA1C	used	
234	zakhele_003018B0CA42	used	
235	zr_mahabane_ps_003018A00D1B	removed	no data

Appendix D: Assignment of applications to general categories

Table D1: General application categories and colour coding

Category	Description	Colour
Edutainment	Games with educational elements incorporated	
Education	Software created purely for educational purposes	
System/DDHomepage	Includes file navigation and DD homepage	
Office	Office suite including word processor, spreadsheet and presentation software	
Reference	Encyclopedia or document reference material	
Games	Software for pure entertainment	
Video/Audio	Audio and video clips and webcam application	

The following tables illustrate the assignment of applications and resources to particular general categories:

Each category is colour-coded according to the colours in Table A2

The following table presents more detailed data for each of the above sites:

Desktop icons:

+-- DD Tutorials

+-- Themba's Journey

+-- What What Quiz Game

Programs menu:

Figure D1: Programs menu

Resources menu (1st two tiers):

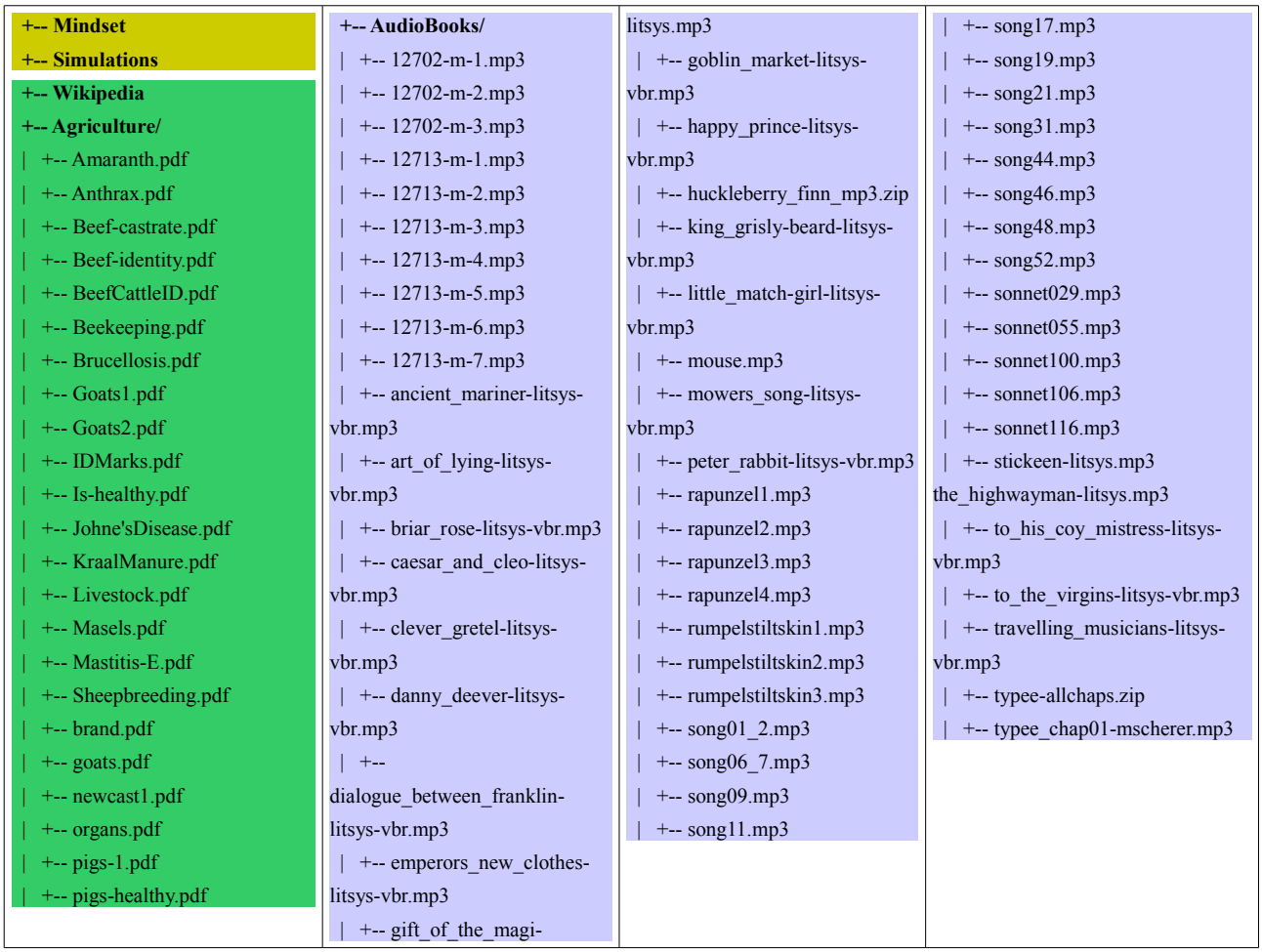

Figure D2: Resources menu

Appendix E: Quantitative data tables

Table E1: General category hit counts

Age code	Ages	Games	Video & audio	DDhome and nav.	Edutainment	Reference	Education	Office suite	Total
Males									
Ac 0	6–9	95	77	21	25	27	44	11	**300**
Ac 1	10–13	1697	994	1087	454	734	600	262	**5828**
Ac 2	14–17	1506	1333	1464	595	1893	701	303	**7795**
Ac 3	18–21	1202	1098	1050	741	809	520	277	**5697**
Ac 4	22–25	684	666	652	223	495	280	144	**3144**
Ac 5	26–60	304	309	292	150	303	195	78	**1632**
Ac99	0–5, 61+	682	335	205	106	192	213	46	**1779**
		6170	**4812**	**4772**	**2294**	**4453**	**2553**	**1121**	**26175**
Females									
Ac 0	6–9	47	25	1	4	5	2	0	**84**
Ac 1	10–13	360	290	132	80	215	117	41	**1235**
Ac 2	14–17	356	223	170	95	475	153	50	**1522**
Ac 3	18–21	191	246	240	39	314	75	40	**1145**
Ac 4	22–25	120	91	79	47	51	36	16	**440**
Ac 5	26–60	100	78	101	22	146	64	19	**530**
Ac99	0–5, 61+	222	108	54	47	57	78	60	**626**
		1396	**1061**	**777**	**334**	**1263**	**525**	**226**	**5582**
Unspecified									
Ac 0	6–9	71	9	11	11	10	7	9	**128**
Ac 1	10–13	990	369	176	235	93	245	124	**2232**
Ac 2	14–17	744	505	409	219	585	294	143	**2899**
Ac 3	18–21	625	493	464	132	337	186	105	**2342**
Ac 4	22–25	115	95	180	44	60	51	15	**560**
Ac 5	26–60	50	41	77	9	103	50	20	**350**
Ac99	0–5, 61+	359	327	306	102	451	256	68	**1869**
		2954	**1839**	**1623**	**752**	**1639**	**1089**	**484**	**10380**
All users (gender independent)									
Ac 0	6–9	213	111	33	40	42	53	20	**512**
Ac 1	10–13	3047	1653	1395	769	1042	962	427	**9295**
Ac 2	14–17	2606	2061	2043	909	2953	1148	496	**12216**
Ac 3	18–21	2018	1837	1754	912	1458	781	422	**9182**
Ac 4	22–25	919	852	911	314	606	367	175	**4144**
Ac 5	26–60	454	428	471	181	552	309	117	**2512**
Ac99	0–5, 61+	1255	770	565	255	700	543	174	**4262**
		10512	**7712**	**7172**	**3380**	**7353**	**4163**	**1831**	**42123**

(GRAPHS AND DATA FROM EXCEL SPREADSHEET RESULTS_AgeCat_Totals_LATEST.ods)

Table E2: General category percentage hits per age group

Age code	Ages	Games	Video & Audio	DDHome & nav.	Edutainment	Reference	Education	Office suite	Total
Males									
Ac 0	6–9	31.7%	25.7%	7.0%	8.3%	9.0%	14.7%	3.7%	100.0%
Ac 1	10–13	29.1%	17.1%	18.6%	7.8%	12.6%	10.3%	4.5%	100.0%
Ac 2	14–17	19.4%	17.2%	18.5%	7.7%	24.4%	9.0%	3.9%	100.0%
Ac 3	18–21	21.2%	19.4%	17.9%	13.1%	14.3%	9.2%	4.9%	100.0%
Ac 4	22–25	22.0%	21.4%	20.0%	7.2%	15.9%	9.0%	4.6%	100.0%
Ac 5	26–60	18.7%	19.0%	17.7%	9.2%	18.6%	12.0%	4.8%	100.0%
Ac99	0–5, 61+	38.4%	18.9%	11.3%	6.0%	10.8%	12.0%	2.6%	100.0%
Females									
Ac 0	6–9	56.0%	29.8%	1.2%	4.8%	6.0%	2.4%	0.0%	100.0%
Ac 1	10–13	29.2%	23.5%	10.6%	6.5%	17.4%	9.5%	3.3%	100.0%
Ac 2	14–17	23.4%	14.7%	11.1%	6.2%	31.2%	10.1%	3.3%	100.0%
Ac 3	18–21	16.7%	21.6%	20.7%	3.4%	27.5%	6.6%	3.5%	100.0%
Ac 4	22–25	27.3%	20.7%	18.0%	10.7%	11.6%	8.2%	3.6%	100.0%
Ac 5	26–60	18.9%	14.7%	19.1%	4.2%	27.5%	12.1%	3.6%	100.0%
Ac99	0–5, 61+	35.5%	17.3%	8.5%	7.5%	9.1%	12.5%	9.6%	100.0%
Unspecified									
Ac 0	6–9	55.5%	7.0%	8.6%	8.6%	7.8%	5.5%	7.0%	100.0%
Ac 1	10–13	44.4%	16.6%	7.8%	10.5%	4.2%	11.0%	5.6%	100.0%
Ac 2	14–17	25.8%	17.5%	13.7%	7.6%	20.3%	10.2%	5.0%	100.0%
Ac 3	18–21	26.7%	21.1%	19.8%	5.6%	14.4%	7.9%	4.5%	100.0%
Ac 4	22–25	20.5%	17.0%	32.1%	7.9%	10.7%	9.1%	2.7%	100.0%
Ac 5	26–60	14.3%	11.7%	22.0%	2.6%	29.4%	14.3%	5.7%	100.0%
Ac99	0–5, 61+	19.2%	17.5%	16.4%	5.5%	24.1%	13.7%	3.6%	100.0%
All users (gender independent)									
Ac 0	6–9	41.6%	21.7%	6.4%	7.8%	8.2%	10.4%	3.9%	100.0%
Ac 1	10–13	32.8%	17.8%	15.0%	8.3%	11.2%	10.4%	4.6%	100.0%
Ac 2	14–17	21.4%	16.9%	16.4%	7.5%	24.3%	9.4%	4.1%	100.0%
Ac 3	18–21	22.1%	20.1%	18.7%	10.0%	16.0%	8.5%	4.6%	100.0%
Ac 4	22–25	22.3%	20.7%	21.5%	7.6%	14.7%	8.9%	4.3%	100.0%
Ac 5	26–60	18.1%	17.1%	18.6%	7.2%	22.0%	12.3%	4.7%	100.0%
Ac99	0–5, 61+	29.5%	18.1%	13.2%	6.0%	16.4%	12.8%	4.1%	100.0%

(GRAPHS AND DATA FROM EXCEL SPREADSHEET RESULTS_AgeCat_Totals_LATEST.ods

Table E3: Cell Chi-square values for age versus application

Age	Application						
Frequency Cell-Chi-Sq. Row percent	**Games**	**Video& audio**	**DDhome**	**Edutain-ment**	**Reference**	**Education**	**Office Suite**
6-9	213	111	33	40	42	53	20
	61.547	3.1681	35.542	0.1219	25.614	0.3324	0.2598
	41.60	21.68	6.45	7.81	8.20	10.35	3.91
10-13	3047	1653	1395	769	1042	962	427
	263.43	1.424	31.816	0.0034	214.61	6.0058	0.9933
	32.78	17.78	15.01	8.27	11.21	10.35	4.59
14-17	2606	2061	2043	909	2953	1148	496
	48.721	13.873	3.7119	9.823	301.89	0.3522	2.81
	21.33	16.87	16.72	7.44	24.17	9.40	4.06
18-21	2018	1827	1754	912	1460	781	422
	22.679	12.849	14.609	31.561	14.502	10.583	1.0364
	22.00	19.91	19.12	9.94	15.91	8.51	4.60
22-25	919	852	911	314	606	367	175
	8.8019	11.419	48.757	2.3116	20.624	2.1683	0.2263
	22.18	20.56	21.98	7.58	14.62	8.86	4.22
26-60	454	428	470	181	552	309	117
	41.732	2.206	2.3041	3.3376	27.67	19.745	0.4559
	18.08	17.05	18.72	7.21	21.98	12.31	4.66
Total	9257	6932	6606	3125	6655	3620	1657

Statistics for Table of age by application

Statistic	DF	Value
Chi-Square	30	1325.6277

Sample Size = 37852

Specific category usage, percentages (per age group)

Percentages are calculated as a percentage of total hit counts per age group. Assignment of specific categories to general categories is indicated in coloured boxes (see legend below figure).

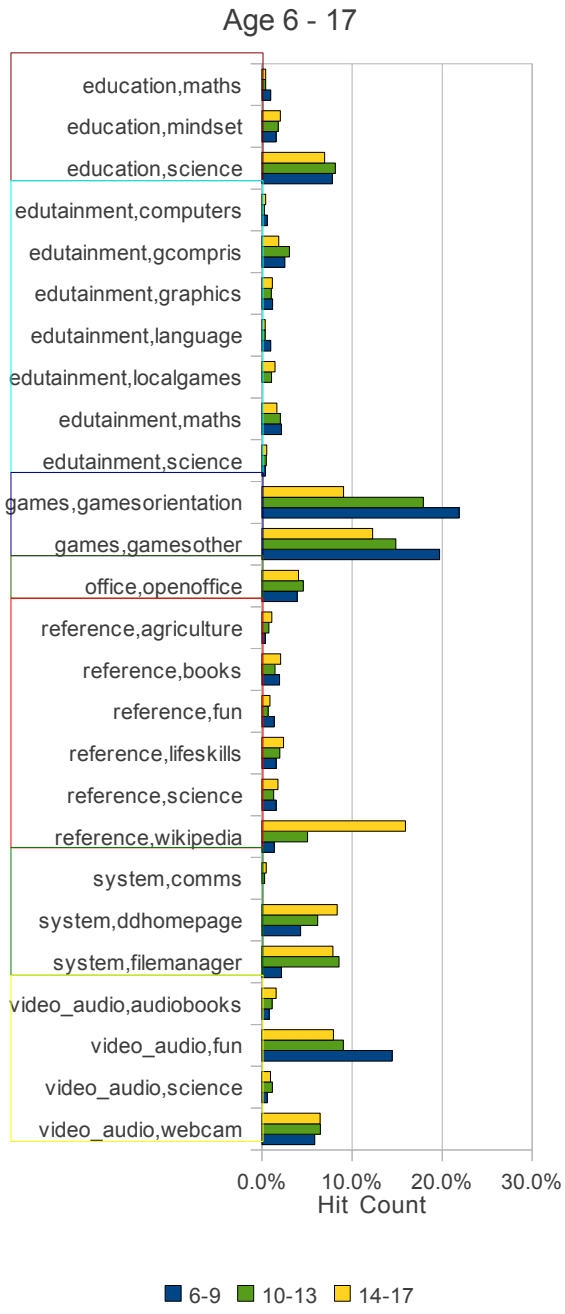

Figure E1: Specific category versus age group 6-17, percentage

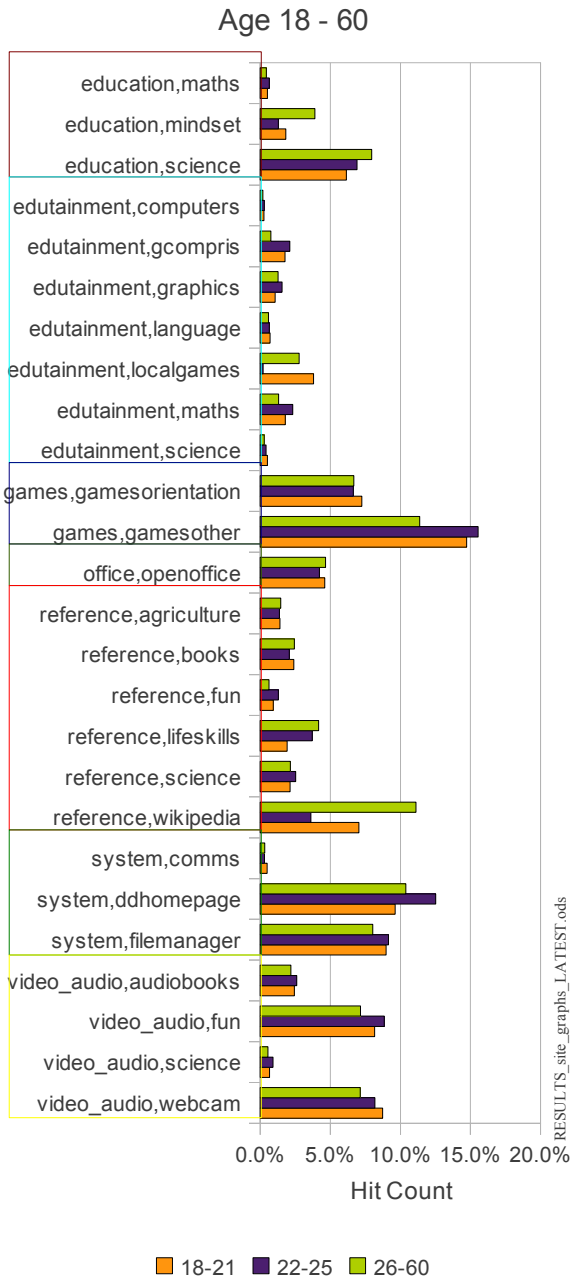

Figure E2: Specific category versus age group 18-60, percentages

General Category – colour legend:

Education **Edutainment** **Games** **Office** **Reference** **System** **Video/Audio**

Specific category usage, actual hit counts

Figures reflect the comparative amount of usage between age groups, as well as the dominant categories of interest. Assignment of specific categories to general categories is indicated in coloured boxes (see legend below figure).

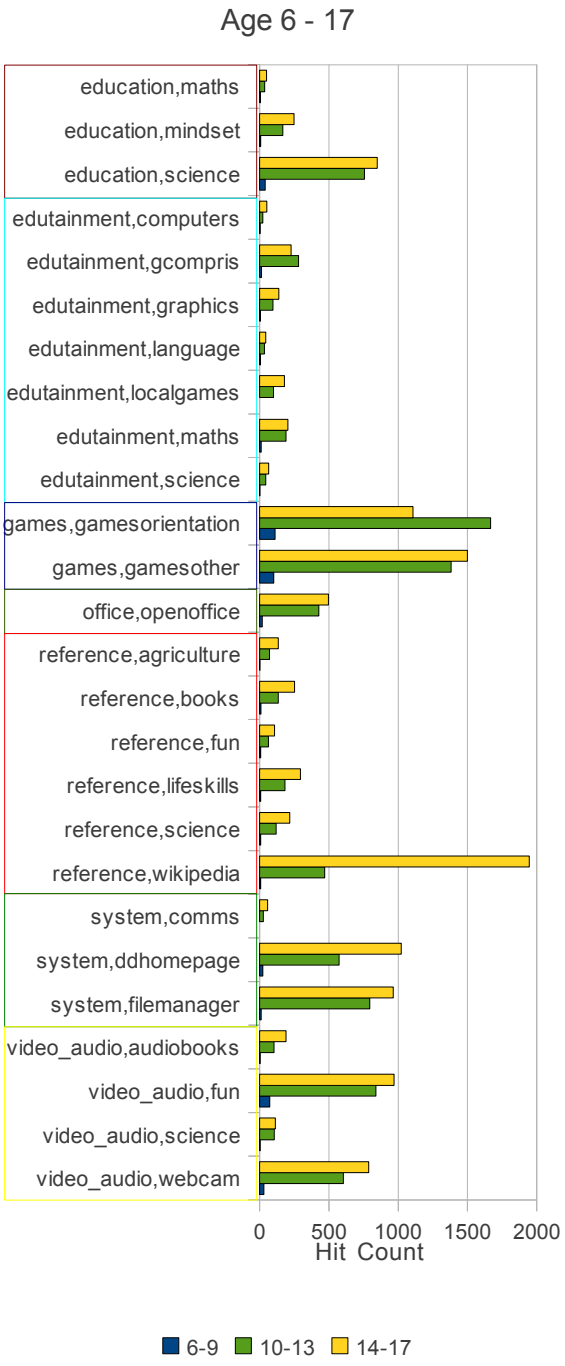

Figure E3: Specific category vs age group 6-17, actual figures

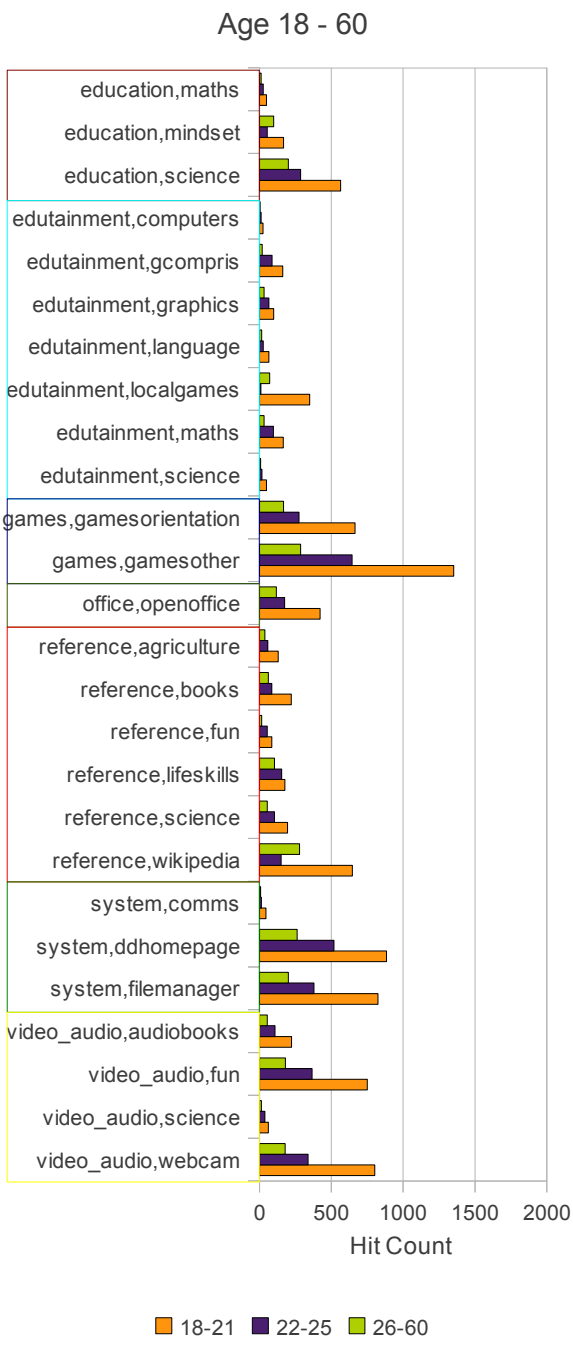

Figure E4: Specific category vs age group 18-60, actual figures.

General Category – colour legend:

Education **Edutainment** **Games** **Office** **Reference** **System** **Video/Audio**

Table E4: Hit-counts and percentages per category, per location

	games	video_audio	system	reference	edutainment	education	office	Total
	No	No	No	No	No	No	No	
Libraries	7454	3936	5863	6972	1699	3088	826	29838
Sec. Schools	4048	4206	2662	1264	1188	1574	539	15481
FETs	9611	5701	4061	2345	1340	1996	1348	26402
Gen. Public	14787	37166	16391	16184	10175	4757	5155	104615
	games	video_audio	system	reference	edutainment	education	office	
	%	%	%	%	%	%	%	
Libraries	24.98%	13.19%	19.65%	23.37%	5.69%	10.35%	2.77%	100%
Sec. Schools	26.15%	27.17%	17.20%	8.16%	7.67%	10.17%	3.48%	100%
FETs	36.40%	21.59%	15.38%	8.88%	5.08%	7.56%	5.11%	100%
Gen. Public	14.13%	35.53%	15.67%	15.47%	9.73%	4.55%	4.93%	100%

results_site_graphs_LATEST2.ods Sheet 5

Table E5: Specific category percentages, per location category

Application Category	Libraries	Sec. Schools	FETs	Gen. Public
edutainment,localgames	0.84%	0.09%	0.00%	3.33%
edutainment,language	0.27%	0.23%	0.36%	0.26%
edutainment,computers	0.37%	0.38%	0.25%	0.21%
system,comms	4.37%	0.45%	0.00%	3.07%
edutainment,science	0.80%	0.78%	0.36%	0.43%
education,maths	0.48%	0.88%	0.54%	0.38%
reference,agriculture	1.17%	0.96%	1.16%	1.21%
video_audio,science	0.80%	0.99%	1.09%	6.83%
reference,books	1.02%	1.05%	1.14%	2.25%
reference,fun	0.80%	1.22%	1.07%	2.57%
reference,wikipedia	14.72%	1.23%	1.22%	3.26%
edutainment,maths	0.51%	1.57%	1.84%	1.63%
education,mindset	1.90%	1.66%	1.02%	0.69%
edutainment,gcompris	1.83%	1.67%	0.84%	2.64%
reference,science	2.47%	1.78%	1.34%	2.65%
reference,lifeskills/health	3.18%	1.92%	2.95%	3.52%
video_audio,audiobooks	1.14%	2.33%	2.34%	6.93%
edutainment,graphics	1.08%	2.95%	1.43%	1.22%
office,openoffice	2.77%	3.48%	5.11%	4.93%
system,filemanager	4.53%	7.13%	6.55%	6.91%
education,science	7.96%	7.62%	6.01%	3.48%
games,orientation	9.49%	7.73%	14.53%	6.95%
system,ddhomepage	10.75%	9.62%	8.83%	5.69%
video_audio,webcam	5.63%	10.70%	8.43%	10.49%
video_audio,fun	5.63%	13.15%	9.73%	11.28%
games,gamesother	15.49%	18.42%	21.87%	7.19%
TOTAL	**100%**	**100%**	**100%**	**100%**

Table E6: Specific category hit-counts, per location category

Application Category	Libraries	Sec. Schools	FETs	Gen. Public
education,maths	144	137	142	399
education,mindset	568	257	268	722
education,science	2376	1180	1586	3636
edutainment,computers	109	59	65	223
edutainment,gcompris	546	259	222	2762
edutainment,graphics	321	456	377	1272
edutainment,language	80	36	95	273
edutainment,localgames	251	14	0	3482
edutainment,maths	152	243	487	1710
edutainment,science	240	121	94	453
games,gamesother	4622	2852	5774	7520
games,orientation	2832	1196	3837	7267
office,openoffice	826	539	1348	5155
reference,agriculture	349	149	306	1266
reference,books	305	162	301	2356
reference,fun	239	189	283	2686
reference,lifeskills/health	949	298	779	3687
reference,science	737	275	354	2776
reference,wikipedia	4393	191	322	3413
system,comms	1303	69	0	3210
system,ddhomepage	3208	1489	2331	5948
system,filemanager	1352	1104	1730	7233
video_audio,audiobooks	339	361	618	7247
video_audio,fun	1679	2035	2569	11798
video_audio,science	239	154	287	7147
video_audio,webcam	1679	1656	2227	10974
TOTAL	**29838**	**15481**	**26402**	**104615**

Table E7: Chi-square calculation table, location versus category

Location	Games	Video_ audio	DDHome	Refer- ence	Edutain- ment	Education	Office	Total
Hit-count Expected Cell-Chi-sq	**No**	**No**	**No**	**No**	**No**	**No**	**No**	
Libraries	7454	3936	5863	6972	1699	3088	826	29838
	6075	8631	4903	4529	2437	1932	1331	
	313	**2554**	**188**	**1318**	**223**	**692**	**192**	5480
Sec. Schools	4048	4206	2662	1264	1188	1574	539	15481
	3152	4478	2544	2350	1264	1002	691	
	255	**17**	**5**	**502**	**5**	**326**	**33**	1142
FETs	9611	5701	4061	2345	1340	1996	1348	26402
	5375	7637	4339	4007	2156	1709	1178	
	3338	**491**	**18**	**690**	**309**	**48**	**25**	4918
Gen. Public	14787	37166	16391	16184	10175	4757	5155	104615
	21298	30262	17191	15879	8544	6772	4668	
	1991	**1575**	**37**	**6**	**311**	**600**	**51**	4570
TOTAL	**35900**	**51009**	**28977**	**26765**	**14402**	**11415**	**7868**	**176336**

Chi-Square calculation:	**16112.00**
DF	18

Appendix F: Consent forms and ethical clearance

INFORMATION LEAFLET AND INFORMED CONSENT

PROJECT TITLE: DIGITAL DOORWAY SOFTWARE USAGE

Primary investigator: Mr K Gush (Researcher, UNISA)
Project supervisor: Prof MR de Villiers

Dear administrator,

You are invited to assist in a research study performed by researchers at the CSIR and UNISA on the Digital Doorway project

WHAT IS THE STUDY ALL ABOUT?

We are conducting interviews with users of the Digital Doorway on how they experience the various software applications on the machine.

YOUR CONSENT

We require your consent on behalf of the users to perform this study on the Digital Doorway. You agree to the study taking place and give permission for users to be interviewed.

*Please note that all participation by users is **completely voluntary**, that participants will remain **anonymous**, and that information they provide will be pooled together and used sole for the study.*

Please also be aware that findings of this study may be published in a dissertation and in academic publications

WHAT ARE THE POTENTIAL BENEFITS THAT MAY COME FROM THE STUDY?

Your participation in this study will help in the continuing improvement of the Digital Doorway software

WILL YOU RECEIVE ANY FINANCIAL COMPENSATION OR INCENTIVE FOR PARTICIPATING IN THE STUDY?

Please note that neither you nor the users participating in the study **will** be paid to participate, and that participation is voluntary.

HOW WILL CONFIDENTIALITY AND ANONYMITY OF USERS BE ENSURED IN THE STUDY?

All the data that users provide during the study will be handled confidentially. This means that access to the data will be strictly limited to the researchers, and the supervisors of the study. No identification of individual users will be linked to any of the data.

WHO CAN YOU CONTACT FOR ADDITIONAL INFORMATION REGARDING THE STUDY?

The primary investigator, Mr K Gush, can be contacted during office hours at Tel (012) 841-**** or on his cellular phone at 084*******.

A FINAL WORD

Your co-operation and participation in the study will be greatly appreciated. Please sign the underneath informed consent if you agree to partake in the study. In such a case, you will receive a copy of the signed informed consent from the researcher.

INFORMED CONSENT

I confirm that I have been adequately informed by the researcher about the nature, conduct, benefits and risks of the study. I have also received, read and understood the above written information. I am aware that the results of the study, will be anonymously processed into a research report. I understand that user participation is voluntary and that they may, at any stage, without prejudice, withdraw their consent and participation in the study.

Administrator's name: _____ (Please print)

Administrator's signature: _____
Date: _____

Researcher's name: _____ (Please print)

Researcher's signature: _____
Date: _____

Participant's name:_____(Please Print)

I _____ the parent / caretaker / legal guardian, give consent for the participant above (or for myself, if over 21) to be interviewed about usage of the Digital Doorway computer terminal

Parent's / Caretaker's / Guardian's signature or Participant's own signature if participants is over 21

_____ *Date:*_____

UNISA | college of science, engineering and technology

Mr K Gush
PO BOX 76026
Lynnwood Ridge

15 July 2010

To whom it may Concern

Permission to conduct MTech Research Project (Ref: 002/KG/2010)

The request for ethical approval for your research project entitled: "Digital Doorways and the analysis of user application usage in 'unassisted learning' environments in impoverished South African communities" refers.

The School of Computing's Research and Ethics Committee has considered the relevant parts of the studies relating to the abovementioned research project and research methodology and is pleased to inform you that ethical clearance is granted for your study as set out in your proposal and application for ethical clearance.

Therefore involved parties may also consider ethics approval as granted. However, the permission granted must not be (mis) construed as constituting an instruction from the SoC's Director or CSET Executive or CSET CREC that sampled interviewees are compelled to take part in the research project. All interviewees retain their individual right to decide whether to participate or not.

We trust that sampling will be undertaken in a manner that is respectful of the rights and integrity of those who volunteer to participate, as stipulated in the UNISA Research Ethics policy. The policy can be found at the following URL:

http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf

Yours sincerely.

Prof S Lubbe
Member: SREC for SoC

Prof L Labuschagne
Director: SoC

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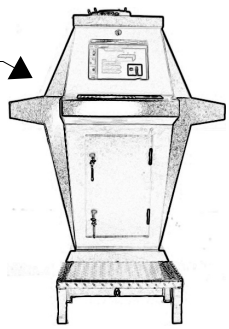
Appendix G: Interview/questionnaire template

DIGITAL DOORWAY QUESTIONS

A digital doorway (DD)



Site name _____

Date _____ Time_____

How old are you? _____ **yrs**	Male / Female? Mark with an ✕ **M ___ / F ____**	What language do you speak at home? _____	What language would you prefer to use on a computer? _____
Do you have access to a computer at home ____ at a friend ____ MPCC/ Internet Cafe ____ School Lab ____			
Is the Digital Doorway useful? _____		What is your favourite Digital Doorway game? _____	
What is your favourite Digital Doorway program (other than games)? _____		**Why** is it your favourite program?	
Please tell us what you like to do on the Digital Doorway: **Play games __ School work/ Reference __ Video/audio __ DD homepage/ file manager __ Educational Programs __ Office programs __**			
How long have you been using the DD?		What time of day do you normally use the DD?	
How many times a week do you normally come here?		How long do you spend per session?	

<table>
<tr><td>Who uses the Digital Doorway the most?

Boys ____ Girls ____ Don't know _____</td><td>Why is this, do you think?</td></tr>
<tr><td>Are there enough programs for girls?

Yes ____ No ____</td><td>Comment:</td></tr>
<tr><td rowspan="2">Do you use the DD

A) on your own ____?

B) together with friends ____?

If (B), what is the typical size of group ____?

C) just watching others ____?</td><td>Do you prefer to learn a computer

on your own _____? with friends _____?</td></tr>
<tr><td>Do you have computer classes at school

Yes____ No___ I'm not at school ____

Do you use Digital Doorway for homework?

Yes_____ No____</td></tr>
<tr><td colspan="2">What other software (programs) would you like on the Digital Doorway?</td></tr>
<tr><td colspan="2">What other information would you like on the Digital Doorway? Information about....</td></tr>
<tr><td colspan="2">What else would you like on a Digital Doorway?</td></tr>
<tr><td colspan="2">Has the DD helped you learn how to use a computer?

Yes ____ No ____</td></tr>
</table>

THANK YOU FOR HELPING US!

Appendix H: Qualitative study data selection

Table H1: Site comparisons: favourite applications and requests

	Gatang	Soshunguve	Emjindini
Favourite games	Cards Don't play games Action Maths/Science game	Cards Don't play games Action Maths/Science game	Cards Don't play games/ unknown Action
Favourite activity	Games Audio and video System and navigation Edutainment Reference Education Office suite	Wikipedia Movies	Powerpoint /excel Resources Celestia Wikipedia Google Games
Why favourite?	Interesting Learn new things Find Information Challenge	Helps research and access to information Gain knowledge and skills	Helps with homework
DD activities	Play games Researching information Learn a computer Watch movies Progress in life Create music	Play games Researched Chat Play with settings Help others	Play games Search Wikipedia Information Movies Play games to relax mind after school wor
App Requests	Maths/Science Internet Windows XP Printing GIS HLT Social Media	Email/Internet News Fablab software (CAD and CAM) Social media Electronics simulators Fashion Drawing Mouse Frequent updates Sound (earphones) 'anything new/interesting' More games	Printer Internet 'I dont know' Movies games Music Java School subjects Take pictures and upload them Chat
Info requests	World Wars 1 and 2; Maths lessons; Jacob Zuma; Bursaries; How children must take care of themselves; Science, so we can explore more; Life science and geography and about life and what is happening; Air pollution and water pollution; Other countries; Information about life on earth; About scientific programs like periodic table; With life science; Global warming; Google information; Weather studies; 'Scientifical careers'; Google search; Information about our school; Biology; Science Matters; Research;	Business; Geographical; Local content; Youth organisations; Our heritage	Other countries; Software programming; Science Careers; Plants Music; Celebrities; Law enforcement; Zulu culture HIV/AIDS; Technology Tourism; Accounting; Mao work; Nature; People; International and national information; Music videos; Language information; Sports; 3d landscape generation tools; Health

Appendix I: Glossary and acronyms

ANOVA – Analysis of Variance
CSIR – Council for Scientific and Industrial Research
DD – Digital Doorway
FET – Further Education and Training
GPRS – General Packet Radio Service, (a cellular data transmission protocol)
HITW – Hole in the Wall
HiWEL – Hole in the Wall Education Limited
ICT – Information and Communication Technology
ICT4D – Information and Communication Technology for Development
MIT – Massachusetts Institute of Technology
MPCC – Multi Purpose Community Centre
NIIT – National Indian Institute of Technology
OLPC – One Laptop per Child
RQ1 to 4 – Research Questions 1 to 4

Shell Script - a text file that contains a sequence of commands for a Unix-based operating system[1]
Ubuntu Linux – A particular distribution of Linux maintained by the Canonical company

[1] *Definitions from:* **http://searchenterpriselinux.techtarget.com/**

Appendix J: Attached CD contents

SPREADSHEETS:

Site_statistics.ods

RESULTS_AgeCat_Totals_LATEST.ods

RESULTS_Hits_AgeGroups_vs_Sites.ods

RESULTS_Specific_category_Hitcounts.ods

Data collated from site visits: Q**ual.ods**

OTHER FILES

Categorised data for all users in selection of 10 quantitative sites: F**inal.txt**

Full list of applications, all sites: A**pplications.txt**