The OLPC XO, Intel Classmate PC and Asus Eee PC user study

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Abstract

Information communication technologies (ICTs) are increasingly considered valuable tools in education, promoting higher cognitive processes and allowing teachers and learners access to a wealth of information. However, these technologies are not easily accessible in developing countries such as South Africa, where a large percentage of the population are poor and are said to live below the breadline. The recent creation of small, low cost and low powered laptops called netbooks, are seen as possible solutions to allow or promote the use and integration of ICTs in education in these disadvantaged communities. This project evaluates the intuitiveness of the OLPC XO, the Intel Classmate and the Asus Eee PC in the context of secondary school education through the use of a user study. The user study involved three teachers and three learners from local secondary schools in Grahamstown. The results of the user study revealed that the teachers and learners (on the whole) felt that the Intel Classmate is the most intuitive netbook for secondary school learners involved in the user study. The presence of the VGA port and the portable nature of the Asus Eee were noted by participants as advantageous. The Asus Eee was also found to be appropriate for secondary school education although it was criticised for its small screen, small keyboard and absence of a webcam. Participants felt that the OLPC XO is less intuitive for secondary school educational purposes and is better suited for small children.

Acknowledgement

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Chapter 1   Introduction

1.1   Background

Information and communication technology (ICT) is the combination of networks, hardware and software as well as a means of communication, collaboration and engagement that enables the processing, management and exchange of data, information and knowledge [Intoweb, 2006]. The use of ICT resources within an educational context is referred to as E-learning (electronic learning). This involves a wide range of technologies including video conferencing, radios, televisions and web based learning. Researchers have shown that when used carefully, ICTs can support effective learning as well as allow learners to be independent [Northern Grid, 2009]. Independent learners are defined as those that know how to use the Internet (which contains a wealth of information) and access the library [Stephenson, 2007].

E-learning has been found to provide easy access to learning material, freedom as well as flexibility to learn when and where you want and at a preferred pace [Learnframe, 2001]. However, there are constraints in developing countries with regards to the implementation of ICT in education mainly because many people are still living below the poverty line and cannot afford access to E-learning technologies [Suliman, Fie, Raman, Alam, 2008]. Several cheap and low power netbooks have been developed and are seen as possible solutions to integrate ICT in education in these disadvantaged communities.

A netbook is defined by Horowitz [2008] as a light weight, cheap, lower powered and web oriented computer. The one laptop per child (OLPC) XO was the first netbook developed and the project was launched by Nicholas Negroponte in 2005 [Laptop Organisation, 2009]. The OLPC project is a non-profit endeavour whose mission is to create education opportunities for the world's poorest children, by providing them with a rugged low cost, low powered, connected laptop with content and software designed for collaborative, self empowering

learning [Laptop Organisation, 2009]. A number of developing countries have been involved in the OLPC project including: Libya, China, Argentina, Brazil, Nigeria, Thailand, Ghana, Rwanda and Nepal. Several alternatives to the OLPC XO laptop are readily available including the Asus Eee; Intel Classmate and Lenovo mini-notebook. Netbooks are gaining popularity world wide and their sales have become the fastest growing sector in computer marketing [Converanet, 2009]. This project seeks to qualify the intuitiveness of the OLPC XO laptop when compared with other similar products readily available on the market (Asus Eee and Intel Classmate) in an educational context.

1.2 Project Goal

The aim of the project is to evaluate the suitability and intuitiveness of OLPC XO, Asus Eee PC and Intel Classmate PC within an educational context for previously disadvantaged learners at a secondary school level. A user study involving local school learners and teachers was conducted to evaluate and compare these netbooks. This assessed the differences and usability of the netbooks as well as the preferences of the learners and teachers for use in the educational context.

1.3 Project Motivation

As a result of an increase in the number of netbooks that are thought to be possible solutions for the integration of ICT into teaching and learning, it is imperative to investigate the intuitiveness of this equipment for the purpose of education. In order for ICT to bring about effective change to education, it should be usable by the targeted market. It is for this reason that I set out to evaluate and compare the usability of three of the available technologies. While it is understood by the researcher that the XO is meant for use by primary school learners, it has been the experience of others that sometimes the intended target market are not the only recipients, thus in this project it was given to secondary school learners to investigate whether it might be suitable.

1.4 Project Structure

The remainder of this thesis is divided into four chapters:

Chapter 2 provides a review of current research literature pertaining to ICT in education. In summary, this chapter attempts to highlight the importance of ICT in education. It is also noted that ICTs are often not accessible to the poor and those in rural areas and I investigate

the measures taken to integrate ICT into education in South Africa. Furthermore, this chapter also examines and compares the three netbooks investigated in this project.

Chapter 3 outlines the design and implementation of the project. A field study was found to be the most suitable research method because it allows detailed and quality information to be obtained from the research study. At the beginning of the user study, questionnaires were used to obtain information about the ICT experience of the participants. Interviews were conducted to gather their views concerning the usability of the netbooks.

Chapter 4 discuss the results obtained from the user study. The views of the participants concerning each netbook are outlined and finally their overall preferences are highlighted.

Chapter 5 concludes the thesis. The goals of the research project are revisited together with the project outcomes. Finally, I discuss possible extensions of this project that could be implemented at a later stage.

Chapter 2　Literature Review

2.1　Introduction

An increasing number of researchers regard education as the route to economic prosperity, the key to scientific and technological advancement, and the means to combat unemployment [Chimombo, 2005]. Education is also viewed by some researchers as a process that is enhanced by engagement with technology and the Internet [School Computing, 2009].

ICT has become one of the crucial building blocks for a better education [Olakulehin, 2007]. When successfully integrated into teaching and learning, ICTs can ensure the meaningful interaction of learners with information. It has also been suggested that ICTs can advance higher order thinking skills including: comprehension, reasoning, problem-solving and innovative thinking [RSA. Department of Education, 2003]. Successful integration of ICTs into teaching and learning has been reported as ensuring that all learners are equipped for full participation in the knowledge society before they leave further education and training (FET) institutions [RSA. Department of Education, 2003].

However, ICTs are often not accessible to the poor and those in rural areas. There are various reasons why the application of ICT in education is problematic in less developed countries [RSA. Parliamentary Office of Science and Technology, 2006], including:

- Lack of appropriate products: Products are often not designed to meet the needs of the poor, or those in remote areas, for example some people face constraints such as limited access to electricity. In 2002, a total of 1.6 billion people worldwide had no access to electricity, 80% of whom were in India and sub-Saharan Africa [Highbeam, 2002];
- Cost: ICTs are costly and the highest proportion of people living in poverty in the world are living in sub-Saharan Africa and can not afford such technology [Department for International Development, 2009];

- Education: Many people do not have the technical skills (such as basic computer literacy) needed to benefit from ICTs even where they are accessible [Mutonyi and Bonny, 2007]; and

- Language: Illiteracy can be a problem when using the Internet. The South African Parliamentary Office of Science and Technology [2006] stated that the Internet predominately contains English-language content while some people in South Africa can not fluently read English.

Due to the problems faced by developing countries, ICT penetration is generally low. This is depicted in Figure 2.1 as presented by the International Telecommunication Union [2007]. The graph details the differences in ICT penetration on different continents. It shows that Africa has the lowest number of people using the Internet and fixed telephone lines. Additionally, there are less mobile subscribers and broadband subscribers in Africa as compared to Europe and America.

Figure 2.1: ICT penetration rate per 100 inhabitants, 2007
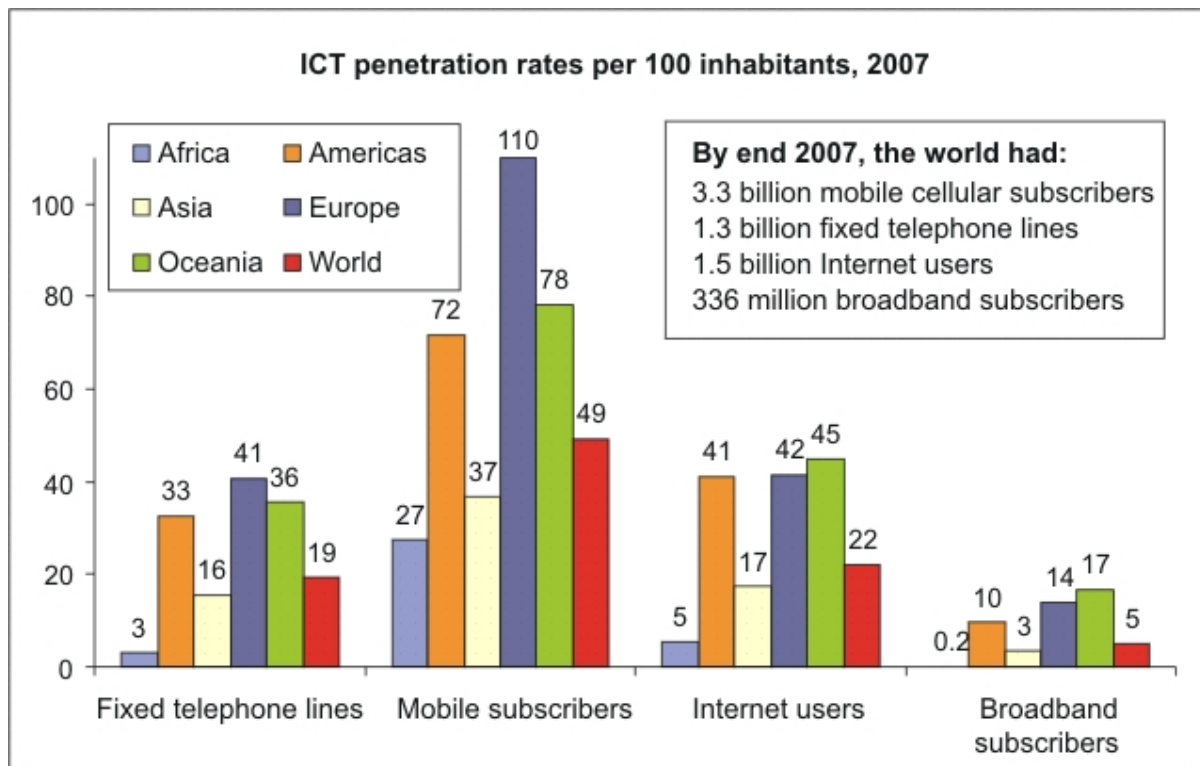
A number of computers have recently been developed to try and address some of the problems faced when attempting to integrate ICTs in education in developing countries, and these include: the Asus Eee PC, the Intel Classmate, the OLPC XO laptop, and the Lenovo

mini-netbook. This project aims to evaluate the usability of the Asus Eee PC, Intel Classmate and OLPC XO laptop within the context of education in previously disadvantaged schools in the Eastern Cape of South Africa.

This chapter is structured into four sections: In Section 2.2, I discuss past research of ICTs in education, specifically focusing on the South African context. Section 2.3 focuses on the types of netbooks under comparison in the research study. To get direction on how to conduct an unbiased, successful survey, a review of literature on user study research methodology is detailed in Section 2.4.

2.2   ICT in Education

ICT has been referred to as an umbrella term that includes applications encompassing: radio; television; cellular phones; computers and network hardware and software; satellite systems; as well as services and applications associated with them, such as videoconferencing and distance learning [Rogers, Berg, Boettcher, Howard, Justice, and Schenk, 2005]. ICT in education is the application of technology within the context of education. This has emerged as a possible solution to problems associated with traditional pedagogies, where teachers are regarded as sources of data. A research group called "The Teacher99" (1999) highlighted out that ICTs can be used in education in various ways, including:

- Computer assisted learning (CAL) which uses a computer to assist in the learning process;
- Engaging in more interactive learning methods like making use of music, videos and pictures;
- Assessing one's knowledge through the use of online tests;
- Using email to communicate and collaborate with others;
- Using the Internet for research;
- Data logging to get more accurate results in experiments;
- Electronic registration of learners; and
- Keeping learners records.

According to the findings from several researchers, ICTs have shown a positive impact in education making people aware of their own learning and motivation to learn [Cordis, 2009]. Sharmar, Nagar and India [2005] also noted that ICT is impacting on all dimensions of life including education, creating a distance-less world where communication is becoming

instantaneous. Maximising the power of ICT will therefore contribute in addressing the issues relating to rural development and poverty.

Schooling is compulsory in South Africa between the ages of seven and fifteen and this contributes in ensuring all children have an opportunity to learn. In addition, South Africa's Bill of Rights ensures that both children and adults have the right to education [RSA. Department of Education, 2008]. The South African e-Education policy aims to ensure that every South African learner in the general and further education and training bands will be ICT capable by 2013 [RSA. Department of Education, 2003].

South Africa has made progress in the integration of ICTs in education. The National Department of Education in South Africa [2003] believes that developments in ICT in South Africa will create access to learning opportunities, restore inequalities and improve the quality of learning and teaching. ICTs can reduce barriers in education by providing expanded opportunities and individualised learning experiences [RSA. Department of Education, 2003]. In addition, former deputy president Phumzile Mlambo-Ngcuka stated on 17 April 2008 in Johannesburg that in order for South Africans to fully capitalise on the potential that ICT holds for education, ICT must be encouraged in schools [Khumalo, 2008].

Provinces in South Africa have different levels of ICT integration in education as depicted by Table 2.1. This is as a result of different development strategies adopted by provincial governments, together with the lingering effects of the past inequalities legislated by the Apartheid regime. Significant progress has been made by some provinces, for example, the Western Cape through the Khanya project. This project is an initiative of the Western Cape Education Department for education and curriculum delivery in the province [Khanya Project, 2008]. It was established in April 2001 to determine the contribution that technology could make towards addressing the increasing shortage of educator capacity in schools. Its objective is to empower every educator in every school of the Western Cape by the start of the 2012 academic year to use appropriate and available technology.

Table 2.1: South African schools with computers at provincial level in 2002
[RSA. Department OF Education, 2003]

Province	% computers for teaching and learning
Eastern Cape	4.5
Free State	12.6
Gauteng	45.4
KwaZulu-Natal	10.4
Mpumalanga	12.4
Northern Cape	43.3
Limpopo	4.9
North West	22.9
Western Cape	56.8

The Gauteng Online project was launched by the Gauteng Department of Education in 2001 [Ramon, 2007]. It is a technology access programme in schools in the Gauteng province. The programme's access model involves establishing a computer laboratory with 25 work stations, Internet and e-mail access, to be used for curriculum delivery. The main goals of the programme are to:

- Contribute towards building the human resources capacity of the province and the country through the provision of quality education;
- Contribute towards stimulating positive economic activity in the country through the creation of a strong local ICT industry that has a capacity for ICT development and innovation;
- Enhance the efficacy of government for improved service delivery and a better life for all;
- Position the province at the cutting edge of change through technological innovation; and
- Bridge the digital divide.

The Connectivity Project in Northern Cape was launched by the former Premier of the Northern Cape, Dipuo Peters on the 5th of May 2005 [I4donline, 2009]. The project is an MTN Foundation initiative that creates multimedia centres in rural and disadvantaged schools

throughout the country. By 2005, more than 10 schools in Northern Cape benefited from this project.

Despite some extreme variations, schools in Gauteng, Northern Cape and Western Cape have, on average, a better ICT infrastructure than schools in the Eastern Cape and Limpopo. Schools in Free State, KwaZulu-Natal, Mpumalanga and North West hold a middle position.

Additionally, the Internet Service Providers' Association of South Africa (ISPA) is also conducting a series of computer literacy training courses in several South African provinces including: Free State, Limpopo, North West, KwaZulu Natal and Mpumalanga [Pambazuka, 2008]. This is aimed at boosting the practical knowledge of educators in different schools.

There was an overall increase in Internet access in South Africa in recent years as shown in Table 2.2. However, in the last three years there has been a dramatic slowdown in Internet access growth in South Africa as also depicted in Table 2.2. Research by ICT Africa in 2009 found that 15% of households in South Africa have working computers, while only 5% of them have access to an Internet connection [Kreutzer, 2009]. A survey involving 500 secondary school learners from less privileged communities in Cape Town, South Africa reported an intensive use of cell phones in place of inaccessible technologies such as desktop computers. They also indicated that they access the Internet via their phones for information, communication and games [Kreutzer, 2009].

Table 2.2: Percentage of people using the Internet in South Africa according to the Internet World Stats [2008], since the year 2000

Year	% of people using Internet
2000	5.5
2001	6.2
2002	6.8
2003	7.1
2004	7.4
2005	7.4
2008	10.5

Like many other developing countries, South Africa is also facing challenges integrating ICTs into education. Some of these challenges include:

- Electricity shortages: 30% of the people in South Africa have no access to electricity [Mbendi, 2008];

- Poverty: In 2006 the human poverty index was 22.6% [UNDP, 2008];

- Language: Approximately five million people in South Africa are totally illiterate [RSA. Parliamentary Office of Science and Technology, 2006]. This means that these people have difficulty with use of ICT as it is predominately English-based;

- Inaccessible Internet : 72.7% of Americans in 2009 used the Internet, however only 12% of South Africans have access to and use the Internet [Internet World Stats, 2008]; and

- Digital Divide: Bickner [2006] describes the digital divide as the gap between people with effective access to digital and information technology and those with very limited or no access at all. Martindale [2002] found that South Africa has one of the greatest divisions between rich and poor in the world, and that this divide is most evident in the technology context.

Figure 2.2: Gini Coefficient [Wikipedia, 2008]
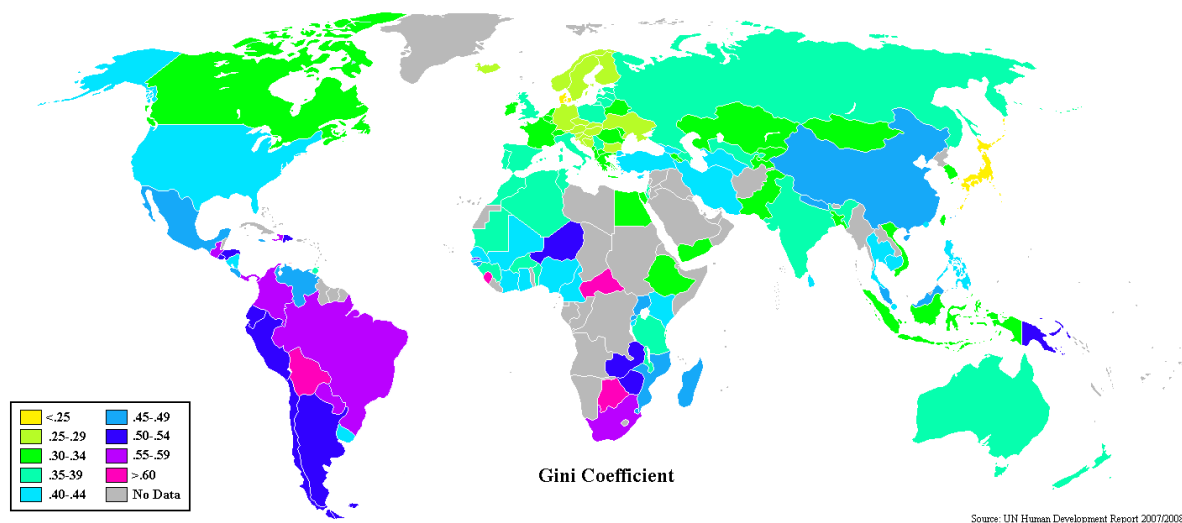
The Gini Coefficient is used to measure inequality within countries. It varies between 0, which reflects complete equality and 1, which indicates complete inequality. In South Africa it is 0.578 and is depicted in Figure 2.2 [Human Developments Report, 2008]. Socio-economic circumstances, imbalanced education policies under the Apartheid regime, as well as language barriers, are some of the factors recognised in this exclusion. Within South Africa, these imbalances are demonstrated even further when we consider the differences in ICT penetration at provincial level as depicted in Table 2.1. The table shows that there is greater ICT penetration in some provinces like the Western Cape and Gauteng. The Eastern

Cape Province and Limpopo have much fewer ICT resources for teaching and learning than other provinces.

A possible viable technological alternative for the poor are the newly developed netbooks which are very competitively priced. These are thought to be solutions to the failures of integrating ICT in developing countries, such as poverty and limited electric power. Three laptops are under evaluation in this project, these netbooks also happen to be some of the devices that Computer Aid International [2009] identified as least costly and less power intensive in their investigation of appropriate computer solutions for rural settings in developing countries.

2.3   Netbook computers

Bergervin [2008] defines netbook computers as small laptops that are designed for wireless communication and access to the Internet. Additionally, Horowitz [2008] says that they are a new type of laptop computer, distinguished from other laptops by their small size, low price and low power consumption. They are believed to be of potential value to the education of the less privileged, which have limited electricity and money and are in need of a quality education. It is for this reason that this research project evaluates their intuitiveness in the educational context.

2.3.1   Asus Eee PC 701w

The Asus Eee PC 701w was first released in 2007 and is well known for its light weight, solid-state drive and relatively low cost [Linuxlinks, 2008]. The newer models have added the option of a Windows XP operating system and traditional hard disk drives. The newer models are more expensive. According to Asus, the name Eee stands for: "Easy to learn, Easy to work, Easy to play".

This netbook has a display area of $140.8cm^2$ that uses an active matrix LCD which does not fill the top panel. Its keyboard is 48.1% of the normal keyboard and the keys, including the delete and return keys are small. The Eee PC has a Celeron M 900 MHz processor but it usually clocks at 630MHz. It also has got a 512KB L2-cache. This netbook has a power input interface; an RJ-45 LAN port (10/100 Mbit) for wired connectivity; 802.11 b/g wireless network interface; three USB ports which are compatible with both USB 1.1 and USB 2.0 devices; a 3.5mm microphone jack; and a headphone jack. Because this netbook is targeted at children, the manufacturers thought that this type of netbook will be vulnerable to knocks and

drops, and is supplied with a 4GB solid state drive (SSD). This netbook was purchased for R2200 and has no camera, as was promised [Linuxlinks, 2008].

2.3.2   Intel Classmate

This netbook is described by Intel as an effective personal learning device for primary school learners in emerging markets. It was developed specifically to enhance teaching and learning [Intel, 2008]. They are said to be rugged, affordable and child-friendly netbooks [Intel, 2008].

This netbook has a display area of $224.25cm^2$. It has a 1600MHz Intel Celeron Mobile processor but it usually clocks at 800MHz. it also has got 1000MB RAM and typically, 2GB Flash storage but some are also sold with standard laptop hard disks. The classmate used in this study has a 60GB hard disk as no solid state models could be sourced at the time in South Africa. The Intel Classmate also has 2 USB ports and a RJ-45 LAN port (10/100 Mbit) for wired connectivity and an 802.11 b/g wireless network interface. The Intel Classmate has a unique cycle touch pad with left and right buttons. The outside cover of this netbook is much thicker, with more plastic bumpers to keep internal components safe from damage if dropped by users [Ackerman, 2007]. Some models of this netbook have a dual mode capability in that they can operate in a tablet mode and a traditional laptop mode. When opened like a traditional laptop, the screen swivels 180 degrees and it allows group work [Classmate PC, 2009]. The models we were able to source for this project did not have these two capabilities and only operate in a traditional laptop mode. This netbook also comes with a built in webcam.

2.3.3 OLPC XO

The one laptop per child (OLPC) foundation is a non profit organisation launched by Nicholas Negroponte in 2005 [Laptop Organisation, 2009]. The founders hoped that it would advance education in the developing world. The OLPC foundation describes the XO as a powerful learning tool designed and built especially for children in developing countries, living in some of the most remote environments [Laptop Organisation, 2009]. Negroponte's idea was influenced by the work of Seymour Papert and others who believed that computers are uniquely able to encourage children in "learning learning" and also provides a platform for children to teach themselves and instil a personal commitment to lifelong learning [Stern, 2007].

The netbook's interface uses Sugar, an open source software environment. The XO has built-in wireless and a unique screen that is readable under direct sunlight for children who go to school outdoors. The screen "swivels" around, allowing the computer to operate as either a tablet or e-book, energy-efficient, and fun [Laptop Organisation, 2009]. It has a carry handle and a liquid-crystal a display area of 175cm^2 which has a dual-mode thin file transistor liquid crystal. Users can switch between colour and black-and-white viewing modes to save energy. The XO has a 1 gigabyte flash drive. It has integrated WiFi, video camera, microphone, three USB ports and speakers. The integrated colour video camera has a resolution of 640 x 480. The CPU clock speed is 433 MHz. The XO laptops can form a mesh network; XO computers in the same neighbourhood can connect and share contents and collaborate on activities.

2.3.4 Comparison of Netbooks

Table 2.3 provides a mostly hardware comparison of the OLPC XO, Intel Classmate and Asus Eee PC according to Wikipedia [2009]. The images of the netbooks are also shown in Figure 2.3.

Figure 2.3: Netbooks under evaluation in this research project. From left: Asus Eee, OLPC XO and Intel Classmate

Comparative studies of netbooks carried out by Computer Aid International [2009] rank the Asus Eee PC netbook as a better choice for emerging economies. In their research, they analysed which one was best-equipped for use in developing countries. It is said to offer an ideal compromise between power consumption, performance and portability in both Linux and Windows-equipped versions [Computer Aid International, 2009]. The same study revealed that the Intel classmate was the least preferred solution due to its higher power consumption and low battery life as compared to Asus Eee [Computer Aid International, 2009].

OLPC XO has been touted by some as the solution to Africa's technology problems. Research conducted by Computer Aid International [2009] ranked it best in terms of power consumption. However, it was the slowest of all tested systems, and the operating system didn't include office applications. Technologists have pointed out that the XO is mainly for children and not for teachers interested in computerizing all aspects of a school's operations. Performance analysis conducted by the Computer Aid International group was based on:

- Start up time;
- Time to start the web browser;
- Time taken to use the word processor; and
- Time taken to copy a file.

In this research study, I hope to achieve an in-depth comparison of the three netbooks with possible recommendations regarding their use in educational environments. An evaluation of the intuitiveness of these three netbook will be done through the inclusion of a user study, to evaluate whether the products meet the needs of the users in an educational environment.

Table 2.3: Comparison of the OLPC XO, Intel Classmate and Asus Eee PC
[Wikipedia, 2009]. I also took some measurements myself

Model	Asus Eee PC 701	Intel Classmate	OLPC XO
Manufacturer	Asus	Intel	Quanta Computer
Weight in kg	0.92	1.5	1.45
Area of Display screen in cm^2	140.8	224.25	175.95
Processor	Intel Celeron-M	Intel Atom	AMD Geode LX-700
Processor Speed in MHz	900	1600	433
Storage type	SSD	hard disk	NAND flash
Storage size in GB	4	60	1
RAM in MB	512	1000	250
Battery life in hours	2:45	3:25	2:45
Keyboard size as a % of a standard keyboard	48.1%	46%	46.5%
Operating system	Edubuntu Linux	Linux Edubuntu or Windows XP (we used Edubuntu Linux)	Red Hat Fedora
Connectivity	10/100M Ethernet WLAN 802.11b/g/n	10/100M Ethernet WLAN 802.11b/g/n WLAN with antenna, fMesh support (Linux only)	Integrated 802.11b/g (2.4GHz) interface; Mesh 802.11s networking supported
South African price	~ R2200	~R3200	~R3000 (if it were available

2.4   User Studies

Kujala [2002] defines a user study as "a practical approach to user involvements for gathering user needs and requirements". An increasing number of researchers agree on the understanding that user studies are, by definition, about people, behaviour and contexts [Banwell and Coulson, 2004]. They need both quantitative and qualitative approaches to be applied for quality and detailed results.

2.4.1 User study rationale

This project involves a user study used to assess the user's preference and opinions with regard to the netbooks. Kujala [2002] states that user studies contribute in identifying user requirements. User requirements are functions, constraints and properties that must be provided to satisfy the user needs. Similarly, Rogers, Sharp and Preece [2007] view user studies as an evaluation to check whether users can use the product and what they like about it. Users want interactive products to be easy to learn, effective, efficient, and safe to use. In addition, entertaining, attractive, challenging and enjoyable systems are of critical importance. Nielsen (2009) argues that usability refers to how well users can use a system's functionality and includes:

Learnability: this is evaluating how well the netbook supports both initial orientation and deeper learning. Jordan, Draper, MacFarane and McNulty [1991], define computer learnability as the amount of time and effort needed to reach a user peak level of performance with the system.

Memorability: this evaluates how easy it is to remember what you learned about the computer. Rogers, Sharp and Preece [2007] argue that a computer interface should be easy to remember such that a casual user is able to return to the system after some time has passed, and use it again with no difficulties.

Effectiveness: is accuracy and completeness with which users achieve specified goals.

Efficiency: is the speed in which users accurately complete their task.

Safety: this is how safe it is to use the product. Health and safety risks exist for both adults and children when using computers. It is argued that computers should not be seen as toys but as items of electrical equipment to be treated with respect [Rospa, 2009].

2.4.2 Approaches to user studies

There are different approaches employed in user studies namely: usability testing, field studies and analytic evaluation.

Usability testing: Usability testing is argued by Rogers et al. [2007] as a scenario where the test environment is controlled by the evaluator. Here, the usability of the product is of greatest concern and the users of the product do not under go any testing to evaluate their preferences. This approach makes use of controlled experiments. Data collection is mainly through interviews and the speed taken by the user to complete a task is usually of significant importance.

Field studies: Field studies are performed in a natural setting, allowing participants to naturally interact with the system. This approach is different from usability testing in that it follows the way people normally interact with the system. Data is collected through observing and interviewing users as depicted by Table 2.4. The advantages of this approach are that researchers get a better sense and more information from the research study [Rogers, Sharp and Preece, 2007]. Questionnaires and interviews are conducted in effective field studies.

Analytic evaluation: Analytic evaluation on the other hand includes use of heuristic evaluation and prediction of user performance. These are normally conducted where users are not easily accessible and experts have to do the evaluation of the system. This method can be very costly. Table 2.4 shows the various tools used by each method.

Table 2.4: Methods used by different user study approaches [UWA, 2007]

Method	Usability testing	Field studies	Analytical
Observing	x	x	
Asking users	x	x	
Asking experts		x	x
Testing	x		
Modelling			x

2.5   Summary

This chapter has described past research that has been undertaken in the field of ICTs in education. It has illustrated the importance of the integration of ICTs in education in

developing countries. There seems to be a relationship between people's level of development and their education, and it is hoped that access to facilities like ICTs in education will make significant contributions in the development of poor countries. Various types of netbooks have been developed to address some of the problems faced by the less privileged especially in the field of ICTs in education. This project seeks to examine the value of netbooks within an educational context through the use of a user study. In the chapter that follows, I will describe the research methodology and implementation carried out in order to assess the value of the netbooks in an educational environment.

Chapter 3   Research Design and Implementation

3.1   Introduction

The manner in which research is designed and implemented is vital as it impacts on the outcome of the project. Research design is the structure of the research and describes how different activities were employed to address the central research questions [Trochim, 2006]. The research implementation describes the procedures which were carried out in the field of study.

This chapter provides a detailed description of the research design and its implementation and is structured into four sections. Section 3.2 describes the research design while Section 3.3 discusses the implementation of the design of the project. The summary of the chapter is found in Section 3.4.

3.2   Research Design

As discussed in the Chapter 2, there are several approaches to user studies. With heuristic approaches, the researcher predicts the performance of system users. Controlled experiments manage the environment of the participants and keep it under predetermined settings. Field studies have been shown to allow natural interaction of participants with the system under evaluation [Rogers, Sharp and Preece, 2007].

In this section, arguments are made about the approach used for conducting this user study. Information is provided about the equipment used in the project, participating schools, participants as well as the ethics governing this user study.

3.2.1 Equipment

The Asus Eee and the Intel Classmate were supplied by the Telkom Centre of Excellence (COE) in the Department of Computer Science at Rhodes University. The OLPC XO was loaned to the COE by one of the OLPC developers in Cape Town, South Africa. For a

feasible comparison, Asus Eee and the Intel Classmate were installed with identical Edubuntu netbook remix images. The OLPC XO however comes with custom operation system and software.

3.2.2 Methodology

It was decided that a field study was the most suitable research method for this project because it allows researchers to get more information from the research study [Rogers, Sharp and Preece, 2007]. A field study is defined by Rogers et al. [2007] as typically used to investigate how people interact with a product in their everyday lives. Nielsen [2002] views field studies as one of the most valuable methods for setting a design project's direction and discovering unmet user needs. They are however considered messy in that activities often overlap and are usually interrupted [Rogers et al, 2007]. Questionnaires and interviews are major components of field studies and are used for data collection.

A questionnaire is a research tool containing questions with the purpose of collecting answers from the participant [Bouma, 2002]. Open format questions are those that ask for unprompted opinions with no predetermined set of responses and participants can answer freely. Open format questions work best when the range of responses is not clearly defined. These types of questions have been found to be true reflectors of respondents' opinions. They increase the likelihood of the researcher receiving unexpected and insightful suggestions [Griffith**,** Cook, Guyatt, Charles, 1999**].**

Closed format questions on the other hand usually take the form of multiple-choice questions and are regarded as easy and fast for the respondent. The following should be considered when constructing closed format questionnaires:

- The possible responses should be mutually exclusive [Stasko, 1997]. The questions and prepared responses should be neutral and not biased;
- The writing style should be conversational, straight to the point and suitable for the target audience [Stasko, 1997]; and
- Categories to choose from should be distinct because respondents should not find their answers in more than one category.

The advantage of this type of questionnaire is that it avoids getting vague and incomplete responses from the respondents [Bouma, 2002 and Griffith**,** Cook, Guyatt, Charles, 1999**].**

However, closed format questions can result in biased responses due to the suggestions by the investigator [Schuman and Presser, 1979].

There are several things to consider prior to constructing a questionnaire. Bouma [2002] argues that it is necessary for the interviewer to understand the reason why the data should be collected with a questionnaire. It is imperative to have clarity of the research questions before a questionnaire is constructed. In the construction of the questionnaire, the researcher is supposed to clarify exactly what the question requires and also ask questions relevant to the research [Bouma, 2002]. The researcher should avoid asking personal and informal questions and abbreviations should also be explained or avoided. Very long questionnaires might end up irritating the participants and wasting their time. The disadvantage of using questionnaires is that they depend on the honesty of the respondents.

Interviews can either be quantitative or qualitative. In a quantitative interview, the interviewee creates statistical models when explaining what is observed. Qualitative interviews on the other hand are a complete, detailed description of observations [Nell, 2007]. Kvale [2007] defines qualitative interviews as efforts to understand the world from the interviewee's point of view and to disclose the sense of people's experiences.

There are various features of qualitative interviews. Qualitative interviews are supposed to be theme oriented, without a theme it is difficult to limit the conversation [Kvale, 2007]. Bouma [2000] also pointed out that clearly focused interviews produce better results and are less disruptive. Such types of interviews should be descriptive, the interviewer should allow the participants to describe their observations as precisely as possible. Similarly to the questionnaires, the use of jargon should be limited in interviews as interviewees may not understand the terminology [Nielsen, 2002].

It is necessary for the interviewer to have an understanding of the research topic for quality information to be obtained from the interview. Awareness of each other's emotions should be taken into consideration when an interview is being conducted to avoid provoking one another. Interviewees are capable of giving ambiguous answers and it is up to the researcher to seek clarity for the answers. Researchers should be aware of the fact that during the course of the interview, the interviewees' understanding of the research topic might change and as a result change their responses.

3.2.3   Sites

The Grahamstown district in the Eastern Cape of South Africa was chosen as the research site because of its proximity to Rhodes University where the researcher is studying. Three previously disadvantaged government schools took part in this study. For anonymity, schools will be referred to as: school A, school B and school C.

School A was started in 1940 by the Education Department of Rhodes University and is a Former House of Representative (FHOR) (coloured learners only) school. It was established to offer a Junior Certificate course to young coloured pupils from Grahamstown as well as training for student teachers at Rhodes University. This school started with 16 pupils who used one of the town halls as a classroom. It has one computer laboratory with 20 Pentium 4 computers and a WiFi (802.11g) Internet connection.

School B was established in 1983 by the government to serve one of the communities in Grahamstown. Before this school was established, the villagers used to travel long distances to School C for secondary education. It is a Former Department of Education and Training (FDET) (black learners only) school. There is one computer laboratory with 30 Pentium 4 Computers and a WiFi Internet connection to this school.

School C was established in 1938 as the first high school to serve the residents of one of the villages in Grahamstown. School C is also a Former Department of Education and Training (FDET) school and it was established as a solution to the absence of local secondary schools for the villagers. The Methodist church built the first classroom and the first teacher taught all six of the subjects which were offered when the school opened. School C has one computer lab with 23 Pentium 4 and Pentium 2 computers. The computers have a DSL Internet connection.

3.2.4   Participants

One teacher and one learner per participating school were invited to take part in the user study, with six participants in total. The participating teachers were chosen by their school principals based on their commitment and interest in the research. The teachers in turn chose the learners they wanted to work with, concentrating on responsible learners from the school.

Teacher A is a grade 11 and 12 accounting teacher at school A with 5 years of teaching experience and teaches classes with an average number of 32 learners. Teacher A knows how

to use both laptops and desktop computers. He uses a computer every day and is familiar with quite a number of operating systems including Windows XP and Edubuntu Linux. Learner A is a grade 12 learner from school A, she is doing science subjects including mathematics, biology, accounting and physics. When she completes school, she would like to enrol at Rhodes University for a law degree. This learner was familiar with both laptops and desktop computers and uses a computer at least once a day. At the beginning of the research project, this learner could only use the Windows XP operating system.

Teacher B is a grade 10 and 11 business studies teacher at school B. She has 10 years of teaching experience and conducts classes with an average number of 35 learners. This teacher uses a computer once a week on average and at the beginning of the research project she had only used a desktop computer. She however knew how to use both Windows XP and Edubuntu Linux. Learner B is a grade 11 learner at School B and is doing science based subjects including physics and mathematics. This learner is undecided about his future study paths. Though he was familiar with using both the Windows XP operating and Edubuntu Linux, he had only used desktop computers prior to this project.

Teacher C, from school C, has more than 25 years of teaching experience and teaches geography. The average geography class consist of 32 learners. This teacher knew how to use both laptops and desktop computers. She uses a computer at least once a day. She also knew how to use both Windows XP and Edubuntu Linux. Learner C is a grade 11 learner at school C and is also doing mostly science based subjects including physics and mathematics. He would like to study engineering after secondary school. This learner knew how to use both desktop and laptop computers. He was familiar with Windows XP and Windows 98 operating systems and used computers once a month on average.

3.2.5 Ethics

Ethics are moral principles governing the way user studies are conducted. Ethical considerations in a user study are important because user studies deal with people and people have emotions and feelings [Bouma, 2000]. Ignorance of ethical issues involved in a research project not only affects the results of the research but also jeopardises future research studies. Bouma [2000] noted that a researcher should be mindful of the needs and feelings of participants. People participating in a research study do so freely giving their time and it is important to respect their time and effort that they put into the research project. Sieber [1992] also pointed out that ethical researchers create a respectful relationship with the research

participants. A researcher can avoid wasting participants' time by making preparations before going out for research meetings and also by being on time for appointments [Bouma, 2000]. Clearly focused interviews and questionnaires also avoid disruption and time wasting. Bouma [2000] states that research sometimes invades the privacy of participants, it is therefore necessary to keep personal details of participants anonymous in such cases. Researchers should avoid embarrassing and annoying participants.

Good researchers seek permission from the people to be involved in the study [Bouma, 2000]. In institutions like schools it is essential to seek permission from school authorities and parents if the participant is a minor. Consent forms are signed by both the participants and guardians as an agreement of involvement in the research project while clearly stating that participants can pull out of the project at any stage. It is good practise to tell the participants why the research is being conducted. However, it is not appropriate to tell them the results that you expect to get as this might lead to biased responses. Researchers should maximise the benefits obtained from the results and avoid risk and harm to the participants [Sieber, 1992]. Bouma [2000] also noted that the potential benefits of a research study must outweigh the potential harm to participants.

3.3   Implementation

Several procedures were followed in conducting the user study. Pre-intervention measures were conducted before the user study to ensure that enough information was obtained about the participants. Actions were taken to guarantee that appropriate authorisation was obtained to carry out the field study. Post-intervention practices were conducted after the participants had spent two weeks with each netbook. This section discusses the procedures that were followed in conducting the user study.

3.3.1 Pre-intervention practice

Approval was obtained from Rhodes University to carry out the user study, a copy of this can be found on the accompanying CD-ROM and in Appendix A, while a list of the documents on the CD-ROM is detailed in the Appendix I. After suitable schools were identified, letters were sent to the principals seeking permission to carry out the user study in their schools (example is in Appendix B while specifics are on the CD-ROM). The letters also informed the principals of the aim of this research project and how it was intended to be carried out. After school principals consented to their schools being participative in the project, they were asked to nominate teachers and learners to participate in the user study. All the learners who

participated were minors therefore their parents also had to sign the consent forms (Appendix C). The consent forms were used as agreements to participate in the research. By signing the consent forms participants were acknowledging their understanding of:

- The purpose of the research and involvement in it;
- They could withdraw from the project at any stage;
- Participation in the project was voluntary;
- The netbooks were to be returned to the researcher at the end of the study; and
- Participant's personal details would be kept anonymous.

Pre-intervention questionnaires (Appendix D and E) were distributed to participants to obtain information about their computer literacy and their views about ICTs in education. This information was used to strengthen the analysis of results and in some cases to inform the post-intervention interviews. The learners' questionnaires were slightly different from those of the teachers' questionnaires.

Learner's questionnaire sought to illuminate the following:

- Which computer technologies they have used before and how often they use it;
- Whether they own a computer;
- Whether they have computers at school and how often they use them for learning;
- Whether the school computers have Internet access; and
- Whether their teachers use computers for teaching and how they think using computers can affect their learning.

Teachers' questionnaire sought to illuminate the following:

- Which computer technologies they have used before and how often they use it;
- Whether they own a computer;
- Whether they have computers at school;
- Whether the school computers have Internet access;
- What they think would be the impact of learners having their own computers; and
- How they would get their learners to use computers for learning.

When the participants had completed the questionnaires, the transcripts were typed into Microsoft Word and stored for use at the analysis stage of the project.

3.3.2 Procedure during the user study

The netbooks were distributed to the participants who were given two weeks to spend with each type of netbook. Due to delivery delays of the Intel Classmate netbook, participants from School B started the user study later than the others. Table 3.1 shows the order in which netbooks were distributed to the participants. Every time the participants were given a new netbook, the researcher spent time demonstrating how to use the device. Guiding notes were also provided to the participants to help them use the netbook (examples can be found in Appendix F and G). During the user study, the researcher was also available for answering questions posed by the participants concerning the use of netbooks.

Table 3.1: The order in which the participants received the netbooks

School	1+2	3+4	5+6	7+8
A	OLPC XO	Intel Classmate	Asus Eee	
B		Asus Eee	OLPC XO	Intel Classmate
C	Asus Eee	OLPC XO	Intel Classmate	

3.3.3 Post-intervention Practise

At the end of two weeks, interviews of an average duration of 15 minutes were conducted with the participants, allowing them to draw out their experience with the netbook (example can be found in Appendix H). An HP Compaq nx9010 laptop, SoundCraft Compact 4 Mixing Desk and two 130^{0}_ Shure Microphones were used for recording the interviews. Sound files were then compressed to MP3 format using Audacity. Microsoft Word was used to transcribe the recorded interview.

The questions asked during the interviews of both teachers and learners included the following:

- Their overall impression of the netbook;
- What they found interesting about the netbook;
- What features hindered using the netbook;
- How they think the netbook can be improved;
- How they used the netbook for teaching or learning;

- Whether they found the usability of the netbook different from that of a traditional laptop;

- How long it took them to get used to using the netbook;

- Whether they would buy the netbook if they had the money; and

- Whether the teachers would recommend their learners buy the netbook.

Three interviews were conducted with each participant. In the last interview the participants compared the usability of the all the netbooks and expressed their opinions regarding which laptop they would buy for learning and teaching purposes.

3.4   Summary

This chapter has discussed the design and implementation of the user study. Post and pre-intervention practices that were carried out in the user study together with the ethical measures employed have been outlined. The analysis of the results obtained from the user study is discussed in Chapter 4. Chapter 4 highlights the views of the participants concerning each netbook's intuitiveness in the educational context and details the overall preference of the participants.

Chapter 4   Findings

4.1   Introduction

This chapter presents the views of the participants pertaining to the use of the three netbooks under investigation in this research project. The factors discussed by the participants are gleaned from the pre-intervention questionnaire and post-intervention interviews. There are no responses from Teacher A for the Asus Eee and Intel classmate netbooks because he withdrew from the research project for personal reasons.

The opinion of the teachers and learners concerning each netbook are presented in different sections. Section 4.2 discusses the OLPC XO; Section 4.3 focuses on the Intel classmate; Section 4.4 covers the Asus Eee; Section 4.5 discusses the overall preference of the participants and Section 4.6 summarises the chapter.

4.2   OLPC XO

Use in learning/teaching: Although four participants said that they could not use the OLPC XO for any educational purposes, Learner C found it useful. He mainly used it for collaboration over the Mesh network by sharing the Internet as well as chatting with his friends. Learner C also found the speak activity intriguing and used it to learn how to pronounce words in different languages. However, the other two learners did not find it easy to use this netbook. When Learner B was asked whether he had used the netbook for learning, he responded by saying:

"*Yes I tried but it does not help me, it showed me some little toys and I just got bored.*"

Teacher C used the XO to access the Internet to do research for the topics she was teaching.

Usability: Both learners and teachers were reluctant to use the OLPC XO, they had the impression that the netbook was for primary school children (which it is technically aimed at). Overall, the participants' comments indicated that the OLPC was not an easy netbook to

become familiar with. Only Learner C felt confident in using the netbook within a day and the others mentioned that they struggled when trying to use it. Learner B stated that he did not get used to it and eventually gave it to his little sister. Teacher C commented on the usability saying:

"*The first two hours were frustrating but I really wanted to push on and find out its usefulness.*"

Similarly, Teacher A, although he had been using laptops for several years, mentioned that he struggled to do even the simplest of tasks with the OLPC XO. He said:

"*I do not consider myself to be a beginner with regards to computers, I know how to navigate myself around computer systems but with XO for myself I had to battle to do simple things.*"

Buying and recommending others buy the netbook: None of the participants showed interest in buying the OLPC XO. Instead, they said that they would recommend it for young children because they felt that the OLPC is not suitable for secondary school learners. Teacher C mentioned that she would not recommend it to the learners saying:

"*I would not recommend it for secondary school children. Maybe the primary school teachers would recommend it for their learners.*"

Learner B also noted that he would not buy it but would recommend it for his little sister, he said:

"*I would recommend it for my little one, the last born.*"

Advantages: Despite the challenges that the participants came across when trying to use the OLPC XO, there are several benefits that they highlighted. The **F1, F2, F3,** and **F4** buttons that are used to access the views made it easy for participants to use the netbook. Rotating the screen 180 degrees so it falls down onto the keyboard and turns the netbook into an eBook seemed to be of particular interest to participants. Teacher A said:

"*I enjoyed the fact that it is compact and the few buttons that you need to press to bring it to the home page you know it also has got the facility were the screen can be turned 360 degrees, I found that very interesting.*"

Participants from School C liked the numerous collaborative activities that could be shared with other OLPC XO users, Teacher C said:

"*I found the webcam interesting in a way and that you can use it for chatting and for seeing some person's image but I did not have much time to practise that.*"

A similar comment was made by Learner C:

"*And also the one were you can chat with some one else without using the Internet. That one was very interesting.*"

Four participants found the webcam and the games available on the OLPC interesting. Teacher A said:

"*I was happy that it had a webcam, it is not a very good quality webcam though.*"

Participants commented that the OLPC XO is rugged and could endure being dropped. The speak activity was also appealing to Learner C.

Disadvantages: While the OLPC netbook was found to have a number of interesting features, a lot of shortcomings were identified by the participants. The first impression that Teacher C and Learner A had when they saw the netbook was that it is a toy. This was because of the unique appearance, Learner A said:

"*It is not really good enough for me honestly, it is a little too like a kindergarten toy for a small child but I like it a lot.*"

Teacher C highlighted the same thing saying:

"*The first impression is, to me I felt that it is targeted to young children, the primary age, the big X and the colours.*"

The most commonly mentioned problem with the netbook was that the cursor appeared to "get stuck" and this hampered interaction with the netbook. Although the researcher demonstrated how to resolve the problem to the participants, they felt that it was discouraging and frustrating. The low processor speed was also mentioned as one of the disadvantages, Learner C said:

"I found that it was a little bit slower accessing something and the mouse as well got stuck and froze."

The comments about the slow speed of this netbook when compared with the other netbooks were expected as the processor speed of the OLPC XO is half that of the Asus Eee and a third of the Intel Classmate (Table 2.3). Some participants found it difficult to move from one activity to another and to locate some of the devices like the memory stick. Saving documents to a memory stick was not an easy task for some of the participants to accomplish. Teacher A commented on the usability of the netbook saying:

"What I found is that it is not very easy laptop to navigate from one field to another and from one screen to another and the thing that I was really disappointed in is the usage in teaching and learning, its not very friendly in terms of being able to save, it took me a very long time to try to find how I can actually save something from a laptop itself to a flash stick."

It was also noted that the battery life was too short and required frequent recharging. This acted as an obstacle to the mobility of the netbook. As a result of these shortcomings, this netbook was not used by four of the participants for any educational purposes during the study.

4.3   Intel Classmate

Use in learning: Of the three netbooks, the Intel classmate was the most often used netbook by all of the participants. Both the teachers and the learners used it for educational purposes. The learners used the netbook for searching on the Internet and writing their school projects and essays. When Learner A was asked if she used the netbook for learning, she responded by saying:

"Yes I wrote my essays on it and I put it on a flash stick and printed it."

Likewise, Learner B responded saying:

"Yes I did my science project using the laptop. I typed in my assignments as well."

This netbook was used for preparing tests and assignments by the teachers. Teacher C mentioned that if the netbook had had a VGA port, she would have used it with a projector to conduct lessons. Teacher B who had not used a laptop at the beginning of the project seemed

to have enjoyed using the Intel classmate and when asked whether she used the netbook for teaching purposes she said:

"*Umm I used it to do my work. Like I did my tests, I typed the assignments. Everything that should go to my file and some of the assignments that should be given, like the last assignment that should be given like the research project, I did type it there.*"

Usability: It was interesting to note how quickly the participants became familiar with using the Intel classmate netbook. All the participants commented that it took an average of a day to become comfortable using the netbook. When Learner C was asked how long it took him to become familiar with using the netbook, he responded saying:

"*Not even long, it took me a second.*"

A similar response was obtained from Learner A, she said:

"*Not long, couple of minutes or so.*"

Buying and recommending others buy the netbook: All the learners showed an interest in this netbook, they pointed out that if they had money they would buy it. Teacher B seemed interested in buying the netbook for her own use although Teacher C mentioned that she would not like to have it for her own use because it had no VGA port for a projector to be connected. The teachers said that they would definitely approve the netbook to their learners. Teacher C said:

"*Umm, this Intel classmate, if you ask me to recommend it for students, it becomes number one.*"

Advantages: Participants commented on the many benefits of the Intel classmate. Participants considered it as suitable for all ages. Learner A stated that:

"*It is the best thing. I enjoyed it. It is more suitable for all ages especially the programs.*"

The handle made it easy for the learners to carry the netbook even without satchels. The screen of the Intel classmate is bigger than the other laptops and this was seen as an advantage by the participants. They also found it easier to type on the keyboard when compared with the other netbooks because it is bigger than the other netbooks they used. The games were also mentioned as one of the interesting features of the Intel classmate (however

the Intel classmate and Asus Eee had the same games because they had the same operating system). Teacher C also mentioned that the netbook looked durable and is therefore suitable for learners.

As an overall view of the netbook, Learner C said:

"The laptop is just great. It was love at first sight. It is just beautiful and attractive. The features it has are just what you want to work with."

Disadvantages: However, there were a few drawbacks associated with the Intel classmate that the participants highlighted. The absence of a CD drive was noted to be a disadvantage to the people without memory sticks. Learner A pointed out that it is always important to have alternatives when it comes to saving documents. Teacher C mentioned that if the netbook had a VGA port it would be more useful for conducting lessons. Learners A and B could not play movies because the software lacked the necessary drivers for the movie players. This is however a software oversight and not a disadvantage of the hardware of the netbook and thus could be resolved by downloading the plugins required. This was of great concern to learners because they wanted to use the netbook for entertainment after completing school tasks. The teachers commented that Edubuntu Linux had a strange spell checker and it kept underlining correctly spelt words

4.4   Asus Eee

Use in learning/ teaching: Although the participants found the Asus Eee similar to the Intel classmate, it was surprising to note that most of them did not use this netbook as much as they did the Intel classmate. Learner C used the netbook to search the Internet in preparation for the exams and the other learners only used it for playing games. Teacher C used the netbook in preparation for her lessons and she also connected it to a projector and used it for presentations in class. Teacher B did not use the netbook for any teaching purpose but only played games with it.

Usability: The participants did not struggle to get used to the netbook. On average, it took them 2 days to become familiar with the applications on the netbook. When asked how long it took her to get used to using the netbook, Teacher B said:

"It was a matter of a day."

Buying and recommending others buy the netbook: The Asus received different reviews from participants. Learners B and C stated that if they had money they would definitely buy the Asus Eee while Learner A said that she would not buy it. Teacher B said that she would buy the Asus for her child and not for herself. Interest was expressed by Teacher C and she made the following comment about her overall impression of the netbook:

"Its lovely, the minute I saw it and before I even used it I liked it straight away. Its handy, its portable, its light and I think it is the way to go. I remember telling you that when they come to the market I intend to buy one for my self."

The portable nature of the Asus Eee was liked by Teacher C and she mentioned that she would buy it as a Christmas present, saying:

"Definitely I would buy it. I saw it in one of the shops in PE and the price is attractive, R3000 so far. I am sure as time goes by it will come down."

Both Teacher B and Teacher C recommended the Asus Eee as a possible laptop for learners in schools. Teacher C however pointed out that the learners have disadvantaged backgrounds and they might not be able to afford the netbook.

Advantages: Participants felt that this netbook was user friendly. Learner B and Learner C described the netbook as easy to understand and unsophisticated. Both the teachers and learners found the games interesting. The participants loved the fact that it has most features of a normal laptop and they liked the numerous USB ports and the VGA port. The VGA port made it possible for Teacher C to use the netbook for conducting lessons. Learner C liked the portability of the netbook and he said:

"Yes I think so it is very small, I like it. You can take it where ever you want and you can put it where ever."

Disadvantages: The small screen was highlighted by several participants as a shortcoming of the netbook. Teacher C stated that:

"Okay the screen area, the speakers occupies the screen area. Maybe the speakers should find another space so that the screen could occupy the whole area."

Teacher C also pointed out that it is too small and susceptible to being dropped especially when it is used by learners. Teachers highlighted that for adults with bigger fingers, the keyboard is difficult to type on. Teacher B commented that some of the games would not open when tried. Again some participants commented on the inability to play movies because the software lacked the necessary drivers for the movie players (as mentioned previously, this was a software problem that could be resolved by downloading the required plugins).

4.5   Overall Preference and Analysis

Overall, the Intel classmate was chosen as the most favourable netbook by the participants. Four participants (Learners A, B and C as well as Teacher B) said that they would prefer the Intel classmate over the other netbooks. Learner B said that the Intel classmate is more suitable for all ages. Participants found the Intel classmate faster and nicer because it did not "*freeze*" like the OLPC XO. Again, this was not surprising considering the hardware comparison in Table 2.3, where it can clearly be seen that the clock speed of the CPU of the OLPC XO is approximately half that of the Asus Eee PC and a third of the Intel Classmate PC. Learners also liked the webcam and the games on the Intel classmate (as mentioned before, the games are the same as those in the Asus Eee). When asked to rate the netbooks, Learner C mentioned that the Intel classmate was the best, followed by the Asus Eee and then the OLPC.

The Asus Eee was not the first preference of the learners because of the absence of a webcam; the small screen and the small keyboard. Teacher C on the other hand pointed out that she would prefer the Asus Eee because of the presence of the VGA port and its portability, she commented saying:

"*Compared to the Asus, my first choice is the Asus for my personal use as a teacher. Then for the students the Intel Classmate is the best.*"

Teacher C had recommended the Asus Eee to the learners before she saw the Intel classmate. At the end of the user study, she then decided that the Intel classmate would be more suitable for the learners because it is easy to carry around.

The OLPC did not make a good impression on all the participants because they felt that it is for younger children and is too slow. Teacher C mentioned that the unique software of the OLPC XO made it difficult to use.

Several research studies have been conducted with netbooks. The Computer Aid International investigated the most suitable netbook for developing countries based on their performance and power consumption. Overall, the Asus Eee was found to be the best of the four netbooks (Intel Classmate, Asus Eee, OLPC XO and Inveneo) [Computer Aid International, 2009]. The Asus Eee was selected as the most suitable netbook because it offered the best compromise between power consumption, performance and portability. A different result was obtained in this research project because it was concerned with the usability and intuitiveness of netbooks for teachers and learners in the South African eduction system. Table 4.1 shows the summary of the results from this user study. It is important to note that the results are possibly affected by limited questionnaire responses from participants and the withdrawal of one teacher.

Table 4.1: Summary of the user study results

Netbooks	OLPC XO	Intel Classmate	Asus Eee
Advantages	Carrying handle; webcam	Fast speed; bigger screen and keyboard; easy to use; webcam; carrying handle.	VGA port; portability
Disadvantages	"The cursor gets stuck"; slow speed; it looks like a children toy.	Absence of VGA port	No webcam; small screen display and keyboard
Usability	With difficult	With ease	With ease
Preference of learners	third	first	second
Preference of teachers	third	First and second	First and second
Recommendations	Primary school learners	Secondary school learners and teachers	Secondary school learners and teachers

The OLPC had a poor reception from the participants due to a feeling that it is for younger learners. This was expected as it was primarily targeted to small children. It is essential to note that the government should not place the OLPC XO in secondary schools. The unconventional interface could be challenging to primary school children hence further investigation is needed.

4.6   Summary

This chapter discussed the results of the user study which intended to investigate the usability of the three netbooks. Learners found the Intel classmate most favourable. Teacher B also found the Intel classmate best for teaching purposes while Teacher C preferred the Asus Eee because of its portability and the presence of the VGA port.

In Chapter 5, conclusions about the usability of the netbooks will be drawn based on these results. The goal of the research project is revisited to highlight whether the objective of the research study was met. Possible extensions of the project are also discussed.

Chapter 5   Conclusion

5.1   Summary

In Chapter 2, ICT in education was discussed. This revealed that there are challenges to developing countries wishing to integrate the use of ICTs in education due to poverty and a lack of resources. I undertook a review of netbooks which are seen as potential solutions to the limited ICT penetration in developing countries. In addition, a comparison of the physical properties as well as the operating system running on them was discussed. Chapter 3 discussed the implementation and design of the project. It explained the steps that were taken in conducting the user study including the ethics that were observed. The views of the participants concerning the usability of netbooks in an educational context are presented in Chapter 4 as well as their overall preferences.

This chapter discusses the outcome of the research project based on the results obtained from the user study. Section 5.3 revisits the goal of the research project, highlighting whether the objective of the research study was met. There are possible extensions to this project that could be conducted in future and are discussed in Section 5.4.

5.2   Project Outcome

The results of the user study highlighted that the Intel Classmate is the most intuitive netbook for secondary school learners involved in this user study. This was indicated by the interest from the learners for this netbook. The teachers also recommended the learners buy this netbook. Participants felt that it was easy to familiarise themselves with the Intel Classmate. The larger screen display and keyboard of the Intel Classmate were mentioned as one of the things that made it more usable and fun than the other netbooks. The participants seemed to appreciate the webcam and the carry handle was advantageous to learners because they could carry it without satchels. The Intel Classmate was assessed as suitable for teaching. However, the absence of a VGA port limited its use in teaching because it could not be used together with a data projector for classroom presentations or demonstrations.

Participants also found the Asus Eee suitable for secondary school learners although the first preference of learners was the Intel Classmate. The Asus Eee was criticised by the participants for its small screen, small keyboard and absence of a webcam. However, one participant (Teacher C) found it suitable for teaching purposes because of the presence of a VGA port and its portable nature.

Participants found the OLPC XO the least intuitive for secondary school educational purposes. They felt that this netbook is better suited for small children. None of the participants were interested in buying this netbook and the teachers did not recommend the learners buy it. Arguably, this recommendation would extend to the South African Department of Education with regards to secondary school learners. Some difficulties expressed by users were that the cursor got "stuck" and participants found it difficult to familiarise themselves with the operating system interface. The first impression of the participants when they saw the OLPC was that it was a children's toy and they were reluctant to use it.

5.3 Project Goal Revisited

The aim of the project was to attain a detailed comparison of the three netbooks with possible recommendations regarding their use in educational environments. This was achieved through a literature review of the technologies together with a user study. The literature review yielded comparative data regarding hardware (mostly) and software of each netbook. While a user study conducted at three schools with one teacher and learner from each, yielded user experiences and comments regarding each netbook's usefulness and intuitiveness in an educational setting. Participants found that the Intel classmate netbook was the most suited of the three to their needs.

5.4 Possible Project Extensions

A project could be carried out at a much larger scale to access the impact of ICT on education using netbooks. This could help resolve whether an investment in netbooks for educational purposes might be an avenue that government and private organizations wish to follow. This investigation would help determine whether expensive and heavy laptops and desktop computers can be replaced by the inexpensive and portable netbooks in schools. This could potentially be beneficial to previously disadvantaged schools with insufficient funds to invest in ICTs.

The participants recommended the OLPC XO for the primary school children. The OLPC organisation also targets this netbook to younger children [Harris, 2007]. Thus, another possible extension of the project would be to investigate the intuitiveness of this netbook in primary education. This could be conducted with the local primary schools in the Grahamstown area.

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Appendix A Approval from Rhodes University

This is a copy of the first page of the ethical standards research protocol from Rhodes University. As can be seen on this page, this study was approved by the Departmental Human Research Ethics Committee on the 24th of June 2009. A copy of this is on the accompanying CD-ROM as "Ethics Committee Approval".

CS

Tracking No:

RHODES UNIVERSITY

ETHICAL STANDARDS : RESEARCH PROTOCOL

Any project in which humans or animals are the subject of research requires completion of this form and submission, for approval, to the appropriate DEPARTMENTAL HUMAN RESEARCH ETHICS COMMITTEE or, where such committee does not exist or cannot unanimously approve the research protocol, to the University's ETHICAL STANDARDS COMMITTEE.

TITLE OF RESEARCH:

Initiating Department:

		Day	Mo	Yr
DEPARTMENTAL HUMAN RESEARCH ETHICS COMMITTEE REVIEW	Submitted	23	06	09
	Approved	24	06	09

Authorized by: _____ * CARO WATKINS
(Chairperson; Departmental Human Research Ethics Committee)

		Day	Mo	Yr
UNIVERSITY ETHICAL STANDARDS COMMITTEE REVIEW	Submitted			
	Approved			

Authorized by: _____ (Chairperson; Ethical Standards Committee)

1. **GENERAL PARTICULARS**

(i)   Name of Principal International Investigator/Researcher
AND/OR
        Name of Principal National Investigator/Researcher:
AND/OR
        Name of Principal Local Investigator/Researcher: CONSTANCE SIBANDA
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                GRAHAMSTOWN
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Revised Application Form: November, 2008

Appendix B Letter to the Principals

This is part of the letter sent to the principals seeking permission to conduct a user study at their school. It explained to the principals the aim of the user study and how I intended to conduct it. A complete letter is on the accompanying CD-ROM as "Letter to Principals".

REF: PERMISION TO CONDUCT RESEARCH AT YOUR SCHOOL

Constance Sibanda (under the supervision of Hannah Thinyane and Ingrid Siebörger) is a computer science post graduate student (honours level) at Rhodes University and is carrying out a research project to evaluate small form factor laptops (called netbooks). The aim of the project is to compare the usability and intuitiveness of different types of netbooks for teachers and learners. The study hopes to achieve a detailed comparison of these laptops with possible recommendations regarding their use in education.

It is hoped that three schools participate in this project. From each school, one teacher and one student will be involved. Three different types of laptops will be circulated amongst the participants with each one having a two week encounter with each type of laptop. The user study will include:

- A pre intervention questionnaire to gauge participants ICT proficiency
- Observations will be carried out through out the project to assess the usability and intuitiveness of the laptops. This will also allow me to field any questions that participants might have.
- A post intervention interview will be conducted to provide an opportunity for the participants to voice their opinions of the laptops.

The duration of the user study is going to be six weeks. During the user study period, both teachers and learners will be allowed to take the laptops home, it is therefore our request that should you allow your school to participate, we will look to you for guidance in choosing responsible participants from your school. Unfortunately, at the end of the research study, laptops need to be returned to the university. Further negotiations regarding appropriate times or participants can be discussed on my first visit to the school.

Findings of this research will hopefully contribute to improving education in South Africa. Thank you for your time and I hope that you will find my requests favourable. Any further queries can be addressed to one of the following people:

Appendix C Consent Form

The consent forms were signed by learners and teachers as an agreement to participate in the research. By signing the consent forms participants were acknowledging their understanding of the terms of the user study. A copy of the consent form is available on the accompanying CD-ROM as "Consent Form". For anonymity, the completed forms have not been included on the CD, but are available at the Computer Science Department on request.

Project Title   One Laptop per Child XO, Asus EEE and Intel Classmate User Study

Researchers   Ms Constance Sibanda, Mrs Ingrid Siebörger, Dr. Hannah Thinyane

- I have received information about this research project.

- I understand the purpose of the research project and my involvement in it.

- I understand that I may withdraw from the research project at any stage.

- I understand that participation in this user study is done on a voluntary basis.

- I understand that at the end of the user study, I will have to return the netbooks to the researchers.

- To the best of my knowledge I have no physical impediments that will stop me from completing this study.

- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.

Name of participant

....

Signed   **Date**

....

I have provided information about the research to the research participant and believe that he/she understands what is involved

Researcher's signature and date   ....

Appendix D Teachers' Questionnaire

This is a portion of the teachers' questionnaire, a complete copy can be found on the accompanying CD-ROM as "Teachers Questionnaire". For anonymity, the completed forms have not been included on the accompanying CD-ROM, but are viewable at the Computer Science Department on request.

Section A

1. Please tick the technologies listed below that you have used before

    ☐ Traditional desktop computer (PC)

    ☐ Laptop

2. How often do you use a computer / laptop?

    ☐ At least once per **day**   ☐ At least once per **week**

    ☐ At least once per **month**   ☐ Less than once per **month**

    ☐ Not at all

3. What do you believe are the effects of using computers / laptops in the classroom environment

    ☐ Using computers can improve my basic ICT skills

    ☐ Using computers can enhance my effectiveness in the classroom

    ☐ Using computers can increase my productivity

    ☐ Using computers makes no difference to my teaching

Please explain your selections

4. Is there any need for your learners to have access to computers for their learning and why?

5. Select the answer that correspond to your learners current usage of computers in the classroom

    ☐ Learners use computer class time primarily to complete school work set for them

    ☐ My learners use the school computers to improve their basic skills

    ☐ Learners use the school computers to understand better what I am teaching them with the aid of the Internet, electronic libraries and CDs

Appendix E Learners' Questionnaire

This is a portion of the learners' questionnaire, a complete copy of the questionnaire can be found on the accompanying CD-ROM as "Learners Questionnaire". For anonymity, the completed forms have not been included on the accompanying CD-ROM, but are viewable at the Computer Science Department on request.

Section A

1. Please tick the technologies listed below that you have used before

   ☐ Traditional desktop computer (PC)

   ☐ Laptop

2. Do you have computers at school?

   ☐ Yes   ☐ No

3. If you answered **yes** to the previous question, where are the computers located?

   ☐ Classroom   ☐ Computer lab

   ☐ Library   ☐ Other: _____

4. Are the school computers connected to the Internet?

   ☐ Yes   ☐ No

5. How often do you use a computer / laptop?

   ☐ At least once per **day**   ☐ At least once per **week**

   ☐ At least once per **month**   ☐ Less than once per **month**

   ☐ Not at all

Appendix F Guidelines on how to use OLPC XO

This is a portion of the guidelines that were given to the participants to help them use the OLPC XO netbook, a complete copy of the document is found on the accompanying CD-ROM as "OLPC XO guidelines".

Getting started with the XO

Switch on the laptop by pressing the power button at the lower right corner of the laptop. After the laptop has completed booting, you will be presented with the view called **home** that lets you switch between **Activities by** clicking on the appropriate activity icons. Along the top of the screen you can access **Neighbourhood view**, **Group view**, **Home view**, and **Activity view** which are shown in the image bellow. You can see these icons by moving the mouse pointer up into the top left hand corner of the screen.

You can also press the **F1, F2, F3, and F4 respectively** on the keyboard to access the views.
Neighbourhood view - will show your available networks (mesh and wireless) and other XO laptops users. This allows you to share activities with people using other XO netbooks
Group view - This shows your local network of friends using XO netbooks
Home view - allows you to switch between activities. When you click on an Activity's icon, it will initialize. Once the Activity is running, you will be placed into its Activity View.
Activity view- takes you to the running activity view.

Connecting to the wireless network

For Internet access you have to be connected to the wireless network. Follow the following steps for wireless network connection;

- Go to neighbourhood view. Wireless access points are represented by circles
- Enter the name of the network you wish to connect to in the search field or move the pointer around network access circles until you recognise the name of the network that you want
- Click the circle of the network that you want to be connected to
- Enter the wireless key if prompted

Appendix G Guidelines on how to use Asus and Intel

This is a portion of the guidelines that were provided to the participants to help them use the Asus Eee and Intel Classmate netbooks, a complete copy of the document cab be found in the accompanying CD-ROM as "Asus and Intel guidelines".

Getting started with the Asus Eee and Intel Classmate

Switch on the laptop by pressing the power button of the laptop. After the laptop has completed booting, you will be presented with a login screen where you type in your username and password. When you press enter, you will be presented with the desktop. On the left hand side of the desktop are **applications**. When you click on any applications a menu appears at the center of the desktop giving you the option to choose different applications that fall under that type.

Getting Help

Go to the applications   ⟹ Go to Accessories ⟹ Help

This will get you to Ubuntu help center. This is where you get information about how to use the various aspects of the Edubuntu interface. The information includes adding and removing software and connecting to a network.

Connecting to the wireless network

To connect to the wireless network, follow the steps below;

- Click on the NetworkManager icon on the top right hand side of the desktop
- Click the radio button next to the network you want to connect to
- If you have connected to the network previously, you will automatically be connected to the network if it is available
- If you are connecting to the network for the first time, a dialog box will open and this allows you to enter security details
- Select the security type
- Enter the key, password and other authentication details
- Click **Connect**

Appendix H Interview questions

When participants had spent two weeks with a netbook, interviews were conducted allowing them to draw out their experience with that particular netbook. A complete copy of the interview schedule can be found on the accompanying CD-ROM as "Interview questions".

1. What was your overall impression of the laptop? Please give reasons for your impression.
2. If you found it interesting, state the things that you found interesting and why.
3. What do you think should be added to the laptop to make it more interesting or to improve upon it and why.
4. Did you use the laptop for learning or teaching?
5. Explain how you used it.
6. Did you find the usability of the laptop different from the traditional one for learning or teaching? Explain your answer.
7. How long did it take you to get used to using the laptop? Explain your answer.
8. Which of the laptops features helped or hindered you complete task? Explain your answer.
9. Did you get the expected results when using the laptop for completing of task? Explain your answer.
10. If you had money would you buy one? Explain your answer.
11. If you are a teacher, do you think your learners would buy a laptop like this? Explain your answer.

Appendix I List of Contents in the CD-ROM

- Approval to carry out a user study obtained from the Departmental Human Research Ethics Committee Review on 24 June 2009: saved as "Ethics Committee Approval"

- Letter sent to the principals seeking permission to conduct a user study at their school: saved as "Letter to Principals"

- The consent forms which was signed by learners and teachers as an agreement to participate in the research: saved as "Consent Form"

- The teachers' questionnaire: saved as "Teachers Questionnaire"

- The learners' questionnaire: saved as "Learners Questionnaire"

- Guidelines that were given to the participants to help them use the OLPC XO netbook: saved as "OLPC XO guidelines"

- Guidelines that were given to the participants to help them use the Asus Eee and Intel Classmate netbook: saved as "Asus and Intel guidelines"

- Interviews questions: saved as "Interview questions"

- Project proposal: saved as "Project proposal"

- Literature Review: saved as "Literature Review"

- Poster Presentation: saved as "Poster"

- Final presentation: saved as "Final Presentation"

- Final write up: saved as "Thesis"

- Copies of all electronic reference: saved as "Electronic References"

Appendix J Poster

A copy of the poster can be found on the accompanying CD-ROM as "Poster".