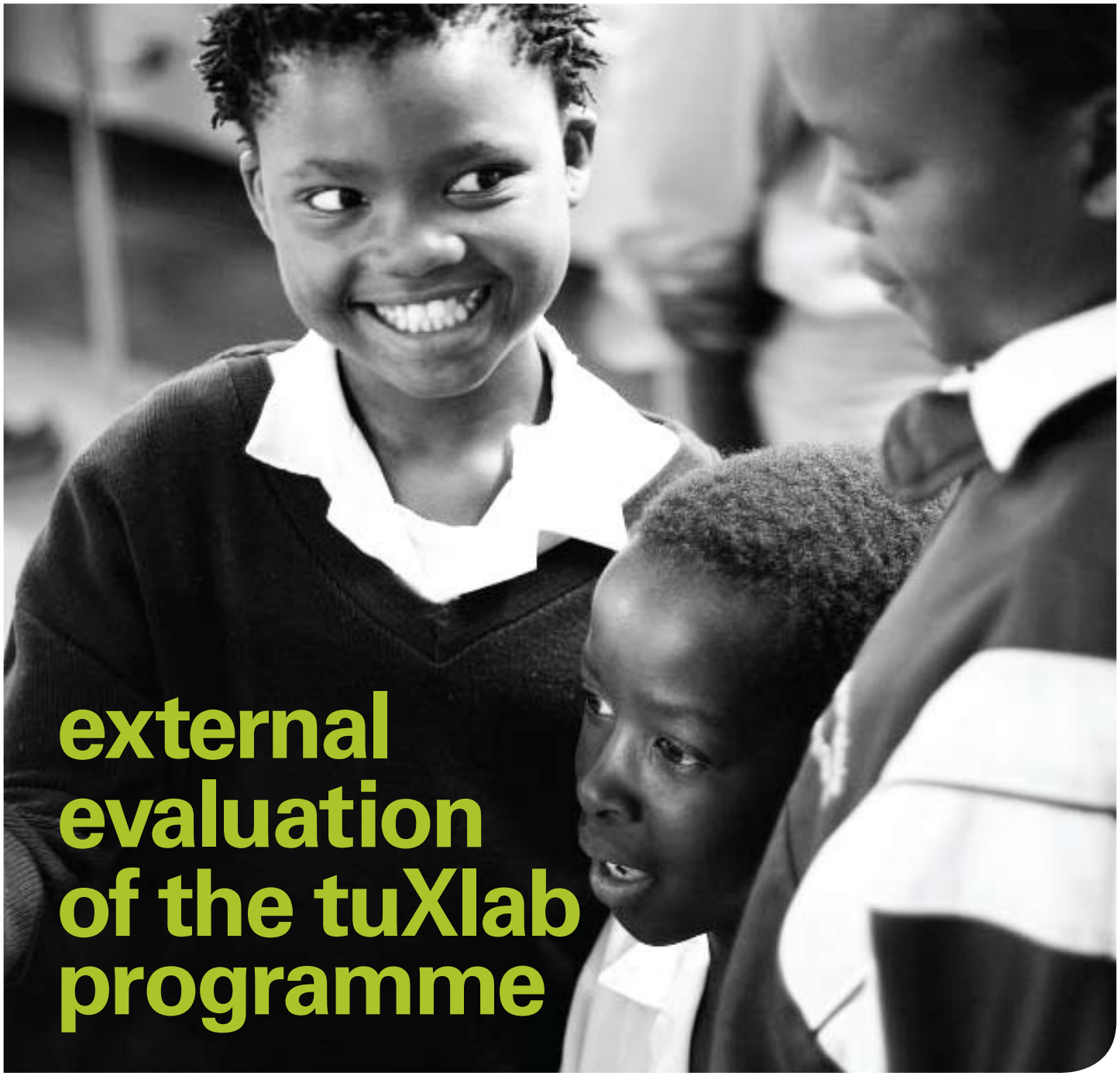

external evaluation of the tuXlab programme

in the Western Cape

summary report by Impact Consulting
www.impactconsulting.co.za

commissioned by the
Shuttleworth Foundation

Written by: Jerushah Rangasami,
Annie Devenish and Anje Coetzer

impact social development consultants | inkululeko TECHNOLOGIES | SHUTTLEWORTH FOUNDATION | tuXlab

contents

glossary

CAT	Computer Applications Technology
FET	Further Education and Training
ICTs	Information and Communication Technologies
IT	Inkululeko Technologies
ICDL	International Computer Driver's License
NQF	National Qualifications Framework
NEPAD	New Partnership for Africa's Development
OBE	Outcomes-Based Education
OSS	Open Source Software
SF	Shuttleworth Foundation
SLA	Service Level Agreement
UWC	University of the Western Cape
WCED	Western Cape Education Department

executive summary

Developments in Information and Communication Technologies (ICTs) allow the sharing of information and resources in the educational sector and have reshaped the way that teaching and learning is taking place. A lack of funds and technical skills, however, means that current usage and distribution is limited, hereby reinforcing the digital divide still prevalent in South African society.

The tuXlab programme, an initiative launched in partnership with the Shuttleworth Foundation (SF) in 2002, provides affordable computer labs to disadvantaged schools. Refurbished hardware and an open source software platform are used. The model emphasises community involvement and programme sustainability. It offers the opportunity to overcome certain challenges associated with cost and access that prevent resource-poor schools from being able to access ICTs.

At the beginning of 2006, it was decided that the tuXlab programme would no longer be managed in-house by TSF. TuXlab programme staff decided to establish Inkululeko Technologies, a service delivery company offering ICT solutions to the education and development sectors. Ownership and management of the tuXlab programme was transferred to Inkululeko in July 2006 with start-up capital provided by TSF. In 2008 Impact Consulting was contracted to conduct an evaluation of the tuXlab programme as managed by Inkululeko Technologies. The evaluation aimed to assess the implementation and outcomes of the tuXlab model from July 2006 through to February 2007 (the time period in which TSF and Inkululeko had a service level agreement in place).

In addition, the study aimed to provide a profile of the status quo of the existing labs in the Western Cape and to learn lessons about the model and its implementation. The study consisted of a survey administered to a representative sample of tuXlab schools in the Western Cape, six in-depth case studies, key informant and staff interviews. A total of 200 respondents participated in evaluation.

Results showed that half of the tuXlabs in the Western Cape are still functioning. A significant majority of schools who have used the tuXlabs reported that there were positive outcomes for both learners and teachers. For learners, primary outcomes have been improved computer literacy, language and maths skills and the enhancement of general knowledge and memory. Working in tuXlabs encourages participative and interactive learning and has also assisted learners to develop their internet research skills (for those who have access to the internet or the wiki) and to become familiar with Linux and OSS programmes.

For teachers, the main outcome has been improved computer literacy; a few teachers also benefited from the acquisition of skills to install and administer an Open Source Software (OSS) lab. Almost three quarters (73.8%) of schools noted that the tuXlabs have made a positive contribution to the school curriculum, and 50% of respondents believe that the lab has been helpful with assisting teachers to teach the curriculum.

The findings of this report indicate that the programme has made important strides in offering an innovative, flexible and affordable ICT model for schools. The programme has facilitated access to computers for many learners who would otherwise not have had the opportunity. A lack of resources and capacity (technical skills, human resources, knowledge of OSS etc), problems with the physical infrastructure and inability to use the labs as income-generating resources continue to restrain the sustainability of these labs in the South African school environment. The tuXlab programme will need to find innovative, cost-effective and practical strategies to overcome these challenges going forward.

context

Information and communication technologies (ICTs)[1] are at the heart of changes taking place throughout the world. The use of digital media has substantially transformed society and has dramatically changed the learning and teaching process by opening up new learning opportunities and providing access to educational resources well beyond those that were traditionally available. Although technology has provided these new avenues of access to information for learning and education, statistics regarding the use of computers continue to reflect and reinforce the digital divide between the haves and the have nots.

Education in South Africa is shaped by the legacy of our unique historical context. The apartheid education system, 'Bantu Education', ensured that government funding for schools was skewed towards historically white schools, leaving historically black schools under-funded and under-resourced. Despite the fact that the largest share of the national budget for 2007/08, approximately R105.5 billion[2], was allocated to education, South Africa still faces enormous challenges in overcoming the apartheid legacy. Illiteracy levels are at 24% for adults over 15 years of age, there is a shortage of qualified teachers, there are very low pass and performance rates (particularly for Mathematics and Science subjects), and many schools are severely under-resourced and over-crowded[3].

There have been significant changes in the South African education sphere since 1994[4], particularly the National Qualifications Framework (NQF) and the new Outcomes-Based Education (OBE) curriculum. The promotion of ICT capacity forms a central component in the government's economic growth and social development plans. South Africa's current Minister of Education, Naledi Pandor, has referred to ICT as the "future and indeed the key to 21st Century teaching and learning"[5]. Ultimately, the Department would like to develop schools into e-schools – characterised by teachers and learners with strong ICT skills and a culture of use and support for ICT practices. ICTs (in the form of computer laboratories) are therefore vital to bring impoverished South African schools into the 21st century. Statistics for 2007 indicate that only 3 in 10 schools have access to ICT in South Africa, and only 1 in 10 schools have Internet access (mainly through dial-up connections)[6]. In the Western Cape specifically, statistics showed that nearly a quarter of schools (23.4%) did not have access to computers for teaching and learning in 2005[7]. Some of the challenges that have been encountered with initiatives to date include: a lack of coordination between ICT programmes and projects in schools, a shortage of leadership and human resources to manage and support various ICT initiatives, a lack of understanding of the value of investing in ICTs, and the lack of a comprehensive policy on ICTs in education that covers all sectors[8].

To meet the aim of internalising the use of ICT in primary and secondary schools by allowing access to ICT into all schools and integrating it into whole-school development requires an extensive and resource-intensive strategy that is innovative, affordable and sustainable. Because of its affordability, Open Source Software (OSS) offers one such potential strategy.

OSS has open copyright licenses that allow users to share software[9]. Principles such as collaboration, self-sufficiency and freedom to share information underpin the OSS philosophy. Advocates for OSS in schools argue that OSS saves money and allows resource-poor schools access to ICT; enables schools and communities to be more self-reliant and it is empowering and democratic because it allows learners to understand how it works and how to customise it to suit their needs. Supporters of OSS argue that it is more suitable for Africa due to its low cost and adaptability. Supporters of proprietary software, on the other hand, argue that proprietary software is more suitable because of its wider use and cost as OSS is often not as cost-effective as it might seem.

---

1. *ICTs include communication devices or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning*
2. *InfoDev, 2007*
3. *InfoDev, 2007*
4. *InfoDev, 2007*
5. *Pandor, 2007*
6. *Pandor, 2007*
7. *Isaacs, ICT in Education in South Africa, 2007, p 9*
8. *Isaacs, ICT in Education in South Africa, 2007, p 2 & 10*
9. *Bridges.org, 2005*

research description

2.1 Evaluation Aim

The study aimed to evaluate the implementation and outcomes of the tuXlab model for the period of July 2006 to February 2007, the first months during which the project stopped being an in-house Shuttleworth Foundation project and began to be managed by Inkululeko Technologies.

The findings in this summary report focus on the tuXlab programme in the Western Cape and provide the following:

- A clear picture of the current status quo as at September 2008
- Assessment of the effectiveness of the model
- Assessment of any outcomes
- Lessons learned that can be used to determine a way forward.

2.2 Research Methodology

2.2.1 Research methods and tools

The evaluation used a mixed method approach combining both quantitative and qualitative research methods including: schools survey, case studies, focus groups, and key informant interviews. Table 1 below details the participant categories and the methods used for each group:

Participant Group	Method				
	Survey	Focus Groups	Face to face Interviews	Telephonic Interviews	Subtotal
School principals			5	1	6
Tuxlab coordinators	84		5	2	91
Coordinators of joint Khanya/Tuxlabs				2	2
Teachers		7			7
Learners		83			83
Current Inkululeko staff and Director			1	1	2
Former Inkululeko staff			3	3	6
Key stakeholders in the Shuttleworth Foundation			1	1	2
Key stakeholders in the WCED Khanya Project			1		1
Total					**200**

Table 1 : Research participants and methods

2.2.2 Sampling

The survey was conducted with a representative sample of 84 schools out of a total population of 109 schools in the Western Cape. The sample group was categorised according to the following: urban/rural, poverty quintile, language, educational district, and ratio of learners to teachers.

2.3 Data and Information Collection

The fieldwork was conducted in five phases:

Phase 1 : Participatory planning workshop and document analysis (documents provided by Inkululeko Technologies and Shuttleworth Foundation)
Phase 2 : Interviews at schools with tuXlab coordinators, principals and teachers using a structured survey
Phase 3 : School case studies (selection) based on survey findings that included observations, focus groups with learners and teachers and in-depth interviews with principals and tuXlab coordinators
Phase 4 : In-depth interviews with Inkululeko staff, Shuttleworth Foundation staff and Khanya Project staff
Phase 5: A participatory workshop with key stakeholders to discuss the draft evaluation report.

programme description

3.1 Programme History

Since its establishment, the Shuttleworth Foundation has been interested in the potential of using OSS in education. In 2001 they became aware of the work of the current Director of Inkululeko, who was running OSS computer training at previously disadvantaged schools.

The Shuttleworth Foundation and the current Inkululeko director piloted the model in two primary schools. Pleased with the outcome of the pilot, the Shuttleworth Foundation decided to adopt the programme as an in-house Foundation project in May 2003. In 2004, the open source education programme was given its current name: the tuXlab programme. In 2005 the tuXlab programme continued to grow with the rapid installation of new labs and the goal of establishing at least 80 tuXlabs in the Western Cape by the 2004/05 financial year-end. The focus also began to shift from the provision of technology in schools to a focus on technology being aligned with the school curriculum. In July 2006, strategic shifts at the Foundation led to a decision that the tuXlab programme would stop being an in-house project. tuXlab programme staff decided to establish a company – Inkululeko Technologies – and ownership and management of the tuXlab programme was transferred to them in July 2006 with some start-up capital provided by TSF.

Around the same time as the tuXlab programme started (in 2001), the Western Cape Education Department (WCED) started to investigate promoting ICTs in schools. The Khanya project was set up, focusing on technology as a teaching aid to facilitate curriculum delivery. The goal of the project was to address the capacity shortage in the education sector and to bridge the digital divide by providing disadvantaged schools with access to ICT. The Khanya Project is not based on open source software or platforms, but has been rolled out very quickly. By 2008, Khanya had provided technology to 945 schools in the Western Cape[1].

3.2 Programme Setting and Location

The tuXlab programme currently operates in the Western Cape, Limpopo, Free State and KwaZulu-Natal. Schools were originally selected in clusters for participation in the programme to enable them to share labs, resources and community support in order to maximise the impact of the programme.

3.3 Programme Clients

Table 2 indicates the main users of tuXlabs in the Western Cape

Direct Beneficiaries	Indirect Beneficiaries	Partners
Learners at all functional tuXlabs	School communities including: parents and learner families	Corporate sponsors
Teachers at all functional tuXlabs those who have received basic or more advanced training	Other schools in the same cluster	Various national and provincial government departments
Schools		Educational companies
		ICT companies
		NGOs

Table 2 : Programme clients

3.4 Programme Financial Information

The figure below indicates spending by the Shuttleworth Foundation on the tuXlab programme

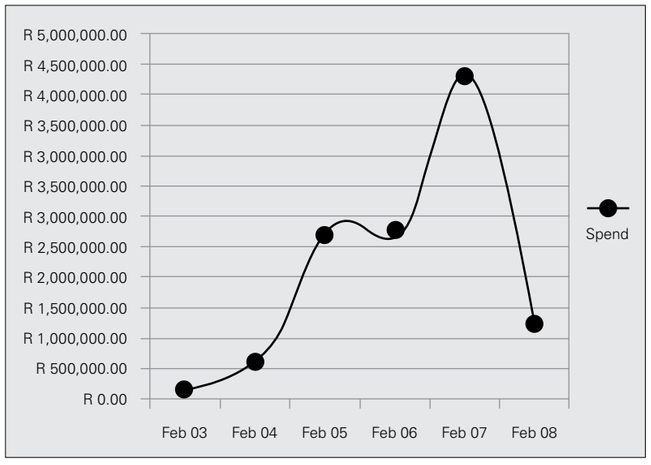

Figure 1 : tuXlab financial information from 2003 - 2008

3.5 The Tuxlab Model

3.5.1 Description of the model

The tuXlab model was originally developed in-house at the Shuttleworth Foundation and Inkululeko continued to refine this model. The version of the tuXlab model presented below is the version that was used for implementation by Inkululeko after the transfer of the programme to the company.

Core components of the model include:

- Use of open source software design based on open source philosophy
- Relevance and affordability to a local context in terms of design
- The fostering of self-reliance and the building of local expertise
- Sustainability and flexibility: the tuXlab model emphasises community involvement and programme sustainability using a seven step collaborative implementation/project management process
- A permanent internet connection is not required.

The lab itself is set up using a thin-client configuration and open source operating systems, software and applications. Infrastructure and security stipulations for the lab itself must be in place. The installation of the lab must be surrounded by certain institutional arrangements that include a business plan for ICT use in the school, a tuXlab champion and a supporting computer committee.

Community support is also required as well as external support such as training and technical support. The tuXlab programme staff are required to report and attend meetings and schools are encouraged to participate in the incentives programme, recruit volunteers and use the labs for income generation.

Figure 2 is an illustration of the model – with the lab itself at the centre and the necessary institutional and external arrangements around it.

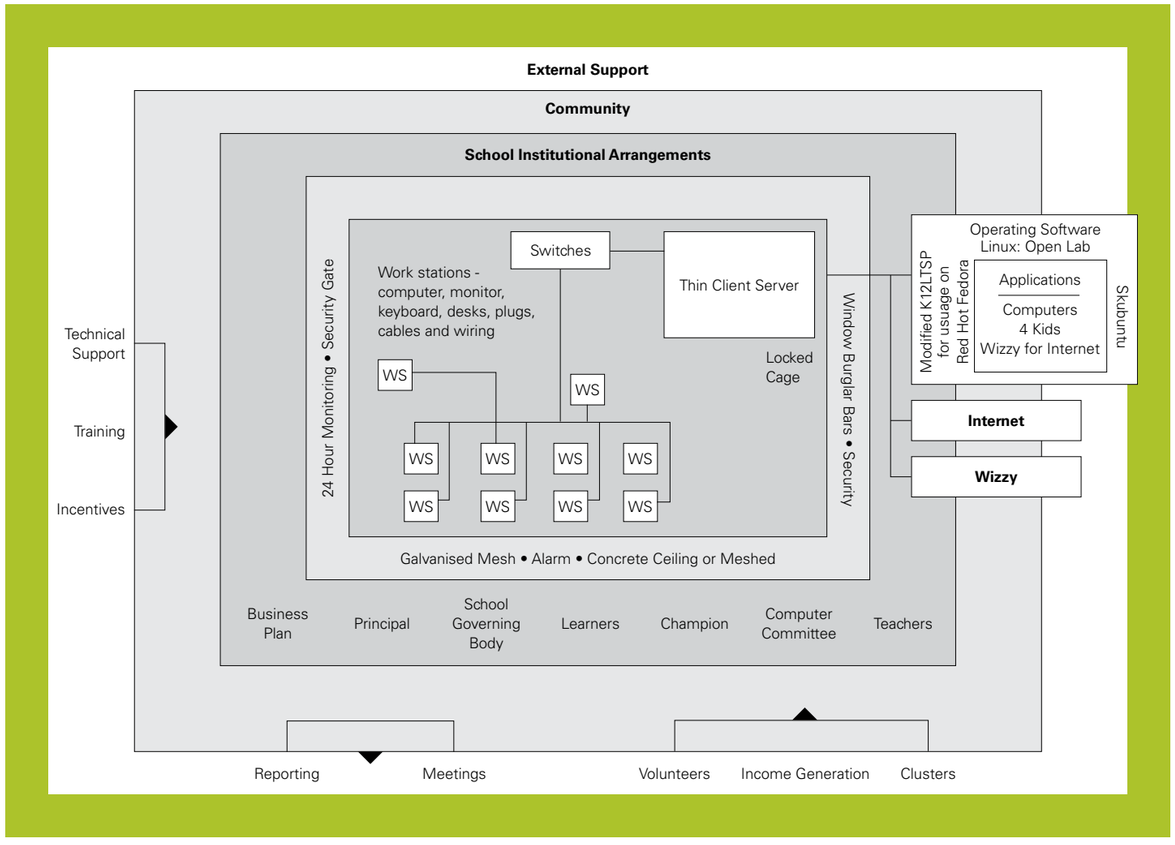

Figure 2 : Elements of the tuXlab model

1. *Khanya website, 2008 www.khanya.co.za/projctinfo*

3.5.2 Implementation of the model

There are five main phases for a school to undertake in order to implement the tuXlab model. These stages are outlined in figure 3 below:

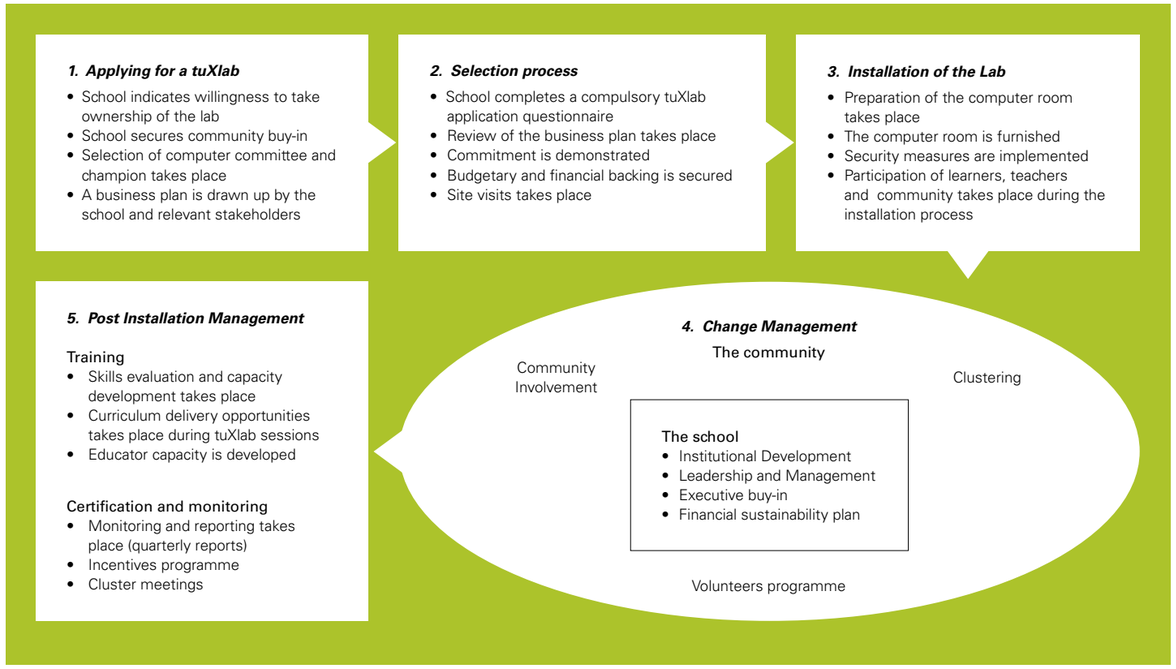

Figure 3 : Implementation process of the tuXlab model

3.5.3 Sustainability of the tuXlabs

When the programme was initially implemented, there was no formal sustainability module. The Second Edition of the tuXlab Cookbook [1], however, identifies a seven-step sustainability component for the model that includes:

- School commitment
- School buy-in and participation
- Ownership
- Planning
- Infrastructure and technology implementation
- Skills evaluation and capacity development
- Curriculum delivery opportunities.

Some of the key success factors that have been identified to promote sustainability include:

- Leadership and management
- Educator capacity
- Curriculum delivery
- Communication and recognition
- Community integration and financial sustainability
- Hardware and software innovation
- Certification and monitoring.

The skills transfer process is a key element of programme sustainability, as well as the importance of building capacity with local communities to ensure community ownership and involvement. The development of partnerships with other organisations is also promoted.

3.6 The Khanya Labs as a Sustainability Factor

One of the key factors in the Western Cape with regard to sustainability has been the rapid roll-out of the Khanya labs, initiated by the Western Cape Education Department.

In high schools, DoE officials have not allowed the CAT (Computer Applications Technology) learning area to be offered on open source software and this forced schools to replace their tuXlabs with Khanya labs[2]. In addition, because of limited space in schools, tuXlabs would often be closed down to make room for new Khanya labs. This provided the Khanya project with a room that was already secure with cable layouts.[3]

An evaluation in 2006/2007 stressed that the older hardware used in the tuXlabs put the programme at a disadvantage when compared with the new equipment made available for Khanya labs. The commercial Khanya software (many of which do not run on open source platforms) is also advantageous as it directly addresses the South African curriculum. This study found that there is still a perception that Khanya labs are better than tuXlabs and this appears to be largely associated with the fact that tuXlabs use refurbished hardware while Khanya labs are installed with brand new hardware. Table 3 highlights general differences between the tuXlab and Khanya models[4]:

	Tuxlab	Khanya
Use and access	All learners have access to labs for all subjects	Only selected grades have access to labs and access is limited to a few subjects (maths and science)
Hardware	Refurbished	New
Software	Open Source operating system and software	Proprietary operating system and software
Architecture	Thin Client	Fat Client
Maintenance	Maintenance/upgrading generally focused on server	Maintenance/upgrading focused on each computer and server
Support	Community-orientated support (assistance from Inkululeko to be paid for)	Free support from WCED (if items are still under warranty) or schools must pay for support
Administration	Relying primarily on school teachers to run the lab	Relying primarily on school teachers to run the lab
Costs	Initial costs low but long term maintenance costs high	Initial costs high but long term maintenance costs low
Initial setup	On average 20 computers per lab	Between 25 and 30 computers per lab
Cost per lab	R60, 000 per lab (for infrastructure and hardware/ software)	R300,000 per lab (for infrastructure and hardware/software)

Table 3 : Comparison between tuXlabs and Khanya labs

1. *Sustainability Module, tuXlab Cookbook, Second Edition, 2009*
2. *Inkululeko Report, 30 March 2007*
3. *A Khanya lab representative noted that tuXlabs have actually paved the way for Khanya, not only in terms of setting up some of the initial infrastructure required but also by preparing teachers and learners with basic computer literacy and knowledge which have made the introduction of the Khanya labs much easier. Khanya Website, 2008, http://www.khanya.co.za*
4. *Khanya website, 2008. http://www.khanya.co.za*

findings

4.1 Demographic profile of tuXlab Schools

Description	Categories	Number	Percentage
School level	**Primary**	**68**	**81**
	Secondary	15	18
	Did not answer/did not know	1	1
	TOTAL	84	100
Setting	**Urban**	**68**	**81**
	Peri-urban	10	12
	Rural	4	5
	Did not answer/did not know	2	2
	TOTAL	84	100
High schools: learner to teacher ratio	**36:1 – 40:1**	**5**	**33**
	31:1 – 35:1	4	27
	41:1 – 45:1	2	13
	46:1 – 50:1	2	13
	26:1 – 30:1	1	7
	25:1 and under	1	7
	Did not answer/did not know	1	0
	TOTAL	15	100
Primary schools: learner to teacher ratio	**36:1 – 40:1**	**28**	**41**
	41:1 – 45:1	18	26
	31:1 – 35:1	10	15
	25:1 and under	5	7
	46:1 – 50:1	4	6
	51:1 and over	1	2
	Did not answer/did not know	2	3
	TOTAL	68	100
Race profile	**Predominantly Coloured**	**36**	**41**
	Predominantly Black	25	30
	Did not answer/did not know	24	29
	TOTAL	84	100
Poverty quintiles	54% of surveyed schools did not know what poverty quintile their school fitted into or did not answer the question. The majority of schools that answered the question were situated between poverty quintiles 3 to 5 (quintile 5 being most advantaged schools on the scale).		

Table 4 : Profile of tuXlab schools in the Western Cape

4.2 Case Studies

Six case studies were conducted at schools – three at schools with well functioning labs and three at schools with labs which were not functioning well. The case studies were conducted to get a better sense of why labs functioned or not, and what some of the contextual limiting and enabling factors were. Two of the case studies are presented here:

case study one:

“Linux is actually not that difficult, people just need a mind shift ”

Situated in the scenic Cape Winelands, School A is a primary school with 700 learners and 19 teachers. Most learners come from disadvantaged socio-economic backgrounds, where opportunities to excel in education (and in general) are limited.

Only 50% of the school’s learners will matriculate and there is a very high level of unemployment within the local community. Much of the work available is limited to seasonal employment on surrounding wine and fruit farms. As 80% of the learners do not have access to computers at home, the general level of computer literacy is low. When their tuXlab was established in 2004, there was much excitement at the school as it was the first time that most of the learners had been given any access to a computer. One little boy in Grade 3 reported that he had never seen a computer before his visit to the new tuXlab and he initially thought that he was looking at a television or a piano.

The school has been lucky to have a dedicated tuXlab coordinator who has received strong support from the principal. The coordinator emphasises that the willingness and motivation from the staff and the principal have been important for him to keep the lab running successfully. The school has also worked hard to fundraise and develop some innovative solutions to overcome the barriers to enable the effective use of their tuXlab.

One of the problems that they faced was that there were only about 16 working thin clients in the lab. With classes of 40 to 50 learners it was very difficult to control the children during classes held in the lab. Discipline was a concern for teachers, and the learners didn't enjoy having to share computers. To solve this difficulty the school used some of the funding that they received from the United States to set up a media centre with a librarian in the classroom next door to the tuXlab. Classes are now split in half and the children spend half their time in the lab and the other half in the media centre.

The same funding was also used to employ a full-time lab facilitator who started in March 2008. Prior to this position, each teacher would bring their own classes to the lab and would supervise them. Now the new tuXlab facilitator is responsible for the planning and teaching of all lessons in the lab.

All learners at the school use the tuXlab. The younger learners play educational games. Their teacher identifies which areas the children are having problems with and then the lab facilitator structures his lessons around appropriate games to assist with these specific areas. They have audio-visual exercises, phonetics and typing. Older learners draw graphs and do mathematical exercises in open source spreadsheets or conduct research on Wikipedia. The school does not have access to the internet, although they do have the satellite dish that was installed as part of the Connectivity Project.

The lab is kept open after school for learners to play and do their homework. Each grade is designated a different afternoon on which they are able to come and use the lab after school. Learners enthusiastically noted that they enjoyed their time there – "the tuXlab is nice for relaxing".

The community uses the lab occasionally on an informal basis. Former learners come in to write up their CVs and parents sometimes use the lab to draw up Church programmes. The new facilitator is very keen to get the community more involved and mentioned an idea inspired by a neighbouring school with a Khanya lab that was offering a three month community computer course for R300.

The facilitator's main frustration is caused by technical problems that the lab has been experiencing, mainly with the server, which does not recognise and upload new software. He noted that the old computers often freeze and he has been unable to work out how to configure the computers.

At this school, the main challenge has been a lack of technical support and a lack of regular communication from the programme managers. The facilitator noted that he doesn't know where to get assistance with his server problems. He would like to see the server fully repaired and installed with USB ports and updated software, and he noted that frequent Programme Manager visits to the school would "contribute to morale." As there had been no communication between the programme managers and the school since the beginning of 2008, the lab has only remained up and running because of the dedication and hard work of the coordinator and the lab facilitator. Because of his technical background, the facilitator has been able to repair some of the thin clients, but they would have remained un-usable if he had not been there. The tuXlab coordinator explained "teachers lack enough knowledge of working with computers…to fix the problems".

The facilitator decided to take on this job because of his commitment to the learners and to social development in his community. He receives a very small salary, which would not be enough to sustain a formal lab facilitator position. His contract expires in June 2009, but the principal is hoping to raise additional funds to allow him to stay on.

Although the facilitator still uses Microsoft on his own laptop, working in the TuXlab has changed his perception of open source software and encouraged him to do some of his own research in this area. He was forced to learn to fix systems working on Linux

and the exposure has made him very pro-Linux and encouraged him to become a speaker for open source technology. In fact, his skills are now very much in demand as schools in surrounding areas (even those with Khanya labs) have been requesting assistance from him.

The facilitator also noted that the open source programmes have allowed him to make his lessons more creative. This change in perception about open source technology has not, however, filtered down to the teachers. They feel that they have not learnt anything about open source software and they prefer Microsoft because it "is just so much more accessible". One teacher felt that open source was "a step back", because the tuXlabs don't have the curriculum programmes that Microsoft has. Therefore, the facilitator faces the challenge of changing the perceptions of teachers who "are quite set in their un-technological ways". Teachers received training a number of years ago when the lab was first established, but they do not know much about the labs or about open source. The facilitator has been encouraging teachers to take more of an active interest in the labs and has noticed that they are starting to experiment more on the computers.

For this champion, the key strength of the tuXlab model is that "it identifies the poverty-stricken schools" and is able to provide computer access to children for the first time in their lives. Without the tuXlabs, these children would not have any access at all. The result is computer literacy for learners and an increase in children's sense of self. One teacher noted that "children are typing faster and with more confidence". There has also been an improvement in learners' mental maths skills and they can also now use various maths programmes to make graphs and add up different currencies. Their general knowledge, chess skills and grasp of literature has improved, as learners have access to poetry through the labs. Equally importantly, the lab has prepared learners to work with computers when they reach high school. For teachers, the hope is that the labs will help children to learn "that the world isn't only as big as South Africa"

case study two:

"At present the computers look like they are about to fall apart... It's like scrap in here... learners don't want to come in here and work on this "

School B, situated in the Cape Town area, is a junior secondary school that was one of the first schools to have their tuXlab installed in 2004. These were the first computer facilities that were established at the school.

The lab was used until 2006 when a series of power cuts in Cape Town "blew the computers". Damage to the hardware as a result of these power cuts put the lab out of commission. There are currently only nine computers in the lab that are in working order, but these are not being used because, as both the coordinator and principal stress, with just a handful of working computers, "it's impossible to bring a class of 30 or 40 learners in to use the lab".

The majority of the learners at the school live in Cape Town townships and the school also has some learners from other African countries such as Rwanda. Most of the learners do not have

computers at home, although a few do have access to a computer "at a friend's house". The principal is aware that the majority of learners are not very competent on a computer. A few who came from primary schools that had Khanya labs "manage much better".

In 2005, the majority of the teachers at the school received computer training from the Shuttleworth Foundation. Only three teachers who received this initial training are still at the school and the skills were not adequately shared to enhance the sustainability of the lab.

Access to the tuXlab used to be scheduled into the school timetable with every learner having a 40 minute period in the lab once a week. Each teacher would come to the lab with their class. Learners played games on the computers and typed and printed assignments. Some teachers used the programmes to do maths and graphs with learners. Learners also used Wikipedia for history assignments, but their Wikipedia was not regularly updated as was promised. The coordinator felt that the programmes that were on the computers were not really suitable for teaching the curriculum for the Grades 8 and 9 at the school as they were more geared towards primary schools.

The TuXlab coordinator at this school does not have particular knowledge or passion for computers – he was designated to the position simply because he happened to know slightly more about technology than any of the other teachers at the school. He has not had much training, nor does he have any administrative or technical skills for running and maintaining the lab. When it comes to solving problems he generally feels disempowered.

The coordinator is also a teacher himself and sighs as he explains that it is very difficult to fulfill his teaching duties and try to maintain the lab at the same time. He is adamant that it is problematic if there is not a dedicated person for the lab. He feels quite isolated in his role as tuXlab coordinator and thinks that he lacks the skills and motivation to make the lab a success. When referring to fixing the server, he dejectedly noted "I don't scratch in that box". He noted that he would only like to receive more training if he could be a full-time computer teacher and not have other teaching responsibilities. The school has not been able to fully participate in the Incentive programme, as meetings were often far away and difficult to access by public transport. Nobody at the school was aware that a volunteers' programme existed.

The main technical problems experienced in this lab included damage to the hardware as a result of the power cuts, problems with log-in passwords not working which have prevented access to the system as a whole, difficulties with computers "freezing and being slow" and monitors sporadically changing colour. These difficulties have demotivated teachers and eventually stopped them from using the lab at all. The school has done their best to replace some of the broken computers, but they just don't have the funds to replace all of them and so they have stopped using them altogether.

The power cuts were not the only reason for broken computers – equipment has also been stolen by learners. The principal explained that some learners have tried to steal computer parts from the lab and sell them down the road. He caught one learner who took some parts from the lab computers to fix his own computer at home. The principal confronted the learner and forced him to bring the part back.

The principal felt that, while the lab was working, it had had a positive impact on learner discipline. Learners were eager to come to use the lab and knew that they had to be well-behaved if they were to be let in. He reported that the learners were interested and enthusiastic about working on the computers and that they frequently knew "more than teachers".

In contrast to the principal, the coordinator felt that the lab had not had any significant positive impact on learners and even less on teachers as they are "so used to Windows and not Linux…Linux is good because it's free, but a person needs a lot of training to be able to use it properly."

To get their tuXlab running again, the school would need to improve its current condition and make it look "better than it is at the moment". The tuXlab coordinator felt that the hardware was so old and run-down that the school could not be proud of the lab and that learners could not respect the equipment:

"At present the boxes look like they are about to fall apart…Its like scrap in here…the learners don't want to come in here and work on this…it needs a lot of fixing"

The principal noted that he would like to get the lab up and running again. However, to do so the school would need new hardware, repairs to existing hardware and more technical support. The server would also need to be upgraded. They felt that further involvement from programme managers, such as regular school visits, would be helpful. In addition, he felt that cluster meetings "need to be close to schools. You need a proper network". The coordinator suggested that it may be useful to get some IT students in to volunteer and help.

4.3 Current Status

The following table indicates the status of tuXlabs at schools in the Western Cape, considering a broad range of elements of the model:

		%	Notes/Analysis
Functioning of the tuXlabs	**Functional status**		• A higher percentage of tuXlabs have been able to continue functioning in primary schools in urban areas (52% in urban schools are still working compared to only 21% in peri-urban and rural areas). • Only a third of tuXlabs in high schools are still working, compared to almost half in primary schools.
	Not working	*50*	
	Still working	45	
	Not answered	5	
	TOTAL	100	
	Reasons why tuXlabs are not functioning		• By far the most common reason for tuXlabs not functioning was due to hardware issues. • Contrary to what TSF staff expected, only 16% of the total set of schools indicated that they stopped using the tuXlabs because they switched to a government-funded proprietary model. • Schools where the tuXlab is still operating are less likely to have a government-funded proprietary system, compared to schools where the tuXlab is no longer functioning. • A total of 65% of schools where the tuXlab is no longer working have government-funded proprietary labs, compared to 42% of schools with working tuXlabs. • Some schools with tuXlabs also have government-funded labs and only use these due to technical and other problems with the tuXlabs
	Computers/server not working	*52*	
	Switched to government-funded programme based on a proprietary model	16	
	Lack of organisation at the school	11	
	Burglary	8	
	Lab being fixed or moved at present	5	
	Computers returned	5	
	Software outdated or not suitable	3	
	TOTAL	100	

		%	Notes/Analysis
Hardware	**Levels of satisfaction with hardware**		• The survey and site visits revealed a very high level of dissatisfaction with tuXlabs hardware. • Teachers report hardware regularly breaking, slow and sometimes freezing computers (causing frustration for both tuXlab coordinators and learners). • Nearly half (47%) of all tuXlab schools have hardware which is four years or older. • A total of 73% of this hardware has never been replaced. • Technical problems with hardware, combined with a perceived inability to access technical support, has been a major cause for the closure of many tuXlabs. • Current hardware in tuXlabs lacks facilities to accommodate USB devices, CDs or disks. This limits users to only using computers at school and not being able to take work home to finish. • Learners at some schools complained that there is no shared drive or C-drive for them to save their work on.
	Satisfied or not completely satisfied	*73*	
	Very satisfied or satisfied	22	
	Did not answer	5	
	TOTAL	100	
	Functioning of the Hardware		• A large proportion of tuXlab hardware is currently out of commission when it is considered that 50% of labs are no longer functioning. • Some of this hardware has been removed from schools; however, most appears to have remained on school premises.
	More than five not working	*45*	
	Less than five non working computers	32	
	No working computers	23	
	Computers are all operating	19	
	TOTAL	100	

		%	Notes/Analysis
Software	**Satisfaction with Software**		• Satisfaction levels with software are much higher in comparison to levels of satisfaction with hardware. • The majority of all the schools surveyed (67%) said that they used both Linux and Computers4Kids. • 10% only use Computers4Kids software • 8% use Linux exclusively • 15% use other software, together with Linux, Computers4Kids or both.
	Good	*40*	
	Average	27	
	Excellent	13	
	No answer	8	
	Poor	6	
	Very poor	6	
	TOTAL	100	
	Software compatibility with curriculum	*77*	• Perceptions of the applicability of the software to curriculum needs vary considerably between high school and primary school respondents. This is understandable as the software programmes provided (such as Computers4Kids) are designed mainly for primary school level, rather than for high schools • Most dissatisfaction with software was because: ◦ Software is more suitable for primary schools than for high schools ◦ Software needs to be more curriculum-aligned ◦ Software needs to be upgraded.
	Software fits into the curriculum	18	
	Software does not fit into the curriculum	5	
	Did not answer	5	
	TOTAL	100	

		%	Notes/Analysis
tuXlab Manual	**Access to the tuXlab manual**		• Most schools still have their tuXlab manuals: ◦ Just over half (51%) only have a hard copy ◦ 6% only have a soft copy ◦ 23% have both hard and soft copies.
	Schools that still have the tuXlab manual	*81*	
	Schools that do not have the tuXlab manual	19	
	TOTAL	100	
	Usefulness of the tuXlab manual		• A large majority of schools indicated that they found the tuXlab manual useful.
	Yes	*77*	
	No	19	
	Did not answer	4	
	TOTAL	100	
Technical Experience and Support			• Technical experience of tuXlab coordinators varied considerably. • All the schools visited who had successfully running tuXlabs all had dedicated tuXlab coordinators (or other individuals) with technical training who were running the labs. • Schools with this in-house "expertise" are in the minority: many coordinators did not have enough of a technical background to solve even basic technical problems. • Inkululeko continues to provide support to schools wherever possible using volunteers. • Most schools indicated that they are unable to pay for technical support due to a lack of funds.

		%	Notes/Analysis
Internet Access	*Schools that do not have internet access*	*63*	• 74% of schools with internet access pay for it themselves.
	Schools that do not have internet access	37	
	TOTAL	100	

		%	Notes/Analysis
Branding and perceptions of ownership	*tuXlabs are sponsored by Shuttleworth*	*66*	• There remains a strong association between the tuXlabs programme and the Shuttleworth Foundation among learners and staff at schools with tuXlabs.
	Inkululeko is the sole sponsor	12	
	Both Shuttleworth and Inkululeko sponsor labs	10	
	TOTAL	100	

		%	Notes/Analysis
Security	**Perception of security**		• Although 95% of schools indicated that they had secure tuXlabs, security was still raised as a major concern by many tuXlab schools. It was also cited as one of the main reasons why the tuXlabs tend to be under-utilised after school hours.
	Schools reporting they have secure labs	*95*	
	Schools reporting they do not have secure labs	5	
	TOTAL	100	
	Security breaches		• One fifth of schools indicated that equipment had been stolen from the lab at some stage.
	Schools reporting some equipment stolen	*20*	
	Schools reporting they had no equipment stolen	80	
	TOTAL	100	

		%	Notes/Analysis
Using the tuXlabs	**Number of learners per computer**		• The way in which the tuXlabs are used varies greatly from school to school. At most schools, the tuXlab periods are built into the timetable. Alternatively, some schools have a tuXlab roster, where time is booked by classes. • In some instances the whole school has access to the lab and in others certain grades are given preference. • The amount of time learners spend in the lab varies from school to school, ranging from one to three hours per timetable cycle during school hours. • The vast majority of respondents said that the lab was used during school hours (87%), while just over half of schools (56%) use the labs for educational as well as recreational purposes. • Labs sometimes have to accommodate two to three learners per computer. Teachers have emphasised that, under these conditions, it is difficult to control and keep discipline over classes and that learners have not been able to use the computers as effectively as they would have if one computer per learner was available.
	2 Learners	*52*	
	1 Learner	22	
	More than 3 learners	11	
	Not answered	*5*	
	TOTAL	100	
	Most commonly taught subjects in tuXlabs		
	Computers/IT literacy	*29*	
	Maths	20	
	English and all lessons	12	
	Science	8	
	Community usage Community members taught in tuXlab	18	• Community usage of the labs has mainly been on an informal and irregular basis, e.g. former learners and parents coming into the lab to type out their CVs and church programmes. Schools reported several challenges with regards to opening up the tuXlabs to the community, which included: • Safety issues, i.e. it is dangerous to leave the school (and the tuXlab in particular) open after-hours which is when the community would be available for training • A lack of availability of teachers to conduct community training after hours
		%	**Notes/Analysis**
Income Generation	Percentage of schools where tuXlabs were used as an income generator	8	• It was hoped that income generation would be achieved to assist with paying for the upkeep, upgrade and technical support labs constantly require. • The challenges that schools have faced regarding community participation and the low level of income generation suggest that there may be a need to seriously reassess the viability of the community involvement component of the tuXlab model.

Table 5 : Status quo of tuXlab schools in the Western Cape

4.4 Most common ways the labs are used

The table below indicates the most common ways in which the labs were used.

	Hot the tuXlab is used
Primary school learners	• Play games that aim to teach computer literacy, and games aimed at improving maths and language skills • Conduct maths exercises in open source spreadsheets • Type school and homework assignments • Conduct research for assignments.
High school learners	• Research purposes • Typing essays, homework and assignments • Printing homework and assignments (in labs where there is a printer facility).
Teachers	• Teachers generally have their own computer facilities at school, but some have used the lab to improve their basic computer literacy skills. • They generally use the lab to teach their learners rather than for personal use.
Community	• Community members (for the most part this means parents and former learners) have used the lab mainly on an informal and irregular basis, for example during the Open Days held by schools • Where the local community has used the tuXlab usage consisted of basic computer literacy, compiling CVs and training courses.

Table 6 : Most common uses for tuXlabs according to type of user

4.5 Issues affecting sustainability

4.5.1 Skills transfer and capacity

Technical and other skills are lost if trained teachers leave the school without any of the other teachers being trained in OSS and in the use and maintenance of the labs. It was clear from the evaluation that a strong champion who is an advocate for open source technology is hugely advantageous when considering sustainability. Coordinators who do not have a specific interest in open source technology are less likely to work towards tuXlab sustainability. In addition, sustainability of the tuXlabs, in the current model, also requires a dedicated coordinator rather than relying on teachers who have other duties.

4.5.2 Generating income

The idea of using the labs to generate income has been unsuccessful to date. Communities have not been as involved in the tuXlabs as was initially conceptualised.

4.5.3 Attempts to promote sustainability

Since 2006, Inkululeko has initiated three other projects to enhance the sustainability of tuXlab schools: the Connectivity project, the Social Entrepreneurship project and the INGOTS project. These have been implemented in tuXlab schools that showed commitment and motivation. In addition, when it was found that hardware issues were affecting lab use, Inkululeko replaced existing equipment with newer second-hand machines wherever possible. They had not, however, set aside any budget to upgrade the equipment of the tuXlabs as the model indicates that schools should take responsibility for maintaining their own labs. Schools were informed that they were to begin paying for technical support from February 2007; however, Inkululeko continued to provide some free support in the interests of enhancing sustainability.

outcomes

A significant majority of schools who used the tuXlabs reported positive outcomes for learners and teachers. According to the survey, the area where the labs have had the main impact on learners is on improving the quality of education in general. For teachers, the main outcome is improved computer literacy. Almost three quarters (73.8%) of respondents' schools note that the labs have made a positive contribution to the school curriculum, while half believe that the lab has assisted teachers in teaching the curriculum. The area where the lab has not had many outcomes is in the realm of income generation.

5.1. Outcomes for learners

The main reported benefits that the tuXlabs have had on learners include:

- Improved computer literacy
- Improved language and maths skills
- Participative and interactive learning
- Improved general knowledge
- Improved memory
- Ability to conduct internet research
- Familiarity with Linux and other open source software programmes
- Fostering an interest in open source programming.

The figure below indicates benefits for learners using tuXlabs:

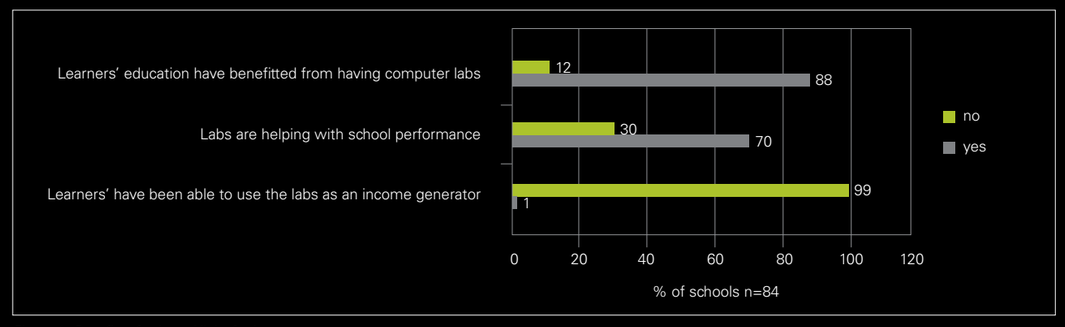

Figure 4 : Benefits of using tuXlabs for learners

5.2 Outcomes for teachers

The main outcomes reported for teachers included:

- Improved computer literacy
- Acquisition of skills to install and administer an open source software lab.

The figure below shows the benefits of using the lab for teachers:

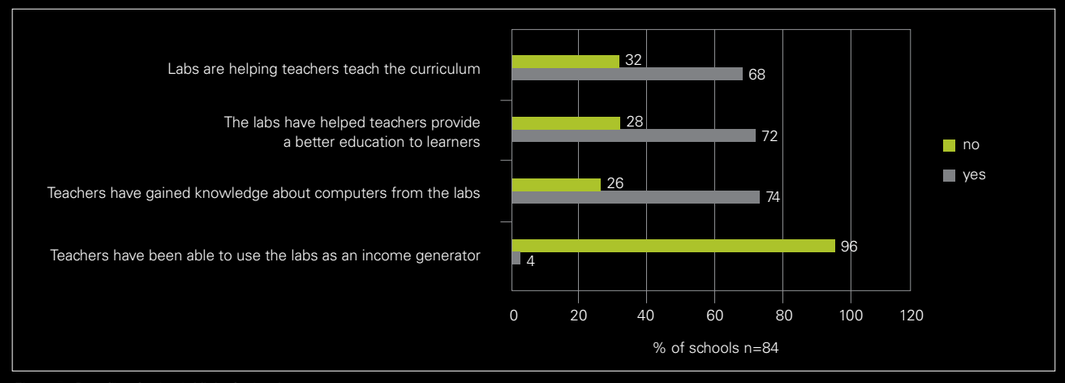

Figure 5 : Benefits of using tuXlabs for teachers

analysis of the model

6.1 Strengths of the model

The main strengths of the tuXlab model that emerged from this evaluation are that it:

1. Provides access to computers for teachers and learners who would otherwise have none. The tuXlabs are affordable for schools with limited resources and the tuXlab is often the first and only computer access that learners from very poor backgrounds have. The Khanya labs in the Western Cape have provided further access; however, these labs are designated for use by specific grades and for specific subjects so the computers are not available for all learners, as is the case with the tuXlab model. Being provided with such access has meant that:

- Learners and teachers are empowered through the provision of ICT skills
- Teachers receive skills necessary to use programme and internet content for teaching the curriculum, while it equips learners with the skills necessary to navigate through such content for research and assignments
- Learners and teachers have exposure to OSS, which will enable them in a tertiary education environment and can foster interest in OSS programming for some.

2. Is flexible: both the open source platform and the tuXlab model itself ensure that the use of tuXlabs is very flexible and can adapt to any school context or plans.

3. Promotes community buy-in and ownership: in instances where the broader school community was involved in the tuXlab installation at schools, this was an enjoyable experience and has enhanced sustainability. Unfortunately, there are not many cases where this has actually occurred.

4. Ensures simple lab maintenance: the thin client model means that tuXlabs are very easy to maintain if the hardware is robust, the lab is properly managed and there is access to adequate technical support. Once tuXlab coordinators are properly trained to use the open source platforms, they can maintain the lab, upgrade the server and upload new software programmes themselves.

6.2 Weaknesses of the model

While the model has been continuously reviewed and changed, there are still several weaknesses that emerged from this evaluation. The main weaknesses have impacted on the sustainability of the labs.

Major weaknesses of the model include the following:

1. The use of second hand hardware has proved to be unsustainable as schools do not have the capacity to deal with problems associated with refurbished hardware. It would be preferable to provide new and robust hardware that is under warranty as it has a longer shelf-life.

Hardware problems and other technical issues with tuXlabs have forced many schools to make the move to Khanya labs in the hope that the change of hardware and software would make the lab run more efficiently. This has contributed to a perception that Microsoft platforms and products (which are provided in the Khanya labs) are better than open source ones.

2. The lack of capacity and knowledge on the teachers' side has meant that they are unable to implement the technical sustainability aspects. The latter involves using a facilitated self-help approach to technical problems, aimed at empowering coordinators to solve the technical skills problems they experience with assistance from the manual and more experienced fellow coordinators in their cluster. Lack of knowledge has also meant that labs have not been used for income-generating purposes as teachers do not have the capacity to assist external users.

3. A lack of a dedicated staff member. Generally, in schools where there is a dedicated tuXlab coordinator (who does not have other teaching duties)[1], there has been ongoing and successful functioning of the lab. These skills must still be shared with other teachers and a succession plan must be put in place to ensure sustainability.

4. A ratio of more than 1 learner per computer has proven to be problematic – many schools do not use tuXlabs widely because it is ineffective when each learner does not have their own computer to work on.

5. Most of the hardware used in tuXlabs does not accommodate USB devices, CDs or disks. This means that users are very limited and cannot save or take their work home and can only work on the computers at school.

1. *In resource-poor schools where this has been implemented, it has been due to a principal or governing body's initiative to fundraise for the lab from the surrounding community*

lessons learned

A number of important lessons for Inkululeko, the Shuttleworth Foundation and for the tuXlab model itself have emerged from this evaluation. The lessons learned have been incorporated into recommendations below which offer a way forward for stakeholders.

Stakeholders for who these recommendations are made are indicated by the following codes:
- Lab coordinator: LC
- Technical support staff: TSS
- Programme manager: PM
- Schools in general: S

7.1 Implementing the tuXlab programme

Despite the tuXlab model stating clear guidelines for sustainability, these strategies have not been practical. If the tuXlab programme continues to run in schools, we recommend that the following aspects be revised to maximise effective use of the tuXlabs and to enhance sustainability:

Aspect	Stake-holders	Recommendation	Reasons for recommendation and further notes
Hardware	PM	If further tuXlabs are installed, the programme should investigate the use of new hardware.	• This will increase the lifespan of the hardware, thereby reducing the need for replacement and for technical support to deal with hardware issues. • Sponsorship of second-hand hardware is common from corporates – these donations should continue to be sourced, as long as all donated machines are carefully screened, cleaned and are no more than one year old.
	PM	Existing tuXlab hardware would benefit from an upgrade across the board.	• Such an upgrade should ensure that lab servers and all computer components are in good working order and that, as proposed in both previous evaluations, a half-thin/half-thick client model is used so that computers have multi-media capability, as well as USB ports and CD facilities so that individual work can be saved.
	PM	Increase schools' awareness of possible financial contributions to the lab	• Schools should be made aware that they will need to make financial contributions to keep the lab running and that they must take responsibility for this, along with the service provider.
	PM, LC, S	Where feasible, tuXlabs should house 30 to 40 computers per lab.	• 30 to 40 computers would facilitate effective use of the labs by larger classes – which are the norm in most primary schools.
Software	PM	The open source platform of the tuXlabs must be made compatible with existing curriculum aligned software programmes. The software developers can also be encouraged to develop open source compatible versions of their products.	• Aligned software will facilitate the use of existing curriculum aligned software programmes. • It would be helpful if the tuXlab team could compile (perhaps in conjunction with Khanya labs), and distribute to tuXlab schools, a list of compatible quality software programmes which are aligned to the curriculum and appropriate for the age groups that will be using them.
Security	LC, S	Security set-ups for in-school and after-school activities should be investigated with each school before installation.	• Security issues, particularly theft and security when using the labs after hours, have limited the sustainability of the tuXlabs. • The latter has limited the use of the labs for income generation, homework opportunities and other community activities.
Training and skills development	LC, S	It is vital that tuXlab schools do not only have one staff member who has the skills to manage and maintain the lab. Schools should have skills transfer and succession plans for their tuXlabs.	• Most participating teachers indicated that they would like further training, not just about how to maintain the lab, but also about open source solutions, the kinds of open source software programmes available and about how content from the internet could be used to teach the curriculum.
	PM	A training programme should include modules that build upon one another as well as post-training on-site support.	
	PM	Training should take place on a regular basis and be held at convenient times and venues for the relevant teachers.	
	PM	The tuXlab training could be redesigned as a programme with a series of modules rather than as a once-off event.	
Technical Support	PM	Technical support staff could possibly have portfolios of schools (possibly within clusters) so that they are familiar with each schools' set-up, skills levels, usage, etc	• This would not only ensure that technical problems could be more quickly handled, but would also allow the programme manager to start building social capital and peer networks between these schools.

Aspect	Stake-holders	Recommendation	Reasons for recommendation and further notes
Technical support	LC, S	Obtain further funding to secure the functioning of the tuXlabs.	• It is clear that a high level of technical support is necessary for schools initially, especially at schools where there are low levels of technical skills. • Disadvantaged schools cannot currently finance their own technical support so alternative means would need to be found until they are able to become self-sustainable. • Volunteers can not be relied on to provide technical support if the programme is being operated as a for-profit enterprise. There are several ways in which this could be achieved: ◦ The programme manager could investigate corporate sponsorship which could be used to finance technical support to schools. ◦ The programme manager could explore the possibility of forming strategic partnerships, for example with Khanya, Edunova Schools ICT Academy etc. ◦ Funding proposals for labs should include a maintenance endowment component for each lab, which would entail a certain amount of money from each grant being invested and the interest used for maintenance (technical support, hardware upgrades etc) in perpetuity.
Commu-nication with tuXlab schools	PM	Regular communication must be kept with tuXlab schools, a portfolio manager would be useful for this.	• A lack of clear and effective communication was identified as one of the key obstacles that prevented the successful functioning of the tuXlabs faced. • If the programme manager is able to improve communication and manage expectations it will greatly facilitate the management of the tuXlab programme.
	PM	Careful attention needs to be given in order to manage the expectations of schools, particularly in terms of promises made to schools.	
	PM	Multiple methods of communication are necessary when trying to contact schools, for example using SMSes as well as regular fax and phone communication	
Working with schools to develop plans for use and sustainability	PM	A training course could be held for principals and/ or coordinators, or tuXlab staff could work with willing schools individually.	• We found that many schools were not using their labs because the use of them had not been scheduled into the school timetable, despite the requirement of having a business plan in place before a tuXlab was initially installed. • These plans could be developed with existing and new schools and support should be provided to assist with initial implementation in each school. • Many tuXlab schools lack the skills and initiative to develop effective income generation or fundraising strategies for their labs.
	PM	Possibly assist with the Open ICDL accreditation of teachers who would be willing to offer formal accredited computer courses and to recommend that these teachers are remunerated to run these courses in some way.	
Ongoing review	PM, S LC	Ongoing review and reflection of the tuXlab model to build and improve on process and systems.	• As the tuXlab model continues to grow and evolve, and as the context in which the project is situated changes, systems must be put in place for ongoing review and revision.
Promoting open source programmes	PM	There is a need to increase awareness for and develop an advocacy strategy to promote OSS among teachers and within the WCED.	• The tuXlab programme has introduced and educated teachers and learners at tuXlab schools about OSS for the first time. • There is, however, still much work to be done in terms of creating awareness of open source software and its potential, and to encourage support of its use in the education sector in South Africa. • This evaluation found that surveyed teachers generally had very limited knowledge of software, which led to resistance to OSS as it was perceived as "different" and "unfamiliar" compared to other proprietary software.
Evaluation of pilot programmes	PM	The evaluation of pilot programmes can play an important role in the early detection of programme faults or shortages.	• It is important that pilot projects are evaluated after an appropriate period of time. • Recommendations should be set in a participatory matter (as was the case in this evaluation) and then implemented.

Table 7 : Aspects of the tuXlab model that should be reviewed

conclusion

The tuXlab programme in the Western Cape fulfills an important need in the education sector by providing learners, who may otherwise not have access to computers, with hands-on experience. The findings of this study reveal that this access has had a number of significant benefits for learners and teachers. These benefits include improved computer literacy, language and maths skills, increased opportunities for research, enhanced learner self esteem and broadened perspective on the world.

Internationally, education is moving towards the use of open source software platforms. The tuXlabs provides learners and teachers with exposure to open source software and therefore plays an important role in preparing learners and teachers to use and engage effectively with open source software in the broader world. Learners, teachers and coordinators all agree that the tuXlab programme is a good concept. The findings of this evaluation, however, suggest that certain elements of the tuXlab model may need to be revisited. The main challenges that the programme faces are around defective hardware that prevent the effective use of the labs, limited capacity for the provision of adequate and affordable technical support, difficulties with capacitating schools to use their labs to become financially self-sustainable and competition with the Khanya Project, which has an advantage in terms of resources and provincial government backing. Even if the costs of the lab were to be increased through the use of new rather than refurbished second hand hardware, the costs saved by not having to purchase licensing fees for software would still be substantial. If tuXlabs programme were to close and/ or be subsumed into the Khanya project or transformed into Khanya labs these unique advantages would be lost.

The tuXlab programme also offers something unique to schools and the education sector in South Africa, in terms of its affordability, flexibility (it is customisable to suit the needs of individual schools) and thin client design, which offers advantages for administration of the system.

references

Davidson, E. 2005. Evaluation Methodology Basics. SAGE Publications, California

Isaacs, S. 2007. ICT in Education in South Africa. Survey of ICT and education in Africa: south Africa country report - South Africa. InfoDev. www.infodev.org

Pandor, N. 2007. "E-learning in South Africa". Department of Education. World Ministerial Seminar on Technology in Education "Moving Young Minds", Queen Elizabeth II Conference Centre. Westminster, London

Public ICT access and software choices in Africa. Comparison study of free/open source and proprietary software in an African context. 2005. Bridges.org. 24 May, 2005. http://www.bridges.org/publications/21/exec_summary

Open source Initiative. 2008 http://www.opensource.org/docs/definition.php

Programme documentation from the Shuttleworth Foundation and Inkululeko Technologies