The Broader Issues of Introducing a Digital Kids Programme

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ABSTRACT

The Digital Kids project is set in the context of establishing a pipeline for science, engineering and technology - as part of the Young Engineers and Scientists of Africa initiative. This was incubated within the Meraka Institute. Digital Kids aims to nurture key 21st century skills, especially digital literacy, in the youth of South Africa, thereby contributing to a larger human capital development process.

Digital Kids starts where computer literacy ends, promoting digital literacy by exposing learners to two- and three-dimensional graphics and animations, video editing, blogs, wikis and an introduction to programming - by using predominantly open-source, freeware and shareware software. Options for future sessions with these Net Generation learners include Live CDs, bootable USBs and portable applications. This paper will also look at some of the lessons learnt from the introduction of Digital Kids into a school environment, since these lessons may have an influence on the development of this initiative.

The concept of a digital divide has been devised to portray a life for learners beyond their level of basic access. This alternative approach integrates the digital divide into a technological ladder, encouraging and equipping learners to find their niche beyond computer literacy - all the way up to an ICT-facilitated practitioner. The country is in need of Prensky's Digital Natives to become thinking technologists - able to take full advantage of a wide range of software to master digital age skills. The skills learnt are to be viewed as tools to enable individuals to take full advantage of the knowledge society.

Key Words

21st Century Skills, Creativity, Digital Divide, Digital Literacy, Innovation, SET Pipeline

1. Introduction

In keeping with the South African Government's intense drive to harness and improve the skills of South Africans needed to sustain an accelerated economic growth, the Young Engineers and Scientists of Africa (YESA) programme was established in 2009 by the Meraka Institute (2007). It was sponsored by the South African Department of Science and Technology (DST). The aim of this intervention was to initiate and nurture the pipeline of science, engineering and technology (SET) graduates and postgraduates by addressing the problems - starting from pre-school to Grade 12.

This was undertaken in direct response to an ever-increasing shortage of skills in these areas. At the launch of the Joint Initiative on Priority Skills Acquisition (JipSA), it was announced that "professional skills in engineering, science, finance and management, as well as technical and artisan skills, were critically needed as the South African economy moved into higher gear" (Mlambo-Ngcuka, 2006).

The Accelerated and Shared Growth Initiative for South Africa (ASGISA) has "identified the shortage of skilled labour as one of the six constraints to its goal of boosting economic growth to 6%" (ASGISA, 2006). As South Africa moves more towards a knowledge-economy, there is an increased need for innovation and associated products, infrastructural development and improved maintenance programmes. The time is now right to make a long-term investment in the future generations by introducing interventions that will contribute positively to the nurturing of future graduates with the right knowledge, skills, attitudes and values needed to feed the South African National System of Innovation (NSI) and to meet the Millennium Development Goals.

This article will focus on one of the YESA programmes that is referred to as "Digital Kids". The intention of the research was not to conduct a detailed quantitative or qualitative investigation, but rather to focus on establishing a proof-of-concept and identifying some of the issues involved in introducing such a programme in a developing world scenario. Open-source, freeware and shareware software were all used to promote creativity and innovation - while developing 21st century skills. The research also sets out to investigate the feasibility of introducing such an intervention into the South African schooling system in extramural technology clubs.

Learners from five primary schools and two high schools in the Tshwane, or greater Pretoria metropolitan area, were exposed to the programme - with one school being adopted as a 'YESA school' - where a technology club was established.

Eighteen teachers attending the Advanced Certificate of Education (ACE) at Rhodes University were also exposed to certain aspects of the programme.

Though the penetration rates are low, there is a growing number of schools in recent years in South Africa that are placing a higher priority on exposing learners to the world of computer literacy through the acquisition of computer labs. This is happening with varying degrees of success. These scarce resources have generally provided limited access to a select number of learners to teach basic computer literacy - with little focus on skills higher up the technological ladder.

The Digital Kids programme should be viewed, not as an isolated entity, but rather as an integral component of a much larger process of equipping youth to operate more effectively in a technology-enriched knowledge economy. Digital Kids starts where computer

literacy stops. It can also contribute to developing digital resources for educational purposes across all subjects and grades.
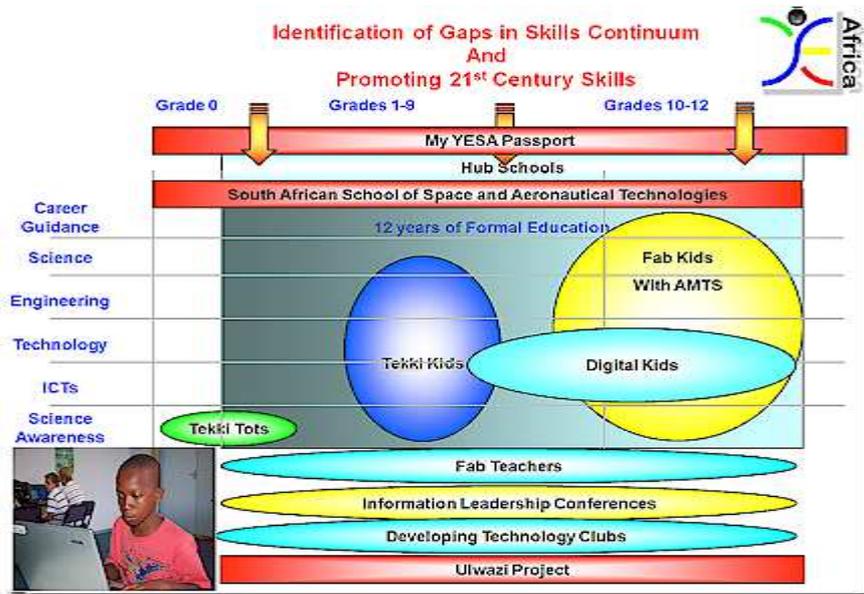

Figure 1: The YESA Skills Grid

Figure 1 represents the YESA skills grid; this was used to conceive the different interventions and to develop a skills continuum across all the grades. Each of the interventions was mapped according to the focus area of the skills involved. This same approach will be used to formulate future programmes to address identified gaps in the current system. The Digital Kids programme is set in the context of the recently introduced Outcomes Based Education (OBE) in South Africa. This emphasises skills development.

2.   Concept Analysis

2.1.   Action Research
The methodology that was adopted for this case study was based on the principles of action research.

> Although there is a plethora of terms coined to describe this, research reflects wide disagreement on many key issues. Most agree on the following: action research is inquiry that is done by or with insiders to an organisation or community, but never to or on them. It is a reflective process, but it is different from isolated, spontaneous reflection - in that it is deliberately and systematically undertaken and generally requires that some form of evidence be presented to support any assertions. What constitutes evidence or, in more traditional terms, data is, however, still being debated(Herr, 2005, p. 3).

> Action research is oriented to some action or cycle of actions that organisational or community members have taken, are taking, or wish to take, to address a particular problematic situation. The idea is that changes occur, either within the setting and/or within the researchers themselves (Herr, 2005, p. 3).

> Typically, action research is undertaken in a school setting. It is a reflective process that allows for inquiry and discussion as components of the "research." Rather than dealing with the theoretical issues, action research allows

practitioners to address those concerns that are closest to them, ones over which they can exhibit some influence and make any necessary changes (Ferrance, 2000, p. 6).

2.2.   Digital Literacy

What exactly does it mean to be *literate* in the "post-modern" world? And what are educators talking about when they use the term "computer literacy" these days? On the one hand, "literacy" conjures up images of the technical skills required to "read and write," the denotation that the United States Army reinforced when it coined the term *functional literacy* during World War II. This line of thinking, as a number of literacy experts have noted, bred the ideas of "survival literacy" and "basic literacy."

However, the second strain of literacy, *critical literacy,* vexes the conversation far more today because of its many connotations, most of which stem from the idea of what it means to be "educated."

Though they may not be able to articulate it, many people intuitively understand that "functional literacy", though the prerequisite to other types of literacy seldom demands higher- order thinking skills. The teacher who incorporates new technology into her classroom may help students to learn how to "read and write", but she also needs to teach them how to interpret and "contextualise" the words and information they encounter in chatrooms, discussion forums, websites and more (Burniske, 2000).

Prior to the 21st century, literature defined a person's ability to read and write, separating the educated from the uneducated. With the advent of a new millennium and the rapidity with which technology has changed society, the concept of literacy has assumed new meanings. Experts in the field suggest that the current generation of teenagers possesses digital competencies to effectively navigate the multidimensional and fast-paced digital environment. For generations of adults who grew up in a world of books, travelling through cyberspace seems as treacherous and intimidating as attempting to speak a new language (Jones-Kavalier, 2006).

The public is often reminded that computers are powerful tools. The implication is, that with their use, personal power can accrue to the user. In the broadest sense, history does show a fluctuating connection between new literacy tools and power - in that success comes to those who can understand and manipulate at least one of two main domains of the information technologies: (a) the technical information infrastructure; that is, the physical properties and raw materials of literacy, including the tools, the technical personnel, the systems design, and the distribution mechanisms; and (b) the information itself, or more precisely, the discursive style that is peculiar to each medium and that shapes its content (Tyner, 1998, p. 3).

Tyner goes on to suggest a third way to use "literacy as a source of social power, and that is the ability to decode information into a variety of forms, analogous to the reading of print, but also applicable to audio, graphics and the moving image" (Tyner, 1998, p. 4).

The primary role of education is to equip a future generation to become effective citizens within a defined community. In an ideal world this would include a global village which is a goal for which educators should strive. With the introduction of modern information communication technologies (ICTs), the concept of globalisation has come to the fore - with more and more individuals finding themselves exposed to other societies. "The dynamic

forces behind this era of globalisation were breakthroughs in hardware - from steamships and railroads in the beginning - to telephones and mainframe computers towards the end" (Friedman, 2007, p. 10).

Given the recent advances made in computers, improved networking capabilities, and more recently the processing power of mobile phones, connectivity to the rest of the world can be achieved from virtually anywhere, at any time – and it is not necessarily confined to an office, school or home environment.

The skills of the digitally literate are becoming as necessary as a driver's licence. The Internet is the fastest-growing medium in history. Whether we like it or not, this will affect you, and those around you at home and on the job, from the merging of your television portraying images with network data, to the emergence of communities of users whose activities will change the shape of commerce and education. The Net's growing universality will create priceless resources for learning and self-advancement. If these won't overwhelm your life overnight, they will surely change it, subtly, continually, and with irresistible force (Glister, 1997, p. 2).

Digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and emotional skills, which users will need in order to function effectively in digital environments. The tasks required in this context include, for example, "reading" instructions from graphical displays in user interfaces; using digital reproduction to create new, meaningful materials from existing ones; constructing knowledge from a non-linear, hypertextual navigation; evaluating the quality and validity of information; and have a mature and realistic understanding of the "rules" that prevail in the cyberspace (Eshet-Alkalai, 2004, pp. 93-106).

2.3.   The Technological Ladder vs the Digital divide
The origins of the term 'digital divide' emerged in the late 1990s in America. It was set in the context of the ancient problem of information inequality, the knowledge gap, computer literacy, and participation in the information society. Commonly, the digital divide was defined as the gap between those who do and those who do not have access to computers and the Internet. Access first of all meant physical access: having a personal computer and Internet connection (van Dijk, 2005, p. 1).

The term 'digital divide' caters for the clear demarcation of those who have access to technology and those who do not, but it does not envisage a future for learners and users beyond mere access. An alternative philosophical approach to the concept of the Digital Divide is to rather view the situation as a Technological Ladder - as represented diagrammatically in Figure 2. This is done in order to convey further development beyond mere access, as proposed by Beyers (2008).
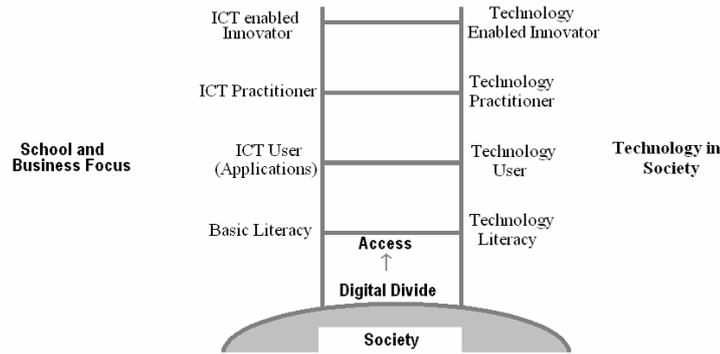
School and
Business Focus

ICT enabled Innovator — Technology Enabled Innovator

ICT Practitioner — Technology Practitioner

ICT User (Applications) — Technology User

Basic Literacy — Technology Literacy

Access
↑
Digital Divide

Society

Technology in Society

Figure 2. A Schematic Representation of the Concept of a Technological Ladder

The importance of the Digital Divide is not diminished in this model, but it is seen as the initial step to be overcome through the provision of access. The concept of a Technological Ladder implies the need to continue to provide ICT developmental targets higher up the ladder to which learners may aspire. Unfortunately, many learners will either remain on the first rung or even slip off it - as they are frequently left unprovided with any additional support or the necessary access time to further develop their newly acquired skills(Beyers, 2008).

Once basic literacy has been achieved, users need to be exposed to a variety of packages in order to become competent users. Beyond that, it is the mastery of the tools where ICT constitutes the main part of their future professions. The ultimate goal is the utilisation of the power of ICTs to conceptualise and realise their creative talents in the form of innovations (and ultimately patents). By providing challenges for ICT and other technology users, they need to be afforded the necessary support and vision of what can be achieved - rather than to be left as casual users of the products (Beyers, 2008).

Developing digital literacy in learners can no longer be merely a "nice route to go" for the more-advantaged schools. The education system needs to nurture more individuals who are better prepared to participate as effectual citizens in a digital world, and who can make a productive contribution to the economy. Simply put, "students who create "documents" to be saved in "folders" and placed on a "desktop" are learning how to speak a corporate language" (Burniske, 2008, p. 9). If this is the case then learners on the wrong side of the digital divide will find it increasingly difficult to compete for jobs in the corporate environment.

2.4.   A National System of Innovation (NSI)

It is important to consider the impact of the formative years on the number of doctoral students a country can produce. The yardstick for innovation is generally the number of PhDs that a country produces. To increase capacity in the pipeline it is necessary to return to the source and make a long-term investment from as early an age as possible - in the hope of increasing the human capital feeder stock. YESA is the start of such an initiative and will feed into the South African government's awareness of the need to stimulate entrepreneurship, innovation and growth in knowledge-intensive businesses.

Science and technology education, innovation and commercialisation are integral components of our National System of Innovation (NSI). The key challenges are adequate funding, skilled human resources, improved private sector R&D, protecting and exploiting intellectual property, and integrating a fragmented government science and technology system (Comins, 2009).

3.   The Digital Kids Programme

The seeds for the Digital Kids approach were sown in the late 1990s. While teaching Science to Grade 10 learners, the researcher had the opportunity to also teach Computer Science to the same group of learners. Given the fact that the curriculum was not very prescriptive in the middle grades in a private school environment, it was possible to introduce additional software packages to encourage learners to draw on a range of solutions – in order to enhance the presentation of projects submitted in other subjects. It was during one of these sessions that learners were asked to apply their newly acquired skills by using two software packages, namely Microsoft Paint and Ulead GIF Animator 1.5.

Assuming a more traditional approach to the teaching of the concept of the Electrolysis of Copper II Chloride, one may assume that the learners would be expected to draw and/or annotate a diagram of the process for which marks would be allocated accordingly. Figure 3 represents a memorandum for the marking of such an annotation.
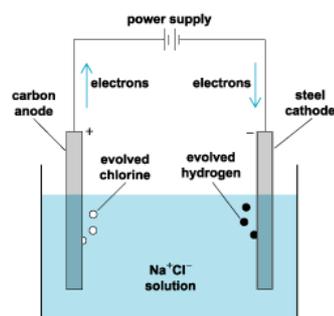

Figure 3: representing the annotation of the Electrolysis of Copper II Chloride (Electrolysis, 2009)

After completing a section on Chemistry the learners were then tasked to produce an animated Gif as part of a cross-curricular project using the newly acquired skills. Though there were varying degrees of success and some poor efforts, there was one in particular which is highlighted in Figure 4 as a successful effort.
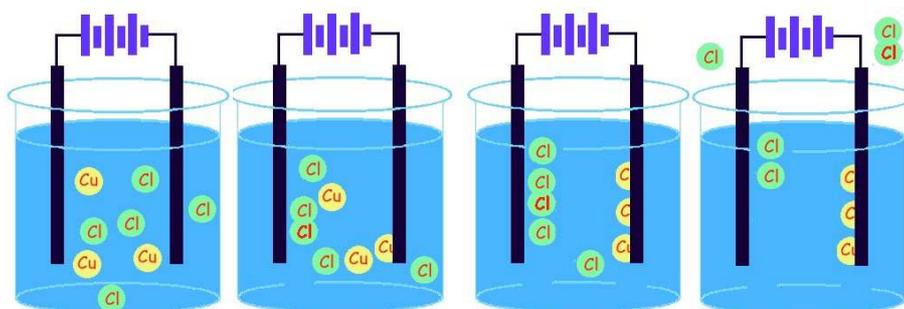

Figure 4 represents a select number of graphics in the animation series.

The following is a summary of three key lessons learnt from the exercise:

- The learners were able to translate their academic content into a digital format.
- This methodology provided for the identification of the more creative individual through the quality of the work produced.
- The materials developed could be used as a teaching resource.

The ability of the teacher to identify misconceptions in Science is often difficult. In this case it was possible to ascertain that the learners who produced the animations had a basic

understanding of the process of electrolysis, but had failed to address the following problems:

- The 'ions' depicted in the animations were not clearly indicated as being charged.
- Chlorine was not depicted as being diatomic, (only in the last diagram).
- There was no indication of the flow of electrons.

Assuming that the learners were assessed in the traditional manner, they would probably have been awarded full marks for annotating and drawing a scientific sketch of the process, but this assessment would not have included an assessment of their ability to 'apply their knowledge'. Given the fact that the animations had inherent faults, one could potentially assume that it was of no use for teaching purposes. On the contrary, this same animation was used on a regular basis to highlight the importance of understanding the scientific processes, rather than absorbing mere rote learning of the content.

This opened up opportunities for further dialogues with the learners who were then encouraged to move on to more complex two- and three-dimensional graphics and integrated as animations. A key element for the researcher was that this provided an opportunity to 'see into the minds of the learners'.

4.   Pilot Project Feedback

A key approach that was adopted during the pilot phase was based on utilising the available resources at the schools where, in this case, all training was conducted in a Microsoft Windows environment. Table 1 represents the number of schools that participated in the pilot project, together with the type of software used for training.

The schools were chosen on the basis of permission from the principal and the availability of a computer laboratory. Most of the schools were also involved in some way with the other initiatives of YESA, but not necessarily with the same group of learners. The decision as to which learners were selected was left entirely to the individual schools where the grades the learners were drawn from, was agreed upon between the school and the researcher at the outset of the meeting with the principals.

Once selected, the parents were sent a letter of introduction, together with a general indemnity form and a request for the necessary permission to proceed.

The software that was selected was based on the availability of open-source, freeware and shareware versions. Though there may well be more sophisticated software available for each of the software titles listed, they were generally selected for ease of use by learners. The emphasis was placed on providing the participants with a broad range of digital experiences during the initial training session. The intention was to then locate more advanced packages during the second and third years of repeating Digital Kids to the same set of learners.

The programme has not yet completed a full year of implementation, but this aspect will be borne in mind. It must also be noted that the list of software packages should not be seen as a definitive list, as further titles could yet be added to the list based on the interest levels of the learners.

	1. Meraka Staff Children	2. Hatfield Christian School	3. Gatang Comprehensive	4. Irene Primary School	5. Lynnwood Primary	6. Rhodes University (ACE)	7. Anton van Wouw Primary	8. Garsfontein Primary
Number of Learners	12	14	28	25	15	18	25	22
Microsoft Paint *Create a series of graphics*	X	X	X	X	X	X	X	X
Paint.Net *Editing and creating images*							X	
ULead Gif Animator *Merging a series of images*	X	X		X	X	X	X	X
Cinema 4D 6E *3D Graphics and animations*	X			X		X		
Microsoft Publisher *Business Cards and Letter Heads*			X					
Microsoft Front Page *Web Page designs*			X					
Microsoft Movie Maker *Capturing and editing video images*	X	X		X	X	X		
Microsoft Gif Animator *Merging a series of images*							X	X
Pivot Stick Animator *Stick animations*							X	X
CamStudio *Screen capturing for training videos*							X	X
PB Wiki *Storing work, blogs, collaboration*		X					X	
Gmail *Email communications*							X	
VLC Media Player *Viewing videos*							X	X

Table 1: Software packages used in the teaching of Digital Kids per group

School 3 presented an interesting case. The intention was to include as broad a range of schools as possible - especially where the institution in question was in a previously disadvantaged community with a computer laboratory that was part of a provincial education departmental project. The PC securities had been so tightly configured that no additional software could be installed, even with six provincially appointed computer laboratory assistants in attendance. As a result of this, the session was restricted to the Microsoft software that was available on the system: with understandably limited outcomes.

The end product of each of the training sessions was a broad range of educational multimedia. Though the scope of this research was not to determine the efficacy of these end products, there can be little doubt that the learners were actively engaged in the process of acquiring new skills. All the lessons were conducted outside normal school hours.

In general learners were left with a positive attitude of "I can do IT". Apart from the school where the securities prevented the installation of software and the university environment where there were technical difficulties and security issues, the rest of the sessions were regarded as being generally successful. This was based on the fact that all the learners were able to complete the assigned tasks with varying degrees of creativity. However, further investigations are necessary to determine the effectiveness of this - by using the appropriate tools and methodologies.

5. Additional research opportunities

During the investigation into different operating systems: open-source, freeware and shareware, further opportunities emerged. The cost factor to the parents was an important consideration. All schools, except for school 7, did not pay for the training that was conducted, as the work was regarded as being part of a pilot phase of the investigation. In the case of school 7, four x five-hour sessions were conducted on Saturday mornings over a period of one school term. The software that was implemented was open-source software, thereby implying that no additional costs would accrue to the Technology Club.

Opportunities that need further investigation include the use of distributing Linux operating systems (OS) on bootable memory sticks, or as Live CD distributions as an alternative OS to Windows. The advantages of this are that users are able to boot up a fully functional OS without affecting the host machine's installation settings. Users are provided with a full Linux experience before deciding to take the bold step of installing the OS on their own PCs. The price to pay for such an experience is additional booting time, but this has to be weighed up against the portability of the OS to another PC.

Other alternatives are to set up virtual machines on the host machine with an additional OS, but this does require higher specifications on the host machine and additional skill sets.

Early versions of computer software did not require complex installation processes involving permanent storage devices - contrary to the modern resource-hungry versions of many office suites and other commercial packages. This model of distribution restricts the software to a single station and further licences are required for additional computers to remain legal. A class of software which is emerging is referred to as Portable Applications which can be installed on to a flash drive.

> Free Portable Software, Portable Freeware and Open-Source Portable Applications that can be run directly from a USB device are also required. It is possible to instal any of the portable appliances to a USB flash drive, thumb drive, pen drive, iPod or almost any other storage device. One can carry applications, tools, software, personal settings and files (in one's pocket) to use on any available Windows (or Mac in some cases) client's computer.

Many applications run entirely from the portable device, saving personal settings and changes back to the same device (Pendriveapps, 2006).

For learners, the ability to customise an application - and to transfer their own personal data between home and school - is certainly an advantage, provided the flash drives are not mislaid. Learners, after a Digital Kids session, often requested permission to remove the files that they had created to 'show their parents'. Portable applications of this nature could be sourced for future training sessions. Two applications that fall into this category would be Gimp (an open-source image manipulation programme (GIMP, 2009) and Blender (open- source, cross platform suite of tools for 3D creation (Blender.org, 2009).

In a teacher-centric mode of education, learners are expected to proceed at the pace defined by the teacher. Given the opportunity - especially in the absence of any supervision - learners who are interested in a topic are able to teach themselves: given the right resources. With the introduction of the Internet individuals have virtually instantaneous and potentially unlimited access to a wealth of information which is now at their fingertips. Numerous text-based and video-based tutorials are freely available for all the software packages used - ranging from entry level to advanced users - with a wide range of examples.

Over the past few years there has been a significant development of a broader range of software solutions which are no longer constrained by computing-processing power or memory and storage capacity. Earlier methods of delivering digital information were text-based. These have now become superseded by high-powered multimedia and virtual reality. These options can teleport learners into worlds previously not possible, giving thereby new meaning to Prensky's Digital Natives (Prensky, 2001).

6.   Conclusions

This paper focuses on some of the issues and possible solutions to introducing supplementary programmes into schools through such initiatives as Digital Kids. This can now be done within the context of YESA, thereby promoting creativity and innovation. Although this paper serves to document the initial stages, further research is needed to measure the learning gains of such an initiative. This can be done by using the appropriate tools and research methodologies. This will assist in unravelling the complexities of introducing ICTs into classrooms - especially in a developing world scenario.

The main outcome of the South African Government's White Paper on e-Learning is for: "Every learner in the Grades 1-9 to be ICT-capable by 2013": (Department of Education, 2004, p. 38). The document also makes reference to the need to go beyond computer literacy and to "developing the skills necessary to operate various types of information and communication technology" (Department of Education, 2004, p. 15).

Given the low penetration rates of computers into schools, high learner-to-computer ratios and inadequately prepared teachers, the chances of this becoming a reality for all Grade 1-9 learners is low.

The question is whether the South African society can afford to bear the costs of computer and digital ignorance - thereby adding weight to the old saying: "If you think education is expensive, try to cost ignorance" (Author unknown).

Educators should be encouraging the Net Generation to become knowledge producers, as learners have the adaptability to take full advantage of the convergence of modern technologies in an era of ubiquitous computing. Educators should be encouraging the use of mobile devices and fostering the ethics behind them to generate new forms of re-usable knowledge by using tools that unleash the creative and innovative spirit amongst more learners.

The Digital Kids experience has provided an opportunity for learners to develop digital and technology literacy within their educational context. "The shift from broadcast to interactive media is the cornerstone of the Net Generation, as they want to be users – not just viewers and listeners" (Tapscott, 1998, p. 3).

The introduction of Digital Kids into school environments has the potential to develop further e-skills to the point where learners can now generate very comprehensive e-portfolios which can be submitted for assessment. The question is whether teachers will be able to effectively assess such work when submitted in this format. This raises the potential to introduce a Digital Teachers programme to create a more sustained intervention for Digital Kids through the introduction of extra mural Technology Clubs in YESA-adopted schools. Digital Parents are also a distinct possibility for creating channels of communication between parents and their children. Parents need to be immersed in the 'language' of their children, while at the same time being exposed to the same or similar skills-development processes.

"Instead of being the targets of an educational system, learners should be offered an opportunity to be actively engaged in a constructivist manner" (James, 2001, p. 37) in the world with which they are familiar. They should further be encouraged to interact with it in ways that adults and teachers find difficult to comprehend - let alone to be able to teach in. Ideally, the modern curriculum should be equipping learners with the tools, skills, attitudes and values needed to take full advantage of what the digital world has to offer.

Digital Kids provides an opportunity for learners to climb the technological ladder. This opportunity is seldom being provided within the national curriculum in most schools in South Africa.

Adopting a more holistic approach to nurturing the SET pipeline, YESA is suitably positioned to make a meaningful contribution to the development of a range of e-skills, while simultaneously exposing learners to 21st century skills of Inventive Thinking, Digital Age Literacy, Effective Communication, High Productivity (Lemke, 2003, p. 5). Added to this is creativity and innovation as recipes for engaging learners within the stimulating environment of Technology Clubs.

Glossary of Terms

2D   Two-Dimensional

3D   Three-Dimensional

ACE   Advanced Certificate in Education

AsgiSA   Accelerated and Shared Growth-South Africa

DST   Department of Science and Technology

ICT   Information Communication Technology

JipSA   Joint Initiative on Priority Skills Acquisition

NSI   National System of Innovation

OBE	Outcomes Based Education
OS	Operating System
R&D	Research and Development
SET	Science, Engineering and Technology
YESA	Young Engineers and Scientists of Africa

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