3D Interactive Visual Simulations (VR) as an aid to Learning in Africa

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VR from an African Educational Perspective

Dr Rita Kizito - UNISA

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VR in Africa – for Africa – by Africa

The Naledi 3D Factory (Pty) Ltd
The Innovation Hub (3rd Floor, Building 46, CSIR)
PostNet Suite 213, Private Bag X844, Silverton 0127
Tel. (012) 844 1010 (082 894 3178)
Fax (012) 844 0024
dlockwood@naledi3d.com (http://www.naledi3d.com)

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1 PREFACE

UNESCO has, since 2000, supported a number of initiatives with the Naledi3d Factory that have explored the potential of Virtual Reality (VR) as a learning tool in Africa, to date in Ethiopia, South Africa and Uganda (summarized in the box).

In order to define a way forward in this project area, UNESCO commissioned this report, which evaluates the comparative advantages of applying multimedia and interactive 3D tools to the learning environment. This project was divided into two parts:

1. An overview of the general practices and approaches to the use of multimedia and interactive 3D tools as learning aids, and
2. An evaluation programme in South Africa and Uganda covering a number of schools and community telecentres.

The authors prepared the overview with the collaboration of three other specialists which were commissioned to prepare four original papers: "VR from an African educational perspective" (Dr Rita Kizito, Learning Developer, UNISA); "Overview of the Brain" (Dr R.S. Day, ICT Executive, UNISA); "The Global Approach to Teaching and Learning" (Dr R.S Day, ICT Executive, UNISA); "Comparison of and the learning characteristics of educational multimedia" (Mr J. Hugo, Usability Sciences). These papers can be obtained on the Naledi3d Factory Publications Archive (http://www.naledi3d.com/navpage.html).

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Local Coordination - Uganda

Professor Paul Mugambi	Chairperson National UNESCO IIP Committee
Mr Lawrence Ssenkubuge	St. Henrys' College Kitovu Kings' College Budu
Mr Daniel Kakinda	SchoolNet Uganda
Professor Albert Lutalo-Bosa	Principal, Kyambogo University
Mr Walugembe	Kyambogo University

To date, VR initiatives in Africa have resulted in:

- The development of a VR model addressing the learning points around basic hygiene in rural African communities. The main aim of this project was to use interactive visual simulation as a means of demonstrating basic hygiene to rural communities and to focus primarily on sanitation, water and the prevention of associated diseases (such as malaria, bilharzia, dysentery and cholera). The resulting model was piloted and used at the Nakaseke Telecentre in Uganda. A second goal of this project was to pilot and test the use of VR as a computerised interactive training method in African Telecentres. Nakaseke is approximately 40 miles north of Kampala.
- The training at the Naledi3d Factory in Pretoria of two VR developers from Uganda. Since the completion of the second training session in early 2002, other pilot VR models have been developed, including "DC motors" and "French for Ugandans", both of which have been used in Kings College Budu and St Henry's Kitovo, both Ugandan schools.
- The creation of a formal VR Committee in Kampala, established to co-ordinate VR initiatives in the country; with representation from two universities (Makerere and Kyambogo), SchoolNet Uganda, the Uganda National Commission for UNESCO, the Department of Education, the National Curriculum Development Centre, as well as a number of local schools.
- A VR workshop, sponsored by IICBA (International Institute for Capacity Building in Africa) and hosted by the Naledi3d Factory of Pretoria, in March 2002 with representation form Uganda, Ethiopia and Nigeria, resulted in pilot models to describe levers, relative velocity and chemical elements.
- A project using VR as an aid to helping young people of all ages in Alexandra (Johannesburg) understand better the job application process, how to keep a job and how to create your own employment space.
- A project to help educators in Ethiopia better understand and teach about HIV/AIDS, including the associated social, cultural and psychological issues.

Mr David Kalanzi	Uganda National Commission for UNESCO
Mr Micheal Galiwago	Educational Consultant
Mr Musa Luyinda	Nakaseke MCT
Mr John Ssenkunja	Ndejje Senior Secondary School
Ms Victoria Kisaakye	National Curriculum Development Centre.
Mr John Ssemmondo	Mengo Senior Secondary school
Mr Fredrick Matovu	Buwama telecentre
Mr Edward Jjuuko	Nabweru Telecenter

Local Coordination - South Africa

Mr J. Ramokwase (Principal-deceased)	Mamelodi High School
Mr R. Sebata (Principal)	Mamelodi High School
Mr C.M. Masuluke	Soshanguve High School

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2 VR from an African Educational Perspective

Dr Rita Kizito. Learning Developer, UNISA. Pretoria. South Africa

Virtual Reality (VR) is the technology that allows learners to become immersed in a computer-generated virtual world, redefining the human-computer interface (Bricken, 1990; Capanema et al, 2001). VR has now evolved into a computer-created sensory experience that allows a participant to believe in and barely distinguish a 'virtual' experience from a real one.

In an educational context, VR can be defined as a mode of interaction between the user (learner) and a computer-generated environment, in which the learner is able to:

a) Both view and manipulate virtual objects in a manner similar to what he or she would do in a real environment.
b) Heighten use of multi-sensory, multi- perceptual and multi-dimensional capabilities (visual, sound etc) in order to increase understanding in learning. (Fallom,2000; Osberg, 1992).

These two aspects, namely, the ability to interact with virtual objects in a natural way, and the heightened use of multi-sensory, multi-perceptual functioning by the learner, are what make VR a potentially powerful tool in learning. According to Fallman, VR can be used to "facilitate an interaction style of learning which stimulates, motivates and enhances student understanding of learning events", particularly in those areas in which uses of traditional methods of teaching have been inappropriate or inadequate.

2.1 VR forms

VR technology uses computerized tools and platforms to represent or re-create reality. This involves the creation of virtual worlds, environments or learning spaces in which the learner is immersed. It also involves the creation of virtual objects which the learner manipulates. Cronin's (1997) distinctions in Fällman (2001) are helpful in defining variations of user levels of immersion with VR, namely as:-

Un-immersive , non real interaction	Using desktop VR computer, the least expensive form.
Semi- immersive	Using work benches and reach-in displays
Fully immersive	Using head mounted display units isolated from the real world.

Fully immersive VR is the most beneficial but also the most costly and time consuming to develop.

The levels of learner participation within the virtual environments and the extent, to which these experiences will improve learning, are the key aspects which will determine whether VR has real benefits for education. Osberg (1992) envisaged that "the fusion of computers and telecommunications would lead to the development of highly realistic virtual environments that would be collaborative and interactive".

There have been recent development in this area. (Maseda et al, 2001) outline a successful initiative which has used virtual 3D environments together with intelligent agents to train teams of people working in emergence situations as part of the ETOILE (Environment for Team Organizational and Individual Learning in Emergencies) project. Another VR explorative initiative is reported in Ligorio's (2001) account on the activities in a virtual world 'Euroland'. The results show a positive impact on learning but the recommendation is towards further research to validate findings.

2.2 Some recent educational uses of VR

The educational benefits of VR depend on how its role in the educational process is defined. Recent uses:

- As an exploratory tool for simulation and training, VR has been used widely used in areas involving the teaching and learning about dangerous phenomenon University of Illinois at Urbana-Champaign, Projects such as such as the Severe storm analysis or the teaching of abstract and difficult concepts in Tracking and visualizing complex biological structures are in this category.

- Another area equally significant is the creation of virtual laboratories and the performing virtual experiments. Examples include :
  - Work at the National Taiwan Teacher's college in their creation of a Geochemistry lab of virtual reality (Fung–Chun et al, 2000);
  - carrying out of Physics experimental training such as that done at Kongju national University ;
  - work in developing web 3D Biology worlds and virtual experiments (Anon, 2002).

- The last area is where significant visualization is required to demonstrate or understand difficult concepts. Examples here are Long-Chyr Chang et al (2000) building of a web-based adaptive and interactive teaching zone for teaching mathematics and Stephen Chan et al. (2000) Computer aided learning systems for appreciation of 3D geometry. The Pauling, Maxwell and Newton worlds are all demonstrations within this area.

VR is usually used in areas where the experiments are expensive or difficult to perform in natural teaching and learning environments, or the concepts being taught are difficult to understand using normal textbook methods. The greatest VR potential use is in the area in which VR support experiences unavailable or impossible to achieve in current learning environments. Osberg (1992) describes this as "a sense of immersion and inclusion in a virtual environments which allows the learner an opportunity to interpret and encode his or her perceptions in a broader , deeper set of experiences than those existing in current standard educational environments".

These would include areas where changes in the relative sizes and perspectives or views are necessary for learning, cases where multi- sensory cues and dimensions would enrich learning, and in the areas which require the creation of abstract learning objects which have no physical representations at the moment. Many learning domains including Sciences, Mathematics, Engineering, Statistics, Economic and Financial Sciences, Art and Cultural exploration have such learning areas.

2.3 What are the educational benefits of using VR?

Previous and recent studies confirm that the benefits of VR use occur because of [Maseda et al, (2000); Fällman, (2000) Osberg (1992); Bricken,(1990); Capanema et al, (2001)].

- The similarity between the psychological processes in virtual and real environments
- The fact that VR gives students the opportunity to manipulate and interact with learning objects
- Increased activity and motivation towards learning that the VR environment induces. The excitement about a subject or the encouragement about learning through exploration, or the opportunity to give students a taste or glimpse of what it is like to be a research scientist in a deprived world such as the one we live in is worth the expense.

There is however emphasis on the fact VR should be used in those areas where text-based or other traditional methods are inappropriate or inadequate. All the recent studies suggest that there is more research still required to understand how and when this new instructional tool with instructional concepts can be effectively used. We need more studies with feedback from pupils collected and analyzed in order to quantify the pedagogical usefulness of this from of instruction.

2.4 The educational challenges of using VR

Osberg (1992) mentions several challenges, including;

- the transferability of the skills gained from the virtual to real environments
- how creativity is encouraged or rewarded in either environment
- the issue of who is really at the base of control of this environment

2.5 Drawbacks of VR in Africa

The potential for using VR has been exploited in areas such as pharmaceuticals, agrochemical and biotechnology research. VR has an important role to play in Africa and other regions of the world. It offers a new way to visually communicate ideas, skills and knowledge in a way that overcomes literacy barriers that are often experienced in education and training (Lockwood, 2002).

The challenges within the African context still lie with issues dealing with equity and accessibility. And as Osberg suggests, there are still questions that will have to be answered; questions such as:

- How is learning in VR beneficially different from that in a traditional learning environment?
- How can individual or collaborative learning be enhanced by using VR?
- How can we ensure that VR learning is empowering and not detrimental to the entire learning spectrum?

2.6 The way forward

There are many applications for VR but as educationists, we should be looking for ways of linking educational VR to real VR uses so as to justify the amount of time and resources that need to be spent on developing VR learning environments. For example, it is purported that surgeons may soon use VR to rehearse surgical operations on virtual patients and that these virtual surgical operations could revolutionize medical training. Scientists could explore celestial bodies; trace the generation and re-generation of harmful viruses using VR applications. Disabled persons, may one day be able to use tele-robotics to perform tasks unthinkable now.

It is time now for Africa to find solutions in which the use of modern technologies such as VR are developed to function in each contextual environment Dede suggests introducing technological reforms in the context of a systemic reform with simultaneous innovations in pedagogy, curriculum assessment , school organization and instructional technology. Extended professional development for teachers in innovative ways of deploying and sustaining technologies implementations is critical. Maximum efforts should be geared to wards developing and sustaining Strategies and delivery platforms suitable for the African context.

The main goal should be to empower the learner by maximizing the potential for learning. (Osberg, 1992).

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