BRINGING GIS TO SCHOOLS – CHALLENGE OR CHILDS PLAY?

Olivier, A

UNIGIS Unit, Faculty of Engineering, Department of IT, Nelson Mandela Metropolitan University, South Africa

ABSTRACT

Formal GIS education is to be introduced into Grade 10 Geography in South Africa as from January 2006. A survey was conducted among schools in the Eastern Cape. Fifty two schools responded. Out of those 88% offered Geography as a subject and only 44% offered computer literacy. The fact that South Africa falls short of other countries in the number of science and engineering graduates it produces must surely be a consequence of these limitations.

This paper will discuss the introduction of GIS education into schools in the Eastern Cape considering the lack of access to Information and Communication Technologies. The basic conceptual framework for highlighting this problem will take the form of a Pilot Project to be launched in January 2005. This Pilot Project will take the form of “adopting” an underprivileged school in the area and providing the necessary GIS training and background to both learners and staff alike.

These findings will be reported on in the paper.

INTRODUCTION

The total mid-year population for South Africa in 2004 was estimated at 46.6 million people, of which the Eastern Cape, one of nine South African provinces, accounted for 15.2% of this total. The Eastern Cape has a large rural population, a low percentage of employed people and a very high percentage of poorly paid employees.

As many schools in this area do not have the rudimentary facilities such as water and electricity, a computer is unheard of. How does one therefore adapt conventional GIS training to suit the needs of these learners?

Education purportedly accounts for a large portion of provincial spending. Up to 1998, the greater part of this was committed to personnel expenditure (salaries), leaving very little for capital expenditure or learning support materials. These aspects of the budget are, however, expected to grow by 35.7% over the next medium-term expenditure framework (MTEF) (RSA 2003:52).

The table below depicts the structuring of provincial budgets clearly indicating that salaries still account for a large portion of the budget.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>2644</td>
<td>2472</td>
<td>3479</td>
<td>3780</td>
<td>4328</td>
<td>4574</td>
<td>4832</td>
</tr>
</tbody>
</table>
Table 1. Provincial education expenditure per program (R million) (Source: RSA 2003:55)

<table>
<thead>
<tr>
<th>Program</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public ordinary school education</td>
<td>33 653</td>
<td>36 966</td>
<td>39 213</td>
<td>44 306</td>
<td>48 804</td>
<td>52 702</td>
<td>56 083</td>
</tr>
<tr>
<td>of which: primary school</td>
<td>20 322</td>
<td>22 200</td>
<td>23 709</td>
<td>24 526</td>
<td>27 121</td>
<td>28 920</td>
<td>30 807</td>
</tr>
<tr>
<td>of which: secondary school</td>
<td>12 493</td>
<td>13 695</td>
<td>14 703</td>
<td>18 970</td>
<td>20 802</td>
<td>22 825</td>
<td>24 293</td>
</tr>
<tr>
<td>Other</td>
<td>838</td>
<td>1 071</td>
<td>801</td>
<td>811</td>
<td>881</td>
<td>957</td>
<td>982</td>
</tr>
<tr>
<td>Independent school subsidies</td>
<td>176</td>
<td>206</td>
<td>187</td>
<td>196</td>
<td>235</td>
<td>245</td>
<td>253</td>
</tr>
<tr>
<td>Public special school education</td>
<td>1 116</td>
<td>1 134</td>
<td>1 356</td>
<td>1 446</td>
<td>1 595</td>
<td>1 665</td>
<td>1 764</td>
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<td>FET</td>
<td>754</td>
<td>827</td>
<td>869</td>
<td>1 082</td>
<td>1 201</td>
<td>1 276</td>
<td>1 360</td>
</tr>
<tr>
<td>ABET</td>
<td>362</td>
<td>410</td>
<td>401</td>
<td>512</td>
<td>551</td>
<td>595</td>
<td>637</td>
</tr>
<tr>
<td>ECD</td>
<td>199</td>
<td>197</td>
<td>248</td>
<td>449</td>
<td>510</td>
<td>538</td>
<td>591</td>
</tr>
<tr>
<td>Auxiliary and associated services</td>
<td>657</td>
<td>653</td>
<td>844</td>
<td>1 111</td>
<td>1 519</td>
<td>1 701</td>
<td>1 784</td>
</tr>
<tr>
<td>Other programmes</td>
<td>266</td>
<td>359</td>
<td>293</td>
<td>132</td>
<td>154</td>
<td>151</td>
<td>161</td>
</tr>
<tr>
<td>Total expenditure</td>
<td>39 828</td>
<td>43 223</td>
<td>46 889</td>
<td>53 102</td>
<td>58 897</td>
<td>63 447</td>
<td>67 465</td>
</tr>
</tbody>
</table>

Economic classification

| Current expenditure                    | 39 369 | 42 551 | 45 507 | 51 251 | 55 730 | 59 958 | 63 792 |
| of which: personnel                    | 36 221 | 39 308 | 41 531 | 46 046 | 49 322 | 52 718 | 55 813 |
| Capital expenditure                    | 459    | 672    | 1 382  | 1 851  | 3 167  | 3 489  | 3 672  |

According to The Development of Education Country Report of South Africa (2004) provincial and national governments have adopted budgetary targets to promote increased spending on non-personnel education inputs such as teacher development, resource materials, learner support materials and infrastructure. Hopefully this will even out the areas of spending which would change the above table considerably. In the 2003/2004 annual report issued by the Eastern Cape Department of Education the actual expenditure for that period amounted to R10 155,294, the budgeted expenditure was R9 911,993 this amounted to an over expenditure of R243,301. The over expenditure was ascribed to personnel expenditure.

So how does this affect resources in schools?

STATUS OF EASTERN CAPE SCHOOLS

“The vision of the Eastern Cape Department of Education is to provide an effective and efficient education system with staff committed to values of accountability, equality and democracy” (ECDOE).

There are many challenges that face the Eastern Cape Department of Education, budgets that do not meet needs, high levels of illiteracy and a Province that consists of a vast poor rural community which places a burden on service delivery.

There are a total of 6087 schools in the Eastern Cape. Of those schools 1279 do not have water, 1138 do not have sanitation, 1924 do not have electricity and 939 have unsafe structures. There are a total of 9835 existing classrooms that consist of mud huts or temporary structures. This places a burden on the introduction of computer technology courses to the schools curriculum.

THE 2006 CURRICULUM

To transform the education system in a way that would allow it to achieve the intended objectives, a major review became necessary. The review focused on the structure of the curriculum and qualifications, subject offerings, and human resource development. This review was carried out in the context of the imperatives of social and economic development and globalization (DOE 2003:11).

It is envisaged to introduce GIS as follows:

Grade 10 (2006 onwards)

GIS – general concepts e.g. systems, information systems, GIS, remote sensing
Geographical concepts e.g. spatial objects, lines, points, areas, scales (small versus large) and resolution (spectral and spatial)

**Grade 11**

Functional elements of GIS including:
- Data acquisition
- Remote sensing as a digital data source
- Preprocessing
- Data processing

**Grade 12**

Functional elements of GIS including:
- Data management
- Data manipulation and analysis
- Spatial analysis
- Product generation
- Application

**IMPLEMENTATION OF GIS AS RELATING TO TECHNOLOGICAL LIMITATIONS**

What are the problems associated with bringing GIS into schools in South Africa? One of the main reasons probably relates to the technological aspects. Most schools lack sufficient infrastructure. “There are still children in this country who are learning under trees. You obviously can’t put a computer under a tree” (Kehoko, 2004). Very few schools have access to computers, school budgets are tight and “luxuries” such as computer hardware, software and data are at the bottom of the list. Not all teachers are computer literate; there is limited use of IT in the pedagogic process, especially in government schools.

Another problem is related to teachers not willing to learn new skills outside their normal working hours, this may be due to lack of support from the education department, no guarantee of career advancement or the structure of salaries in South Africa. Further problems relate to educators being either under qualified or unqualified. In a study conducted by the World Bank, it was found that 60% of South African educators had not been trained in mathematics and science. An address by the South African Minister for Education, Naledi Pandor on the 25 August 2004 stated that the number of unqualified teachers had dropped from 85,000 in 1999 to 20,000 in 2004. These are still alarming figures.

Considering these limitations it is very clear that the implementation of the new curriculum may be unsuccessful taking into consideration the number of schools without computers and even more problematic, the number of schools without electricity.

**PILOT PROJECT**

**Selecting a school**

**Background:**

During the past few years the Spatial Technologies Unit at the former Port Elizabeth Technikon, now known as Nelson Mandela Metropolitan University has been running Geography/GIS Awareness Projects. Each year these projects had a different theme. Themes included:
- “Where do my possessions come from” where pupils had to demonstrate the importance of exploring the earth’s natural resources and the way that people use these resources.
- “Charting Countries of the World” where the aim was to explore the division and control of the earth’s surface which intended to help pupils attain skills in acquiring, organizing and analyzing geographic or spatial information.

The original decision of choosing a school was based on a number of different criteria:
- Continued participation of school over the past few years
- Quality of projects handed in
- Enthusiasm of school pupils
- Enthusiasm of teachers involved
- Lack of resources

The first school that was approached had entered excellent projects in relation to the facilities they had at their disposal ever since the project was started. The school does have water and electricity but only have access to one public phone. They have ten computers, none of which work. There is no money in the budget to have these fixed. The school also has one television and one video recorder, both broken. Their Geography teacher always showed a very keen interest and went to great lengths to uplift the education of her pupils. However, an unexpected predicament was encountered. The school’s principle would not allow us access to her school as the school was not going to receive any financial benefit per se. We tried explaining the benefit her pupils would derive, especially due to the introduction of the revised Geography Curriculum in 2006 but to no avail.

As a result, a decision needed to be made to approach another school. We found this task more daunting than anticipated. Our initial expectation was that schools would accept our offer of free GIS training without hesitation but this proved an incorrect assertion. After a number of phone calls and letters we received a positive response from one of our previously disadvantaged schools, Woolhope Secondary School. Thanks to the wonderful efforts of their Head of Geography, lessons commenced on Monday afternoons after the official school day had ended.

**Woolhope Secondary School:**

Woolhope has about 860 pupils and 30 staff members. Geography is offered as a subject from Grade 8 through to Grade 12. Computer Science is offered from Grade 10 to 12. The school is positioned in the suburb of Malabar which has a mixed community of Indian and Colored residents. The Malabar suburb originated as an Indian township on the farm Woolhope. It was previously also known as Woolhope, Indian, India and finally Malabar.

![Map 1. Port Elizabeth Suburbs (Source: Nelson Mandela Bay Tourism)](image-url)
Where does one start? The whole idea was to offer skills development to both teachers and pupils. Should lessons be theory based or application based? The first lesson focused primarily on map literacy skills. This was achieved by making use of a resource called MapTrix. In essence the MapTrix Kit is an outcomes-based learner kit covering twelve basic geography lessons. The kit progresses as a game. It consists of fifty-two work cards, fifty-two answer cards, ten learners’ booklets, an educator’s guide and finally a 1:2 000 000 wall map of South Africa. The fifty-two work cards feature different extracts from the South African topographic map sheets with ten graded map reading questions. The back of the work cards clarify all the geographic terminology and certain information about the area depicted. This lesson was very well received. The pupils were so engrossed and the scheduled lesson finished much later than anticipated. Once we were satisfied that the pupils had the basic map literacy skills we moved on to the basics of GIS. This included explaining what is GIS, how does GIS work, what does one need to make GIS work.

One observation made was the lack of spatial thinking within the classroom. The pupils struggled with the concept of spatial thinking, especially when based on specific scenarios. The pupils were asked what they wanted to do when they completed their schooling. They were then asked how GIS might be of assistance in their chosen profession. This brought about much confusion. The pupils seemed to follow the Auditory-Sequential way of thinking. This relies on hearing and words, they think in sentences and remember what they hear better than what they see. Teaching methods in South Africa lean towards Auditory-Sequential thinking i.e. the teacher will give a verbal lesson and the pupils will then make notes or at most work through a lesson plan/sheet. This however may change with the introduction of Outcomes Based Education (OBE). 2006 marks the year of implementation for the new National Curriculum Statement. OBE was to be phased into Grade 10 in 2004. Grade 11 will be phased in during 2005 and Grade 12 during 2006. Will this solve the problem in the Eastern Cape? There are not enough teachers in many of the Eastern Cape schools to service the new curriculum offerings due to budget constraints. The provincial office also lacks subject specialists to provide guidance and quality control, therefore it remains to be seen if OBE will succeed.

Spatial thinking requires the pupil to rely on images, they think visually. “I am always ready to learn, but I do not always like being taught” Sir Winston Churchill.

According to the book “Upside-Down Brilliance: The Visual-Spatial Learner” spatial thinkers are known to have some of the following strengths (Silverman 2002):

- Fascinated by computers
- Excellent at geometry
- Visual memory
- Creative
- Imaginative
- Abstract reasoning
- Excels in analysis
- Good reading comprehension
- Excellent sense of humor

Dr Silverman (2002) has suggested various instructional strategies for increasing spatial strengths:

- Using visual imagery in the class
- All hands-on experience
- Avoid timed tests and allow more classroom assignments
- Avoid drill and repetition
- All pupils to construct, draw or create visual representations of concepts
- Use computers i.e. material presented visually

To understand maps and their creation, the pupils will have to form an appreciation for the use of images and a holistic picture that links the eye, mind, ideas and maps needs to be forged.

The practical component of the lessons makes use of ESRI products. The textbook entitled Mapping Our World: GIS Lessons for Educators was used as a basis. In addition to the lesson plans the book also includes a one-year licence of ArcView 3.x. The textbook was re-written by GIMS (Pty) Ltd South Africa, the local ESRI suppliers using South African data. Before embarking on the practical component, the pupils needed to focus on certain questions.

- How do they perceive things?
- What are they doing when they interpret what they see?
• How in their minds do they use the images they see?

These questions are essential when it comes to GIS from the design phase through to the completed map.

There are a number of GIS-based activities available to improve spatial thinking skills. ESRI’s ArcVoyer was created as a tool for developing spatial thinking. The software moves from simple exploration to critical analysis of patterns and trends.

A tentative lesson plan has been setup, however as this is a pilot project; changes are bound to be introduced as the project goes along. The tentative areas to be covered to date are as follows:

• Computer literacy
• Map types
• Basic cartography
• Point, line and area data
• Basic database concepts
• ArcView layouts
• Views and tables
• Navigation
• Manipulation
• Legends
• Querying
• Aerial Photography
• Satellite Imagery
• GPS
• PDA

During these lessons it is hoped to address social and environmental problems through the examples used also to emphasize group work and co-operation. This experience needs to be about cooperative learning and teamwork.

CONCLUSION

With the unemployment rate in South Africa at a staggering 26.2% as measured in September 2004 by Statistics SA, school leavers need to equip themselves with skills relevant to face this challenge. There is a great need for transformation in education, from an operations point of view to one of educational content. With the new National Curriculum Statement being brought into effect from 2006, may this be a step in the right direction.

The Nelson Mandela Metropolitan University UNIGIS Unit hopes that this pilot project will bring some enthusiasm and above all enjoyment to both the teachers and pupils at Woolhope. One does not always need the best facilities or endless resources to educate willing minds.

“If you are planning for a year, sow rice; if you are planning for a decade, plant trees; if you are planning for a lifetime, educate people” Chinese proverb.
REFERENCES


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Olivier, A

UNIGIS Unit, Faculty of Engineering, Department of IT, Nelson Mandela Metropolitan University, South Africa

Biography

Ann Olivier is currently reading for her Masters degree in GIS from the Nelson Mandela Metropolitan University. She has worked in the field of GIS for the last 9 years. She heads the Spatial Technologies Unit at the Nelson Mandela Metropolitan University and lectures Introduction to GIS, Data Acquisition, Data Quality and GIS and Organizations.

Her research interests are education and GIS.
A Geographic Information System (GIS) combines maps and information databases to produce graphic displays that allow users to see and manipulate data in new ways. Learn how a GIS works and how to create your own GIS classroom activities. Included: Online resources for GIS lessons, activities, and projects. NASA used it to determine landing sites for the Mars Surveyor. School administrators use it to determine school district boundaries and school bus stops. Students in Harrisburg, Pennsylvania used it to measure radon gas levels in local housing developments. Students in Boston used it to study the water quality of the Muddy River. Students in Detroit, Michigan, are using it to locate, identify, and map hazards and dangerous conditions in their neighborhoods.