GIS in the geography curriculum

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In 2006, the department of education introduced GIS (geographic information systems) as part of the Grade 10 geography syllabus for the first time. It has meanwhile been extended to Grades 11 and 12. Against this background, research has been conducted during the course of 2008 focussing on the perceptions and challenges of educators in teaching GIS in the classroom.

Geography educators all over the Western Cape recently underwent a two-day training session to familiarise themselves with the software-package ArcView 3.3. Unfortunately, many schools in the Western Cape, like the rest of the country, are challenged by the difficulties of implementing GIS as part of the school curriculum.

GIS has become a fundamental tool in geographical analysis as it exploits one of the most fundamental principles of geography, that location is important. GIS is seen as a tool which can enhance the subject of geography by supporting content delivery, developing spatial awareness and providing the context for critical thinking. As a result, in 2006, South Africa followed the trend set by many countries in the world, and incorporated GIS into the school curriculum.

The introduction of GIS into the National Geography Curriculum of South Africa poses many challenges to education authorities, educators (both at tertiary and secondary levels), scholars and vendors of GIS software. During the past three years, various workshops have been organised by the Western Cape Education Department (WCED) to familiarise geography curriculum advisors (CAs) and educators with GIS, which until now has chiefly been taught at universities and other tertiary institutions as part of their under- and post-graduate curricula.

Although information and communication technology (ICT) is one of the main factors which might be an obstacle to the introduction of GIS into schools, other challenges include the level of preparedness of education departments, as well as educators.

Information obtained from various role players within the education community, reveals that some of the major problems facing geography educators are as follows: lack of any, or any adequate training in GIS; inadequate computer laboratories; other school subjects competing for computer access; change in the teaching approach and time constraints limiting proper instruction in GIS. In order to address these issues, initiatives have come from the private sector, tertiary institutions and public institutions, which include workshops, GIS exhibitions, seminars and training sessions. These initiatives are evaluated against the proposed FET (Further Education and Training) curriculum in which GIS has been introduced.

The article aims to address perceptions and challenges faced by geography educators with the introduction of GIS into the schools. Other challenges include the level of preparedness of education departments, as well as educators.

Outcomes Based Education (OBE)

The study has been conducted against the background of OBE. OBE appears to be enquiry-based: through an anomalous approach to teaching, GIS can be used to meet curricular goals as set out by the National Curriculum Statement (NCS).

Prior to the introduction of GIS to the geography curriculum, the Department of Education had implemented curriculum 2005 as the national curriculum. Through his research, De Waal [1] distinguishes curriculum 2005 from OBE by advocating that the former dealt with an outcomes-based philosophy derived from the constitution and the latter is seen as “the vehicle to deliver the critical outcomes defined in the NQF” [1]. The Department of Education introduced the new curriculum to secondary school educators via cluster training sessions and compulsory one to two
How can geography educators gather the symbolic living flower? The solution will probably involve developing or looking for paths in the symbolic garden. Putting this into context it refers to fully developing and using the potentialities which GIS has to offer for the educational sector.

GIS is a science that can be used as a set of tools not only to enhance learners’ computer skills, but also to develop their social cognition through didactics applied by the educator. The actual potential of GIS is to be discovered if appropriate didactical and pedagogical practices have been applied. Morrell [3] advocates in her paper that using GIS within secondary geography would encourage not only the use of geographic enquiry skills, but also students’ communication, vocational GIS and information and communication technology (ICT) skills [3]. Morrell continues by suggesting that these skills can be developed beyond the boundaries of geography. They are skills that are hugely transferable, and will benefit students for the rest of their academic and working lives [3].

The National Curriculum Statement regards geography as a subject which should contribute (amongst others) to enhancing learners’ ability to think critically and creatively. Developing critical thinking and -skills form one of the foundations on which OBE is based on. Unfortunately, due to circumstances which constrain learning in many schools, learners’ critical analysis and -thinking have not been adequately tested and developed. With the correct methods of teaching, GIS, as part of the geography syllabus can fill that gap.

Audet & Ludwig [4] as cited in Fargher [5] describe the role of GIS in the school curriculum in a very profound manner: “A classroom that uses GIS as a problem-solving tool is a classroom in which the walls are invisible and the teacher and student assume roles that are non-traditional…. Adopting this technology is not for the fainthearted. But integrating GIS into the curriculum rewards teachers by creating intellectually challenging and demanding learning opportunities.”

Secondary schools in the Western Cape

The research conducted during 2008 focussed on the perceptions and issues and challenges (reflexive competence).

According to the National Curriculum Statement (NCS) document, only a fractional part of the Geography syllabus is allocated for the theoretical part of GIS in each of Grades 10, 11 and 12. On the contrary, GIS can be utilised as a powerful teaching tool.

The advantages of using GIS in the classroom are that it makes the teaching of geography more creative and provides a visual format which assists students with the learning process. Within the broader framework, GIS also promotes the use of information and communication technology (ICT) where technology is seen as a means for improving general education.

**The philosophy behind GIS in education**

“For Socrates… what is fundamental to education is not tradition but criticism. Criticism has plucked the imaginary flower from the chain, not so that man shall bear the chain without fantasy or consolation, but so that he shall cut off the chain and gather the living flower.” — Karl Marx
challenges of educators in teaching GIS in the classroom. Schools which participated in the research hail from different social and economic backgrounds from all over the Western Cape. During the course of the period of research, the boundaries of the different Education Management and Development Centres (EMDC) had been changed.

The research focussed on some key aspects which included:

- Educator’s profile
- Teaching experience
- In-service training
- Teaching conditions
- Perceptions of educators
- Challenges in teaching GIS

Some of these aspects will be discussed.

Teaching conditions

In 2005, less than 10% of South African schools had access to information and communication technologies (ICT). Against the background of the stark contrast of inequalities that still exists in South African schools, the WCED aims to ensure that all schools become e-learning schools by 2012. This initiative emanates from the development of ICT skills within the broader framework of enhancing learning through technology. Initiatives by the WCED in cooperation with the Khanya-project, has ensured that many (secondary) schools have computer-laboratories and internet access. Fig 2. shows that a total of 96% of the respondents have indicated that they have internet access and computer laboratories at school.

Despite the high figure indicating that most of the secondary schools in the Western Cape are equipped with computer laboratories, it is also apparent that the number of workstations available at a given time is inadequate. This situation, together with the advantage that subjects such as mathematics and mathematical literacy, as well as computer applied technology (CAT) enjoy above geography, makes it difficult for geography learners to access the computer laboratories. The educator-learner ratio prescribed or recommended by the national education department for high schools is currently 1:35 [6]. Most respondents from schools in previously disadvantage areas indicated that their average class size was about 40 learners per class. An educator from Khayalitsha indicated through an informal interview that the largest class (Grade 10) he has to handle on a daily basis consists of 55 learners. This figure is precipitously high in order to successfully and effectively implement GIS teaching in the classroom.

Challenges anticipated

There is a general view that educators need to be trained on a more frequent basis because there is a lack of training for educators. Currently, 70% of the respondents indicated that access to computer laboratories is limited and in some cases there is even no access to computer laboratories at schools at all. GIS competes with subjects like CAT, mathematics and mathematical literacy for the use of computer laboratories. In addition, due to the fact that the practical part of GIS is not compulsory, specific outcomes can only been assessed on theoretical and data-response questions. Lack of time, slow computers, workstations not being in a proper working condition and oversize classes restrict most of the educators from accessing the computer laboratories with their classes at any one time. Most veteran and experienced educators are not computer literate, which implies that continual support is required. Like some educators, many learners are also not computer literate, which necessitates the need to use the computer laboratories to acquire basic computer skills first before imparting GIS knowledge.

Challenges in teaching GIS

Challenges that have been noted by teachers on the questionnaire are more or less the same and vary from lack of time to a lack of computer skills. The comments made by educators include the following:

- “They know more about computers than me. I cannot stimulate them/ challenge them” or “They know less about computers than me which equals disaster!”

| Educational reform | • Promotes change and growth for students and teachers, at their own pace  
|                    | • Promotes a means to find answers, rather than providing answers for students  
|                    | • Active learning |
| Vocational tool    | • Develops basic ICT skills  
|                    | • Geographic enquiry skills – questioning, research, analysis, presentation  
|                    | • Career skills |
| Develops multiple capacities and intelligences | • Critical thinking  
|                                                                 | • Logical – mathematical intelligence  
|                                                                 | • Linguistic intelligence  
|                                                                 | • Spatial intelligence  
|                                                                 | • Interpersonal intelligence |
| Fosters mindset of exploration | • Encourages discovery learning  
|                                                                 | • Encourages students to see multiple views of a single issue |
| Promotes research | • Helps identify appropriate information  
|                                                                 | • Promotes data integration  
|                                                                 | • Promotes suitable use of different data types |
| Promotes spatial awareness | • Helps students to identify patterns in nature of society  
|                                                                 | • Encourages students to explore and integrate data and information at multiple scales to identify patterns and processes |
| Promotes computer literacy | • File management  
|                                                                 | • Database manipulation  
|                                                                 | • Spreadsheets  
|                                                                 | • Graphics tool use  
|                                                                 | • Using remotely sensed data  
|                                                                 | • Accessing the internet  
|                                                                 | • Presentation  
|                                                                 | • Integrating additional technology, i.e. GPS |
| Learning how to use GIS effectively | • Use over time helps students identify which tools to use for simple or more complex tasks |

Table 1: Educational benefits of GIS. (Source: ESRI 1995)
• Time, time, time!
• Lack of computers
• Access to computer laboratory
• “Older teachers lack computer skills.”
• “The major problem now is that I can only do it in theory and not in practice.”
• “I don’t think sufficient guidance and or training has been given.”
• “Unsure how to go about teaching GIS.”
• “There is too much information and to sift through the relevant stuff can be a real problem.”
• “I need to change my mindset and become more open to changes that are happening in geography.”
• “I’m a BC person” (BC = Before Computers)
• “I need to become more familiar with computers and not to be scared or put off by them.”
• “I need to learn all these new terminologies and language usage.”

Getting educators to a stage where they can prompt successful and productive group activities with ICT in the classroom and select appropriate opportunities for student’s individual use of ICT is a potentially complex and challenging task [7]. It is quite obvious that changing the perceptions of teachers in general towards GIS technology will only be possible through effective training.

**Benefits of GIS**

Introducing GIS into the geography curriculum makes geography more interesting. Through GIS, learners learn how to use a computer and enhance their ICT skills. The visual format of GIS assists learners with their learning process. The overall opinion of some of the educators on GIS teaching is that it makes teaching geography much more creative. Enhancing the learners’ computer skills via GIS will also help make them more marketable for the employment sector. The educators also feel that instead of being just passive spectators, they will become more involved in assisting with problem solving. There is also a general feeling that, as long as the data provided for a GIS project or lesson is relevant or localised, the role of GIS will be more effective. One educator also indicated that the use of GIS as a tool can be used beyond geography and should also be introduced into other subjects such as physical science, life science and even economic management science.

In 1995, ESRI published a table in which the educational benefits of using GIS were listed. This table contains numerous specific areas of learning that would benefit from the use of GIS (see Table 1).

**Conclusions and recommendations**

It is a postulated fact that the level of GIS awareness is not yet very high in South Africa.

Although many tertiary institutions and private vendors promote GIS through GIS-awareness initiatives (see Fig. 3), it is also apparent that GIS has diffused slowly in the South Africa education system since its introduction into the curriculum in 2006.

The educator is still the prime facilitator in the classroom when GIS is being taught and applied. The potential of GIS must be developed to such a level that it can be applied in order to conquer difficulties and challenges which teachers currently face in teaching with GIS. The increased awareness of GIS and related technologies such as GPS and remote sensing, gives us a platform which can promote a larger educational agenda [8]. The approach with GIS should not be, “How can we teach GIS which forms part of the curriculum?” but “How can GIS help meet curricular goals?” Currently teaching in the geography classroom in the FET level in South African schools puts the emphasis on teaching about GIS rather than teaching with GIS.

In other words, at the FET level, GIS should be a tool used by educators to help them to develop learners’ spatial cognition and to make them GIS competent. Special didactical and methodological adaptations need to be applied when teaching with GIS, in order to develop other skills of the pupils as well. It is pedagogically insufficient to use the software’s power to teach students how to map data such as earthquake locations. Instead, the focus must be placed more upon substantive educational considerations such as how we can deepen students’ understanding of concepts such as seismic activity and plate tectonics through analysing spatial patterns in real data [8].

At present many higher institutions are offering GIS courses outside education faculties. Higher educational institutions like universities should play a more prominent role in training current and aspirant educators pedagogically and to use didactical methods that meet the needs of pupils to properly prepare them to become more GIS competent rather than just imparting knowledge.

Having GIS training sessions or workshops on an annual basis with the same educators is only good if the training sessions are taken to the next level; the level of content relevance using GIS as a teaching tool. Through this approach, training will become more effective and education specific. I vehemently agree with Coulter [8] who advocates that the need for GIS as an integral learning tool is a necessity, and should not just be used as a technology add on.

**Acknowledgement**

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**Fig. 4: A two-day GIS training session at Breederiver/Overberg EMDC.**

**Table 1: GIS Educational Benefits**

<table>
<thead>
<tr>
<th>Specific Area of Learning</th>
<th>GIS Benefit</th>
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</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>GIS assists in teaching geographic concepts.</td>
</tr>
<tr>
<td>Life Science</td>
<td>GIS aids in teaching spatial science.</td>
</tr>
<tr>
<td>Earth Science</td>
<td>GIS helps in teaching geological concepts.</td>
</tr>
<tr>
<td>Economic Management Science</td>
<td>GIS aids in teaching economic management.</td>
</tr>
</tbody>
</table>
References


[8] B Coulter: Maximising the Potential for GIS to Enhance Education, Missouri Botanical Garden (www.mobot.org/education/gis/mapping/28/02/08)


[23] M Mcnerney: Presentation to the ESRI User Conference 2003, the Next Step with GIS in the Curriculum, Approaching the Question of GIS and the Classroom Pedagogy, Findon High School, South Australia.


[25] National Curriculum Statement Grades 10-12 (General), Geography.


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