

Presentation to the ESRI User Conference 2003

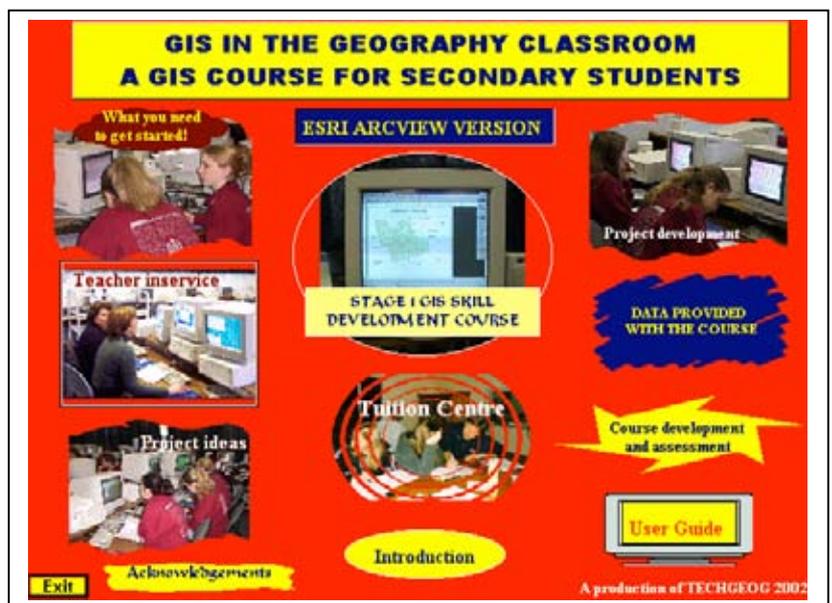
THE NEXT STEP WITH GIS IN THE CURRICULUM APPROACHING THE QUESTION OF GIS AND CLASSROOM PEDAGOGY

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1. Approaching the question of methodology using GIS in the classroom

GIS is a wonderful learning tool for the classroom and over recent years much time and effort has gone into the areas of skill training and classroom resource development. This presentation will attempt to move the discussion of the use of GIS in schools into the area of classroom methodology and pedagogy. There is a need to create a philosophical and intellectual framework around the use of GIS in the curriculum. That is, to shift the emphasis from discussing GIS as a thing to do, to a focus on an awareness of spatial learning and the role of GIS in enhancing our efforts to develop student spatial cognition and perceptions. The introduction of GIS into the curriculum is more than just about the introduction and use of a new technology but really is concerned with engaging students in meaningful spatial learning. We have moved on from just using the technology as a “cool” tool. The next step is to develop a Spatial Learning Model using GIS and the development of a teaching approach that can incorporate GIS as a meaningful enhancer of spatial cognition and hence spatial learning.

In an effort to develop a framework to guide teachers using GIS, this paper proposes a spatial learning model as a starting point to discuss issues of methodology and approach. The model is a work in progress and has provided an interesting starting point for teachers incorporating GIS into their teaching. In particular, the model has provided a stimulus for teachers using GIS skills and gathering the necessary GIS resources available. Indeed, the processes involved in such a discussion is imperative if teachers are to crystallise their pedagogy and teaching approach using GIS in their classroom.



“GIS in the Geography Classroom”
interactive CD Rom.
A comprehensive guide to using GIS in the classroom.
Available from manning@chariot.com.au

2. Towards a Spatial Learning Model

To encourage a coherent approach to the use of GIS for the purpose of developing spatial cognition amongst students the following Spatial Learning Model is proposed.

2.1: Components of the model

Various components can be identified as integral to the learning methodology of spatial learning. There is no one particular starting point but as the following pages discuss all components are integrated and the subsequent teaching and learning can be structured in a variety of ways depending on the needs and abilities of the student group.

GIS Skill Development

Objective: Students learn the manipulation and potential of the GIS software.

Activity: Demonstration of GIS skills and student self-progression through GIS Skill Development activities. Development of hypothesis methodology introduced.

Outcomes: Students engage with the processes of GIS and develop skills that can be used for a wide variety of applications.

Spatial context

Objective: Students introduced to Geographical concepts such as global referencing, scale, projections, symbols, directions and GIS application concepts such as, geo-referencing, proximity, adjacency, buffering, over-layering etc.

Activity: Experiences and learning involving written material, Internet, workplace visits, videos, quest speakers/demonstrators and examples of GIS work

Outcomes: Students have a spatial context and concepts within which to use GIS skills.

Application

Objective: To provide the opportunity for students to apply their GIS skills in a meaningful way via project development and application.

Activity: Student generated applications of skills and concepts. Students to develop a spatial enquiry in response to a problem or issue and to apply GIS skills to explore and develop possible ways forward.

Outcomes: Students have an understanding of the “real-life” application of GIS to solve/explore spatial questions.

Understandings

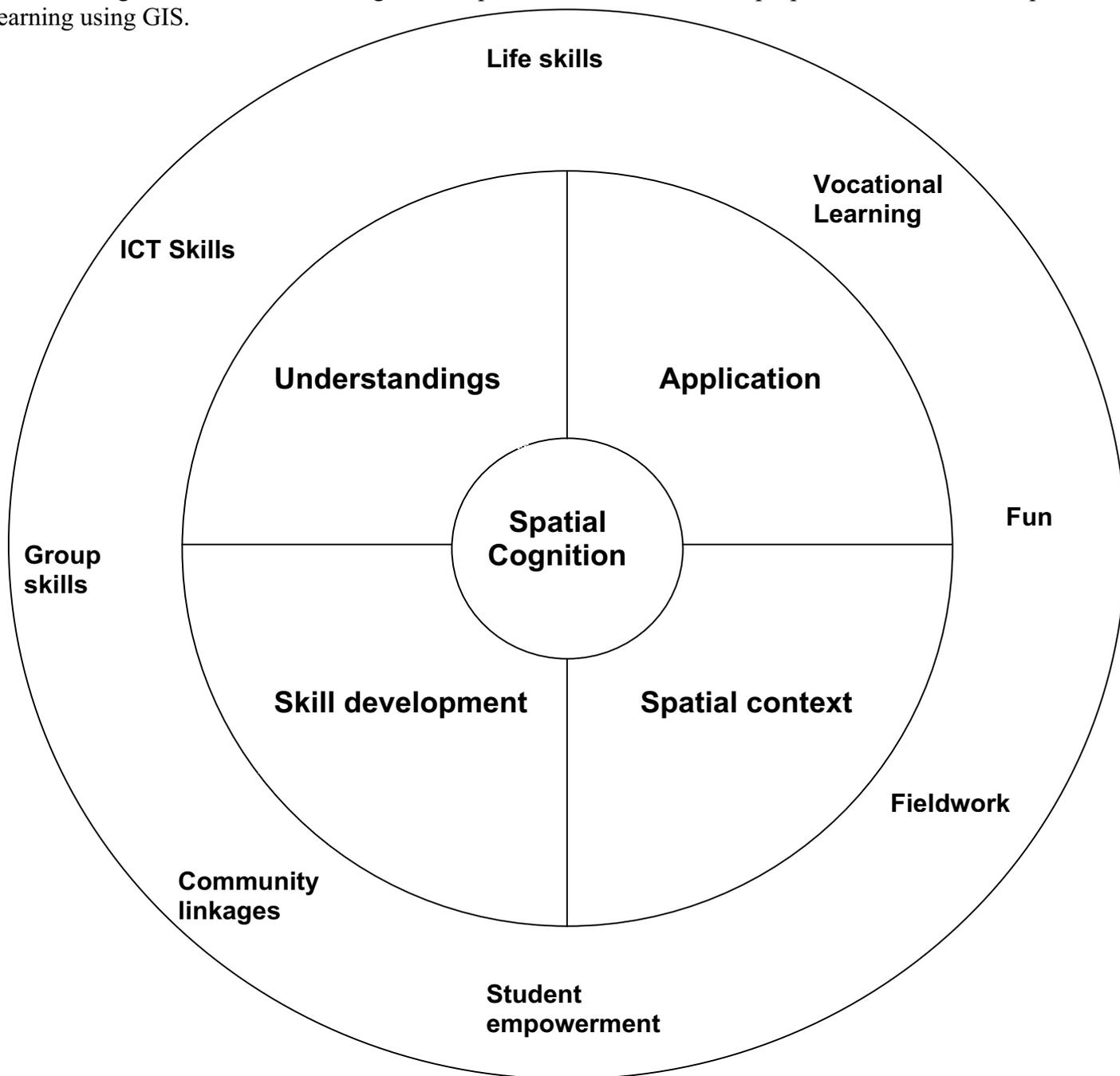
Objective: To reflect on process for the purpose of developing an understanding of spatial trends/processes that enhanced or constrained the spatial decision making of the completed project. Also to develop broader understandings such as those related to futures, identity, interdependence, thinking, communication, literacy, numeracy and ICT's.

Activity: Students to undertake a report on the developed GIS application that involves analysis of spatial patterns and processes. Report to involve future projections and interdependencies analysis involving recommendations/social action as outcomes. This stage could include elements of testing/experiences to ascertain the levels of understanding of spatial concepts.

Outcomes: Students to have an awareness of spatial concepts such as distribution, patterning, trending, agglomeration, proximity and interdependency as a result of their project analysis. Associated essential learning outcomes such as understandings related to the future, identity, interdependency, communication, literacy, numeracy and ICT's.

2.2: An integrated approach to the model

It is recognised that any learning model is not linear but rather interdependent and dynamic. To this end the following interactive model using the components outlined above is proposed as a model for spatial learning using GIS.



GIS Skill Development

Students learn the manipulation and potential of the GIS software. Students engage with the processes of GIS and develop skills that can be used for a wide variety of applications.

Spatial context

Students to explore Geographical concepts such as global referencing, scale, projections, symbols, directions and GIS application concepts such as, geo-referencing, proximity, adjacency, buffering, over-layering etc. As a result students have a spatial context and concepts within which to use GIS skills.

Application

To provide the opportunity for students to apply their GIS skills in a meaningful way via students generated project development and application.

Understandings

To reflect on process for the purpose of developing an understanding of spatial trends/processes that enhanced or constrained the spatial decision making of the completed project. Associated essential learning understandings related to futures, identity, interdependence, thinking, communication, literacy, numeracy and ICT's.

3. The components of the model

3.1: The GIS Skill Development component

There is much debate whether this component should or should not be the starting point for the model. What is agreed however is that at some stage students need to be guided through an achievable and practical skill development process. We do not see that our role is to train students in all of the GIS operational skills available to the GIS consultant. Whatever skills are taught must meet the needs of the curriculum, the abilities of the students, the technology available and the motivational capabilities of the teachers in the time available. If the skills are not required then why teach them? Again, this topic has provided a vigorous debate between the classroom teachers and the University lecturers and indeed the GIS Software Industry. Despite the rocky ground covered in this debate, teachers in South Australia have developed a GIS skill development process that has demystified and simplified GIS skills and provided a sequential approach to the acquisition of the required skills. As a result the development of GIS skills have become more achievable for teachers, more relevant to the curriculum and hence more likely to be introduced into the classroom. In short, why insist on high level GIS technical skills for teachers if their acquisition merely become a “roadblock” to implementation. By developing an achievable GIS Skills Development Course we have customised GIS to the needs of the education system. The stages of GIS skill development have provided “leaping off” points or rather sequential learning stages for teachers to feel comfortable about learning GIS and subsequently to introduce GIS into the classroom at a level they view as achievable.

The GIS skills course is based on the following developmental stages:

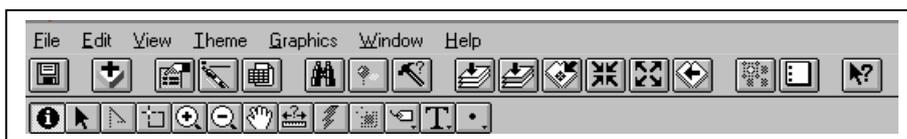
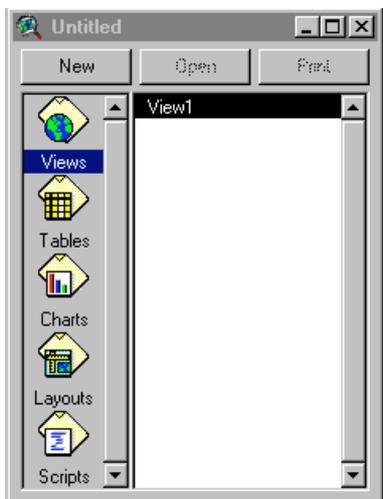


The GIS Skill Development process page on the CD Rom, “GIS in the Geography Classroom”.

3.1.1. The GIS Skills Development Course

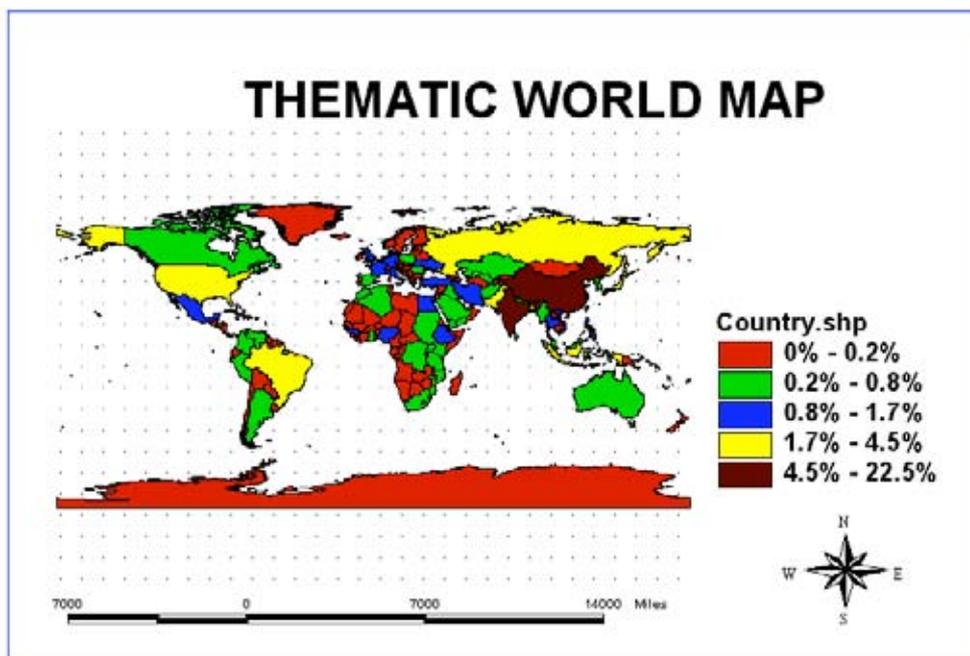
PART A: BASIC GIS SKILLS INVOLVING DATABASE MANIPULATION AND MAP DEVELOPMENT

Stage 1: Orientation to the programme: Basic instruction in the use of the GIS software and a general awareness of the dynamics of the programme. At the end of this stage students should feel comfortable finding their way around the programme and be ready to create their first map using the programme.



ESRI ArcView: GIS Software

Stage 2 and 3: Building “Thematic maps”: These stages see students using the free data on the ESRI ArcView 3.2 programme and provided census data to develop Thematic maps. Initially students are given instruction on the opening of databases and the manipulation of layers via the “table of contents”. Such manipulations involve the customising of colours, shadings and labels to meet the cartographic needs of the map. The creation of Layouts involving the representation of a scale bar, symbols, ruler, statistics and information are also introduced in this unit. Students should now be ready to start using and manipulating databases.



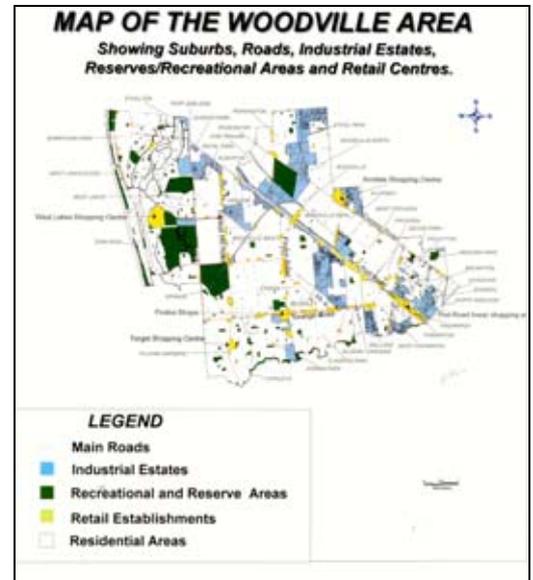
A Thematic Map developed in Stage 2

Stage 4: The creation of “Selection maps”: This stage involves the manipulation of data tables by selecting specific features and creating “Selection Maps”. These “Selection” maps involve students opening databases (attribute tables) and selecting only the data that is required. For example instead of having 30 schools plotted on the map, students are asked to manually select only three from the data base for their map. Again a very useful skill when student’s get to the stage of creating their research maps that may require the selection of certain items from a database.

Stage 5: The development of “uncluttered Composite maps”: For the purposes of simplification and student learning we have coined the phrase “composite” maps for those maps that are simply the receivers of a diversity of data with no selection customising. In essence, students open the provided database and simply ask the programme to plot all the features that appear in the database. Considering the enormous amount of data involved, students finish with a rather “cluttered” map showing all the layers requested. The key skill focussed on at this stage is that of map “decluttering” without getting rid of data and the subsequent development of a user friendly map that can be easily interpreted by the user. Some of the “decluttering” techniques employed are those of “Map within Maps”, label change, legend creation, label moving and symbol creation.



A “decluttered” Composite Map generated at Stage 5.



Stage 6: Query maps and buffering: This stage involves finding by search techniques specific data from a database. This search or rather querying process and the resulting “Query maps” provide a much-needed shortcut when students are searching through enormous databases. A common task for research projects is the searching of land use databases for specific land use that is relevant to the spatial problem. For example, searching for the location of accommodation or medical facilities for groups of visitors to a town would require a query select procedure.

Shape	Fips_code	Gmi_code	Entry_name	Sovereign
Polygon	AA	ABW	Aruba	Netherlands
Polygon	AC	ATG	Antigua and Barbuda	Antigua and Barbu
Polygon	AF	AFG	Afghanistan	Afghanistan
Polygon	AG	DZA	Algeria	Algeria
Polygon	AJ	AZE	Azerbaijan	Azerbaijan
Polygon	AL	ALB	Albania	Albania
Polygon	AM	ARM	Armenia	Armenia
Polygon	AN	AND	Andorra	Andorra
Polygon	AO	AGO	Angola	Angola
Polygon	AQ	ASM	American Samoa	United States
Polygon	AR	ARG	Argentina	Argentina
Polygon	AS	AUS	Australia	Australia
Polygon	AU	AUT	Austria	Austria
Polygon	AV	AIA	Anguilla	United Kingdom
Polygon	AY	ATA	Antarctica	Antarctica



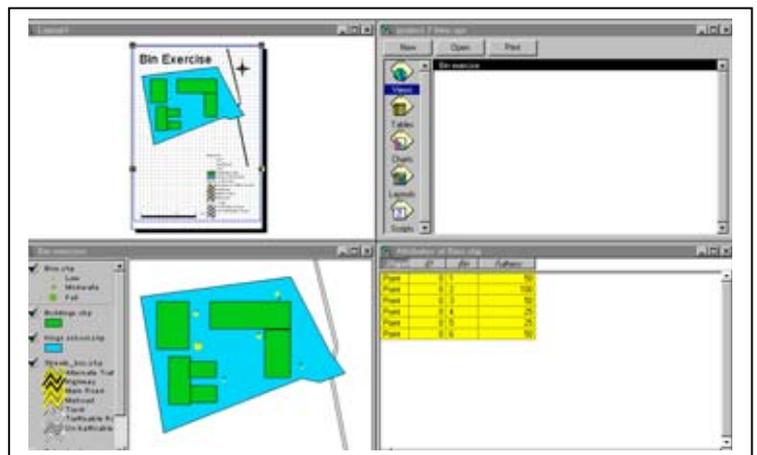
Selection and query procedures
An attribute table that could be used for manual selections or query searches in Stage 5 and 6.

PART B: CREATION OF STUDENT GENERATED DATABASES AND CUSTOMISED MAPS

An important aim of GIS teaching is to reach the stage where students collect their own data and graphically represent their findings on a map. If a digital map is not available for student use then the techniques of creating customised maps or the manipulation of topographic maps or aerial photographs can be undertaken.

Stage 7: The creation of customised maps from scanned images, topographic maps and aerial photographs. Often it is difficult to attain digital maps for your study area. To overcome this problem this stage teaches students how to create base maps or images that can then be the basis of their data plotting or representation. Again, these processes are very simple and provide a cheap and accessible way to create valid data representations.

Stage 8: The development of databases from the collection of data. As a teacher using GIS I am constantly looking for spatial problems that require the collection of data that can provide a quantitative component for students to develop their maps. Once the data is collected the process of creating data bases ready to be represented as pie charts or thematic symbols on a map is remarkably simple and achievable for students. A good example of such an exercise was our Recycling study that won the 2000 University of New South Wales, Research and Investigation Section of the Sustainable Living Competition. In this project students created buffer districts within which to collect recycling data that could then be mapped across the district. Following the mapping process students worked at analysing the maps so as to determine trends and patterns of recycling across the district and between different socio-economic areas.



Shape	ID	Yard name	Holdens	Fords	Toyotas	Others	Total
Point	0	Beecroft	2	11	13	6	32
Point	0	Copeland	11	5	12	5	33
Point	0	Pennant Hills	11	5	4	7	27
Point	0	Orchard	14	1	6	4	25
Point	0	Kirkham	4	6	7	3	20

PART C: THE APPLICATION OF DIGITAL IMAGES, DIGITAL MAPS AND AERIAL PHOTOGRAPHS.

Stage 9: Reinforcing spatial concepts, GIS skills and introducing GIS theory. At this stage students are required to undertake a range of assessed practicals that require them to demonstrate their skills of data manipulation, database creation, map generation and layout. This stage of the course also provides an opportune time to introduce GIS theory and applications. A variety of Internet sites and exercises are used to develop the conceptual framework that good GIS project development and analysis requires.

Stage 10 & 11: This stage instructs students to integrate their digital base map into the purchased topographic map or aerial photograph. While a technique that is usually only employed by the most able students, the use of topographic maps and aerial photographs for student data representation is a very achievable and extremely valid spatial exercise for students.

PART D: THE USE OF GLOBAL POSITIONING SYSTEMS (GPS) AS A DATA DEVELOPMENT TOOL AND MAP GENERATION TECHNIQUE.

Stage 12: Using GPS in you GIS work: Undoubtedly the most exciting stage of GIS skills development. Students can have enormous fun using GPS and develop some very impressive data collection techniques. Again the application of GPS skills is dependent on the nature of the student project. For example if the project requires the specific plotting of points or the trace of a journey then the GPS is a wonderful tool for the geographer to use. Naturally for schools to use this advanced stage of GIS work they will require more elaborate digital maps, the GPS unit and associated software that adds to the overall outlay for the GIS course. However these impediments should not put off the introduction of GPS into GIS courses but possibly it will be the last stage of the teachers learning curve and will require some extra planning and training.

Stage 12: Using Global Positioning Systems(GPS) in GIS work

- The purpose of this exercise is to introduce you to the use of a GPS unit and give basic instructions on how to get the GPS data into your computer and onto your maps. GPS is a great way to plot features in the local landscape and develop a customised map.
- This practical presumes that you have mastered the operation of the GPS unit after following the basic instructions of how to create a route and mark the relevant waypoints.
- The Garmin GPS 12XL(12 channel) GPS unit was used in this practical.
- This Practical is focussed on you being able to transfer your data from the GPS unit into an ArcView view for the purpose of site plotting(street lights, bins etc) or detailed route tracking



Return Next

Stage 12:
The top end of GIS skill development in the classroom. Using GPS in project work.

3.1.2. The philosophy of skill acquisition

By the time students have worked their way through this GIS Skill Development course they should have the array of skills and knowledge required to develop their very own GIS research project. Naturally the ability of the students will determine the complexity and demands of the project but the course up to this stage has given them all that they require to complete a successful project.

The process outlined above is not intended to be prescriptive and “set in cement”. However teachers have gained much comfort from the process being available and the stages of development have reduced the overwhelming feeling many of us felt when embarking on the GIS learning curve with no tertiary training in the area. The reality in Australia is that most Geography teachers left University before computer technology was accessible for educational purposes. It is indeed a “big ask” for teachers to be expected to pick up elaborate GIS skills in their spare time with no formal training. What the skills course does is provide achievable entry points and realistic exit points for teachers grappling with learning GIS.

3.2. The Spatial context component

Many teachers consider that this aspect of spatial learning needs to be taught as a distinct entity early in the student experience while others consider that it can be integrated into the GIS skill development course. Much of the spatial context work involves concepts and content that has always been taught within the discipline of Geography. In fact, concepts such as global referencing, scale, and projections are nothing new to the teachers of Geography. What is relatively new is GIS jargon application concepts such as buffering, adjacency and overlaying. Again, the demystifying of GIS terms and theory is an important stage of the learning model. The Internet provides many excellent sites that make the teaching of the spatial context component a simple and creative task. As was the case with the skill development component, the spatial context component has seen healthy debate between teachers and University lecturers. What teachers see as appropriate and achievable spatial theory/context is often seen as inadequate and even as fallacious in its simplicity by those highly trained. Our focus is achievability towards meaningful classroom implementation. The context must meet a curriculum need within the time, ability levels and expertise available. If the theory is too difficult the uptake of GIS as an across the curriculum and inclusive methodology for all students will be limited. Our philosophy with the use of GIS in schools is that all students are exposed to this powerful and socially important technology. We are not on about training GIS technicians but rather students using GIS as a tool to enhance their spatial learning. We are not the training ground for providing students for GIS university courses or technicians for the Spatial Industry. Hence the spatial context and inherent theory must be focussed on the needs of the curriculum, student abilities and teacher achievability.

GIS RELATED INTERNET WEBSITES			
Areview: ESRI http://www.esri.com	GIS data on the web http://gis.esri.com/fims/index.cfm	Geographic Dynamics Corp. http://www.gdc-online.com/	
Areview: ESRI Australia http://www.esri.com.au	GIS Internet portal http://www.gis.com/	GISCA (Adelaide Uni) http://www.gisca.adelaide.edu.au/	
Atlas of South Australia http://www.atlas.sa.gov.au/	Geography Network http://www.geographynetwork.com/		Spatial Australia www.spatial.org
ABS www.abs.gov.au	Toilet Map http://www.toiletm.ap.gov.au	World http://www.nationalgeogr.anhic.com/maomachine/	National Mapping (Aust) http://www.auslig.gov.au/
US Geological Survey http://info.er.usgs.gov/research/gis/title.html		ESRI Schools Page http://www.esri.com/industries/k-12/index.html	Aussie Home http://www.aussiehome.com/
Uni of Texas: GIS Course http://www.utexas.edu/depts/grg/hudson/grg3		Sydney: http://citymap.cityofsydney.nsw.gov.au/	
SICOM: Spatial Info Society http://www.dehaa.sa.gov.au/mapland/sico		ESRI Australia http://www.esri.com	National Mapping http://www.auslig.gov.au
Australian Spatial Data Directory http://www.environment.gov.au/database/metadata/asdd/		Curtin University GIS course http://webet.curtin.edu.au/KandD/welcome/708SM/GIS/GIS.htm Site user name and password is: australiaedu	
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Useful Internet sites to be used during the Spatial Context Component of the course.



3.3. The GIS application component:

Once the students have developed appropriate GIS skills within a spatial context, the next and what I consider the most exciting component of the model is the GIS Application component.

3.3.1. Consolidation v's Creative Enquiry methodologies

It is in this stage that the full potential of GIS in the classroom is realised. This component also provides us with the core methodological issue in relation to the use of GIS by students in schools. At this point it warrants signalling the warning that GIS could just become another "busy tool" to occupy students for the purpose of "crowd control". Why not just give them some coloured pencils instead of the paraphernalia of high technology hardware and software? To avoid the mis-use of GIS we need to have a debate about the reason why we have introduced this technology into the classroom. Is it merely about providing a "hands on tool" to make the subject more attractive? If so, that is fine but why not make the tool work to it's full potential? To do this we need to examine the pedagogy surrounding the use of GIS. Is the application component about using GIS to consolidate knowledge or is it about creative problem solving? The former is often the approach demonstrated by teachers. For example, the locating of capital cities or volcanoes around the world. Could looking at a provided map not do this? Do we have to produce our own map at great expense and teacher heartache to consolidate such knowledge? This is not saying that there is anything wrong with such an approach but GIS offers so much more to the educator and in turn student spatial cognition. The approach I am advocating can be loosely called the creative enquiry GIS approach. That is, the use of GIS skills to explore and possibly solve spatial problems. Once students have GIS skills within a spatial context they are extremely good at developing spatial problems to investigate. Such problems, depending on the ability of the students, can range from simple problems to highly elaborate investigations.

3.3.2. Project development

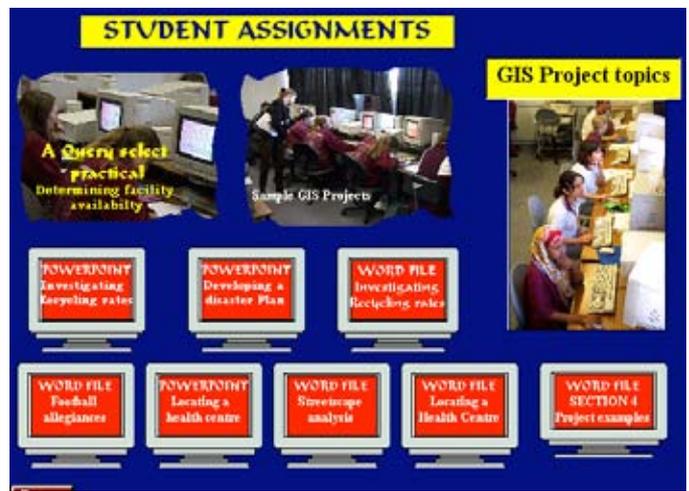
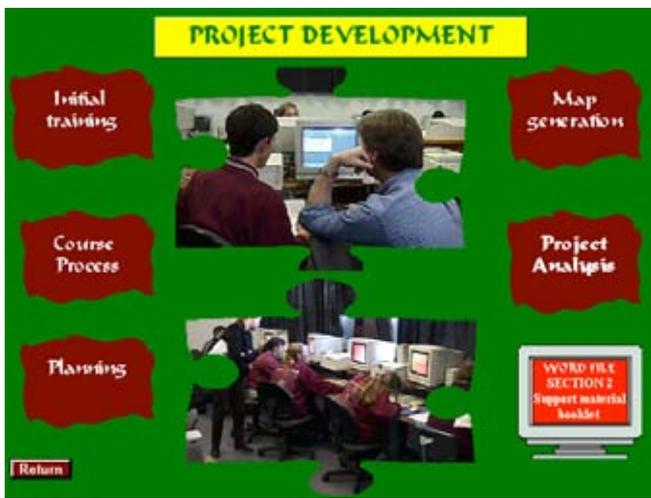
To make the issue development relevant to students it is necessary to familiarise students with their local data. Armed with local data, field experience from living in the area and GIS skills, students can be incredibly creative in their problem development. Here are some of the problems generated and explored by my students over the years:

- Are the medical facilities better in a country area or in a city area?
- Where in the local area would the Environmental Health be the best?
- Where would be the best location in the local area for a family (mother, father, two boys and a girl) with the following requirements to build their house? To be near a primary and high school, public transport to the city, park for jogging, gym and football club and shopping facilities.
- Would the facilities provided be better in a high socio-economic area than those offered in a lower socio-economic.
- Are the rubbish bins appropriately placed around the School? Are they placed to optimise collection?
- What are the Football team allegiances across the local Council area?
- Do student socio-economic profiles differ across the Council area? Based on indicators such as car ownership and TV ownership.
- Is there a difference in health lifestyle across Socio-Economic regions? To develop buffer maps showing differences in smoking, drinking, food intake and exercise habits between zones.
- How do streetscapes differ between Socio-economic areas and what can be done to improve the aesthetic appeal of a suburban area? Maps to be developed that show ratings of aesthetic appeal in buffer zones across the region. Custom made maps of the streets to be made showing urban renewal intervention strategies.

Once the problems are developed, the students need to develop relevant maps and in turn undertake analysis to explore the problem. The creative application process draws on the skills gained by the students during the skill development and spatial context stages of the course and as a result students are undertaking unique research using high order problem solving skills.

By the end of such a creative process the students have:

- ✓ Developed a problem.
- ✓ Collected primary and secondary data.
- ✓ Decided on maps to develop.
- ✓ Generated maps.
- ✓ Conducted spatial analysis, identifying trends and patterns.
- ✓ Drawn conclusions and future recommendations.



Course project methodology and sample GIS Application Projects contained on the CD Rom "GIS in the Geography Classroom".

3.3.3. The Australian GIS Resource Kit: Examples of good GIS practice using the creative enquiry approach

To encourage the development of this creative enquiry approach amongst teachers in South Australia a GIS Resource Kit for schools has recently be developed. The kit is on the Internet on the Spatial Australia site at <http://www.spatial.org.au/seda/kit/> and showcases ten award winning student GIS projects from across Australia. The projects include the data required to conduct the projects and detailed process worksheets for student use.

Resource Kit	
Beginner	While the applications have been designed by geography teachers, the subject material is often applicable to other disciplines such as economics.
Using GIS Development	Projects
Intermediate	Beginner Level
Skate Park Pest Plants Bushfire Risk Water Quality Real Estate	<ul style="list-style-type: none"> • Working with GIS • Development Indicator Analysis for Less Developed Nations
Advanced	Intermediate Level
Streetscape Wasp Nests Environment	<ul style="list-style-type: none"> • Skate Park Locational Analysis • Pest Plant Species Invasion • Bushfire Risk • Water Quality Analysis • Real Estate Analysis
Home Credits GIS resources	Advanced Level
	<ul style="list-style-type: none"> • Streetscape Quality Assessment • Wasp Nest Spread • Environmental Management - Revegetation



As a footnote to this discussion on the application component, the discussion on the pro's of the creative inquiry method does not devalue the use of GIS to consolidate knowledge. There is a place for both in GIS education. However if GIS is to offer schools a dynamic and meaningful tool for spatial learning across the curriculum then continued emphasis should be placed on the use of GIS via creative inquiry methodology.

3.4. Understandings

Rather than a distinctive entity, this component really is an outcome of the accumulative work undertaken during the skill development, context and application components of the model. Even so, it warrants to be discussed as a component in terms of reflection. Such reflection could take the form of testing, reporting or social action to indicate overall understandings.

To highlight such understandings I have drawn on a document developed by the Department of Education and Children's Services (DECS) in South Australia called Essential Learnings.¹ I consider much of what educators are aiming to do with the use of GIS is to develop amongst our students some essential learning's or understandings in relation to the world they live in.

Whilst not wishing to make GIS as the educational panacea, GIS and the methodology it encourages as discussed in the Spatial Learning Model does provide meaningful and relevant overall learning whilst enhancing spatial learning.

The essential learning's are described in terms of futures, identity, interdependence, thinking, communication

3.4.1. Futures: To develop the flexibility to respond to change, recognise connections with the past and conceive solutions for preferred futures.

The Understanding stage of the GIS learning model is very focussed on the future in terms of making recommendations and suggesting social action as a result of the spatial project. Such involvement encourages students to see that they can have an impact on the future if they have valid and considered representations and analysis behind their perceptions. A GIS project can provide such confidence and an understanding that the futures suggested have overt connections with the present and the past.

3.4.2. Identity: To develop a positive sense of self and group, accept individual and group responsibilities and respect individual and group differences.

The methodological premise of the Spatial Learning Model is one of empowerment of the student learner. This is particularly evident at the Skill Development and Application stages of the model when students need to work collaboratively. Such peer support could be in the form of peer tutoring during the Skills stage or the development of an issue to explore at the application stage. In the model, students are encouraged to develop the spatial problem or issue themselves and not to rely on the teacher to supply content. Such student-centred learning encourages the development of meaningful and student relevant tasks whilst also developing student confidence and personal awareness within a group setting. The community focus of GIS work also encourages students to be learners in the wider community and develop inter-personal skills when relating to people outside of the school.

3.4.3. Interdependence: To work in harmony with others and for common purposes, within and across cultures.

The core business of Geographical Education is the exploration of interactions and interdependencies in the natural and human environment. What GIS technology and the Spatial Learning Model does is to provide the medium for high level analysis of interdependencies. GIS in essence is an interdependency demonstration programme with layers being applied over layers. Such "overlaying" enables the learner to see the impact and interplay of a plethora of natural and built features/landuse on the environment. A key component of the Understandings stage of the model is to analyse the interdependencies exposed by the maps that are generated in the Application stage.

3.4.4. Thinking: To be independent and critical thinkers, with the ability to appraise information, make decisions, be innovative and devise creative solutions.

The use of GIS and the Spatial Learning Model encourages the use of high level thinking skills in the form of:

- Hypothesis development
- Data and map suitability
- Map creation and representational features
- Exploration of concepts such as adjacency, proximity, containment and overlaying
- Spatial analysis to identify patterns and trends
- Drawing of conclusions and framing recommendations

These "thinking" skills are focussed on the issue or problem explored in the Application stage and go towards developing impressive problem solving skills amongst students.

¹ Go to the DECS website for more information on the Essential Learnings curriculum:
http://www2.nexus.edu.au/ems/sacsa/downloads/finaldraft/general_intro/page2.html

3.4.5. Communication: To communicate powerfully.

A form of communication, which is often underestimated, is that of visual communication. The associated issues of spatial cognition and visual literacy are critical if we are talking about essential learning. The technology of GIS enables students to visually represent an enormous amount of information. Such information is usually represented as data in table form making it difficult to analyse without spatial referencing. What GIS provides to students is the opportunity to develop and use their visual representational skills to communicate information to others whilst undertaking high level spatial analysis. GIS is a powerful communicator that can be manipulated for specific purposes. It is important that students are aware of the technology behind GIS generated maps so that they can demystify and analyse the validity of the spatial representation.

3.4.6. Literacy, Numeracy and ICTs

Literacy is the ability to understand, analyse, critically respond to and produce appropriate spoken, written, visual and multimedia communication in different contexts. GIS technology provides learners with a powerful tool to bring spatial referencing to their investigation and analysis of data related to personal, local or global issues. Through the use of this technology learners are able to develop dimensions of their numeracy related to spatial relationships, data handling and visual representation and connect with their literacy through the preparation and delivery of reports and recommendations. Critical aspects of numeracy will also feature prominently as learners reflect on the methods of data collection, representation and analysis. Learners should use critical questions to interrogate the whole process, for example, What is the question? Who decides on the question? How was the data collected? What does it mean if the data is displayed differently? How is the data connected to this visual representation? Whose interests are served? Who is left out?

Rapid advances in technology have led to a data drenched society in which increasing emphasis is put on the visual display of information. While this can be seen as a positive influence supporting the dissemination of information to broader audiences it can also support power imbalances through the deliberate misrepresentation of information. One of the most powerful ways to empower learners to look below the surface of the information presented is to give them experiences in collecting, sorting, presenting and analysing data themselves, experimenting with manipulating data for different purposes and exploring the full range of technologies available. GIS has a growing user base across business and government so it is essential that all learners are empowered through experiences with this technology.

3.4.7. In conclusion, the use of GIS in school is not solely knowledge based. Instead within the spatial learning model it involves the activities of skill development, issue development, application and analysis in a group setting to enhance student learning of things that we as educators consider essential for their future in society. Hopefully the use of GIS helps students to make sense of the world they live in.

4. Core business of the model: Spatial Cognition

Whether we talk about spatial cognition, spatial literacy or even the learning of “spatiality”, such spatial understanding is at the core of the spatial learning model associated with the use of GIS in schools.

4.1: Spatial understandings

To guide discussion in relation to spatial cognition, the following understandings across space or rather landscapes can be proposed:

4.1.1: Perceptions involving:

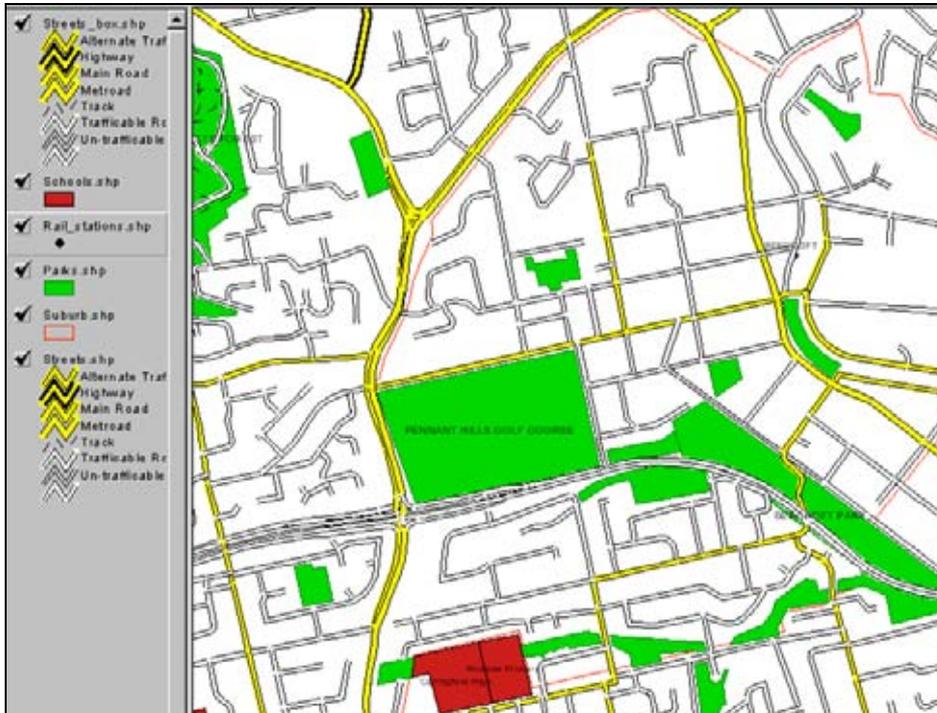
- ✓ Location of features.
- ✓ Identification and location of environments.
- ✓ Distance and depth of features and environments.
- ✓ Distance between features and environments.
- ✓ Vertical and horizontal interactions at localities and between localities.
- ✓ Distribution patterns and trends within identified localities and across environments.
- ✓ Interdependencies of features and environments and the multiplicity of cultural and human features at a particular location interplaying and interacting with each other.

4.1.2: Appreciation of:

- ✓ Changes across space that occurs over time.
- ✓ The diversity of environments across space.
- ✓ The relationships between places and landscape features.
- ✓ The transition and changes in environments across space.
- ✓ The reasons for the relative location of features and environments.

4.1.3: Ability to:

- ✓ Describe the relative location of features and environments.
- ✓ Estimate distance and depth.
- ✓ Analyse interdependencies between places and environments.
- ✓ Discuss and analyse the reasons for the relative location of features and environments.
- ✓ Identify and describe spatial trends, patterns, correlations and overall relationships between places and places, places and environments and between environments.



Spatial literacy understandings

- ✓ Distance and depth
- ✓ Location of features and environments
- ✓ Vertical and horizontal spatial interactions
- ✓ Relative location
- ✓ Distribution patterns
- ✓ Locational reasoning
- ✓ Change over space and time
- ✓ Interdependencies
- ✓ Spatial correlation

Naturally such spatial cognitive skills and literacy is at the core of Geographical Education. However it needs to be recognised that such spatial skills are also overtly necessary in all areas of study. Only when a spatial overlay has been applied to an issue, phenomena or event can comprehensive understanding be an outcome. Hence the Spatial Learning Model discussed in this paper has applicability to all areas of study in schools.

5. Related outcomes of GIS in the classroom

Much of this paper has focussed on the four core components of the learning model. However there are related outcomes to the incorporation of GIS in the curriculum. These appear as the outer circle of the model. They provide many of the reasons why teachers have so enthusiastically embraced GIS in South Australia. They provide the reason why we do it beyond enhancing spatial learning alone. Such reasons can include any of the following outcomes:

- Life skills
- Vocational learning
- Empowerment of learning
- Student motivation and fun
- Community potential
- Out of school learning
- ICT skills
- Group skills

6. Conclusion

Generally it is now recognised that GIS is a wonderful tool for teachers in schools to use to create and deliver new and exciting learning experiences and pathways for students. However we must now go beyond the “wow” stage of implementing GIS into the classroom and honestly and realistically examine why we want to use GIS and how we will use it in the future. Such methodology and pedagogical discussions are imperative if GIS is to be more than just classroom entertainment. I hope the draft learning model presented in this paper can provide a starting point for such discussions and encourage the next step in GIS implementation in schools.

About the author

Malcolm McInerney is the Geography Senior at Findon High School in Adelaide. He is a Geography graduate from the University of Adelaide and has been teaching in South Australian schools for 28 years. Malcolm has been involved in the AURISA "GIS in Schools" Competition since 1997. In 2000 and 2002, Malcolm's students won the Research and Investigation prize in the University of New South Wales, Sustainable Living Competition with their GIS projects on recycling rates and water quality. In 2001 and 2002 the students of Findon High School also won the AURISA "GIS in Schools Competition" in South Australia and were Australasian runners-up. As the basis of his classroom methodology Malcolm has developed a GIS course for Secondary students that is being used in over 300 schools across Australasia. The course has also been used as the basis for GIS teacher training in South Australia and other states of Australia during 2002-3. The course, including process documents, student worksheets and GIS project examples is available as an Interactive CD Rom directly from Malcolm (Email: manning@chariot.com.au)

In 2001 Malcolm was awarded the D D Harris Award from the Geography Teachers Association of South Australia for his work promoting GIS in South Australian School and his work was further recognised in 2002 with a National Excellence in Teaching Award. 2002-3 has seen Malcolm becoming increasingly involved in the "teaching the teachers" process across Australia.

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