Embedding Geographical Information Systems into the Curriculum

Royal Geographical Society with IBG
Advancing geography and geographical learning

Copy of PowerPoint Page Notes

Page 2

The aim of this online CPD is to highlight the (unrealised) opportunities for embedding GIS within your department's curriculum. The materials presented here can be used in a variety of contexts – thus a 'toolkit' is offered in which the presenter can offer a flexible programme tailored to individual need.

For example this online CPD may be used to:-

1. Inform the adoption of a school GIS.
2. Identify teaching and learning opportunities for the use of GIS.
3. Curriculum map GIS within Medium Term plans.

Page 3

A GIS is a computer database system capable of capturing, storing, analyzing, and displaying geographical data from a vast variety of sources.

Whilst much of the associated jargon, such as georeferencing and geoprocessing is arguably intimidating – albeit much of it avoidable – one should not underestimate the level of ICT literacy or appetite of the average secondary school student. They can and do cope with such jargon - and rarely share the teacher's fears.

The geographical key to GIS is that all data is identified according to location. A GIS, in consequence, is most often associated with maps – composite maps - given any GIS capacity to layer digital information such as satellite images, aerial photographs, graphs, census tables and written text.

A GIS, therefore, stores, retrieves, manipulates, analyses and displays whatever combinations of information the specific task requires - so revealing spatial patterns and inter-relationships. Furthermore, in the sampling and selection of data, followed by application of logical analytical rules, it can be used to create models of geographical reality that reveal important new information. This is essential to effective decision making – a key skill today for every secondary school student.

Page 4

A GIS is capable of handling multiple 'layers' of data. (Data is information that has 'meaning' attached to it).

Providing each layer of data is georeferenced, in other words, can be attributed to a precise location, multiple layers of data can be interrogated by the GIS. A GIS is therefore a powerful analytical tool with the ability to interpret and draw conclusions from the 'real world'.

Page 5

The late-20th century concluded with geographical information systems (GIS) coming to the fore globally as a breathtaking new technology.

GIS applies the infinite scope and value of Geography to remorseless advances in ICT. As such, its potential for exciting, constructive, practical use in 21st century secondary education is considerable – a potential already clear to many teachers and a growing realization for others.

Increasingly user-friendly and cost-effective GIS packages are already available - freely online (see, for example, the popular *Google Earth* or lesser known *NOMAD* – Nottingham City Council's interactive website).

More powerful commercial software is also well within the scope of secondary school budgets.

Furthermore, the importance of GIS is recognised as a geographical skill in the revised Key Stage 3 Programme of Study, new A-Level specifications and is an Option Unit worth 25% in the current Pilot GCSE. It is also a central geographic skill on the new GCSE specifications (September 2009). Within the Primary Review the importance of GIS as a cross-curricular skill can also not be underestimated.

Royal Geographical Society with IBG
Advancing geography and geographical learning

Page 6

There are a range of GIS solutions available. Indeed, given the range of GIS applications, a structured and informed approach is advised prior to adoption.

At this point, the accompanying handout, ‘GIS Solutions’ might be discussed within the framework that follows.

Page 7

No one GIS solution ‘fits all’. It is likely to be a difficult compromise between price, access and functionality.

The next slide provides some clarification on each of these overlapping headings.

Page 8

<u>Definitions</u>:

Price – whilst the functionality of freely available (mostly web based) GIS solutions is limited, there remains significant scope for teaching and learning opportunities.

Functionality – the ‘tools’ and ‘features’ of the GIS that allow the end user to interact with the software. Increased functionality allows a greater personalisation of a user’s experience. This may, however, be at the expense of a more complicated user interface, or the ‘buttons’ that need to be clicked in order to perform an operation.

Access – networked solutions in school afford a degree of reliability, albeit access to a suite of computers in school may be difficult for all pupils; a teacher may therefore be ‘forced’ to share a GIS via an interactive whiteboard, for example. A web based GIS, freely available, opens access to pupils outside school. Needless to say, such is the file size of georeferenced data, anything less than a dependable broadband connection, will result in a disappointing experience.

Royal Geographical Society with IBG
Advancing geography and geographical learning

Page 9

Within the planning and feasibility framework suggested, clear consideration must be given as to the place of GIS within your curriculum – in other words, what do you want to achieve from embedding GIS within the PoS?

MapPilot is run by Becta, in conjunction with The Advisory Unit: Computers in Education and eMapSite with funding from DfES and support from Ordnance Survey. It allows Ordnance Survey digital maps to be accessed free of charge to schools and to GIS providers within the pilot. The trial period for the project has recently been extended beyond the original July 2008 deadline.

Page 11

The series of case studies that follow are intended as a starting point for discussion – ideas, techniques and the use of accompanying screenshots will afford the audience a clear understanding of the potential of this exciting tool.

The examples are rooted in class room practice but it is hoped that by using these materials teachers will be encouraged to select ideas, change them to meet their own learners, and begin to use relevant teaching strategies elsewhere in the curriculum.

Digital Worlds website is www.GIS4schools.com. Digital Worlds is a powerful all-in-one educational solution for GIS; it has lots of functionality yet resources can be readily created for access by all abilities and ages of student.

Page 12

This case-study follows an urban investigation undertaken by Year 10 as part of their GCSE coursework. Initially, the use of a GIS to help inform prior planning and organisation are considered. Second, the collection of additional, appropriate electronic data on the day of the fieldwork is discussed. Finally, upon completion of the fieldwork, the use of a GIS as a sophisticated presentational and analytical tool is considered.

Each Year 10 student must choose to answer either the question:

How do environmental and social factors differ between residential districts within an inner city zone of transition and an outer suburb?

or test the following hypothesis:

There are marked environmental and social differences between residential districts within an inner city zone of transition and an outer suburb.

Page 13

GIS supports self-study – particularly relevant in the context of GCSE coursework, where independent thought and initiative are rewarded. Indeed, the ability to support all learners, whilst simultaneously encouraging progress is essential.

A GIS is able to:

- identify clearly defined geographical areas – allowing 'physical' boundaries to be set on the day of the fieldwork, thus promoting a safer working environment

- introduce each area and allow familiarisation - an important stage in prompting relevant geographical discussion and ideas prior to fieldwork. In essence, everyone is aware of 'what to expect', and consequently, may prepare accordingly

- present secondary (census and crime) data – thus avoiding intrusive questionnaires and inevitably skewed responses from, for example, the aged and unemployed

- support individualised learning – given that the demonstration of student initiative is an important aspect of all GCSE fieldwork investigations. Within class, opportunities for differentiation are provided. This includes encouraging students to design data collection forms that extend the material and resources provided. Copies of all relevant teaching materials are saved as electronic copies on the school intranet, including *PowerPoint* files of electronic interactive whiteboard lessons.

Page 14

Dependent on ability, students use a combination of teacher provided sheets and student generated forms. Students collect and record geographical (and by nature, georeferenced) data associated with a particular location. Examples include:

- land-use survey – the function of buildings or land-uses are identified
- detailed observations – including representative individual houses or streets
- environmental survey – two quantitative examples, including bi-polar tabulation
- parked car registration – record of vehicle age and condition by street
- service/amenity provision – tally of shop/service type
- field sketches – labelled by location
- photographs – digital.

Page 15

Many GIS applications will allow the user to save the associated ‘layers’ of georeferenced data as one (project) file. In practical terms this means that the pupil need only open one ‘folder’ to access all the relevant data for that particular lesson.

Page 16

Whilst a variety of web-based map tools allow the creation of electronic maps, a fully functional GIS allows the user to customise a map to individual need.

At a basic level, students use Ordnance Survey map files saved in the fieldwork project file to show the location of each area. For example, students use drawing tools in Print View to identify the location of each area. They may then annotate the map layer to add compass and scale, and to identify urban land-uses (**see next slide**).

At a higher level, the inclusion of urban land-use models is encouraged. The same skills are repeated to allow the identification of sampling points and the annotation of environmental observations. These simple skills deliver polished presentation, but in the annotation and discussion of urban landforms and processes, provide opportunities for higher-order analytical reasoning.

Page 17

Location map of study area overlaid with pupil annotation layer.

Page 18

Spatial awareness, particularly the ability to relate a flat two-dimensional map in the classroom to primary data collected in the field, is a difficult skill. In the use of satellite photographs overlaid on to Ordnance Survey maps, students are better able to interpret the fieldwork environment.

The use of fade or swipe tools allow students to view the three-dimensional reality beneath or alongside the map view (**see next slide**). This is a powerful tool, made even more striking by the attachment of class fieldwork digital photographs as hyperlinks.

Either in a whole-class situation, or individually, students are thus provided with opportunities to view, and subsequently interpret, the fieldwork environment in three contrasting views. Significantly, as all the ‘layers’ of data (map, aerial and digital photography) are georeferenced, ‘zooming-in’ or ‘zooming-out’ does not affect the relationship between the information – in essence, the scale of one layer is adjusted concurrently as another is changed.

Page 19

Simultaneous use of swipe and fade tools allows for striking comparisons.

Page 20

Whilst less appropriate for whole-class teaching, the availability of historical map files (and latterly, census data) allows more able students to add a temporal dynamism to their work.

For example, the impact of urban renewal, redevelopment and the wider consequences of urbanisation and urban growth can be evidenced by the overlaying of historical map files (**see next slide**). Again, annotations can be added to identify and articulate social and environmental contrasts and/or make reference to contemporary urban theory.

Page 21

1860 historical map overlaid on top of Ordnance Survey location map – excellent tool for examining, for example, land-use change and associated socio-economic differences.

Page 22

Despite the ageing nature of the data (for example, the effect of eastern European migrants in Lincolnshire is not included), 2001 census statistics remain an invaluable secondary resource.

In the example discussed, it avoids the difficulties in using questionnaires or interview responses to illicit socio-economic data – essential if environmental and social contrasts are to be analysed. Census and statistical data in general are underused in student GCSE investigations.

Indeed, in our experience it is not the interpretation of the data that is difficult, but the connection between the data set and the place - in other words giving the ‘data’ geographical meaning.

Percentage figures for unemployment, housing tenure, crime, central heating, age structure and socio-economic groupings are all made available for census wards in Lincoln. Students map the data selectively, considering its value and relevance in addition to the suitability of any map symbol used. By overlaying the mapped data on top of previously saved layers, including satellite imagery and the OS map, striking geographical patterns for later analysis are identified (**see next slide**).

Page 23

Choropleth mapping of selected 2001 census data overlaid on Ordnance Survey map of study area.

Page 24

Students currently entering secondary school in Year 7 inevitably come with a variety of geographical backgrounds, interests and existing skills. Of these, the appreciation of spatial patterns is arguably the most challenging. Regardless of Key Stage 2 directives, Ordnance Survey map-work skills cannot be assumed to be automatic - even at a basic level. Ordnance Survey maps are rich in geographic data, but therein lies the difficulty - the interpretation of a flat two-dimensional map into three-dimensional reality represents a challenging feat for any student, particularly younger ones who may have limited connection with their surroundings and questionable existing map interpretation skills.

The Ordnance Survey Free Maps for 11 year-olds, is continuing to prove a great success in helping to break down these traditional barriers. Indeed, the emphasis now should be for teachers to ensure that students are given the necessary skills to make full use of this excellent resource. GIS has a key role to play in helping to teach and reinforce these core geographic skills at an early stage.

In the following case study, *Digital Worlds* GIS is loaded with 10km x 10km map tiles centred on the city of Lincoln and the location of the school. Importantly, the map tiles overlap the same area as the aforementioned Free paper OS Maps.

Page 25

Grid references

Conventional teaching allows a majority of students to understand the application of grid references. However, there remains great variety in the accuracy of the calculations and the appropriateness of either four or six figure grid references. As a means of a simple introduction to the study area, students identify points and areas from the GIS map viewer. Following discussion on the suitability of four or six figure grid references, students use their paper maps to calculate and then share results using 'mini whiteboards'. In whole-class review students then either use the tools of the interactive whiteboard (IWB) software, or the drawing tools within the GIS application, to annotate the map projection.

Scale

Students are given a number of points, expressed as six figure grid references. Again, these may be negotiated between the students and teacher to give some meaning or association with the places chosen. Students are then asked to measure the separating distances both as straight ('as the crow flies') and indirect measurements.

Following student answers, they repeat the measuring process using the GIS measuring tools. In essence, the electronic measuring tool recreates the paper and pencil process, breaking the curved line into a number of straight sections.

Dependent on ability, students may then be directed towards the measurement of particular map areas - again either as a paper exercise or using the GIS tools. Further extension activities may be possible as students interpret the units - for example, the association of one grid square representing 1000m or 1km in length. Following the export of distances from the GIS in to a spreadsheet application, simple statistical analysis such as mean area or distance may be calculated.

Page 26

Increasingly sophisticated aerial imagery is available freely to help in the exacting and often misunderstood skill of relief interpretation (see, for example, *Flash Earth*). Furthermore, commercially available programs (for example, the affordable *Memory Map* series) offer sophisticated 'fly by' views. Nevertheless, the advantage offered by a GIS is the connectivity between elevation models, aerial photographs and realisation of scale.

The interpretation of any landscape demands particular attention to the appreciation of relief, particularly in the analysis of settlement patterns. Site and situation factors are a central theme in many Geography Year 7 schemes of work.

As a whole-class activity, site and situation factors are examined for a pre-determined settlement within the local '10km x 10km' map area. Within the GIS, an elevation model is overlaid on to the map tiles. Using the fade tool, the ‘flat’ paper map is brought into vivid three-dimensional life (see **next slide**).

Furthermore, if applicable, it can be compared to earlier hand drawn student cross-sections. Subsequent use of the measuring tools then allows named points or areas to be related to relevant site and situation factors - for example roads or water features. To help with later student analysis, a number of labels, saved as a separate map layer, are overlaid on to the map.

Page 27

High quality elevation models are expensive, but visually stunning.

Page 28

The aforementioned skills may be combined in to a student-centred exercise describing their journey to school.

Following the introduction (or re-cap) of drawing layers, students ‘trace’ their route using the GIS. The route is then measured within the GIS and the answer expressed in kilometres.

One physical outcome of this exercise is a printed copy of the route plus suitable annotation that describes the journey - for example, the interpretation of landscape features. This higher-order skill not only demands a good understanding of the software, but the correct interpretation of symbols, scale and relief. For less able students, aerial photography, elevation models, or partly completed electronic ‘templates’ may be provided. Later teacher led whole-class analysis or follow-up activities may include the use of a GIS to create a ‘Buffer Zone’. This informs higher-order reasoning such as the interpretation of possible spheres of influence around the school (see **next slide**).

Page 29

Sphere of influence of school based upon pupil responses.

Page 30

Given pressures on the wider curriculum, it is more important than ever to ensure time spent in the ‘field’ is a quality and valuable experience. Consequently, time invested in planning and preparation, particularly for younger age groups, is a necessary but invaluable activity. Herein lies the potential benefit of a GIS - as a tool that maximises classroom preparation.

Prior to fieldwork in Castleton in the Peak District, Year 8 students are introduced to the study area via 10km x 10km Castleton map tiles, aerial photographs and elevation models.

Page 31

Given the demands of the day, involving individual and group work, teacher and student led activities, and booked tours of a limestone cavern, fieldwork timing is tight. Furthermore, the location is potentially hazardous – demanding due care and attention.

Use of the GIS allows the precise programme of the day to be shared, mapped, annotated and then printed as a high quality paper copy, complete with grid lines, for use on the day (**see next slides**).

Students are then given semi-structured tasks and a copy of the fieldwork booklet. Students further familiarise themselves with the environment by exploring the ‘hidden’ hotspots or hyperlinks on the drawing layer overlaid on the Castleton map. Each hotspot provides oblique digital photographs (taken on previous field visits), short film clips (commercially available) and web links (see **later slide**). This allows students to become familiar with the wider fieldwork area. It also simulates, albeit at a superficial level, an engagement with the landscape that will be replicated on the day of the fieldwork.

Page 32

Fieldwork route drawn as an annotation layer over the elevation model and Ordnance Survey ‘base map’.

Royal Geographical Society with IBG
Advancing geography and geographical learning

Page 33

As previously with aerial photographs now included to help with the familiarisation of the environment.

Page 34

On the day of the fieldwork, students are encouraged to make use of digital cameras to record their experiences. On return to school, they attach the digital photographs as hyperlinks to a drawing layer. The skill is to correctly locate and justify the position of the photograph.

Finally, as the nature of fieldwork activities is in part determined by the weather, teacher led explanation or practical exercises may be continued or developed in the classroom. For example, fieldwork sketches may be better interpreted when placed in the wider spatial context – for instance, the full scale and extent of Winnats Pass, or the otherwise partially hidden Hope Valley cement works and quarry (see **next slide**).

Page 35

Hyperlink attached to earlier route map to reveal unexplored or inaccessible fieldwork locations.

Page 36

Use an evaluative framework to allow informed decision making for the adoption / purchase of a GIS.

- Curriculum map opportunities for the embedding of GIS within your PoS. Use the ideas presented today to identify appropriate areas for the use of GIS. This will be particularly pertinent as an examined skill within the revised GCSE and GCE curriculum.

- Establish a time frame for the planning, implementation and evaluation.

- Use the attached Further Reading to keep abreast of this rapidly emerging, exciting and increasingly central geographic skill.