Future Landscapes

A Futurelab prototype context paper

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1. INTRODUCTION

The aim of the Future Landscapes project is to create an interoperable, responsive tool that allows young people (12-14 years old, school Years 7 and 8) to engage with, imagine and discuss ideas about human influences on future landscapes.

It is envisaged that this tool will combine current mapping techniques with existing or emerging visual technologies to allow young people to enter and manipulate different kinds of data in order to explore the influence of humans on the environment. The tool will support existing fieldwork practices in geography by providing learners with the opportunity to easily enter and manipulate field notes such as images (eg digital images or their own drawings) of the landscapes, quantitative (eg population, number of houses etc) and qualitative (eg interview or sound bits from local residents) data. The tool will help learners visualise these changes in a two-dimensional and three-dimensional format.

This document aims to summarise the current state of geography and understanding of mapping techniques within the Key Stage 3 curriculum as it relates to Future Landscapes. It then discusses key research in the area of understanding mapping techniques, the role of two-dimensional and three-dimensional representations, and how it fits in with geographical information systems (GIS) software which is currently the focus of much research. The document concludes with the identification of key research questions based on the existing research in this field.

2. FUTURE LANDSCAPES WITHIN THE CURRENT CURRICULUM CONTEXT

According to the guidelines from the QCA at Key Stage 3, geography should be taught for 95 minutes per week (QCA 2004). At this key stage the National Curriculum states students are required to ask geographical questions and identify issues, then analyse and evaluate evidence and draw and justify conclusions about planning issues. Students are also required to understand for the first time OS maps (DfES 1999). They must also use secondary sources of data, such as photographs, and interpret various ways of communicating data – such as choropleth data sets. The requirements relevant to Future Landscapes are the bold statements in Box 1.

1) In undertaking geographical enquiry, pupils should be taught to:

a. **ask geographical questions [for example, 'How and why is this landscape changing?', 'What is the impact of the changes?', 'What do I think about them?'] and to identify issues**
b. suggest appropriate sequences of investigation [for example, gathering views and factual evidence about a local issue and using them to reach a conclusion]
c. **collect, record and present evidence [for example, statistical information about countries, data about river channel characteristics]**
d. **analyse and evaluate evidence and draw and justify conclusions [for example, analysing statistical data, maps and graphs, evaluating publicity leaflets that give different views about a planning issue]**
e. appreciate how people's values and attitudes [for example, about overseas aid], including their own, affect contemporary social, environmental, economic and political issues, and to clarify and develop their own values and attitudes about such issues
f. communicate in ways appropriate to the task and audience [for example, by using desktop publishing to produce a leaflet, drawing an annotated sketch map, producing persuasive or discursive writing about a place].

2) In developing geographical skills, pupils should be taught:

a. to use an extended geographical vocabulary [for example, drainage basin, urban regeneration]

b. to select and use appropriate fieldwork techniques [for example, land-use survey, datalogging] and instruments [for example, cameras]
c. to use atlases and globes, and maps and plans at a range of scales, including Ordnance Survey 1:25,000 and 1:50,000 maps
d. to select and use secondary sources of evidence, including photographs [including vertical and oblique aerial photographs], satellite images and evidence from ICT-based sources [for example, from the internet]
e. to draw maps and plans at a range of scales, using symbols, keys and scales [for example, annotated sketch maps] and to select and use appropriate graphical techniques to present evidence on maps and diagrams [for example, pie charts, choropleth maps] , including using ICT [for example, using mapping software to plot the distribution of shops and services in a town centre]
f. to communicate in different ways, including using ICT [for example, by writing a report about an environmental issue, exchanging fieldwork data using email]
g. **decision-making skills, including using ICT [for example, by using a spreadsheet to help find the best location for a superstore].**

Box 1: National Curriculum requirements (DfES 1999)

However, Ofsted considers one of the reasons that the number of pupils taking geography as a GCSE subject has declined is the uninspiring experience that some pupils have of geography in Key Stage 3: "In too many schools the Key Stage 3 curriculum is tired and content heavy" (Ofsted 2005). Specifically the annual review recognises:

- subject content, with an accompanying emphasis on recall of knowledge, dominates at the expense of the development of concepts, skills and understanding
- cross-curricular elements such as literacy, numeracy, information and communication technology (ICT) and citizenship have been added into schemes of work in an unstructured way to meet school or national requirements, but do not enhance the delivery of geography
- activities identified in the scheme of work are often repetitious and rely too much on published texts and worksheets, which can make the subject dull.

The difficulty identified by Ofsted, that ICT has been introduced but often in a way that fails to enhance the subject, may be related to the fact that teachers have a curriculum requirement to use ICT (DfES 1999) but there are issues preventing its use, for example, accessibility of computers in school and at home, and the availability of appropriate software (QCA 2001). The former point is now partially being addressed by the availability of interactive whiteboards, enabling more students to take part and to view an enquiry into landscape change. Moreover, digital cameras are becoming increasingly available to teachers and these open up opportunities for manipulating images to help students to visualise landscapes. As Fox (2001) states: "Images enable students and teachers to gather information about shape, scale, size and distances as well as make their own judgements on aesthetics". Yet there is still scope for software to enhance understanding of geography. Martin's (2001) report in the use of ICT in teaching geography suggests that its use is currently limited to research on the internet and the presentation of information in PowerPoint, Word or Excel.

The second curriculum area that Future Landscapes is applicable to is citizenship. The software is designed to enable students to become active participants in the planning process, something they are encouraged to do through the citizenship agenda. This also links in with thinking skills, as the students would be engaged in prediction and applying ideas (DfES 1999).

3. DISCUSSION OF RELATIONSHIP BETWEEN PROPOSED PROJECT AND POLICY CHANGES

Future Landscapes is applicable to the revision of the geography curriculum initiated by QCA in 2001: "The purpose of this project was to ensure that national curriculum geography and history were responsive to the changing world of the early twenty-first century" (Westaway and Rawling 2003). All phases of geographical education should encourage young people to envisage alternative scenarios, and promote an awareness of alternative futures. Moreover, they should promote curiosity by drawing on fieldwork, the characteristics and issues of the local area, and engaging with young people's own experience.

These skills will be utilised by the newly introduced geography GCSE. In both the short course and single award students are expected to investigate questions and issues with a genuine contemporary significance relating to the economy, society and environment. They will need to engage critically with maps, diagrams, field investigations, research reports and findings, newspaper reports, websites, and geographical information systems. Skills developed in Key Stage 3 include: identifying issues and areas for enquiry, collecting data, analysing and interpreting it, synthesising ideas and then communicating them, and evaluating findings and methods used.

This new policy introduces the idea of digital fieldwork. This contrasts with the current DfES scheme of work which focuses on actual activities undertaken outside. However, the first suggested field trip occurs in Year 8 (Unit 7 Rivers – A fieldwork approach) despite the National Curriculum (see points 1a, 1b and 2b in Box 1).

4. DISCUSSION OF RELEVANT 'GENERIC' RESEARCH LITERATURE

The original Future Landscapes proposal was to create software that would combine a number of technologies in order to allow the user to ask 'what if' questions, ie to simulate change from present landscapes in specific locations to several options for future landscapes. This section discusses the key research from this area: specifically students' current understandings and misunderstandings in geography, the use of two-dimensional and three-dimensional images, and existing geography software.

4.1 Understanding of geography at Key Stage3

The ability to understand maps and to interpret the data they represent is called graphicy. Various aspects that are difficult for students in this field were summarised by Fred Martin (Bath Spa University College, and originator of the Future Landscapes proposal) and are shown in Table 1.

Topic	Issues
Scale	Children find it extremely difficult to interpret real sizes from map scales. As scale increases, understanding of distance and area diminishes. The underlying maths required to support working with ratios is often lacking.
Map grids	Whilst this may seem a relatively easy problem to solve, children struggle to make effective use of grids as they seldom use them.
Map symbols	Whilst using symbols simplifies the creation of maps, children often struggle to translate between the symbol and the feature the symbol represents.
Simplification and selection	For a map to be really useful there needs to be a certain filtering of information. Cluttered maps do not aid comprehension. However students struggle to understand why some things are not shown on the map, and why different scaled maps show different information.
Colours	Use of colours is problematic – they may aid clarity in the visual aesthetic of

	the map, but can be the source of misconceptions. Students naturally associate some colours with certain types of reality, eg water is blue and grass is green. Whilst this is not a problem when displaying certain types of data, it can lead to difficulties when these colours are used to represent other types of data. For example a world map of relief can show the Sahara desert in green, simply because it is low land.
Relief	Another area of difficulty is imagining relief, eg slope steepness, landforms etc. Even 3D transformations are problematic because they often exaggerate differences in relief to such an extent that an understanding of slope becomes even more difficult.
Understanding perspectives	One of the map-reading and photo interpretation problems that children have is to do this matching activity; they become lost by the different perspectives, ie with photos having perspective and distance and maps having none.
Quantitative symbols	Showing data on maps helps us to understand it. The brain is able to process the data visually, making sense of data that can seem difficult to understand in a table.

Table 1: Issues preventing understanding of Key Stage 3 geography

One difficult graphicy area identified by research lies around students' understanding of relief maps, and their ability to interpret contours (lines that join points of equal height). Weignand and Steill (1997), for example, asked students (aged 5-11) to draw plan views of hills made of sand. These representations were in boxes with transparent lids. Children were given an acetate laid across the top of the box and asked to draw the sand model. Not surprisingly there were a number of different attempts at this. Of the sample as a whole when using the basic hill model, 29% chose to use contours, and 68% represented the hill as a plan view and correctly located the highest point. This highlighted an early understanding of the ideas of contour lines. As the children progressed to more complicated topographies their maps became more cartographically complicated. However none of the students numbered their contours – which would mean an observer seeing the map for the first time would not be able to distinguish between a hole and a hill. This suggests that primary school children have an understanding of contour lines as representations of geological features but that their understanding is fairly limited.

The idea that information can be treated as a whole or in parts (ie as layers) to overcome some of these problems is used in existing geography software discussed in the next section.

4.2 Using software to address issues in graphicy

Some of the issues discussed in Section 0 could be addressed by enabling students to relate a two-dimensional image to a three-dimensional one. For example, using a map in the field would allow a student to recognise scale if they knew where they were (possibly by using a global positioning system (GPS)) and could enable them to identify landmarks near them on the map and in the real world. This would imply that students have to: 1) recognise the symbols used for landmarks; and 2) appreciate that colours on maps do not relate to the colours in the world. Similarly, they could relate relief on the map (the position of contour lines) with the steepness of the viewed slopes in the real world. It is hypothesised that this understanding could be achieved by students using photographs, maps and three-dimensional images of the same area so that a similar comparison can be made, that is, relating a map symbol to a structure, or colours on a map to colours on the photograph, or contours of a map with contours of the real world.

The latter is possible as technology gives computers the capability to render height field data, the topography of the land, from a digital elevation model (DEM) or a digital terrain model (DTM). Thus a student can see how a two-dimensional OS maps onto a three-dimensional version. The Ordnance Survey (OS) has line map data of the whole of the UK. These can be in one of two formats; either vector data, where each point is plotted into a grid, or raster data, where the map has been scanned in. A scanned-in image has disadvantages as its resolution is implicit to the original image, and once this is expanded the detail is not improved. (This can be seen on streetmap.co.uk where only certain scales of maps are available for use.) Vector data on the other hand is much more flexible, and can be filtered and expanded as necessary with no loss of integrity of the data. Line map data is vector data, this is made up of polygons and lines, denoting roads, boundaries, fields and buildings. This data is available freely to schools.

From digital maps there are several forms of 3D visualisation. The first uses DEM to create a wireframe image of the area being studied. Images can be draped onto this wireframe. The image could be an aerial photograph, OS line map data or any other digital image of the user's choosing. Whilst photo-realistic landscapes of the non-built environment are convincing, equally realistic creation of the built environment is difficult.

The second method is based on rendering photorealistic landscapes from the basic height and GIS data. The landscape is determined using fractals to grow grass, trees, hedges and to create skies etc (see Genesis software). These images are of a very high quality but are only useful for natural landscapes. The GIS data enables the programmer to identify field lines, forests and rivers, and to assign these certain looks and feels.

A third method, which works particularly well for the built environment, is based on using GIS data. This data is represented in a number of forms, but includes polygons that detail buildings. These polygons can have height data associated with them, and can be extruded to represent the buildings in 3D. Further realism can be generated by draping photographs over building facades. Whilst this works very well for certain situations, the buildings thus generated have flat roofs, which is not representative of most buildings.

A fourth method for the built environment has been adopted by Virtual London. Every building has been measured and input as a set of data points, enabling the building to be represented in 3D very accurately. This project is being run by CASA (Centre of Advanced Spatial Analysis) at the University of London. When new buildings are created, the architects also produce a model of it for incorporation into the existing model. Over the past few years CASA have been responsible for creating a digital version of the model – enabling people to explore London, and look at the potential impact of putting new buildings in and removing others. As the model is digital it is hoped that more people can engage with it, and that changes could be explored in a shared web space. The data can easily be manipulated, and would enable quite extensive exploration. Even games creators have developed datasets like this. SpiderMan is based in a gaming environment of a 3D model of Manhattan – and this model, whilst forming merely the background to the game, contains all the data necessary to explore landscape change in Manhattan.

4.2.1 Examples of existing geography software

In addition to using the internet for research and Word, Excel and PowerPoint for presentation, there are specific packages to manipulate map data. Organisations such the Royal Geographical Society[1] have summarised the key features of the most common ones, while other organisations such as the Ordnance Survey[2] provide teaching material. However, a key feature of many of these packages is their two-dimensional and three-dimensional representations. These are usually geographical information systems (GIS).

GIS are a visualisation software tool; they allow information - eg topographic map (physical surface features, eg roads, rivers, buildings), contour map (isobars), and choropleth map (common features, eg political maps, crop types) - to be linked to a geographical location. GIS systems store the data in layers that can then be superimposed over a base map, thus enabling students to try out different styles to find one that seems to portray the data in the

[1] www.rgs.org/category.php?Page=maineducation
[2] www.ordnancesurvey.co.uk/oswebsite/education/teachingresources/index.html

way that is most visually effective. Using GIS allows users to remove some of the clutter on the map, in order to explore the relationships between user defined variables.

Examples of GIS software being used in schools at Key Stage 3 that address similar areas to Future Landscapes are InfoMapper[3], Memory Map[4] and Digital Worlds[5]. All enable students to compare an OS two-dimensional map and a three-dimensional representation – this can be an aerial photograph or the OS map draped over the heightfield data. In the first two these views can be synchronised so moving in one is reflected in the other, as is zooming in and out. In InfoMapper students can view a two-dimensional and three-dimensional image side by side, or use a slider control to gradually shift the two-dimensional into a three-dimensional or aerial photograph of that area. Alternatively a student can align an OS image next to an aerial photograph to give a continuous map of an area but in different representations. By adding an overlay students can also add internet links, text boxes, or photographs to the map in the form of hotspots which can be accessed by other users.

In the Memory Map software students can view a two-dimensional and three-dimensional version of the same map side by side. In addition, they can select a camera angle, height and position, then record and play back their own custom flight path. It can also be used in conjunction with global positioning systems (GPS); this enables the user to see where they are on the map when doing field work outside.

One feature of Digital Worlds is the ability to add polygons, shapes drawn on the map denoting land use. The student can add an overlay layer and draw over the required area, select the colour, shading type, add a key and then repeat as required. Although a slow process, this would allow them to add choropleth data gathered from a field trial, for example land usage or population density, to their map.

4.2.2 The impact of rendering within software

The software discussed in the previous section does not enable students to add models to a landscape. Such systems exist, architects and planners often enable the user to visualise the impact of their idea in relation to existing structures. The Genesis software, for example, allows people to visualise the impact of planting and cutting down forests on the surroundings. This capability fits in with the alternative futures aspect of the curriculum, the ability to see how decisions impact the environment.

Future Landscapes will enable us to find out more about how children develop their understanding of maps, and to discover the value of having 3D visualisations of landscape change.

5. RECOMMENDATIONS FOR DEVELOPMENT

As a consequence of the Ofsted report there is a need to consider how ICT can be integrated into an activity where there is a focus on the development of concepts rather than drill and skill activities. This suggests that there needs to be an open task that the teachers and students can adapt according to ability and interests. It would have to be flexible, and be able to be used as a whole class activity on a whiteboard as well as by individuals. To satisfy the newly defined curriculum goals the tasks should be authentic and relate to real issues. Existing software, and the original proposal that related to field work, implies that the tasks should be local to the students, ie be based in an area that the students have seen and can relate to.

[3] General details about InfoMapper can be found at www.webbased.co.uk/infomapper/whatis.php

[4] General details about Memory Map can be found at www.memory-map.co.uk/index.htm

[5] General details about Digital World can be found at www.digitalworlds.co.uk

The review of areas of weakness in geography students (Section 0) implies that any prototype developed needs:

- a clear mechanism for mapping a two-dimensional image onto a three-dimensional one so that the students can interpret the:
  - scale between the two representations
  - meaning of symbols within the two-dimensional image by relating it to the three-dimensional one
  - use of colours to represent data, ie blue may represent water if one data set is displayed, but it may represent low lying land if a choropleth data set is being referred to
- the incorporation of grid references with tasks that require their meaningful use
- an accurate representation of relief
- a mechanism for selecting what information to display, and how the scale impacts this representation
- some form of ruler to give an idea of scale between places
- if a three-dimensional model is to be inserted it needs to be to scale with the environment in which it is being inserted.

The learning environment itself needs to have a GIS aspect. For example, the students need to be able to collect and input relevant choropleth data and overlay this information onto the underlying OS map or aerial photograph.

Moreover, the two- and three-dimensional images must be high quality graphics, so that the visualisation is meaningful. If an image is to be rendered that supports an argument for placing a man-made structure, it has to relate to how this choice would actually appear in the environment.

Fred Martin's (2004) original proposal argued that the prototype "…would combine digital mapping and photo images to create landscape options as an aid for decision taking. This could, for example, relate to evaluating a landscape as a possible location for a new housing area or other development. Elements of the technologies to do this already exist, for example, the ability to change landscapes in games such as Sim City, the use of GIS technology to create both plan view and 3D landscapes, and the ability to morph between images. Programs that allow the user to plan gardens and kitchens also contain elements of what I envisage. These elements, however, do not appear to exist in a single program that would allow the user to visualise and perhaps also to 'walk through'".

The goals identified by Futurelab initially are identified below:

1. **To create an interoperable, responsive tool that allows young people to engage with future landscapes:**
   - to create a tool which enables field work, research and OS line map data to be combined seamlessly
   - impacts of different developments could be highlighted for different interventions. So if the child had selected a wind farm – the top three objections could come up with protestors and banners, and the top three long-term impacts eg land-use change, visual impact etc
   - the data field for each chosen study needs to be chosen by the student or teacher – the tool needs to be flexible enough to allow for this – but it would be useful to have a framework to work with. This framework would be responsive – so if a child were to highlight bridge and height square a text pop-up would say why the height data would be interesting.

2. **To create an interoperable, responsive tool that allows young people to imagine future landscapes:**
   - to help children visualise landscape changes

- working from their own photos and linking these with the map is a key part of this project. The ability to see how these photos change due to intervention is really important. Currently we see two ways of doing this:
  - geo-reference their image, and then cut and paste scalable features into the image. This could also be mediated through the map. Add feature to map and it appears to scale in the image – cf 3D visualisation
  - create a second image – from the resources create a 'cartoon'-like image with all the key landscape components. This then enables you to remove or add any feature without getting blanks where the features were. This is particularly possible if you use 3D technologies…

3. To create an interoperable, responsive tool that allows young people to discuss ideas about future landscapes:

- to provide a launch pad for children to discuss future landscapes
- to help children explore possible future landscapes, and subjective and objective factors in determining them
- to facilitate groups to create ways of communicating the visual impact of planned landscape change, alongside other impacts – in order to help inform discussion about such changes, for example, rendering images for students to use in canvassing opinion about said change, creating 3D fly-throughs accessible on the web – for consultation.

4. To ensure that we address the need of young people to visualise the landscapes:

- to enable students to render their own images of landscape change with reference to the photographs they have collected.

5. To ensure we enable students to manipulate these landscapes in meaningful ways – linked specifically to real life situations:

- to help children explore possible long-term impacts on the landscape – linked to the specific case study they are exploring
- to provide a tool for teachers and students that enables them to construct 3D landscapes specific to their local area.

6. How can we motivate teachers and students to engage in future scenarios:

- to create a tool that is flexible enough to enable teachers to use it to create relevant case studies – local to their school.

7. How can new technologies help us in realising the potential for children to think through and discuss future landscapes:

- to create real responses during the field study – enabling students to see the possible landscapes of the future when they are standing in the field of study – mediated through a PDA. This would also enable them to hear the sound of the landscape change.

To summarise, it was believed that students should have a prototype that provided:

- an opportunity to manipulate local landscape using 2D photos, maps and 3D visualisations
- a seamless and responsive tool that enables them to explore the visual impact of land use change
- an opportunity to gather data in the field and to see how land-use change would affect the visual landscape
- an opportunity to see how databases link to maps through GPS-linked database – where data they have been responsible for collecting immediately appears in the grid.