THE BEST OF BOTH WORLDS?
COMPLEMENTARITY IN EDUCATIONAL CARTOGRAPHY

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Cartography and GIScience in education: Where we are now

Maps have never been so popular, neither have they been so relevant to education. 'Graphicacy' has been viewed for many years as a fundamental skill: the 'fourth ace in the pack' along with articulacy, literacy and numeracy and therefore meriting its inclusion in the curriculum from an early age (Balchin and Coleman, 1965). Free or low cost supply of hard copy maps and digital data to schools from national mapping agencies has increased the availability of teaching materials and raised student motivation. The potential of GIScience is promoted vigorously by software companies and charismatic individuals for its potential to make a contribution to young people's development, especially through education for eGovernment and citizenship. This reaches beyond the classroom: much digital mapping involving young people is community focused (English and Feaster, 2003; Knapp, 2003). Maps are not relevant to young people's lives just because they are technologically appealing however. Maps also retain for children and young people their propensity for fantasy, taking them to faraway places with strange sounding names. They continue to offer an escape to the imaginary geographies of children's literature: the Hundred Acre Wood; Narnia; Earthsea; Middle Earth and Oz.

We might expect, therefore, that map education for children and young people would be buzzing with energy. Yet this is far from the case. There are few, if any, countries in the world where geography education is increasing its curriculum share. In the UK and elsewhere, discourse in geography education has steadily, and over a lengthy period, drifted away from maps as a key pedagogical issue. Attempts to re-configure geography for the twenty- first century curriculum market have not positioned maps as a high profile element of the brand. Neither has mapping in schools kept pace with developments in cartography. Some years ago, Gerber noted that 'much of the mapping skills work in schools relies heavily on cartographic thinking that is at least twenty years old' (1992:201). Progress since then has, at best, been slow and there remain a number of significant paradoxes and unresolved issues in relation to learning and teaching with maps. Maps are, for example, increasingly important in the real world yet the status of map learning in school seems even less secure now than in the past. Maps in the workplace are increasingly digital yet, despite massive investment in school hardware and teacher training in ICT, the take-up of digital cartography in education has been limited. Perhaps the most significant adult use of a map is to find the way, yet this is a skill not generally taught at school. Conversely, some school mapping tasks appear to have little practical utility for the world of work. Most important of all, map-related pedagogy is poorly developed. The role of visual variables in determining how maps represent information is generally not recognised by teachers, yet this is a key understanding that children need in order to make their own maps, particularly when selecting from the wide range of options available to them in mapping software. Geography teachers, despite being under considerable pressure from competing curriculum areas, have not appeared to capitalise on the enormous potential of GIS: one of their subject's most distinctive 'unique selling points'.

The evidence for children and young people's learning with maps is fragmented. Many teachers, even geography teachers, regard maps (and especially small scale maps) as being unproblematic for learners. Research evidence in relation to young people's thinking with maps is stronger for pre-school and primary age children than it is for secondary school students. Evidence is also stronger for children's thinking with large scale plans of small spaces (such as a room or playground) than it is for their thinking with small scale maps and atlases. We have almost no longitudinal studies providing evidence for the development of individual children's ability to access cartographic information or the progression in learning made by a cohort. Above all, we know very little about school students' engagement with higher order thinking in cartography and geo-information science and it is here where pedagogy is weakest. The contribution computer mapping can make to education is often promoted with missionary zeal but we are short of hard evidence about what students actually learn. Problem solving, making inferences and decision making (especially with interactive mapping tools) is under researched as is young people's use of maps to learn 'subject' knowledge such as geography, science or history. We therefore have less evidence on which we can build effective teaching strategies incorporating progression in conceptual and skill learning. In most map related research the map itself (although frequently omitted from the research report) is a given. There are few examples of children having to select the most appropriate map for a specified purpose.

Learners, teachers and the internet

The internet uniquely offers the potential of interactive multimedia for learning, incorporating a variety of modalities (such as text, audio, images, video, VRML and other applications) all brought under user control. These modalities offer especially powerful teaching and learning possibilities when linked together. The internet also provides opportunities for collaborative working in a potentially worldwide network. Users are able to interact and exchange ideas with those from other cultural backgrounds. The means of communication has been said to remove face-to-face biases leading to, it is claimed, greater risk-free expression, greater self esteem and increased self confidence (Collis, 1992) thus increasing the quality of users' writing and thinking. This has particular value for school education.

The internet allows 'real world' interactive communication and access to abundant up-to-date information. It provides a huge object database and archive and a setting for enquiry learning and communicating with authoritative sources. It gives young users a set of tools for collecting, selecting, annotating and publishing. It has the potential for enabling young people to engage and delight in democratic participation and argument. It can soften the distance between school, home and the workplace. Electronic access offers new possibilities for participation by physically remote, disabled, or disadvantaged individuals and groups as well as extending the range of what may be available locally to gifted learners or those with special interests .

So here too we would expect school based internet activity to be a vibrant enterprise? Sadly not. Student access remains highly variable. Provision varies between schools, between the primary and secondary sectors and the impact across subject areas has been mixed. Accessing material can be time consuming and so too can 'set-up' arrangements to enable the potential of the internet to be unleashed. Collaborative work between schools, for example, involves issues of establishing common curriculum and pedagogical purpose across state and education authority boundaries. Difficulties also arise from the nature of the materials available on the WWW. Students need to be taught how to distinguish between authoritative sources and those which require further verification. Learners need new skills such as effective strategies for browsing and searching. These, and other, issues are compounded by the current general debate in education. Much of this concerns the balance to be found between polarised views on what, where and how children learn. Should the emphasis be on facts and vocational skills or on concepts and capabilities? Should learning take place in the classroom or the community and workplace? Should children be taught in mixed or same-ability groups, in classes or as individuals and should the curriculum be prescriptive or 'child centred'? Should the process of argument, debate and scholarship assumes a more prominent position for assessment purposes than the traditional product such as an essay or report? How does access to internet learning materials change the nature of home-school partnerships and the role of parents and teachers in supporting learners?

Web cartography and schools

The cartographic resources available on the internet are growing rapidly. Some offer powerful interactive multimedia tools which bring complementary modalities under user control and offer the opportunity to enhance users' understanding of spatial relationships. Others are no better, and some much worse, than conventional hard copy maps. A comprehensive review of theoretical perspectives and practical applications of web cartography has been provided by Kraak and Brown (2001). This paper attempts to append some particular considerations that apply to children's use of maps on the internet. These include issues of accessibility, age appropriateness relevance, and support for learning.

The common assertion that the WWW offers high levels of user accessibility needs to be slightly qualified in an educational context. On the whole in the UK (and in many other developed economies) teachers and learners do have ready access but opportunities for structured teaching with the teacher, students and web map resources all at the same place and time may be limited. This may impose pedagogical constraints on teachers (as, for example, when students have to access maps out of class time) so that WWW based activity is construed as 'extra' rather than 'core' curriculum experience. There are also issues of entitlement and equality of opportunity in cases where, for example, some students have unlimited broadband access at home and others have to share limited facilities during breaks at school. Typically, teachers and students are more likely under these circumstances to view cartographic resources as illustration rather than as a tool for visualisation. Life is certainly easier for teachers when students are working on shared 'public' mapping tasks than when they are engaged on individual 'private' map use. Hutchings, et al. (1992) identify three dimensions to educational hypermedia products: the degree to which the learner governs exposure to the materials (control), the extent to which learners can process materials actively rather than passively (engagement) and the degree to which learners are able to create materials and relationships compared with merely observing them (synthesis). They recommend the development of materials that are high on learner control, creative synthesis and active engagement. Managing this type of learning, however, requires much adjustment from a generally conservative teaching profession and learners themselves may need to have considerable insight into their own learning in order to maximise the potential of hypermedia and to select optimal routes through it.

The fact that most web maps have not been produced with young users in mind is not necessarily a problem (although some teachers may view it so). Interpretation difficulties are probably compensated for by immediacy and the opportunity to take advantage of children's ephemeral interests. Nevertheless, on-line maps are generally more about information retrieval than constructed as resources for supporting learning. The number and variety of cartographic resources available however suggests a need to reconceptualise some aspects of the curriculum. It is, for example, essential that school students are empowered to make an appropriate map selection for a particular purpose (such as illustrating a project report, wayfinding or using the map as a source of evidence). A suitable activity might be to select 5 maps of the same place or on a similar theme from the internet and rank them for quality against a list of criteria. Few schools teach these relatively high order map evaluation skills. Similarly, although most secondary school students 'do' grid references, few teachers conceptualise this activity within the broader context of location finding skill including, for example, using post codes to identify location with an interactive map. Fewer still might consider with their students the misleading nature of how postcode searches commonly represent a target area on the map.

Some practicalities limit the educational use of online map resources. Clearly, the work environment for most students is not entirely computer based. Schools generally have effective and well established procedures for ordering and purchasing hard copy maps and atlases but online purchase of maps and geospatial data can be problematic. For many schools the financial and accounting mechanisms for online subscriptions appear to be a significant hurdle and a barrier to adoption. Although the British government has supported elearning through provision of a system of 'credits', the money has generally been required to be spent in advance of effective cartographic materials available for purchase. More sophisticated use of the internet (some might say exploitation of its greatest potential) such as collaborative visualisation, requires a high level of teacher commitment to set up and run. Effective school-to-school networking of maps and data exchange is rare. Collaborative mapping tools for education need to be simpler to implement than most GIS packages currently available for school use.

Complementarity in educational cartography

It is likely that map learning in school classrooms will be dominated by hard copy materials for a number of years to come. The current issue for educators, therefore, is to devise models whereby the advantages of the hard copy product are used in conjunction with the advantages of the web-delivered product. This 'complementarity' poses challenges for teachers, students and cartographers but may represent in the short term the best route into internet cartography for schools.

In one model, web maps mirror hard copy maps but add value to them through the provision of additional functionality such as cursor rollover, live web links or webcams and tools for measuring distances and areas as well as annotating the map. This functionality blends into standard GIS operations such as the exploration of data by 'brushing', i.e. when selection of an object on the map automatically highlights corresponding elements in related graphics (Monmonier, 1989) and alteration of thematic map classification parameters. An example for young users is where a static picture map can be animated in an electronic version (see Dorling Kindersley's My First Amazing World Explorer). Users can animate map-located pictures, thus avoiding many of the misinterpretations known to be a characteristic of children's picture atlases (Wiegand and Stiell, 1996).

In another model, a website attempts to add additional resources that expand the use of a conventional product. Customer expectation is such that most major curriculum schemes and textbooks are accompanied by a website but the mechanism for cost recovery on the publishers' side has not been entirely resolved. Are the costs, for example, recovered through a subscription or front end loaded onto the cost of the hard copy product? Many publishers have in fact avoided the issue and prefer to sell accompanying materials on a CD using their established ordering and supply procedures, in effect treating the interactive electronic resource as a conventional publication. Many issues in relation to authors' and software developers' reimbursement also remain, not least the costs of maintaining the site and updating when, for example, the hard copy materials are rebranded. The more successful sites need ongoing, thus expensive, editorial input.

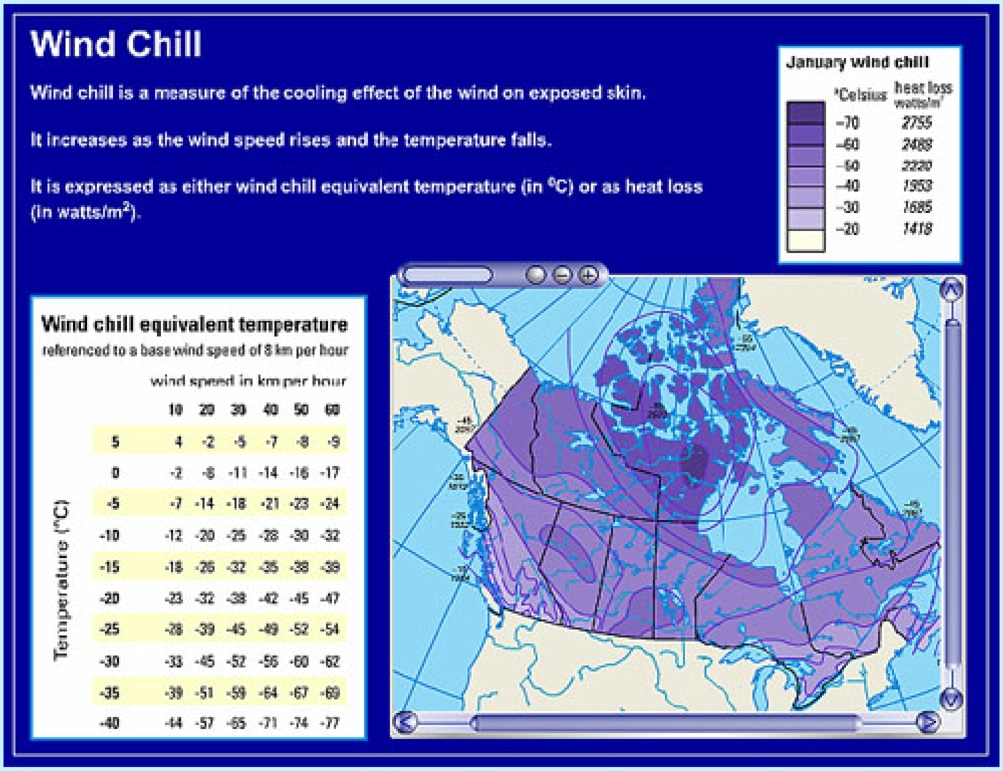

Figure 1: Map and graphics of windchill in Nunavut.

An example illustrates some of the issues so far raised. The Oxford Student Atlas (Wiegand, 2002) is a conventional hard copy volume of 160 pages designed to meet the curricular needs of school students aged 11-18 in UK secondary schools. It provides topographic and thematic coverage of the world with a particular focus on the British Isles (an international edition is also available, without the British Isles emphasis). A website was launched just after publication: http://www.oup.co.uk/oxed/secondary/geography/atlases/. The site is free. This particular atlas is intended to remain in print for a substantial period and therefore avoids the use of case studies (which are subject to the vicissitudes of curriculum change). An obvious use of a website therefore is to select case study areas of topical interest and present larger scale topographic as well as thematic mapping materials on the site in response to user demand. The site currently has case studies of Hong Kong and Nunavut: both being of topical interest at the time the atlas was launched. Both case studies include maps that have additional information on cursor rollover as well as visual images linked to hotspots on the map face. Arrows on a land use map of Hong Kong are linked to orientation photographs and contrasts are highlighted between the old an new airports. A map of windchill in Nunavut provides 'brushing' of a legend graphic that enables students to see how the two components of windchill (windspeed and temperature) combine to give the values in equivalent temperature and heat loss marked on the map (see Figure 1).

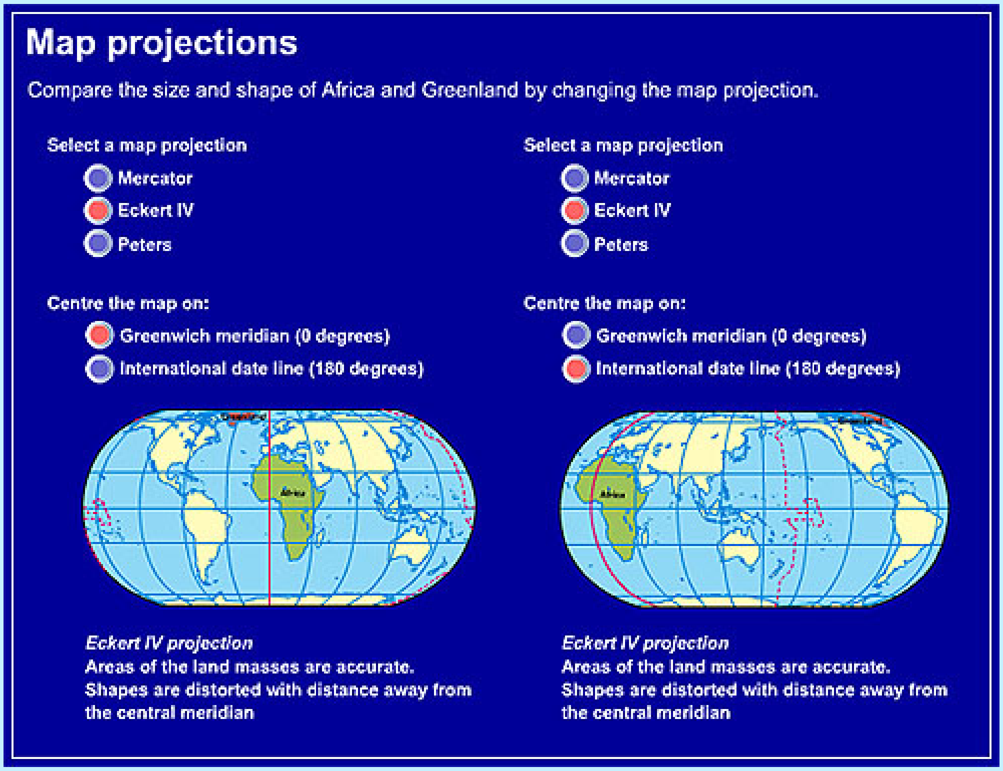

Figure 2: Comparison of map projections.

A modest multimedia component is also provided in the form of Flash graphics that help support student understanding of map projections (see Figure 2). It was intended to provide through this an 'antidote' to the presentation of only the Eckert IV projection (virtually adopted as the 'official' projection by the National Curriculum for England and Wales and often the only projection that students experience). As a means of providing teacher resource support, customisable outline maps were also included, matching the projections used in the atlas and offering the possibility of including the 'key locations' noted in the curriculum requirements for geography (see Figure 3 for the British Isles map: red spots indicate the layers selected for this particular map). Legends mirror those in the hard copy atlas. Zooming and panning tools are designed to be intuitive and are based on computer game applications. The maps are designed to be printed and so, at one level, they simply offer a means of printing a worksheet. At another, they act as a bridge between the hard copy maps and the internet environment. The popularity of map quizzes among students and teachers, as well as a simple means of recording individual student attainment, proved too hard to resist and so the site includes some simple self-monitoring place knowledge tests.

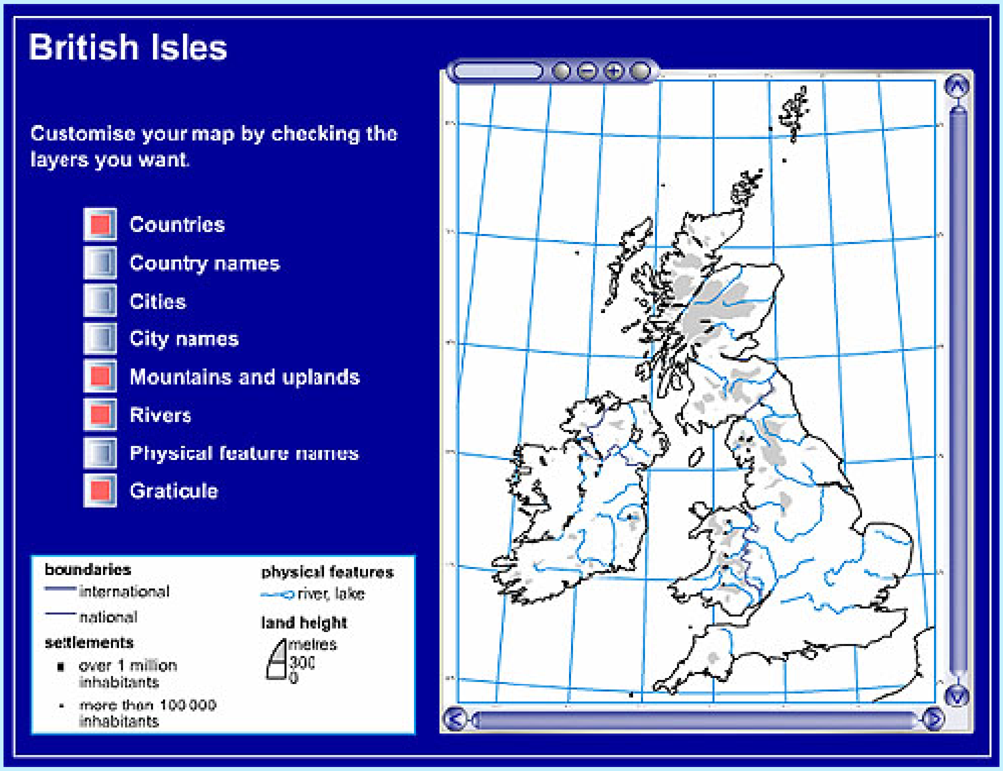

Figure 3: Customisable map of the British Isles.

The site is simple, technologically unambitious but inexpensive. The short to middle term challenge for educators and publishers is to use the potential of the medium to add value to conventional classroom materials within sustainable means of cost recovery. The longer term challenge is to develop robust platforms through which compatible datasets can be shared enabling online collaborative cartographic learning between school students.

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Illustrations from The Oxford Student Atlas website, copyright © 2002 Oxford University Press. Some of the points made in this paper are amplified in Patrick Wiegand's forthcoming book, Learning and Teaching with Maps, to be *published by Routledge in 2005/6.*