EDUCATIONAL CARTOGRAPHY: MAPPING A THEORETICAL FRAMEWORK

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ABSTRACT

Although school atlases represent a major sector in cartographic publishing, we know little about how these materials are developed. This is partly because the number of people directly involved in research and development worldwide is relatively small, partly because commercial competition has generally stifled debate and partly because theoretical perspectives on map design for young people remain underdeveloped. Although the content, appearance and sequencing of school atlas maps are influenced by theories of young people's understanding as well as of how the maps will be used in classrooms, these theories are rarely made explicit. School atlases have been described as a category of 'establishment' mapping and resistant, therefore, to innovation. If this is true, how does it happen and how can it be prevented? Where does power lie in the development process and on what basis are choices made? These are key questions because the materials themselves play a significant role in shaping children's world view.

CHILDREN'S ATLASES

There are a number of loosely defined categories of maps made for children. The most visible sector consists of children's atlases. These can be broadly divided into 'educational' atlases intended primarily for school and 'trade' atlases intended primarily for home use. The former are characterised by more tightly defined content (generally determined by curriculum specifications); the latter tend to have a higher proportion of visual images and text. Pictorial maps, for example, are common in children's trade atlases yet rare in atlases for school. The literature on children's trade atlases is largely limited to book reviews and recommendations for librarians but 'educational' products have been better documented. There have been, for example, several formal classifications of school atlases, some of which are quite complex (e.g. Sandford, 1983a, 1983b, 1984; Gerber, 1987) as well as of related materials such as workbooks and teacher guides (Sandford, 1983c). The principal dimensions of these classifications include educational *phase* (e.g. primary, middle or secondary school), breadth of *focus* (e.g. local, national or world coverage), map *type* (e.g. the relative proportions of topographic and thematic maps), instructional *content* (e.g. the amount of front matter allocated to explanatory material) and degree of non map *illustration* (including artwork, photographs and satellite images).

School atlases play a key role in shaping children's view of the world but much commentary on the way they are used in classrooms has been pessimistic. Sandford attributed the generally low standard of atlas map work by school examination candidates to 'a long period of self-deluding complacency among teachers, apparently assuming an innate or intuitive ability with atlases'(1985:3) among school students. An atlas has too frequently been seen simply as a tool for looking up the location of places (Sandford calls this 'lexical' usage) rather than, for example, visualising complexity and deriving generalisations from it (Castner, 1987). Concern has also been expressed about the extent to which school atlases are up to date and age-appropriate. Schools appear to 'buy for growth', often using atlases intended for older students throughout the school rather than buying editions specifically designed for the needs of younger students (Wiegand, 1998).

School atlases carry important messages about the relations between the home country and the rest of the world and about 'what's worth knowing' (Sandford 1980a). They do not provide a balanced view of the world as the selection of maps often emphasises the home country and approved regional and/or thematic case studies. Maps for school frequently contain images legitimated by school (front matter explaining scale, compass directions and symbols is usually illustrated with pictures of school buildings or equipment) and they rarely start from children's interests (such as football teams, pop stars and soap operas). Of course, children's interests are often ephemeral and don't sit easily with the economics of book production, but that is another feature of the social message delivered by most conventional school atlases: that they come in bound volumes (often 'badged' by examination boards and learned societies) and are made to last. School atlases have been described as a category of 'establishment' mapping (Monmonier, 1981) and resistant therefore to innovation. If this is true, how does it happen and how can it be prevented? Where does power lie in the development process and on what basis are choices made?

The content and the style of cartography in school atlases varies widely internationally (Sandford, 1984, 1987; Gerber, 1992; Keates, 1996) and authors and editors seem to proceed from very different sets of assumptions about classroom practice (Petchenik, 1987). Some appear to conceptualise the atlas as a textbook, others as a reference work.

ACCOUNTS OF RESEARCH AND DEVELOPMENT

Although a number of cross disciplinary perspectives (from theoretical cartography, educational psychology, educational media, geographical education and curriculum theory) were assembled in a *Cartographica* monograph on school atlases (Carswell, et al., 1987) and a helpful review undertaken by the Institute for Cartographic Analysis at the University of Stellenbosch (Vlok and de Necker, 1989), we have very few accounts of the research and development that underpin individual atlases. The studies by Bartz (1965, 1966, 1967a, 1967b) in preparation for the maps in the *World Book Encyclopedia* are a notable exception. Ormeling's (1979) centennial overview of the *Bos Atlas*, widely used in Dutch schools, is an unusual account in that it also describes issues of commercial competition, the character and skills of the atlas's successive editors and principles of editorial policy, albeit generally from a safe historical distance. Ormeling identifies what he considers to be key factors in the success of the atlas, including close contact by the publishers and editors with atlas users and careful monitoring of changing trends in school geography. In particular, he notes that 'involvement of the editors in geography education was considered more important by the management than cartographic know-how' (1979:106). A substantial biography of the *Bos Atlas* by Ormeling *fils* is anticipated this year. Editors of school atlases are not entirely free to develop the publication in the way they would like (Klawe, 1965). Production economies may be such that map materials designed for children have to be re-purposed from existing cartography rather than custom made (Cowles and Guelke, 1979, cited in Carswell et al., 1987). Many maps for students are simplified versions of those provided for adults (Miller, 1982) and this may be the case as much for electronic as for conventional resources.

In recent years, there has been increasing interest in case studies of educational cartography products (e.g. Almeida, 2003; Bandrova, 2003; Coelho and Le Sann, 2003; Innes, 2003; Martinelli, 2003) and the advent of digital atlases aimed at children has presented an emerging opportunity for developmental accounts (see for example: Brede and Williams, 2000; Carrière, 2000; Anderson et al., 2003; Targino et al., 2001; Filippakopoulou et al., 2001). These latter typically focus more on the structure and access of material and less on characteristics of the cartography. Although electronic atlases are increasingly popular, in most educational settings (including schools in more economically developed countries) conventional hard copy atlases still dominate in classrooms.

Several attempts have been made to model the planning and production of educational cartography products. Marcotte and Tessier (1987) visualise the production system as a cog between two large wheels representing, respectively, a system of users' needs (such as desired changes in behaviour, curriculum requirements and teaching objectives) and a system of available resources(such as cartographers, consultants, designers, information sources and media production facilities). The role of the market has generally been underplayed in accounts of how atlases are developed. Map production takes scarce resources and is dependent on both the needs of map users and what they are prepared to pay (Petchenik, 1985). Educational cartography is a complex market and the ultimate end users (i.e. children) are rarely the customers. School atlases are generally bought by teachers or by central purchasing organisations (with or without teacher recommendation). Thus the normal market linkages between product, user response and price mechanism are, in this case, indirect. Significant user involvement in atlas design has, in the past, actually been rejected by professional cartographers (Hocking and Keller, 1992), but users now appear to exert a much greater influence on design and content. Bartz (1971) recognised earlier than most that young users were an important part of the development process and consulted children about their perception of maps before designing the maps for the *World Book Encyclopedia*. Extensive trialling, however, of educational cartographic materials in classrooms remains limited. What follows is a brief discussion on selected features of school atlases, based on (where it exists) evidence for children's thinking.

CONTENT AND LAYOUT

Conventional atlases have a finite number of pages available, requiring careful decisions to be made about content and map scale. In the Oxford Student Atlas (OUP, 2002) for example, ten pages were available for topographic coverage of Europe. France, Spain, middle Europe, Italy and the Balkans are shown at 1:5 000 000; Eastern Europe/Turkey and Scandinavia (with an inset for Iceland) are shown at 1:10 000 000; Benelux is shown at 1: 2 500 000 and the British Isles (in addition to larger scale mapping of the UK elsewhere) is shown at 1: 4 500 000. An alternative strategy would have been to represent Europe at a constant scale (much as a road atlas might do) of, say, 1:7 000 000 and there is a strong case for doing this in order to avoid perceptual bias. However, on the whole, school students in the UK study individual countries or coherent groupings of countries and north-western mainland Europe is particularly rich in curriculum exemplars. There is also merit (particularly in a continent consisting largely of peninsulas and islands) in

students being able to see coherent geographical units (e.g. the Iberian peninsula, the 'boot' of Italy, the Scandinavian peninsula, etc.). The pragmatic solution adopted is one that is generally preferred by teachers but it comes at a cost. British students' sketch maps of Europe frequently under-represent the area of Scandinavia (Axia et al., 1998) and a possible reason for this is that they have so frequently seen it at a much reduced scale.

Page orientation is largely dependent on the shape of the area to be mapped (Argentina is 'portrait', whereas Turkey is 'landscape'). Sandford (1980b) prefers landscape format for maps where possible as it is said to match children's page scanning patterns more closely. Whatever the page orientation though, there are significant advantages in putting a clear frame around the map area. Frames help to separate the map from its peripheral tools such as scale and legend boxes, which need to be prominent in order to be effective (Miller, 1982). 'Bleeding' maps off the page edge, however, has been said to reinforce the notion of continuity of the Earth's surface but this thought may only occur to children if it's pointed out to them. 'Floating' maps can be effective for making comparisons when repeated side by side as well as economical of space but can also be misleading. Islands and other non-contiguous areas can appear to 'belong' to an adjacent map. Framing is, in any case, a well-established teaching tradition and there is a strong belief among many teachers that maps *must* have frames. Framing may also support students' scanning strategies and make the use of a grid easier (Klawe, 1965; Sandford, 1980b).

For most children, the dominant visual form on a small scale map is the coastline and therefore sheet lines of land-locked areas should be extended where it is reasonable to do so in order to help 'fix' the mapped area in the context of recognisable coastline shape (Sandford 1980a). Effective land/sea differentiation on the map is important for figure/ground discrimination. Land/sea discrimination can also be supported by type such as the use of horizontal lettering on the land area and curved lettering on the sea. Unlike adults, children may not recognise 'part of the whole' and will find a locator map helpful in showing the 'big picture' of a wider geographic context. This is likely to be most effective when the viewing area of the map is related to an outline of a whole country or a continent. If the target area of the map is very large, a globe locator can be used but the extent to which this will be helpful depends on children's understanding of the configuration of the Earth's land masses. Bartz (1967a), for example, found that although some children understood that on a globe locator showing Africa, America was 'round the other side', many others did not.

Insets are not generally well understood by children (Bartz, 1965) and, if possible, their use should be avoided. Many American schoolchildren appear to have thought that Alaska was an island to the southwest of California as this was the common position of an Alaskan inset, often at a smaller scale, on maps of the coterminous USA before the Alaskan State legislature's request to publishers in January 1990 to place it in its correct geographical position (Holmes, 1991)

SCALE INFORMATION

Bartz (1965) suggests that graphic scales for children should never start with any value other than 0 at the left end of the bar as children invariably assume that the left edge starts at 0. Scale information is likely to be more effective when it is to be found in a predictable place on the map (Miller, 1982) and when unfamiliar terms (e.g. 'statute miles') are avoided. As children often assume that, because atlas maps fill the same size pages the areas they represent must be at the same scale (Bartz, 1965), scale information should be highly conspicuous on the page and it seems likely that children's understanding of scale is better supported when round values are used (such as *1:1 million* or *One centimetre on the map represents 100 kilometres on the ground*). It may be unhelpful to put a scale bar on a world map where the scale is generally only true for the equator as it encourages children to measure non-equatorial distances inappropriately. This can be a difficult decision for the professional cartographer who feels obliged to provide scale information and the student (or teacher) who may not understand its limitations.

For large scale maps, scale may be effectively shown by reference to distances the reader knows. A map of an unfamiliar locality might, for example, have a line annotated as being the same distance as from school to a familiar location. For small scale maps, a *comparitor* (a map of a known place presented at the same scale as the target area) is useful, but only if readers have a clear understanding of distances in relation to the area it shows.

SYMBOLOGY AND LEGENDS

The majority of map users want maps that are easy to read and on which it is easy to find locations (Hocking and Keller, 1992) but school students and teachers often consider maps for school to be 'too cluttered, too crowded, too cramped, too complicated and too confusing' (Keller et al., 1995: 417). A common call is that maps should not have too many names. There is an interesting cartographic relationship between impact (less detail) and information (more detail) but also a paradox involving young readers (Bartz, 1967b). The more information there is on the map, the more difficult it is to locate the name you are looking for but the more likely that, once located, the name will make a more secure connection between the map and places that you know in the real world. Children searching a simplified map

that only has large cities marked will not find the small town in which they live so finding it on a more detailed map may be worth the additional effort. Too much generalisation gives an overly simplified, and thus inaccurate, view of complexity. Sandford argues for more towns to be marked but for fewer of them to be named (1980a) creating the impression of higher settlement density in some areas but not cluttering the map with unnecessary text. Jay (1954) argues in favour of abandoning objective criteria altogether and marking on the map only those places which have 'significance' for school geography. This idiosyncratic approach appears not to have found favour with cartographers although anecdotal evidence suggests that it remains popular with teachers.

A major design goal in developing maps for children is to provide age-appropriate support for the detection, discrimination, identification and interpretation of symbols (Keates, 1996). Symbol detection by younger users can be supported by bolder keylines and clearly recognisable differences between visual variables. Children are said to prefer bright colours with strong contrast (Sorrell, 1974) and there are classroom advantages in using colours that can be simply named and thus easily referred to (yellow and orange, for example, rather than salmon and beige). Symbol discrimination can be supported by greater differentiation between point, line and area symbols. Pictorial images also need to be age-appropriate. In a children's atlas of Bulgaria (a country where tobacco production is high and many people smoke) an image of a pipe, instead of a cigarette, was used to represent tobacco cultivation. The pipe image, although perhaps less obvious as a symbol, was judged by the editor as less likely to promote smoking among children (Bandrova, 2003). Symbol interpretation may be aided through provision of additional support in the legend. Children may assume, for example, on a political map (where, say, five colours are used arbitrarily to distinguish countries) that countries sharing a colour have something in common. In this situation a legend note (e.g. 'Colours show where one country ends and another begins') may be useful. Some extended legends for young readers incorporate photographs or artwork to elaborate the text entry. For example, land height may be shown in colours representing: mountains; moors and uplands; hills; and low land. Photographs of each relief category may be provided with a caption and brief explanation with the relevant map colour 'tagged' to each photograph. Further support in the form of pictograms abstracted from the vocabulary pictures can also be added to the legend in order to aid recall of the photographs. Where numerical values are identified in the legend (such as *Land below 100m* or *Temperatures over 30^0C*) these can be complemented by category labels (such as *low land* and *hot places*).

GRATICULE AND GRIDCODES

Much of the knowledge embedded in the graticule of meridians and parallels appears sadly to have been lost to school education and maps for school commonly have an alphanumeric grid code instead. This may be a vicious circle as educational publishers recognise that latitude and longitude coordinates are little used, so their type size is reduced and they therefore become more difficult to read. The increasing use of GPS receivers in many everyday activities, however, seems likely to raise awareness of latitude and longitude coordinates in education.

There are a number of co-ordinate options that can be used for small scale maps for children. Omitting the graticule altogether may allow the shape of the land masses to be more easily visualised without interference from the net of meridians and parallels. Providing the meridians and parallels only may be a challenging option for younger users. Miller (1982) for example, found that fewer than half of students in grades 4-6 were able to answer a simple location question using latitude and longitude coordinates. Providing a rectilinear gridcode only may be easier to use but the form of the grid is arbitrary and relative location cannot be compared from one map to another. A commonly used strategy is to embed an alphanumeric code in the 'columns' and 'rows' formed by the meridians and parallels. This can work well where the meridians and parallels are approximately vertical and horizontal (for example, on a map of Africa) but can cause difficulties in high latitudes where the meridians bunch together (for example, on a map of Russia), making use of the grid challenging because the columns change (sometimes substantially) in width across the map.

TYPE AND TEXT

The legibility of type on maps has been investigated in a number of studies but generally with inconclusive results. Bartz (1970) found little variation in the time adolescents took to find place names when all the labels on the map were set in the same style (e.g. all in a serif, or sans serif, or bold, or condensed face), nor when all names were set in capitals or in upper and lower case type. She concluded that none of the fonts used was superior and that 'cartographers can feel relatively free to make choices from a relatively wide spectrum of available type' (1970: 107). By contrast, in tests with Australian and English children, Gerber (1982) found that fastest search times were achieved using a map on which names were shown in the sans serif typeface Univers with the largest settlements shown in bold condensed type (this typeface was also most preferred by young users). Sandford (1978) also suggests that a sans serif typeface is more effective. Names set in upper case type are generally said to be more difficult to read than names set in lower case with an initial capital (Dent, 1993). Lower case is considered easier for insecure readers because the ascenders and

descenders of letters aid word recognition by forming a recognisable silhouette. Size of type is the most common way of indicating position within a hierarchy and for young children, it has been suggested (Miller, 1982) that maps should have no more than three or four type sizes. As empirical evidence is inconclusive, children's map designers tend to rely principally on experience and informed judgement about what is effective. Thus the Junior Atlas of Alberta (Wonders, 1980) used Century School Book for page title, questions, statements and text and Univers for the map face and for graphics.

Readability of type is significantly enhanced when the map user has some expectation of the typographic appearance of the name searched for. When scanning for placenames, readers make use of the first letters of each word in deciding whether to 'reject' and move on to the next word or 'examine further'. The use of differentiated type face enables readers to reject 'non relevant' words more efficiently but only if they have some understanding of the typographical 'code' that gives clues to word meaning. The *positioning* of labels on the map profoundly affects children's interpretation of them. Some well established principles of type placement (Imhof, 1975) are particularly significant for children.

Considering the complexity of place names, there might seem to be an obvious case for the use of standardised names in maps and atlases for children. Young users, however, need to connect their everyday, non-standardised, experiences with the words they read on the map. However, the place name strategy adopted will probably vary according to the age of the target readership. The choice also depends on prevailing attitudes, which may change over time. In the UK, I was aware of a significant trend towards reducing ethnocentrism in geography education in the 1970s and 1980s and the greater use of foreign language names in schoolbooks. The advent of the National Curriculum, however, from 1991 seems to have been accompanied by a reversion to greater emphasis on anglicised forms.

FUTURE DIRECTIONS

Mapping for children is a large sector in cartography but our knowledge base in relation to school atlases is disproportionately small. We need more commentaries on how children's map materials have been developed and more research evidence on how maps are used in classrooms, including controlled studies of 'what works' in relation to children's interpretation of maps. Although the Cartography and Children Commission of the ICA has promoted a debate about school atlases and other teaching materials (Wiegand, 2003 and numerous references above) there remains further work to be done as well as a consideration of other categories of educational cartography. These include maps in school text books (see Trifonoff, 2004, for a historical perspective on these) and the large, informal and ephemeral sector consisting of maps made for children by teachers.

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BIOGRAPHY

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Educational Cartography. Article in International Research in Geographical and Environmental Education 12(4):344-353 Â· December 2003 with 61 Reads. How we measure 'reads'.Â Distributed mapping is a mode of cartography arising from the convergence of the World Wide Web, GIS, and digital cartography. It marks a significant break with traditional cartography because (1) the set of rules ...Â After discussing some theoretical issues in the history of cartography, I locate the multiple origins of distributed mapping in the work on animated mapping during the quantitative revolution in geography and the availability of computing power from the 1960s through the 1980s. Download Citation | EDUCATIONAL CARTOGRAPHY: MAPPING A THEORETICAL FRAMEWORK | Although school atlases represent a major sector in cartographic publishing, we know little about how these materials are developed. This is | Find, read and cite all the research you need on ResearchGate.Â Search was used as an experimental task to investigate one aspect of legibility in cartographic typography. Subjects searched a variety of maps under several different conditions. There are four major conclusions from this research. For random search of the maps containing only one typeface, the typographic variation from map to map did not produce a significant effect on average search time.