

## Chapter 17 Education in cartography

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This book which you are reading shows that the world of maps and mapping is an exciting and important place, where a wide range of activities is undertaken to effectively collect, archive and present information about the world in the form of maps. So, how can you learn more about cartography, how can you become a trained cartographer, and what are the possible ways of making cartography your chosen career?

#### History of education and training in cartography

The United Nations definition of cartography gives some suggestion of the large number of different, but connected, procedures and tasks which are involved in the effective handling of data about the earth and the processes which happen on it (including human activities): “Cartography is considered as the science of preparing all types of maps and charts, and includes every operation from original surveys to final printing of copies.” This definition implies a ‘flowline’ of tasks, from initial surveying and measurement through a range of scientific procedures to the final production of a paper map. These procedures can include manipulation of the measurements, enhancement using other data collection methods such as aerial photography, and drafting the data in graphical form. There is potentially a lot to learn in order to master the flowline and understand what needs to be done to effectively and scientifically prepare the maps which present the data. Education and training in cartography up to very recently did focus on this flowline and taught people at every stage and every level of responsibility about their specific tasks involved.

Whether you were a manager or an apprentice your role was defined by your place in the flowline, and you were taught what was needed to occupy that place.

Therefore, it was possible to be educated in

- techniques of land surveying – how to observe measurements in the field and adjust them to ensure they are as accurate as possible;
- methods of obtaining information from aerial photographs – often using photogrammetry and complex mathematics to geometrically match the photographs to known points on the earth and extract further detail;
- compiling, editing and drafting data for the construction of a map document – using judgement in design and developing content and skill in creating a fair drawing;
- in reproducing the map – which could involve a number of professions such as photography and printing, each of which require significant training to master;
- understanding the economics and marketing of map production;
- the different skills of map reading and using the maps for a number of human activities.

You can see that there was potentially an enormous breadth of education needed to understand the whole flowline. It was no surprise that those interested in cartography specialised only in part of the subject: for example, a national mapping organisation or government map production agency would employ individual surveyors, photogrammetrists, cartographic editors, thematic geographers, photographers, printers, sales representatives, and educational advisers, all

calling themselves cartographers but educated and trained in only a small part of the overall subject. The education and training could be acquired from study in the classroom, or by on-the-job training. The latter predominated as the technologies involved in the flowline were best understood and learned by actually doing and practicing the various tasks: such as survey measurement, plotting from aerial photographs, drafting the original map, or printing the copies. The cartographic profession was hierarchical, with academically trained managers and supervisors, who knew enough about their part of the flowline and how the procedures fitted together, working alongside apprentices who were trained to be skilful in some specific aspects of the cartographic work.

#### Contemporary cartography and educational possibilities

As cartography has developed so much recently, the flowline described above has changed beyond recognition. No longer is map-making a linear process, and it can now involve an even wider range of procedures and methods to assist in the efficient handling of ‘geo-information’ (information about the earth). And as the range of activities has expanded, so have the ways of learning about them. Where and how you learn about cartography is not limited to the school or college lecture room, or by observing experienced cartographers on-the-job. Today, there is even more to learn, and many different ways of learning it.

How is education and training in cartography reacting to the changing nature of the subject? Perhaps the first point to make is that, for experienced educators and practitioners in cartography, there are still many

fundamental concepts and ideas which must be learned. These principles apply whether you are interested in the practical tasks of producing maps, or in thinking about how maps work, or in finding ways of using maps on new devices (such as smartphones). Such basic aspects and issues need to be instilled in apprentice cartographers as they develop knowledge and skills through education and training. For example, it is essential that cartographers

- possess attention to detail;
- understand the transformations inherent in the mapping process;
- have a comprehensive view of the world and the complex processes which occur in it;
- are knowledgeable about the datasets which are sourced from the world to reflect that complexity and the geo-information used to represent it;
- understand the possibilities and limitations of using such datasets for scaling, visualising, archiving, analysis and decision making;
- ensure communication of information through a unique medium (the map);
- show an ability to manipulate and process data whilst retaining accuracy;
- create effective information communication within an aesthetic and well-designed framework.

All these aspects are highlighted in the definition of cartography which is presented by the International Cartographic Association (ICA), the world authoritative body for Cartography and Geographic Information Science: “Cartography is the discipline dealing with the art, science and technology of making and using maps.”

This statement concentrates on the map as the defining element of the job of the cartographer, and it is now acknowledged by most cartographers that some of the other disciplines implied in the United Nations definition of cartography – land surveying, photogrammetry, satellite remote sensing – do not have the map as a core component of their activity, so they are not considered further. However, although the ICA definition of cartography might appear to be now more restricted, in fact it has widened further as it has now embraced the developing topic of geographic information science. The ICA has a definition which enhances its definition of cartography: “Geographic Information Science (GI Science) refers to the scientific context of spatial information processing and management, including associated technology as well as commercial, social and environmental implications. Information processing and management include data analysis and transformations, data management and information visualisation.” Properly educated cartographers need to have learned about the concepts indicated in this definition also.

### **What should we learn?**

There are fundamental topics under the heading of art, science and technology of making and using maps, and there are fundamental principles which are guided by training in GI Science. How, therefore, does contemporary cartographic education address the many objectives which follow from these definitions: objectives such as encouraging innovative flexibility, using the scientific method, developing creativity, and strengthening the basic principles? Educators in cartography are no different to any other cartographers – so along with the fundamentals, modern developments have been embraced with enthusiasm and, as a result,

cartographic education has been re-assessed and changed significantly in recent years.

Cartographic education today can be guided by formal programmes such as the creation of a ‘Body of Knowledge’ relevant to geo-spatial science. This ‘Body of Knowledge’ helps to shape a dynamic syllabus for those studying and those teaching cartography. An initial American attempt to develop a ‘Body of Knowledge’ for geographical science as a whole recognized cartography’s special role by defining a broad knowledge area called ‘Cartography & visualisation’. This knowledge area included the themes ‘History & trends’, ‘Data considerations’, ‘Graphic representation techniques’, ‘Map production’, and ‘Map use & evaluation’, and each theme was further divided into a number of topics. This whole ‘Body of Knowledge’ project has shown that cartography is intimately connected to all other geographical sciences. It also helps teachers by presenting definite learning outcomes and educational objectives which can be assessed; it highlights the large amount of current research in cartography now being undertaken and links it to the taught programmes; and it ensures that the role of the human being is promoted, showing that cartography is not just a series of checkboxes on a technological flowline. The latest additions to the ‘Body of Knowledge’ proposed by ICA have stressed five core areas which have been identified as the subjects which cartographers should be learning about today:

- Data acquisition and Sensor networks (Section 3, Section 8 in this book);
- Internet cartography, Web Mapping and Social Networks (Section 11 in this book);

- Location Based Services, Ubiquitous Computing and Real-time cartography (Section 11 in this book);
- 3D, Augmented Reality and Cross Media (Section 16 in this book);
- Geospatial data infrastructures (Section 14 in this book).

These subjects may be new to you, and may seem complicated, but they address topics which will form the future of cartography, as well as embracing the fundamentals which were mentioned earlier. Look in the rest of this book at the sections mentioned after the listed areas above to find out about each of these topics.

*Exercise: look at the Body of Knowledge at [http://www.aag.org/galleries/publications-files/GIST\\_Body\\_of\\_Knowledge.pdf](http://www.aag.org/galleries/publications-files/GIST_Body_of_Knowledge.pdf): pages 69-79 show a detailed list of some of the important topics which a cartographer should know about. Some of these topics use unusual and difficult words, so it will not be possible to understand everything here. However, a good education in cartography will give you the chance to learn more about these topics. If you are interested in any of these tasks and questions, then you will be interested in learning more about cartography.*

### How do we learn?

We noted before that cartography used to be taught in the classroom, or on-the-job. Today there are many other educational and training methods by which cartographic education can be undertaken. Education recognizes many different ways in which knowledge can be transferred. Certainly, a school classroom is a good environment to learn about maps; but it may be better if

this is supplemented by trips into the outdoors so that school children can learn how to use maps. A small computer software company, which puts maps onto web sites for commercial clients, would be a useful place to learn how to supply geographical information to the Internet; but it would be better if the trainee cartographer was also given some time to explore tools like Google Earth herself. In fact, there are many further contemporary methods in which education can be effective: we could add to the above

- education at university level, where students are encouraged to work independently to make connections between cartography and other disciplines;
- education for interested amateurs, for example for retired people at the University of the Third Age;
- distance-learning methods in which a student follows an on-line course;
- and continuing professional development when experienced senior managers learn about new techniques which they could apply to their everyday work.

The students can differ in age, previous experience, their varying interest in pursuing formal academic qualifications, the size of their class, and cultural setting.

### Issues: school

Despite this variation in content and delivery, education and training in cartography does involve some common approaches and possibilities. For example, there is an increasingly formal inclusion of cartographic material into the primary, elementary, or high school education

syllabus. Some countries have a national educational curriculum which specifies that cartography must be included in school lessons. School children are exposed to a range of educational products in the form of modern school atlases, access to printed and on-screen maps of their own locality, topographic maps supplied by government agencies, and sophisticated GIS software which can allow pupils to make their own maps. Traditionally, the school atlas was a reference work which consisted only of regular maps of the world, continents and countries, with an index or gazetteer (list of names) in the back. Today, even printed school atlases have supplementary information such as satellite images, lists of statistical information, web links to help with further study, and explanations of many geographical phenomena such as climate, geology and even the solar system. School atlases which are supplied on DVD have even greater flexibility in customized mapping, searching, and animated maps.

*Exercise: what school atlases do you have in your classroom? do they show extra information as well as maps? is there any information in your school atlas about how maps are made, and how they are used?*

Many producers of GIS software packages support the early introduction of school children to their products. Children can learn about the data which can be handled and used to make maps; they can also add data which they have collected themselves

*Exercise: do you have access to any GIS software in your school? do you think you could use a GIS software*



Figure 17.1. National Geographic atlas page showing maps, diagrams and photographs.

package to learn more about your own town? For example, you could combine some population census data with a base map from your national mapping agency to see where the younger people live (perhaps they live close to schools) or where only few people live (perhaps not so many people live close to factories and industrial estates).

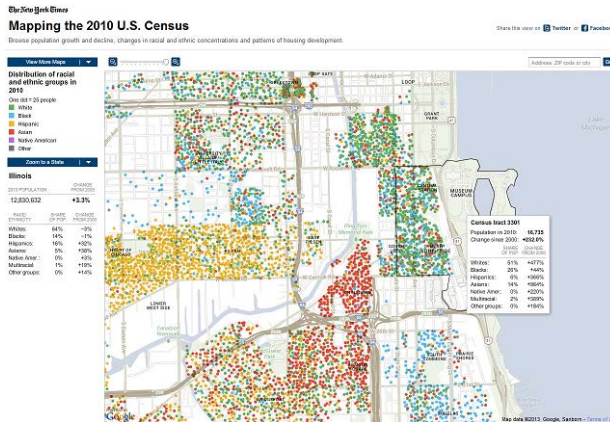


Figure 17.2. Census data for Chicago (USA) displayed using GIS.

The use and importance of maps can be taught at school using a range of maps and atlases. And these can be used in geography lessons, information technology classes, in history, even in mathematics, and perhaps in physical education: in all these, maps can support the teaching of young people.

*Exercise: find the website of your national mapping agency website and see if they have a dedicated 'education' section. If not, you can examine the special education sections of national mapping agencies such as Ordnance Survey Great Britain (<http://www.ordnancesurvey.co.uk/oswebsite/education-and-research/index.html>) for English speakers; Institut Géographique National (France) (<http://education.ign.fr/>) for French speakers; Instituto Geográfico Nacional (Spain) (<http://www.01.ign.es/ign/layout/cartografiaEnsenanza.do>) for Spanish speakers; the State Bureau of Surveying and Mapping (China) (<http://www.tianditu.com>) for Chinese speakers.*

*These web sites vary: do they let you see a map of your street? do they tell you how maps are made or how they can be used? do you think your teacher could use these resources in your lessons? do they give information about advanced research as well as information which a school child can understand?*

### Issues: college

What if you wanted to go beyond using maps to actually finding out about how maps are made, and the nature of the information which is shown on maps? After high school, you might like to specialize in learning more about these topics, and this is possible by seeking out

specialist courses in cartography available in full-time education at college or university. ICA maintains a register of such courses which will give you a broad and deep education in the art, science and technology of mapmaking, and also allow you to understand the nature of geographic information and the fundamentals of GI Science.

Often these courses can be competitive to enrol on: you will need to show that you have a good background in geography, mathematics, and computer science which are important for cartographers to study. Some interest in humanities subjects such as history and archaeology would also be valuable, as would some social science background, for example in economics or business. Some of your experiences outside the school classroom could also contribute to success in these courses: if you have done some outdoor activity such as orienteering, sailing, or mountaineering; participated in organized activities such as scouting or military classes; or if you have travelled widely; then these can all be beneficial. Clearly, cartographers can come with a range of different experiences, and even just a fascination with maps can be a passport into study of cartography (in fact this is probably a requirement!).

*Exercise: access the ICA list of university courses in cartography at <http://lazarus.elte.hu/cet/undergraduate/index2012.htm> Which is the nearest course to where you live? Do you have the background necessary to be accepted onto this course? Do any of the course outlines here show how you can become employed in the cartographic industry?*

There are some college courses which are not full-time, and give an opportunity to gain a technical qualification, such as a diploma, while you are working in the industry

and given one day off per week to study. Such courses used to be quite numerous, but there are not so many available today, because most cartographic companies or organizations would prefer to teach you about their procedures and methods in-house. Such in-house, on-the-job training has been used for centuries to teach apprentices (for example in printing, or in draftsmanship). It is now a good model for those cartographic companies (the majority) which concentrate on using web technologies and which rely on enthusiastic individuals to help their work, rather than employing large numbers of people doing mechanical and routine work. Whatever the organization, the need for a well-trained workforce is regarded as paramount, and with procedures and possibilities in the revised cartographic flowline changing constantly, it is essential that a well-educated workforce can receive updates in the workplace itself.

### **Issues: individual learning**

A further alternative way of learning about new technologies, which are so central to all contemporary cartographic activity, is for you to follow an informal route of learning yourself. There are numerous opportunities to investigate and master novel web-based tools and systems which could be of benefit to cartography. Perhaps the most valuable new tool for cartography for the next decade is being developed as an 'app' at the moment, and you could be the first to demonstrate its value for mapmaking. The age of the individual cartographer is already with us: instead of working for a large traditional mapping agency, there are many cartographers who are self-employed and learning about the subject every day. Such cartographers explore flexible and innovative ways of using map data, creating

exciting graphical maps, serving cartography over the web, and linking maps to an almost infinite range of applications.

As formal courses become more expensive to enrol in, as government investment in higher education is pegged-back, and as more people prefer continuing education rather than the sacrifice of full-time study, informal education including this individualistic approach is becoming more popular.

But formal qualifications are still valuable, as they show that the student has learned about the fundamental concepts. Dedicated, and sometimes open, workshops can be presented in many different ways around the world, and these may offer a certificate of attendance, showing that the student has been exposed to some aspect of cartographic education and training. Such workshops can be and are being offered by learned societies (such as ICA), by pan-governmental outreach programmes (for example, those associated with organisations such as UNECA or the World Bank), by charities (for example, WaterAid in sub-Saharan Africa), and by institutions which have been set up to commit to extension teaching away from their main base (for example, ITC in the Netherlands). Commercial companies can also play a large part in delivering such workshops, concentrating notably on their own products and methods.

Because of the difficulties in gathering people from many different places together for workshops, an increasingly important method for education is by using on-line technologies. Some workshops are presented as 'webinars' – on-line seminars with interactive participation by students and engagement with teachers.

Further collaboration between some commercial course suppliers and well-respected educational institutes have led to the development and delivery of extensive education using MOOCs (Massive Open Online Courses), attractive, freely available, authoritative courses which are often at an advanced, university level (for example the course developed by Coursera and Penn State University).

### **Summary**

Whatever your age and level of experience in the subject of cartography, education and training is essential to consider at all times. As cartography develops rapidly, all cartographers need to undertake 'continuing professional development' (CPD), keeping their skills up-to-date. The Body of Knowledge can assist in showing what needs to be learned and what needs to be revised, whilst on-line courses, workshops, and CPD modules offered by traditional colleges and universities are all likely to be useful. It is important to recognize the value of cartography as a focused subject addressing many of mankind's most pressing problems, but at the same time note the value of cartography as an embracing discipline allowing a world-view of sophistication, accuracy and value to be presented to the world: it is educated cartographers who can use their learning and training to fulfil this destiny.

### **References**

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