Digital Cartography in the Surveying Department of TEI of Athens: Reforms, Changes, Challenges and Problems

DIMOS PANTAZIS, PANAGIOTIS STRATAKIS, SOFIA KARAPATSIOU, VASSILIKI KYRIAKOPOULOU
Research Group SOCRATES (Society for Organizations Cartography Remote sensing and Applications using Technology on Earth and Space)
Surveying Department, School of Technological Applications
Technological Educational Institute (TEI) of Athens
Agiou Spyridonos, 122 10, Egaleo, Athens
GREECE
http://www.teiath.gr

Abstract: - “Digital Cartography” is a mandatory course of the 7th semester in the Surveying Department of TEI of Athens. This paper focuses on the structure of the course subsequent to it being reformed in 2001, the choice of its content, and (planned) future use of new technologies in teaching (computers, Internet, Multimedia), as well as the organization of the laboratory. In addition, the paper presents the relationships between professors and students in the frame of the course, the examinations and tests used, the connection with research projects of the department, and the comparison with similar courses in other European and American universities. Finally, problems and perspectives are also discussed.

Key-Words: - Digital Cartography, contents of a Digital Cartography curriculum, teaching problems

1 Introduction–objective of the paper
This article is concerned with the presentation of the curriculum of the course “Digital Cartography” in the Surveying Department of the Technological Educational Institute of Athens, Greece. The objective is to give an integrated and, at the same time, detailed description of its content and the teaching methods used, presenting also the problems and perspectives for the future.

The structure of the course is presented in Section 2, whilst the choice of the course content is discussed in Section 3. Section 4 describes the use of new technologies in teaching and Section 5 discusses the relationship between the lecturers and students. The assessment of the course using examinations and tests is described in Section 6. Section 7 concerns the relation of the course and the students dissertations as well as the actual research programs of the department. A comparison with similar courses in foreign Universities in Europe, Canada and U.S.A. is given in Section 8. Finally Section 9 describes some problems and gives future perspectives of the course.

2 Structure of the course
Digital Cartography is a 15 week full time mandatory course of the 7th semester - (the studies in the department have a total duration of 8 semesters) - consisting of lectures (3 hours per week), laboratory sessions (3 hours per week). The laboratory sessions include demonstrations and exercises as well as a project which demonstrate the techniques and applications of digital cartography in a more practical context. Each theory session is followed (after two days) by a laboratory session.

The course aims to introduce students to conceptual knowledge and hands-on training through lectures, tutorials, lab exercises, case studies and group work.

Both the theory taught in lectures and laboratory sessions take into account both “classic” (e.g. [1]) and modern methods and concepts for teaching cartographic/geographic materials.

2.1 Theory lectures
The presence of the students in the theory lectures is not mandatory. During the lecture sessions, the theory chapters are presented as they are organized in the semestrial schedule. Discussions, questions and answers and further analysis of the chapters are realized during the theory sessions, in addition to which, invited speakers from the public and private sector occasionally present to the students various topics in the field of digital cartography-geoinformatics. The number of external speakers varies each year, whilst occasionally foreign...
researchers and professors have given lectures. Students are advised to prepare themselves (references research, study of similar cases, etc.) in order to facilitate the discussion and the understanding of the conference topic. It is also important to mention that often the laboratory exercises are distributed and discussed during the theory lectures, in addition the semestrial project of the students is also discussed during the lecture.

2.2 Laboratory work
During laboratory sessions students are divided into groups of two and work together on the weekly assignments. However, each of them has to additionally work on an individual research project. All assignments have to be prepared with professional-level organization, neatness, accuracy, and appearance. Assignments must be submitted on the due date to avoid devaluation. Furthermore, students learn how to present their project and improve their presentation skills. In general, for each theory chapter a set of exercises and questions are distributed to the students.

Several styles of laboratory work are used (during the 3-hour laboratory sessions) e.g.:

- Demonstrations designed to display particular skills, given by the instructors,
- Controlled assignments, wholly devised by the instructors that yield known results,
- Structured questions, where students might be given an objective but they are free to choose a data set and they have to develop their own procedures and provide their own interpretations of the results.
- Open questions. These require students to identify a problem, formulate it clearly, develop appropriate procedures, interpret results and consider their implications. Students are requested to develop the ability to research different types of information and have a critical point of view.
- Research projects. Project topics might be selected by the students or instructors.

3 Digital cartography course: Content
The content of Digital Cartography has been designed keeping in view the emerging trends in the field of Geomatics and the emerging and modified needs of skilled manpower in the sub-field of Geoinformatics. This has been done recognizing that the traditional disciplines of photogrammetry, cartography, remote sensing and surveying cannot anymore only be autonomous but a closer collaboration between them could most of time speed up progress and the effectiveness of mapping.

Various topics are included in the course, such as: sources of digital geospatial data and methods of input, storage, display, and processing of spatial data, digitizing, scanning and editing of maps using various software, creation of hybrid data, generalization, map registration and compilation, real world and user coordinates, file import and export, attribute data attachment.

The study of spatial data structures and their application in digital cartography is a major topic. Raster and vector data structures are examined, as well as attribute schemes and topological models. Data transformation, information loss, data quality, and the role of metadata are also included.

Conceptual and logical database design, building and coding of attributes, relating spatial and attribute data, using databases and database management are examined thoroughly.

More specifically the lectures are divided into the following chapters:
1. Introduction, basic concepts and principles.
2. Digital cartographic data types.
3. Sources of digital geospatial data.
4. Software and equipment.
5. Geographical digital data characteristics.
7. Conceptual modeling of spatial databases and CASE - tools.
8. Spatial Database structures.
10. Digital terrain models.
11. Cartographic generalization in digital maps.
12. Metadata and data dictionaries.
15. Cartography with satellite images.
17. Digital maps on the INTERNET.
18. Geographic digital data for Greece.
19. Special topics.

The laboratory sessions mainly concern:
- The understanding of, and practice, on the concepts of digital cartography and spatial databases as reported in the theory.
- Familiarization with basic software and hardware used in digital cartography. Development of cartographic databases, Conceptual models of alphanumeric and spatial
databases, data dictionaries, topological relationships of cartographic data, digital maps’ quality control. Raster and vector digitization.

- Generation, update and digital map control.
- Special issues (i.e. use of satellite imagery and aerial photography).

Special attention has been given to the updating of the content of the course according to similar courses (e.g. [2]) but also taking into account the everyday use of digital cartography in many activities of the citizens (GPS for car/boat navigation, maps in mobile phones, maps on the Internet, etc).

4 The use of new technologies
During the theory sessions a projector with transparencies is mainly used together, occasionally, with a laptop equipped with Internet connection and PowerPoint. The Internet connection is used for demonstrations, e.g. for digital maps on the websites with related educational materials and data, free/open software, applications of cartographic databases, real time navigation cartography etc.

The laboratory is equipped with 16 PCs, a local network server, one plotter and 4 small digitization tables.

Hands-on training is provided on various software packages (including AutoCAD, Imagination Engineer, Arc View, Idrisi, Surfer and Dbmain, Office, WWW browser, zip utilities) under the Windows environment. Free and open software is also used.

Students are provided with a tutorial, written by the instructors, with the basic commands for each of the special software programs and are requested to explore them further and not to be restricted to specific commands or the interface of one system. They are also encouraged to explore freeware software and utilities over the internet.

The continued growth of digital cartography as a dynamic discipline mainly depends on how students and staff respond to new technological challenges. The plan for the use of new technologies intents to:

- Provide electronic resources for students to work with, in order to eliminate the time spent seeking for them.
- Support feedback mechanisms for students and teachers in order to enhance or dilute components of the course or teaching techniques used.
- Provide an e-learning environment to promote interaction between students, enabling every student to play an active role in the learning process. Communication should firstly take place between students via e-mail, chat and whiteboard discussion before official help is requested from the instructors.

In addition, distance learning for those who do not have the opportunity to attend a scheduled course could be also be provided [3].

5 Relationship between teachers and students
During the theory lecture, the lecturer can have a general impression of the about 60 students. Discussion, questions, remarks etc. establish a first general impression of each one of them.

During the laboratory sessions the ratio of students / lecturers (tutors) is 10/1 (three groups of 20 students, each of whom has two tutors). The three-hour session provides the possibility not only for general remarks addressed to all but for an individual step-by-step instruction concerning the exercises and the semestrial projects. It is expected that students attend all laboratory classes; however there is a maximum of two legitimated absences during the semester.

Basic problems arise from the attitude of some students who believe that by only being present in the laboratory session they can successfully pass the course. Objections also occur about the number of exercises and the size of the project. Concerning the first matter, the comparison with similar curricula of foreign universities (e.g. University of Liege-Belgium) shows that the volume of work is broadly similar. Concerning the second matter, and given the fact that the volume of the project is determined by the student (individual projects) and the tutor, it has to be said that after a “difficult” start, the students generally arrive at satisfactory results.

In general, contact with students is limited to class hours. Despite this, a close relationship between tutors and students is formed in the classroom because of the individual character of the exercises and projects, helping the individual gradual progress of each student.

6 The examinations and tests used
The course examinations consist of two different test procedures; theory and laboratory. Theory counts for 50% of the final grade and laboratory work (assignments, individual project and exams) for the remaining 50%. To successfully pass the course students must achieve in both exams a minimum of 50%.\n
Theory exams consist of a set of multiple choice questions covering all the issues discussed during the course lectures. The overall percentage of students that pass on their first attempt is 50 to 60%. Although the students are eligible to repeat the test after a week, only 30% succeed this second time.

At laboratory examinations each student has to demonstrate the knowledge that they have acquired during the semester. The questions asked include practical implementation that requires the use of the previously mentioned software. The assessment takes place in the laboratory and consists of an oral examination with questions on the methodology they have used the software in order to get the results.

The final grade is weighted by 40% for the weekly assignments, 30% by the individual project and 30% by the laboratory examinations. It is remarkable that only 5 to 10% of students fail the laboratory part.

7 Digital cartography and research programs of the department

There are several research groups in the Surveying department. One of the most important ones, taking into account the number of realized international research projects and the number of publications, is the SOCRATES (Society for Organizations Cartography Remote sensing and Applications using Technology on Earth and Space) group. Basic and applied research is being developed mainly in the frame of bilateral research programs with China (National Remote Sensing of China) financed by the EU and private companies, also having the support of the Hellenic Geographic Military Service.

SOCRATES is composed of professors of TEI but also from other scientists. In the frame of different research projects in the field of digital cartography / cartographic databases / geoinformatics some semestrial works of the course constitute small parts of those research projects. Dissertations in the field of digital cartography have also been integrated in different research projects. From 2000 until 2005 about 15 dissertations are related directly or indirectly with research projects of SOCRATES. This means that the research programs became a sort of real field in which students can participate improving their knowledge and testing their abilities, learning at the same time the fundamental steps of doing research.

8 Comparison with similar courses

The content of the digital cartography courses, the level and duration as well as the amount of practical work vary as they depend on the educational policy of each university.

At the National Technical University of Athens (NTUA), School of Rural and Surveying Engineering, there is a similar course called “Digital Cartography”, which is an elective course of the 7th semester but still a mandatory course for students following the section of surveying. The course includes a laboratory session and deals with [4, 5]: data structures, data collection, cartographic database design including accuracy and errors issues, algorithms for cartographic generalization, surfaces representation and interpolation methods, digital data representation, quality of spatial data and cartographic data exchange.

At the Department of Rural and Surveying Engineering of Aristotelian University of Thessaloniki (A.U.TH), “Computer and Assisted Cartography” deals mainly with [6]: the role of automation in Cartography, vector and raster maps, digital map, spatial databases, digitized map transformations and accuracy of digitization, spatial data models, interpolation methods and cartographic generalization, relationships between GIS and digital maps.

In general the basic core of the above two courses is the same. “Digital Cartography” in the Surveying Department of TEI, Athens, deals with basically the same topics. However, some additional ones are included in the curriculum of different courses at NTUA and A.U.TH. since the above universities have 5 year programs instead of the 4 at TEI.

Digital cartography courses in the USA and Canada are mainly taught in Geography departments. The structure of the courses includes, amongst other topics, scale, coordinate systems, projections, digital map topology, data acquisition, geocoding, and data compilation [7, 8, 9]. However, they emphasize cartographic visualization which includes principles of graphic design and methods of thematic map production. Most of those subjects are taught in the framework of a 3rd semester course of our Department called General and Mathematical Cartography.

Cartographic education in the UK has faced a significant threat since the Geography departments have reduced or removed cartography courses and replaced them with Geographic Information Systems (GIS) modules [10]. Although GIS provide a useful tool these courses don’t deal with many of the
principal aspects of mapping, in terms of coordinate systems, map projection and map design.

Generally, there are various differences in cartography courses among educational programs in European Universities [11].

9 Problems
As already mentioned, whilst lab attendance is mandatory lecture attendance is not. This practically means that some students come to the laboratory without the necessary knowledge to follow the exercises and the semestrial project. A percentage, which varies from 65% - 95%, is present during the theory sessions. As a result some students ignore information and instructions given in the theory hours, and have many difficulties during the laboratory hours.

The students undergoing Digital Cartography come with the theoretical and practical background of diverse courses including geodesy, cartography, remote sensing, photogrammetry and GIS. Most are conversant with the basics of computers, but still there are some that must be helped in order to explore computers and software capabilities, while very few are familiar with programming.

Students are not familiar with enquiries (structured or open) and research projects. They prefer demonstrations and controlled assignments.

Because there are only two courses related to cartography and a lack of courses relating to databases, many topics have to be squeezed in a short time.

Four people are involved in the course realization: a professor (who gives the theory lectures and some of the laboratories sessions, and has the overall responsibility) and 3 other laboratory scientific collaborators under contract. As about 60 students are registered each semester 3 groups of 20 students are formed. For each group 2 scientific collaborators (and / or the professor) are assigned. This means that, in general, no one has a general overview of all the students in all laboratory groups. A partial cure for this is the presence of the professor some times in the third group as also specific rules and teaching methods the same for all people involved in teaching the Digital Cartography. This means that a kind of standard in teaching is achieved.

Occasionally problems with the hardware, software or networking arise that should be eliminated for the laboratory to work more efficiently. Despite the fact that the department seriously considers managing and supervising the laboratory by full-time support staff, bureaucratic problems very often do not permit the easy solution in small technical problems.

Because, as already mentioned, the laboratory serves several classes, it is not available for further work after class. Some students who don’t own a computer complain about the non-availability of computers and, in particular, of special software to work with, elsewhere at the Department.

Finally, last but not least is the partial “overlapping” of the course content with other courses of the department such as: GIS, Applications of GIS, Spatial analysis, etc. Where to start and finish the digital cartography is a question that preoccupies very often many colleagues. In any case such kind of problems affect (or could affect) and/or are related most of time with human/personal problems.

10 Conclusions - Perspectives
An analytical description of the course of Digital Cartography in the Surveying Department of the Technological Educational Institute of Athens has been presented.

In comparison with similar courses offered in other foreign universities, concerning the structure and the contents, we believe that we use more or less the same standards which exist elsewhere. The successful continuation of many of our students onto MSc degrees in foreign universities is a kind of “confirmation” of this “affirmation”.

Nevertheless, continuous reviewing of the course is necessary regarding to the progress of the technology in the field and also the changes in fundamental concepts and in the way that we see cartography and cartographic databases now and in the future. Different processes are established to achieve this objective: a) establishment of a virtual observatory of the contents of similar courses in Greek and foreign universities; b) regular participation in relative congresses of all scientific subjects involved in the course, aiming at understanding new trends in digital cartography and geoinformatics; and c) open channel for regular collaborations in the field of digital cartography/cartographic databases with organizations and private companies in Greece and foreign countries.

Concerning the academic level of the teaching group, we consider that all members are at a very high level taking into account their degrees (PhD, MSc, Eng degrees), research work and scientific publishing activity.
Amongst the perspectives for the near future (next semester) include:

a) The use of special software (e-class) via the Internet which will permit the distribution of educational materials, exercises and homework to the students electronically, as also their examination and distribution of the results with the same manner. In any case the classic laboratory sessions will remain but the students will also have the possibility to work and send their works from home directly to the professors.

b) The purchase of new software specific for the needs of digital cartography.

c) The integration of the realization of a large dimensions map (in addition to the small ones realized until now) by bigger group of students.

d) The videoconference sessions with foreign or Greek colleagues from similar departments of the same scientific field.

e) The integration into the teaching process of more bibliographic work by the students having as aim the familiarization of the relevant literature.

f) Enrichment and improvement of the quality of the website of the course.

g) Participation of the laboratory of applied informatics (which supports the course of Digital Cartography) in international associations in the geoinformatics field (e.g. AGILE association).

h) Creation of a remote education course via Internet based on digital cartography lectures (e.g. [12, 13]).

i) Integration in the laboratory sessions of special software concerning modular teaching platform including supervision of all the screens of the students, running demo at the same time to all students, monitors and keyboard lock, visualization tool master pointer, chat between all and individually each student and the teacher etc.

j) Purchase of special equipment such as interactive boards, interactive plasma display and image capturing system.

References:


