DEVELOPING CARTOGRAPHIC SKILLS THROUGH PROGRAMMING ON GEOVRML

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ABSTRACT:

In the emerging Learning Society, an increasing attention is paid on employability and its basic skills such as computing capability, Internet communication, ability to monitor problems and capacity for analytical and synthetical thinking.

GeoVRML is an environment in which cartographic knowledge may be applied while joining effective communication and personal creativity. It offers a common background to simulate the geometrical fundamentals of the discipline, relays on visual communication, which stimulates curiosity and transversal thinking and it is and standard in the Web and so, an appropriate media to disseminate results.

This contribution reports the experience of some teachers working in the Cartography and Land Engineering Department of the University of Salamanca. We have developed some teaching tools supported by GeoVRML to ease the students assimilation of main cartographic concepts such as Spatial Transformations, Interpolating on DEM, TIN design, Photogrammetric Project Planning, Camera Resection or Ortophoto fundamentals.

Key words: Learning Society, employability skills, Internet, GeoVRML

MOTIVATION AND BACKGROUND

Cartography is a part of the Knowledge Society. An essential feature of this rising paradigm is the growing capacity of controlling technology through abstract models (software). Even more, Cartographic Engineering may be portrayed as an inverse engineering in which the conceptual flow takes place from reality to representation (and not vice versa). This means that dependency on machines (hardware) may be minimized and so, a more constrained-free approach may be set up.

In the Information Society, in which the main issue is an endless growing access to information, it is crucial the arising of knowledge. The main difference between information and knowledge is the creative way in which the latter is always generated. Information is a cultural feature and is transferred or captured whilst knowledge is a personal feature and is created. The main challenge of the XXI century society is that each of its citizens may be able to discriminate, analyze and asses relevant information from the raw accessible records and to generate meaningful and profitable knowledge.

In this new approach, a great emphasis is being placed on the skills agenda. Not only the Bologne process is stressing this new approach but rather a world wide trend is increasingly demanding a new point of view. A new set of education targets is being largely discussed, implemented, and assessed. The most recent of these, and probably the most surprising one, is ethics. No one would stand arguing, some years ago, that we would have to teach ethical competence. Nevertheless, the ethical or personal behaviour competence is gaining ground as the core idea that supports professional competence. Enemark and Plimmer (2002) state that this is the core to the other three (Knowledge, Cognitive and Professional Competences) and define it as the possession of appropriate personal and professional values and behaviours and the ability to make sound judgements when confronted with ethical dilemmas in a professional context.

The rising Quality Culture is building an increasingly awareness on user and consumer rights and on professional outcomes. Ethical values such as integrity, client confidentiality, transparency, accountability, objectivity, respect and personal reputation are gaining ground and becoming a common reference to design and develop mutual recognition of qualifications across Europe and the whole world.

Educational designers are compelled nowadays to consider a breadth frame in which the emphasis is moving from input (relying on the traditional knowledge body) to output (establishing professional profiles demanded by stakeholders) and
from self estimation (university is a self sustained world with a "wisdom treasure" to preserve) to accreditation (university efficiency must be measured according to precise predefined criteria) (Ledger, 2002).

The University changes may be summarized as the transition from an institutional environment based on tradition established rules to a technological environment based on market rules. In this space, Universities are compelled to be competitive if they are to survive. Some features of the new situation are:

- Universities become virtual: offer not only the traditional presence courses but also distance courses based on the Internet and mixed options.
- The permanent renewal of knowledge and technologies claims for citizens that are long life learners. This demands a way to acknowledge diffuse curricula.
- Flexibility leads to collaboration among Universities by means of networks. The scene is changing from classical classroom to individuals connected on / off line.
- Universities will be expected to contribute to society welfare and that means specially the local society in which the University is integrated.

NEW SKILLS

Employability becomes the main objective of the Higher Education System and it is better expressed (rather than knowledge) in terms of professional competences. Consequently, we witness a shift from a teacher centered approach in which students mastering academic contents is the main goal to a student centered approach in which these are given chances to exercise the competences they will have to exert in their future profession.

According to Fallows (2000), the growing importance of skills is owed to:

- Transition from university to labour is not straightforward.
- Awareness of other attributes within classical subject knowledge.
- Permanence at a job place is a decreasing feature.
- Growing expectatives from students.

There is a high agreement about which are the most valuable skills. An important number of employers and graduates of a wide range of european countries have expressed through the Tuning questionnaire, that the main competences are (in this order):

- Capacity to learn in an autonomous way.
- Capacity for analysis and synthesis.
- Capacity for applying knowledge in practice.

Across a number of publications concerning the skills topic we will find a well defined, high frequency, group embracing (not hierarchical order):

- Dealing with communication and information (including Information and Communication Technologies).
- Group work
- Problem solving
- Self management

The key feature to understand this new trend is the growing need for a self-reliant graduate whose skills are the same of the self-reliant learner. The main skill is to develop personal autonomy in acquiring skills and so, the education goal
becomes to create incurable learners, to build learner autonomy through skills. Against this background it is not surprising that general (and not subject dependent) skills are the most valuable to get a job.

In this frame, there is a key concept that gathers the meaning of them all and provides motivation and inspiration to help redesigning syllabus adequately: feedback. Professional and learning competence may be synthetized on the capability of generating, monitoring and learning from feedback:

- Developing awareness, positive attitude and gaining experience on open, related, transversal, multidisciplinar, complex and fuzzy actions / decisions where linkages are as important as deepness or specialized, vertical foundations.
- Developing awareness, attitude and capacity on monitoring own performance within a system of related elements. To improve is not to perfectly control every expected action and its consequences but rather to be able to deal with uncertainty and unexpected circumstances and accepting positively that own performance is improvable while confronted to real system evolution. So, we must pursue to be open minded and humble (intelligent) enough to foster (not only accept) means and channels to obtain feedback.
- Developing awareness, attitude and capability on modifying own performance according to results. This places the stress on evaluation and, of course, on the educational program evaluation. On one hand, it is important to suggest and encourage students to improve their self-assessment ability as a main professional skill. And on the other hand, programmers must address, while redesigning syllabi, to create an environment in which students have chances to provide themselves feedback. In this approach, the classical issue - teachers evaluating students performance - is not a final step but rather a means of achieving the former.

On the other side, the quality control culture demands a coherent, standardized and exhaustive specification on system objectives and processes. Therefore, a somewhat awkward and complex documentation on teaching / learning labour is unavoidable. Regarding evaluation, this becomes critical because assessing students performance is a not accurate and a not reliable task. According to Fallows (2000), Assessment of skills is problematic: the most favoured approach is to acknowledge the skills practiced along curriculum and transcripting the way in which the skills had been addressed.

Besides this, we must consider that feedback culture rather collides with owns students expectations:

- They only expect feedback in the final test and just in the form of acceptable / not acceptable verdict.
- They do not expect feedback from the teacher. They do not see the teacher as an instrument of gaining feedback.
- They do not expect to be asked to provide feedback to teacher. Furthermore, providing feedback to the teacher is - to their eyes - a "risky" action.

According to Hakel and McCreary (2000) the best practices in teaching are:

- encourage student - faculty contact
- encourage cooperation among students
- encourage active learning
- give prompt feedback
- emphasize time on task
- communicate high expectatives
- respect diverse talents and ways of learning

As quality culture is recursive, the teaching staff should be encouraged to (Harpe and Radloff, 2000):

- Reflect on own teaching practice
• Introduce innovative ways to develop skills
• Monitor teaching and learning outcomes
• Document and disseminate experiences

NEW CARTOGRAPHY

In recent years, Cartographic Engineering has evolved enough to sustain a new technological paradigm: the so called Geomatics Engineering. This new frame has been entailed by the growth of the satellite and the information programs, and is able to generate a great wealth and to actively participate in a world wide market.

In this new paradigm, land management by means of a consistent set of tools applied on georeferenced data is the central core. Through GIS, geographic information is made available to multidisciplinary teams (from archaeologists to risk preventers) in order to provide support for sustainable wealth to the whole society.

Quality control is becoming not only an urgent need but also a basic tool. Quality Assessment is critical as a mean of preserving maps in high standards while Quality Management provides the framework in which cartography can fluently and efficiently provide interactive tools in a connected world. As the capacity of cartography surpasses the classic representation objectives, entering in an immersive context, new quality parameters have to be considered and implemented.

Against this background, a broad space for creative and personal enrichment is available. Cartography through GIS is a field where professionals can exert their capacity of problem solving through the powerful means that Information Technologies offer.

The solution of today geographical problems requires the application of concepts and skills derived from diverse disciplines. More and more, the Geomatic world is characterized by a holistic approach to dealing with spatial abstractions. Professionals must not be just graduates trained in the use of software but rather individuals with a wide reference frame, technically efficient as well as able to work in teams, to communicate both orally and verbally, and to solve problems.

More and more, Geomatics applications focus upon obtaining analytical automated solutions to spatial problems and upon the use of advanced visualization means to help the understanding of the results. Consequently, Geomatics syllabus must rely heavily on students ability to identify problems with spatial components, to develop potential solutions to these problems and to effectively apply existing concepts and tools to their solution.

To achieve this (Strawman Report, 2003), students must be exposed to real market practices as part of their education. These practices in fact extend beyond specific Geomatics skills to embrace a set of activities such as project management, programming, ethics and values, written and oral communication and the ability to work as part of a team. Central to all paths is the development of problem identification and problem solving capabilities.

According to the Strawman Report: Existing undergraduate programs involving GIS&T components are often deeply disciplinary in their focus and, within this narrow context, far too many of these choose to stress the attainment of rapidly outdated software manipulation skills at the expense of acquiring the conceptual knowledge necessary to cope with the continuing, rapid scientific and technological change that characterizes GIS&T. Academic approaches to GIS&T education have also characteristically exhibited some basic confusion regarding the way that the relevant scientific, engineering and application components of GIS&T relate to each other as well as to the scope and role of the traditional disciplines in GI&ST.

GEOVRML

Maybe VRML is not, as it has been said, Virtual Reality (for it is only very partially immersive) nor a Modelling Language (for it is preserved deliberately simple). Its strength has arose from other - less impressive - features: VRML is "only" an exchange standard and, in this sense, provides a wide range of shared meaning to render such items as hierarchy transformations, light sources, points of view, texture materials, ambient conditions, movements, ...

Equally important is the fact that it has become a world wide standard at the Internet in the graphics environment, equivalent to HTML in the text one. So, VRML becomes a powerful communication tool and enhances greatly education and researching capabilities. It is convenient to remember the main goals of VRML developers:
- Develop the technology step by step
- Keep it simple
- Develop standards only about questions that are well understood and solved
- Foster research and developments at the body borders
- Do not reinvent technologies that are already outside the VRML frame.

Is important to remember that VRML takes advantage from other well established formats like JPG, GIF (images), WAV (sound), AVI (video), text (HTML) or Java / Javascript (programming code).

Some powerful features are:

- Object based code addressing 3D reality objects and object properties. Objects - named nodes - may be grouped (and accordingly, may accept children) and so, may lead to the creation of large scenes or complicated devices. It also includes a prototyping system for encapsulating and reusing whatever recursive set of nodes. This tool may be accessed from some other VRML file.

- The objects (3D) support a geometry (shape and pose). This geometry is expressed by means of simple primitives such as Boxes, Spheres, Cones and Cylinders or by sophisticated ones such as ElevationGrids (equivalent to cartographic raster Digital Elevation Models) or IndexedFaceSet (equivalent to cartographic 3D Triangular Irregular Networks). Objects also support a "skin" representation by means of a material implementation that may specify the surface response to light sources and by means of a texture or pattern representation of the surface.

- Objects may be endowed with sensors, and so, become "sensitive creatures". Sensors detect user movements through the scene or when he/she interacts with some input device. Sensors are the starting point of routes that build up an information web.

- Objects (nodes) may communicate with each other through an event or message - passing mechanism. Each node type has got a event generating or receiving specification.

- Objects may move, may receive events from so called interpolators of different types. These interpolators compute intermediate values, rated by a clock, within a set of determined set of values specified by the designer.

- Objects may be integrated in a decision taking (intelligent) frame. Flow control may be held by so called scripts in which java or javascript code may be written to analyze diverse circumstances and consequently adopt the better response.

GeoVRML adds to VRML some interesting features:

- Geographical coordinate system: and so supporting directly georeferenced data derived of any kind of sensor and reinforcing consequently data fusion and exchange. GeoVRML supports Geographical Coordinates as well as Rectangular Local and Geocentrical ones. It also provides a variety of ellipsoid models and cartographic projections.

- Double precision and so, it allows to deal with UTM data and WGS84.

- Scalability to manage large multiresolution data both on vector or raster format.

- Animation: ability to interpolate within coordinates for definition of animations with respect to anchor points on the earth surface.

- Introspection: capacity to manifest the coordinates of georeferenced points.

- Navigation such as the issue of elevation scale speed.
DEVELOPING CARTOGRAPHIC SKILLS THROUGH GEOVRML

To work within a 3D world such as the provided by VRML gives a chance to the following:

- Allows to work in a unique space, avoiding the traditional rift relative to plane (X,Y) coordinates and a height (Z) coordinate.
- Implies a global view, relies on synthesis rather than analysis.
- In this sense, recent developments in cognitive science emphasize the importance of images in our understanding abilities. Our mind rather works as a fuzzy network than as straightforward algorithm. In this sense images, and specially 3D rendered representations, have the power of suggestion.
- Allows the user not only to dive into the scene but also to access augmented reality in which impossible points of view or manipulations become feasible.
- Provides the conditions necessary for research activity: firstly, as it provides an open scenario for free exploratory work; secondly, as it provides a symbolized (and comfortable) model of the world in which simulation can take place; thirdly, as it becomes the best mean of presenting and disseminating the results.
- Provides a consistent context in which developers and users (irrespective if they are planners, researchers, students or viewers) can share the same background. Concepts such as texture pattern, material illumination properties, light sources properties, point of view properties, and so on, are there to be grasped in a wide variety of forms: from completely passive to completely active.
- Time and sound are added to 3D Cartography to become 5D Cartography.
- On the counterpart, we must mention the high storing and computing demands required by 3D files. Designers have to account on the final size of the created file, especially if it is to be accessed through the Internet. Fortunately, hardware and software developments continually diminish this limitation.

In a more specific fashion, developing software or, more specifically, developing tasks or simulations relative to cartography fundamentals or processes, provides the following advantages:

- Publication or results dissemination may be supported by the proper developing tool.
- Students can train their system handling capability
- Students develop a competence that, more and more, lays at the core of the Geomatic Engineering curriculum.
- Students may generate qualified, efficient products.
- They may display their personal creativity.
- They are given the chance to relate a serious and demanding work with recreational considerations.
- Build on team work, including the teacher.
- They may establish a researching environment to relate, explore, test and contrast hypothesis.
- To amplify this environment to a teaching / learning one in which is possible:
  
  - To highlight the discipline foundations.
  - To integrate and structure theoretical contents with practical skills or tasks.
  - To understand and analyze situations from diverse points of view.
  - To provide feedback on which autonomous leaning is based.
To spread information sources diversity.

- To adapt realizations to any student level

**SOME EXAMPLES**

At the Cartographic and Land Engineering Department we have developed some applications on VRML:

- Analysis of Projective Geometry in space: Projective Geometry may be analyzed through its basic parameters including both mathematical and geometrical interpretation and taking into account vanishing points as structuring keys of the scene.

- Camera degrees of freedom and photogrammetric flight planning: user may manipulate the parameters that constrain the image acquisition. A terrain model is provided to allow trial and error activities to facilitate students understanding on stereoscopic geometry.

- Camera resection: a graphical environment is set up to highlight geometrical fundamentals supporting the Exterior Orientation process.

- Interpolating on DEMs: students may manipulate diverse interpolating instructions and visualize almost on line its effect on the terrain representation.

- Generating and interpolating on TINs: TIN is generated from a point cloud and several interpolating instructions are offered.

- Generating an Ortophoto: An ortophoto is generated from an available TIN and from an available oriented image.

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