Assessment of Topography E-learning with Exomatic

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Key words: e-learning, open-source software, online topography, non-formal learning.

SUMMARY

The Swiss Federal Institute of Technology in Lausanne (EPFL) has successfully integrated the Bologna reform process that standardizes the Bachelor and Master programmes across Europe. This reform particularly affects the curriculum offered by the EPFL schools of civil and environmental engineering that share students during the bachelor program. Geomatics, the branch which deals with the acquisition and management of geographical data, is one of these courses to be attended by the students from both schools. As we merge classes of many students, we decided to introduce e-learning in this changing educational context.

The Geodetic Engineering Laboratory launched the concept of topography e-learning during its first year class gathering more than 150 students. The idea is mainly based on a set of personalized exercises on the Web, followed by automatic corrections. This allows a substantial increase of the number of students in the course while maintaining the same level of comprehension and computational rigour. This simple concept, called Exomatic, encourages the students to be autonomous in their learning.

This paper is divided into two parts: the first presents the architecture of the software developed for the Exomatic concept that notably improves the management of the exercises and of their automated corrections. The second part focuses on the assessment of Exomatic by the students and by the teachers.

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1. INTRODUCTION

Efficient teaching progressively relies on Internet-based technology. This trend, termed as "computer-aided instruction", implies the integration of new media in formal training. One of the most sophisticated implementations of e-teaching is the integrative approach, where lectures and non-formal learning are equally important. This means that modules, information-processing systems, and collaborative tools represent a mandatory part of instruction. Such an integration aims at increasing the lecture flexibility either by adjusting the periods, or by focusing on specific methods or themes. Consequently, the curriculum choice is not linked anymore to an educational training with predefined rooms and schedules.

Geomatics refer to an engineering sector that is more and more present in our daily activities. Oxford dictionary defines this field as "The mathematics of the Earth; the science of the collection, analysis, and interpretation of data, especially instrumental data, relating to the Earth's surface". Since 80% of the political decisions concerns our life space, and that all actors on the environment stage can face the acquisition or the use of spatial data, a coherent teaching in geomatics must be offered. The latter is based on three bedrocks: topography, imagery, and GIS. From the beginning, each significant step of this training must integrate these three components.

The Geodetic Engineering Laboratory at the Swiss Federal Institute of Technology (EPFL) is traditionaly involved in the teaching of topography and geodesy. These disciplines comprise a large part of mathematics (linear algebra, geometry), computer science, and the optics and mecanics needed for the knowledge of the surveying instruments. Practical aspects are tackled by exercises in the field. The result is that traditional teaching in this branch requires a significant time investment and small-size classes (less than 50 students). The use of Internet modules offers the ability to accomodate more attendees. For example, script-based tutorials confront students with the monitoring of topographic measurement in an intuitive manner.

2. TOPOGRAPHY COURSE AT THE EPFL

During the academic year 2004, the School of Architecture, Civil and Environmental Engineering launched a transdisciplinary curriculum that provides the students with the tools needed to design and build together within a complex environment. The Geomatics teachers decided to play a leading role in this reform. The management of electrical networks, of road traffic, or of water supply, to quote but a few examples, requires more and more people who can analyze spatial information without being specialists of data acquisition. Consequently, more students must acquire the basis of geographic information.

Together with the preliminary course of geoinformation, “topography” offers knowledge in Geomatics for those who will specialize in other disciplines of civil or environmental engineering. Once the Bachelor program over, any student can choose the specialized classes of the Master program that are necessary to join the professions of surveying, of navigation or of geoinformation. The number of environmental-engineering students has been growing for the last years. Moreover, the fusion of both sections of civil and environmental engineering ended up tripling the number of students who attend the basic curriculum of topography and geoinformation, i.e. about 150 persons.

3. TOWARDS E-TEACHING

Traditionally, lectures of topography are followed by individual exercises that help the learners to autonomously master the concepts seen in class. The personalization of these exercises mainly allows increasing self-esteem, which is particularly welcome to counteract the anonymity among first-year students. This also satisfies our pedagogical demands by preventing the simple copy of results as well as the passive wait of the correct version.

To maintain the benefits of individualized exercises while leading research activities, the teachers from the Laboratory have introduced e-learning as a natural evolution of the topography course. Traditional lessons remain, although the focus is now on non-formal learning via online exercises or tutorials designated as Exomatics.

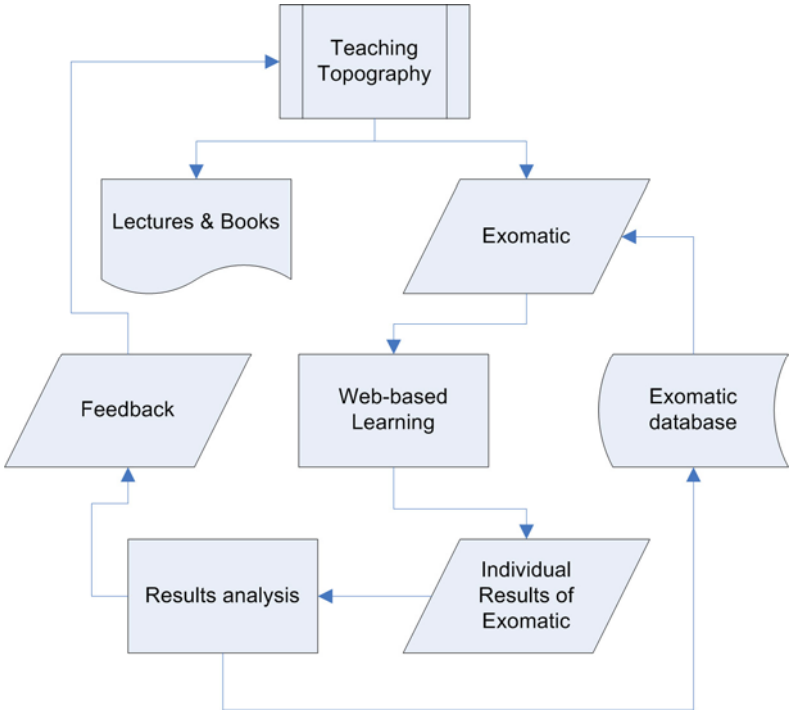

Figure 1. Concept of Internet-assisted topography lessons

This concept of e-learning is better accepted when it is supported by a direct contact with the teaching staff (Platteaux et al., 2004). With this approach, real faces can be associated with this virtual world that is not necessarily attractive at first glance. For a student, the insertion of online educative resources in such a context is reassuring. It simultaneously offers the teacher an opportunity to elaborate interactive and gratifying courses.

4. EXOMATIC IN ACTION

4.1 Introduction of Exomatic

Figure 1 illustrates the progressive introduction of e-learning in topography. Each lesson is divided into two parts: one formal lecture presents the theory and the conceptual development, then a practical exercise, the Exomatic, proponing the application of data-handling algorithms. A comprehensive overview of the Exomatic is given to all attending students so that they can subsequently carry out the exercise in an autonomous manner.

4.2 Exomatic in detail

Conceived as a cross-platform application, Exomatic largely automates the production and marking of individualized exercises. Entirely implemented with the scripting language Perl, Exomatic is a collection of interactive bricks as illustrated on Figure 2.

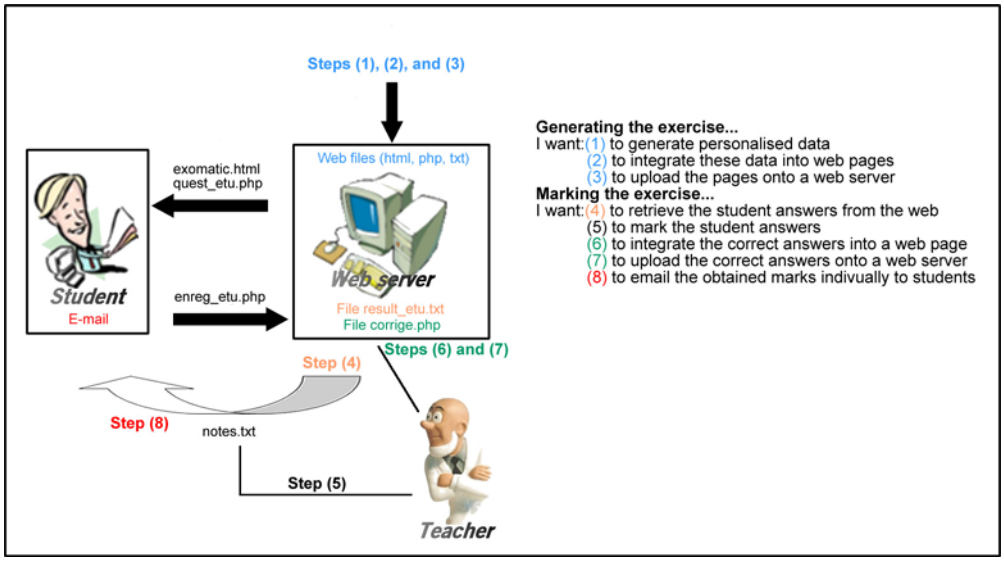

Figure 2. The structure of Exomatic

- The preparation of individualized exercises is based on the data related to the school students (first names, last names, and e-mails) and on the aptitudes the teacher wants to test. These data are integrated within interactive web pages that are automatically deposited on a web server (steps 1 – 3)

- Each student has direct access to the website of the course (Figure 3). After reading a possible reminder of the goal of the exercise, he can see his own data on the basis of his name. Once his problem solved, he retranscribes numerical values. These results are stored on a text file at the server level.
- The automation of the marking comes down to comparing the student's values to the correct ones, by taking into account a certain tolerance. The marking is automatically e-mailed to each student, and the correct version is published on the Internet once the deadline is reached.

In case the student's numerical results are out of tolerance, the teacher endeavors to identify the error source and to manually adjust the marking. Let's note that, during the redaction of their exercise, the students can add comments, and the latter are always read by the teaching staff that may accordingly react. A personalized discussion may follow.

Figure 3. Screen capture of Exomatic at the EPFL

In concrete terms, Exomatic provides a pedagogical material to solve exercises via a user-friendly interface that stimulates the students' involvement. Attractive illustrations and the fact of addressing the students by their first name create a catchy environment that is publicly visible via any web browser.

4.3 Exomatic under GPL

Most of the platforms for e-learning require good skills in programming and Internet navigation. On the contrary, Exomatic is implemented with well-documented and rather user-friendly software. The laboratory released it on the GNU-General Public License, to guarantee a coherent development of a project that may attract a community of academic developers at least.

This approach should help:

- mutualizing competences,
- speeding the development,
- making rigorous and independent tests,
- being more open about the students' needs.

It is also a question of modesty and integrity: the languages (Perl, PHP) and the editing tool for web pages (NVU) are all open-source software that allows carrying out the Exomatics in a quick and coherent manner.

5. ASSESSMENT OF EXOMATIC

5.1 Evaluation mode

The EPFL has developed a center for research and support of training and its technologies (CRAFT) that evaluates courses at the teachers' request. The CRAFT has a long experience in assessing the pedagogical methods and offers to willing teachers questionnaires specifically related to their course. These questionnaires are distributed to the students who fill them out and then individually evaluate the lesson. After a careful processing of the students' answers, the CRAFT assesses the content of the course and eventually gives advice to the teacher. This high-quality methodic analysis provides useful data for the enhancement of the pedagogy at the EPFL.

5.2 Assessment criterions

The Exomatics were evaluated by the CRAFT during the Summer semester '06. 119 students over 125 from the civil engineering and environment engineering sections answered a series of questions and brought commentaries about the weaknesses and strengths of this teaching method. These questions mainly focus on:

1. the clarity of wording
2. the quality of the on-line documents
3. the coherency between the course and Exomatic
4. the level of difficulty
5. the usefulness of the Exomatics to apply the knowledge
6. the quality of the supervision
7. the e-mail communication with the teaching staff
8. the means of monitoring the progress made by the students
9. in-depth training
10. monitoring system suited for the test of knowledge
11. number of hours worked by week

For each question, the students give an appreciation: totally agree, agree, disagree, totally disagree, no response. They also give a general appreciation on the set of Exomatics, graded on a scale from 1 (bad) to 6 (excellent).

5.3 Analysis

The Exomatic is basically judged from sufficient to good: 63% of the students assess it as good, 28% as sufficient, and a few percentages as insufficient. This result is very encouraging, knowing that the first-year students at the EPFL are more accustomed to classical exercises in basic sciences such as maths and physics. This is a positive sign of acceptance of this kind of exercises, which incites the teaching staff to follow the path of e-learning.

With regard to the detailed evaluation via the questionnaire given to the students, the block of questions can be divided into two parts: first part from 1 to 6 concerning the acceptation of the form of teaching (cf. Figure 4) and second part from 7 to 12 concerning the supervision and the training (cf. Figure 5).

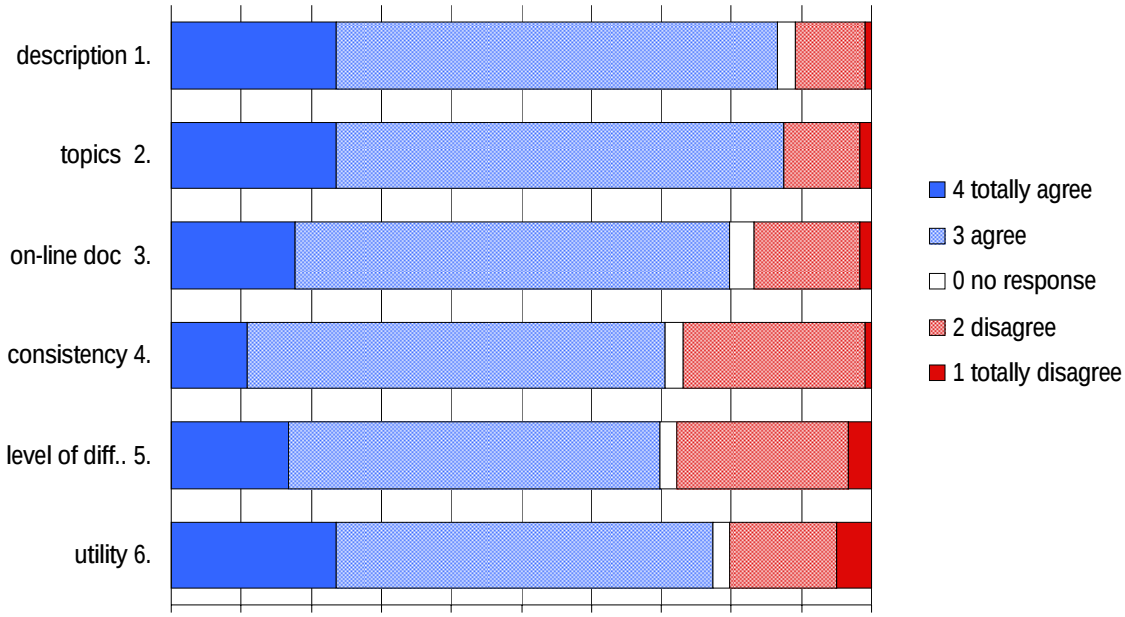

Figure 4. Questions 1 – 6, form of teaching

In the first block of questions, one can notice a relative uniformity of the students' answers. The topics and the documentation are well evaluated with more than 80% of favorable opinions. However, a high percentage of students (25%) disagree with the coherency between the course and the Exomatics, as well as about the complexity. However, this global analysis seems reassuring and reflects a positive acceptation from the students, for whom this computer-based approach represents no major difficulty.

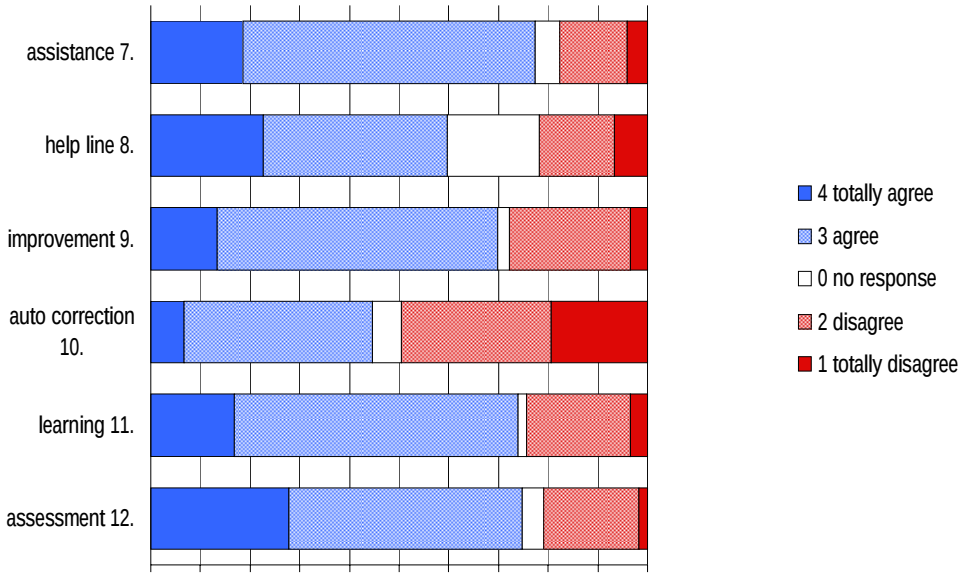

Figure 5. Questions 7 – 12, supervision and training

The second block of questions is more uneven, and reveals a few problems. On the whole, the assessment remains positive although the automated correction (10) is decried. This means that the content of the correct version emailed to the students was not sufficient for them to enhance their competences. Among the other criterions, one can observe that the supervision (7) offered to the students is much appreciated, and the assessment system (12) is well accepted.

5.4 Viewpoint of the teaching staff

Since 2004, the establishment of the Exomatics has allowed an efficient organization of the course of topography for an attendance of more than 120 students. A balance between lectures and exercises generates a direct link between the theory and applied calculus. The time gain for answering the questions and marking the exercises is noticeable, and allows managing such a teaching with one teacher aided by most of the time one or several assistants. However, a good start of these automated exercises still requires contacts during the lectures. This allows the teachers to ensure that the autonomous work following the contacts will happen in good conditions.

6. PERSPECTIVES

This evaluation of the Exomatics goes with a series of remarks and propositions by the students. These elements will have to be taken into consideration for the evolution and the enhancement of this form of training and for the second stage of development of the Exomatic.
One can distinguish the following principal points:

- to enhance the computer security,
- to enhance the online help during the computation steps,

- to develop self-correction mechanisms that allow the students to redo their computations step by step with an online help,
- to develop a graphical part for the visualization of certain geometric figures and quantities.

It should not be forgotten that Exomatic is a complement to the part of the theoretical course. It is absolutely not envisaged to develop a global concept of web-based training, only a better integration between the course and Exomatics is planned.

7. CONCLUSIONS

Since the introduction of the Exomatics in 2004, this means of teaching has considerably evolved and now inserts itself into a clear concept of e-learning. The fact that the students are quickly autonomous when carrying out their exercises shows that this pedagogical approach is a promising path that has to be followed and enhanced.

The release of the Exomatic code under GPL (http://sourceforge.net/projects/exomatic) is a way of publicizing this web-based training and, if possible, to federate the interests in such an approach. The use of convenient tools and targeted objectives on the exercises has proven to be a durable solution for implementing online exercises. An evolutional behaviour remains a major asset for web-based training, and allows an adaptation of the basic product year after year, or according to the course to be organized. It satisfies the will of the teachers from the Geodetic Engineering Laboratory: to monitor the acquisition of theoretical concepts via their correct application.

8. AKNOWLEDGEMENTS

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BIOGRAPHICAL NOTES

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