Incorporating Free/Open Source Software in Remote Sensing Education. Pros and Cons from Teaching Applications in Remote Sensing

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Abstract. Students' practical training in applied disciplines as Remote Sensing involves collecting, evaluating and processing of contemporary scientific resources and data and the use of sophisticated software is required. Whilst different software can be available over the internet which has become an invaluable source of such information, the selection of remote sensing software that will be used for the student's laboratory practical training has always been a complicated task with two main problems: (a) the cost and (b) the software's "learning curve". The cost can be a limiting factor as classes grow in numbers, which means that for commercial software more licenses need to be purchased and the use of such software is usually limited within the lab; students cannot install it on their own machines at home. On the other hand, as the total number of lab sessions per semester is limited to 13, the use of sophisticated but complicated software, poses a serious threat to the educational procedure that is to miss the educational target and to convert it from "Remote Sensing" to "software training". With those concepts in mind, an effort has been made to incorporate the use of free and open source software to the educational procedure in the Applied Remote Sensing classes at the Geoinformatics & Surveying Department of the Technological Educational Institution at Serres, Greece. During the past two semesters, students were trained using both the free software Multispec (Purdue Research Foundation, Purdue University, USA) combined with the open source gvSIG package and the Erdas Imagine commercial software, which has also been used for the past 10 years. The evaluation considered the capabilities that both software packages provide remote sensing analyses and procedures needed for the teaching purposes. At the end of the second semester, students gave feedback regarding the ease of use, the time spent to learn the software as compared to the time spent on the remote sensing applications subject itself and the prospect of using the software after graduation. The conclusions that came out for the particular case presented in favour of the use of combined Multispec with gvSIG in all aspects; the students felt very comfortable with it and plan on using it as professionals as they feel confident about it's effectiveness and they appreciated the fact that it's free of charge; moreover, the time they spent to learn using it was minimal, so teaching time was almost completely dedicated to Remote Sensing education.

Keywords. Remote sensing, education, training, multispec, freeware, open source software.

1. Introduction – remote sensing education

The expansion of remote sensing applications during the recent years has led to opportunities for entry-level positions that require a working-level knowledge of remote sensing theory and applications. The continuous development of applications in new scientific fields leads to a steady rise of professional positions offered to graduates. As a response to that, Universities have to adjust curricula and teaching practices to better adapt to the required by this developing industry and standards [1], [2]. Within this context, undergraduate programs should be transformed to emphasize on project-based courses and to offer students opportunities for independent research. These projects should also incorporate an emphasis on current issues as resource protection and management, urban planning, natural hazard mitigation and others, linking in this way education and training to professional needs and opportunities. Within this context, teaching procedures of the "Remote Sensing Applications" course in the Geomatics & Surveying Department at TEI of Serres and especially the decision of using free software for student practical training, is presented and discussed.

2. Remote sensing courses outline at Geomatics & Surveying department, TEI of Serres, Greece

Geomatics & Surveying Department was established in 2000 at the Technological Education Institute of Serres, Greece, committed to provide education in disciplines as Surveying, Photogrammetry and Geographic Information Systems. The department promotes education in the aforementioned fields and implements an educational program which includes an undergraduate program in Geomatics & Surveying Engineering and a postgraduate program in "Natural Hazard Prevention and Management" in collaboration with the Department of Geology & Geo-environment of the National & Kapodistrian University of Athens.

Remote Sensing education in the department comprises of "Remote Sensing Principles" and "Remote Sensing Applications" courses taught during the sixth and the seventh semesters respectively.

"Remote Sensing Principles" course unit aims at providing the students with the necessary theoretical background, needed to understand the means, the way, and the potential applications of Remote Sensing. Background theory includes fundamentals of Remote Sensing, aerial photography, satellite imagery, characteristics of the photos and images (parallax, flight line, side-lap, focal length etc) as well as concepts like spatial reference, scale, data resolution and management.

The "Remote Sensing Applications" course unit aims at extending the theoretical background, provided in aspects of remote sensing applications in various cases and scientific fields and also in fusing remote sensing with Geographic Information Systems.

Teaching via lectures in groups is supported by multimedia presentations and its objectives include sensors and data available, potential applications, spatial, radiometric and spectral resolution, False Color Composites, Band ratios, Indices, Principal Component Analysis, classification and applications in geology, land cover, land use, change detection and archaeology.

Teaching is supported by the Serres TEI e-learning platform (http://elearning.teiser.gr) which provides to the students help and support to various aspects.

Assessment is through final exams and the presentation of an assigned final project. Training aims at providing students with practical skills in order to solve "real world" problems.

3. Laboratory teaching methods and practices - arising problems

During the past years, laboratory training in both courses was based on using commercial software as ERDAS Imagine and IDRISI. Both are excellent pieces of software with great potential but at a cost especially in time spent for learning how to use it.

The limited session time (2 hours), the limited number of classes per semester (up to 13), the number of students (25-30) participating in each of the laboratory sessions and the complexity of the otherwise sophisticated commercial software, led to a training procedure that started to deviate from its educational target.

Consideration of the balance between "training the students to get competent with the use of commercial software and at the same time converting the educational target from "Remote Sensing Applications" to "software training" as a first option and "teaching Remote Sensing Applications" as a second one, can only be in favour of the second option. Additionaly, limiting the use of commercial software factor, is the cost of the licenses needed, especially as the students grow in numbers. Considering also the fact that students rely more and more for their work on personal computational resources, i.e. they need to install the software on their own computers and prefer to work at home instead of the lab, it becomes visible that the associated cost becomes larger and affects the individual student budget.

With those concerns in mind, a decision has been made to incorporate the use of free and open source software to the educational procedure in the Applied Remote Sensing course. Multispec[2] (Purdue Research Foundation, Purdue University, USA) was chosen to support laboratory practical training. The open source gvSIG[1] software was selected in order to provide the GIS platform for Remote Sensing data integration with additional geographic information.

4. Facing the problem (methodology)

The selection of remote sensing software that will be used for the student's laboratory practical training has always been a complicated task with two main problems: (a) the cost and (b) the software's "learning curve".

The cost can be a limiting factor as classes grow in numbers, which means that for commercial software, more licenses need to be purchased and the use of such software is usually limited within the lab; students cannot install it on their own machines at home and laboratory availability problems arise. Moreover, time and effort is needed for a student to get competent with the software installed in order to execute certain actions and follow processing procedures. A fully featured but at the same time complex software, requires a lot of teaching time which is not available, and this pertains to all kinds of software both free/open-source and commercial ones.

On the other hand, free or open source software has no cost, it can be used anywhere at any time but again; it may be difficult to master, making its learning procedure tedious (Figure 1).

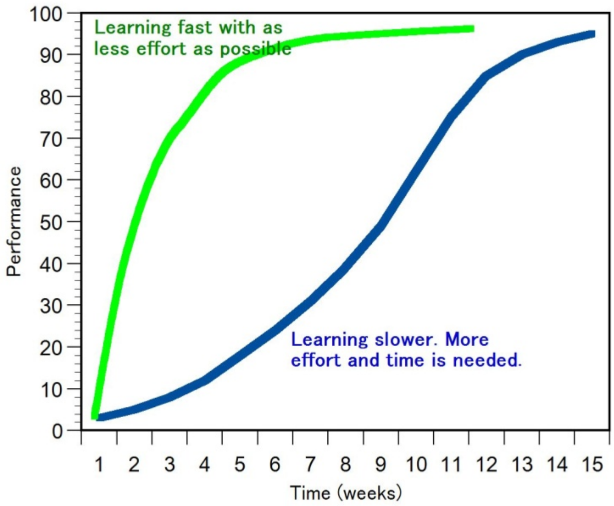

Figure 1: When considering software, learning curves present the time and/or effort needed to master it. In the case of laboratory training, software that presents a learning curve similar to the green one is the most appropriate.

In such case, supportive material, custom made for the course, can play a very important role and help minimize time and efforts students have to make.

[1] www.gvsig.org, [2] https://engineering.purdue.edu/~biehl/MultiSpec/

As Laboratory sessions cannot be considered and revised alone, a course re-design in 2011 was based on principles and methodologies suggested by various [3], [4], [5], [6] and a series of principles of Effective Teaching [7] that can be summed up as follows:

a) the course design and classroom teaching must be based on the relevant students' knowledge and application skills acquired during the previous course.

b) learning objectives, assessments and instructional activities must be aligned with each other.

c) learning objectives and policies must be clearly identified and linked to each other.

d) knowledge and skill goals must be prioritised.

e) provisions must be taken in order to recognise and overcome deficiencies and problems.

f) appropriate teaching roles must be adopted in order to support the learning goals.

g) continuous student feedback on all aspects of the teaching process can be used to refine the course.

When considering the software to be selected for the Laboratory sessions, basic teaching principles [1], [8] regarding teaching practices, as optimized scheduling, focusing to certain features, visual-verbal instructions integration, example-rule coordination, worked example presentation, prompted and corrective self-explanation, analogical comparison and self motivation, were taken into account.

Assumptions that can be based on the above principles suggest that, students learn best when the learning environment is supportive and productive and when it promotes independence and self-motivation [8]. All those parameters improve when the students' needs, backgrounds, perspectives and interests are taken into consideration and are included in the learning procedure. Additionally, the students learn and perform better as professionals at a later stage, when they are challenged and supported to develop critical thinking and when applying best strategies to solve problems. All those things happen, when assessment practices are an integral part of teaching and learning and motivation raises when teaching material that corresponds to social interests and practice beyond the classroom is being used.

Multispec [9] was chosen because it provides the ability to work with both multispectral and hyperspectral images, it's readily and freely available over the internet [10] and it presents a very simple and self-explanatory interface. All processing functions fall under the Processor menu whilst classification functions appear under the Project menu (Figure 1).

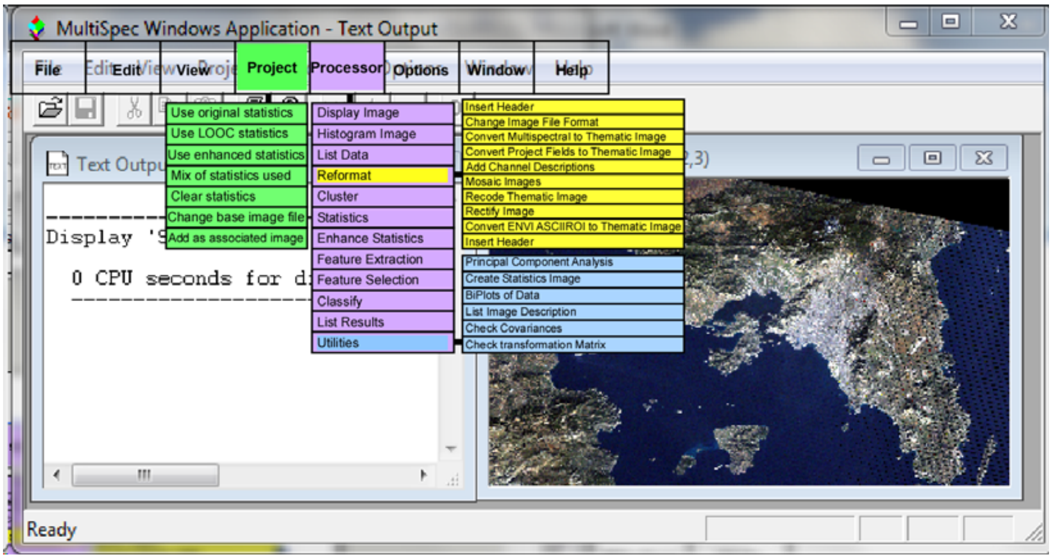

Figure 2: Multispec essential processing functions' menus.

It covers all of the processing aspects required by the course including image enhancement, multispectral image creation, rectification, mosaicing, principal component analysis, supervised and unsupervised classification, false colour compositing, band rationing, calculation of indices, image transformation etc. Practical training on this course can be limited to the aforementioned issues without compromising the course's targets as the other basic image processing procedures (i.e. georeferencing by ground control points, ortho-rectification) are already covered by previously courses attended by the students. In any case, this issue was also covered by the use of the open source GIS software gvSIG.

As a matter of creating a supportive environment, the first step was the development of a series of tutorials in Greek with the permission of the software creators (D. Landgrebe and Larry Biehl).

These tutorials [11] include basic principles and guidelines regarding the procedures described in them (i.e. for unsupervised classification: what the procedure is about, what kind of parameters are involved, how are these estimated, how are the assessment results evaluated etc) and then a step-by-step guide of how the processing is applied to remotely sensed images using Multispec.

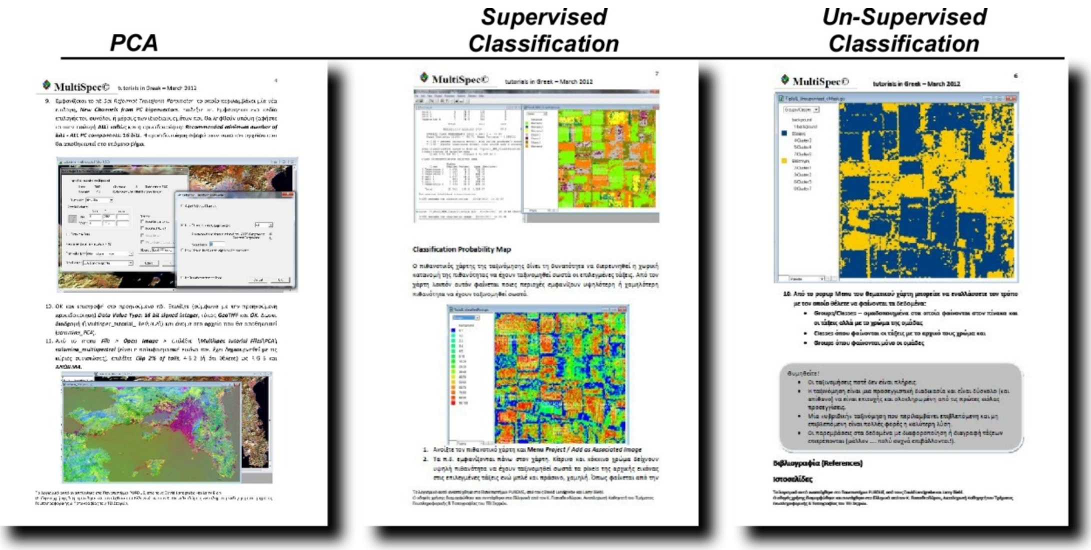

Figure 3: Multispec tutorial pages. Step-by-step guides that combine visual-verbal instructions and key points (grey box).

In this way, students can have in the same document, a clear idea of what they are doing, why they are doing it, how to do it, what they should expect as results and how to evaluate them. This is considered as an approach that can minimize students' dependence on the teacher's supervision or that can make them almost totally independent from it.

Additionally, all teaching material regarding theory and applications (presentations etc) was made available to students via the e-learning platform whereas Multispec tutorials and gvSIG tutorials and examples in Greek were made available to everybody over the internet.

Lessons in Multispec begin with "Data Search" that links to GLCF (http://glcf.umiacs.umd.edu/) and EarthExplorer (http://earthexplorer.usgs.gov/) and contains a detailed description of the procedure that has to be taken in order to find and download available free remote sensing data. From that point on, lessons take the students from the basics of opening image files, rectifying and creating multispectral images from separate bands or other multispectral images to more complex procedures as Principal Component Analyses and both supervised and unsupervised classifications. Following the step-by-step procedure, the students are absolutely able to conclude successfully all lessons, based entirely on their own efforts. As the software is totally portable, they can use it anywhere at any time by keeping everything in a USB flash drive. Help is at all times available to them through the e-learning platform and through direct communication over the internet (emails, facebook, skype).

Students are assigned a final project that is being carried out in steps, as the teaching procedure proceeds throughout the semester. They are encouraged to find and work with images that cover their hometowns so that there is an additional interest and motivation developed. They can work both in the Lab and at home separately or in groups, get advice from the teacher when needed, helping each other and progressing through a learning procedure that offers them the ability to make decisions, find, understand and correct their mistakes and discuss with each other about certain issues that affect their work. In this way, they find new interests in applying the new knowledge they receive in the theoretical sessions and as a matter of choice, they work more at home than they have to in the classroom. Moreover, they study in a supportive and productive environment based on their needs, interests and backgrounds; an environment that promotes independence and self-motivation. Therefore, they develop critical thinking and are learning to evaluate procedures and to apply best strategies to solve problems. All those things lead to a more effective teaching procedure and laboratory practical training dedicated solely to Remote Sensing Applications.

5. Student feedback

As any major change, this one was first considered by the students with skepticism, mainly because they had already used ERDAS Imagine during their previous semester and they were afraid that there was going to be the same painful -as they thought- procedure once again in order to learn how to use it. The skepticism was converted to optimism after their first contact with the teaching material and the procedure that was planned –read the tutorials and execute in a step-by-step manner- and after that, to relief because at this later stage they discovered that the software and the learning procedure as a whole was much easier to handle. They finally gained confidence in the software but more than that; they gained confidence in themselves as they worked alone, discovered and corrected their mistakes and developed critical thinking. Even more, they appreciate the fact that most of the time spent in the Lab sessions, is dedicated to learning remote sensing and its applications. As for the software, students now consider Multispec as an easy to learn but powerful enough software, which they can use even after their graduation, for its processing capabilities and for its ease of use.

6. Conclusions

Incorporating free or open source software to higher education requires a complete course redesign, basically because the available support is different (at different level and presented with different formats) than the commercial software and additionally because students can easily acquire and install such software on their private computers.

Essential principles that have to be considered include optimized scheduling, visual-verbal instruction integration, example-rule coordination, analogical comparison and self motivation.

A supportive environment is also essential in promoting the use of such software.

The adaptation of Multispec in Remote Sensing Applications course of the Geomatics & Surveying Department of Serres T.E.I. was a successful case as it helped students to:

- improve their understanding of processing procedures
- develop critical thinking
- learn how to develop and apply best strategies to solve problems
- gain self confidence

The adaptation of Multispec also helped relieve the Laboratory classroom schedule, so classrooms are available to students more hours a day and computer maintenance can be carried out as required.

A very limited time (less than 10’) is now spent during Lab sessions to software training so most of the time is spent on teaching principles and methodologies within the context of Remote Sensing Applications instead of teaching “how to use the software”; a fact that is appreciated by both the teaching stuff and the students.

Student feedback also showed that they felt very comfortable with Multispec and even plan on using it as professionals because they feel confident about its effectiveness and the fact that it’s free of charge.

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