CSS or OSS for education in GIS ?

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Abstract. The comparison of experiences with OSS4G on the one hand and CSS4G on the other hand in a vocational training programme offered to participants from developing countries showed a better overall participant satisfaction with the former. Since the design of the OSS4G-training was more oriented towards self-learning and self-helping than the CSS4G-case, it cannot be concluded that the observed difference in satisfaction is related to the inherent generic characteristics of OSS4G as compared to those of CSS4G. We do believe however that OSS4G-technology has reached a level of maturity which enables the -at least- partial substitution of CSS4G in geo-awareness raising, general purpose training in GIS and also in basic academic GIS-education. For more advanced education, CSS4G keeps the advantage of meeting more closely the direct requirements of the labour market. OSS4G may however offer more incentives for students to explore and develop creative solutions beyond the algorithms built-in in CSS4G.

INTRODUCTION

According to the University Consortium for Geographic Information Science, the US Geographic Information Science and Technology (GI S&T) education infrastructure fails to supply adequate numbers of adequately skilled geospatial professionals to meet the current and potential needs of the sector (DiBiase et al., 2006). Two specific critiques are given: (1) academic certificate programmes are insufficiently regulated and (2) undergraduate programmes are insufficiently rigorous. In an attempt to better scope and define such programmes, the Consortium compiled a so-called body of GI S&T knowledge (DiBiase, 2006) with a view to address six competency levels as identified by Marble (1998) in figure 1. The body distinguishes ten knowledge areas for the GI S&T domain, each with several constituent units. In these, not any reference is made towards software systems to be used in support of the education programmes.

Recently Open Source Software (OSS) which may or may not be offered free of charge started to challenge the established Closed Source Software (CSS) in the geomatics sector. Ramsey (2007) inventoried the numerous active OS-GIS software projects and classified them based on their implementation language (i.e. C-, JAVA-, .NET- and Web-projects). The availability and active development of these projects generate a growing user-base and growing businesses in providing OSS4G-based services. As a consequence, the demand for OSS4G-related education is also growing. Schutzberg (2007) states that students are demanding such training to give them an edge in the marketplace while teaching staff are looking for ways to broaden student experiences. In addition, researchers are finding OSS a viable and valuable resource (Schutzberg, 2007). According to Chapell (2007), introduction of free and open source software for geomatics (F)OSS4G in education should go along with a change in teaching methods. However, at the current moment there is little experience nor research regarding teaching methods adapted to (F)OSS4G within academic education or vocational training. With regard to research-based education, Mitchell (2007) presented observations, advantages, challenges and wishes for incorporation of (F)OSS4G. In addition to general discussion on the establishment and maintenance of infrastructure needed to effectively incorporate (F)OSS4G into the academic environment, he presented a specific case study. This illustrated how an intensive team research experience comparing two specific forest mapping projects has evolved into a range of undergraduate and graduate learning opportunities. The use of OSS4G tools throughout this work has facilitated the exchange of data and algorithms, allowing spin-off projects to develop without the constraints of specific proprietary software. He concludes that increasing interest in, and new attitudes towards OSS4G-alternatives are apparent in the past few years and that there is a growing need for geomatics education to support and take appropriate leads in both educating students and furthering the geographic information science behind the tools.

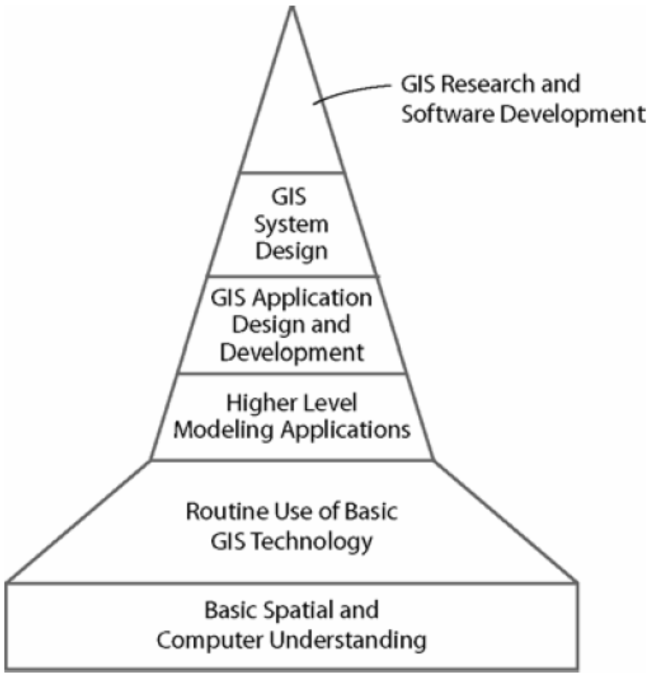

Figure 1: Six levels of competency in the geospatial domain with the relative abundance of required personnel (Marble, 1998)

These evolutions have not remained unnoticed to the European Commission. The EC has launched research and dissemination projects with the aim to inform and educate professionals and even the general public about the potential of (F)OSS in general and (F)OSS4G in particular. The Cascadoss project (Cascadoss, 2007) is an example of an EC-supported project on how to encourage end-users of geospatial data in adopting OSS by setting up a trans-national cascade training programme on Open Source GIS&RS software with an emphasis on environmental applications. The programme aims at training, on an international level, small groups of 'high-end' geospatial data users (e.g. high level GIS and/or RS and/or IT experts) who will be expected to transfer, on the national or regional level, the knowledge and abilities they have learned to 'low-end' geospatial users (e.g. scientists, public administrators,..), who could support each other in finding OSS-solutions for environmentally related problems.

In this paper we address the question which of CSS4G or OSS4G presents better scope for educating professionals and students with regard to the second and third level of competency defined by Marble (1998), i.e. (i) Routine use of basic GIS-technology and (ii) Higher Level Modelling applications. The question is addressed by a comparative assessment of two two-week training courses organized at the Katholieke Universiteit Leuven in Belgium for researchers and professionals from developing countries. The first one was organized in June 2005 and made use of following CSS4G: ArcGIS 8.2[1] and ERDAS Imagine 8.6[2]. The other one was organized in August 2007 and dealt with the OSS4G Quantum-GIS 0.8.1 Titan and GRASS 6.2. The thematic context of both courses was physical land evaluation and land use planning at medium cartographic resolution. Participants of both training initiatives were amply questioned about various topics and had the opportunity to express personal observations. These questionnaires provide the basis for our assessment and lead us to formulate points of attention regarding the introduction of (F)OSS4G in vocational training and academic programmes.

CSS4G VERSUS OSS4G

Table 1 presents a generic overview of features of CSS(4G) on the on hand and OSS(4G) on the other hand.

Table 1. CSS4G versus OSS4G

	CSS	**OSS**
Software	Not free, the student may face difficulty in accessing the software after the course	Free, every student having access to the appropriate hardware can use the software directly after the course
Documentation	Comes with the software; Keeps pace with software development	Availability is not guaranteed. May lag behind software development
Tutorials	Redistribution is mostly restricted to hardcopy	Free to be used, updated and re-distributed
Licence	The licensor does not distribute the software source code as it is kept secret	Software source code is available
	Sublicensing is prohibited, or is a very limited right	Sublicensing is permitted. Licensee may distribute the source code for modifications
Upgrade	All development and upgrades are done by the vendor	The user may do its own development and/or hire any third party to do it
Support	Mostly quick and guaranteed response	Not always guaranteed. Response depends on the goodwill/experience of the community
Cost	Fees for the software license, maintenance, and upgrades	Fees, if any, are for integration, packaging, support, and consulting
Migration	Costs may be limited (only software	Costs may be high (new staff,

[1] http://www.esri.com/software/arcgis/index.html

[2] http://gi.leica-geosystems.com/LGISub1x33x0.aspx

	costs)	trainings, risks)
Stability	Mostly stable. Bugs are mostly resolved in new updates	The software is available already from the developing phase. It may take some time until a stable version is produced

MATERIAL AND METHODS

Both the CSS4G- and OSS4G-course were organised by the Spatial Applications Division of the Katholieke Universiteit Leuven in Belgium (SADL) with the support of the Flemish Interuniversity Council (VLIR). Each time VLIR provided 12 scholarships and contributed to the organisation costs. The courses were taught in English and the duration was two weeks.

- The courses were intended to provide the participants with an update regarding:
- The evolving concepts of physical land evaluation and land use planning;
- The concepts and functionality of Geographic Information Systems;
- The principles of earth remote sensing for acquisition of land-related data for further processing in GIS.

In addition, the purpose was to enable participants to:

- Evaluate the potential of CSS4G (ArcGIS and ERDAS-Imagine) viz. OSS4G (QGIS and GRASS) for the discipline of physical land evaluation;
- Identify strong and weak points of the software-solutions and ways to handle them;
- Acquire hands-on experience with the software for spatial data handling and processing in the context of physical land evaluation and land use planning.

Participants were recruited via projects funded directly or indirectly by the Belgian federal development cooperation and via a web-announcement. For the CSS4G-course (2005), the 12 scholars from developing countries were selected from 40 candidates. For the 2007 OSS4G course, there were 52 candidates. In order to be eligible for selection, candidates needed a background in the management and/or planning of natural resources (soil, water, vegetation, and climate) and being familiar with maps and PC’s. GIS should not be completely new for them. They were professionals or researchers or future professionals or researchers dealing with rural development and planning. They had an ambition to play a leading role within their current and/or future organizations regarding education and training in land evaluation and land use planning, GIS and earth remote sensing. In 2005, the 12 scholars were joined by 3 self-funding trainees. In 2007, 10 extra-persons participated, mostly from developing countries also.

At the end of each week of each course, participants were requested to express their appreciation and identify strong and weak points. They also had the opportunity to provide general comments and suggestions for future issues. Questions pertained to (i) fulfilment of course objective, (ii) status of course materials, (iii) teaching practices and (iv) future use of the course materials. Participants were asked to rate a number of statements according to one of five levels: (i) fully agree; (ii) agree; (iii) neutral; (iv) don’t agree; and (v) don’t agree at all. For 2005, 14 complete questionnaires out of 15 (93%) were returned. For 2007, 18 out of 22 (81%) questionnaires were completed.

METHODOLOGICAL PECULIARITIES OF THE OSS4G-COURSE

Whereas the CSS4G-couse was dispatched in a more traditional way in which theoretical lectures and demonstrations were alternated with individual hands-on exercises, the OSS4G-course was conceived in a 'Train the Trainer' spirit and focused on self- and group learning and on self- and group help. Table 2 lists and describes the most important of these additional characteristics.

Table 2. Characteristics of the OSS4G-course

Course Material	At the end of training, all software used + the materials (documents, presentations, exercises, and quizzes) in addition to the data used to realise the exercises were compiled on one DVD and supplied freely to the students. Their eventual re-use, copy, redistribution were allowed under the condition that they should make use of the open source creative common licence (CC 3.0) that allows the reuse of the contents after refereeing to the original author. This is in contrast to the CSS training course where the students were only given a print-out copy of the contents so that re-use of the materials is difficult.
Self-installation of software	Often OSS is not straightforward to be installed. The students were expected to find, download and install the concerned software themselves. The detailed installation guide was provided later so that students were able to trace and fix problems if any.
Zero-measurement	A so-called zero-measurement was performed at the beginning of each major part of the course (GIS and Remote Sensing) The students were requested to fill in a form as a way to measure their background knowledge and assess their specific interests. Student responses were used to provide targeted feedback during the further development of the subject and to compose groups for various group activities and presentations.
Work in Group	Groups were composed based on the zero-measurement results to (i) prepare and present to the full group introductory statements regarding course topics, (ii) discuss approaches for solving exercises and (iii) discuss outcome of exercises. These findings were used later by the teacher to provide targeted feedback for the full class.
Quizzes	At the end of every discussed main theme a quiz was distributed with questions related to the topics dealt with. This was clearly not an exam, rather a refreshing way to help the students measure/test their understanding of the different subjects. The questions varied between straightforward, comic and indirect but related. In order to answer these quizzes, the students were regrouped again in different groups, where every group was composed of students with different backgrounds and varying capabilities. Every group took the time to find answers for the different quizzes and present them to the other groups. Finally the teacher distributed and justified the right answers.
Questionnaire	The optional and anonymous questionnaire for evaluation of each major theme was not identical to the one used in 2005. It was more adapted to the 'Train the trainer' spirit and the new learning methods used.

ANALYSIS OF THE QUESTIONNAIRE DATA

Since the questionnaires of 2007 (OSS4G) were not completely identical to the ones of 2005 (CSS4G), student's reply to a subset of statements only could be compared. The 5 possible appreciations were reclassified into 3 according to Table 3. This made it also easier to compare between the two courses.

Table 3. Reclassification of questionnaire replies for analysis

Questionnaire	Analysis
Fully agree	Yes
Agree	Yes
Neutral	Neu
Don't agree	No
Don't agree at all	No

The original questionnaire contained several statements for the student to evaluate. Table 4 presents a summary of all common statements used in both questionnaires.

Table 4. Contents of the questionnaires, common to 2005 and 2007

Topic		Statement
Course objectives		
	(1)	Gained practical experience
	(2)	The amount of new information and added knowledge
	(3)	Whether the contents and the aim were as expected
	(4)	Whether the re-exposure to the geomatics discipline and its sub-discipline was useful
	(5)	The way the course was organised
Course Materials		
	(1)	Usefulness to understand the course
	(2)	Whether the course had handled all topics in an appropriate way
	(3)	Whether the amount of exercises were sufficient
	(4)	Whether the exercises went fluently
Teaching practice		
	(1)	The allowed space for personal contribution
	(2)	Whether the questions were answered clear and thoroughly
	(3)	Whether the pace of the course was adequate
	(4)	The experience level of the teacher
	(5)	The clarity of the presentations

	(6) Whether the teaching practice was adapted to the objectives
Material conditions	
	(1) The quality of the contents
	(2) The suitability/adequacy of the infrastructure
	(3) The student's impression about the way the course material was presented
Future use	
	(1) Whether the student intends to re-use the course material in his future practice

RESULTS AND DISCUSSION

Out of the two questionnaires, only the most pertinent common statements in table 4 were used in the assessment. Table 5 presents the summary of the questionnaire results.

Table 5. Comparative assessment of the OSS4G (2007) and CSS4G (2005) courses

Course Objective	**CSS**		**OSS**	
	GIS	RS	GIS	RS
	Y/Neu/N	Y/Neu/N	Y/Neu/N	Y/Neu/N
(1)I've gained a lot of practical experiences	80/13/7	73/20/7	100/0/0	100/0/0
(2)I've received a lot of interesting information	86/7/7	100/0/0	94/6/0	88/12/0

Course materials	**CSS**		**OSS**	
	GIS	RS	GIS	RS
	Y/Neu/N	Y/Neu/N	Y/Neu/N	Y/Neu/N
(1)The course was easily understandable and useful	93/0/7	86/7/7	100/0/0	100/0/0
(2)Course material is sufficiently complete (all topics handled appropriately)	80/13/7	87/13/0	82/18/0	83/17/0

Teaching practice	**CSS**		**OSS**	
	GIS	RS	GIS	RS
	Y/Neu/N	Y/Neu/N	Y/Neu/N	Y/Neu/N
(1)There was enough possibility for personal contribution	71/21/8	80/20/0	100/0/0	100/0/0
(2)Questions were adequately answered	93/0/7	100/0/0	100/0/0	83/17/0

(3)The pace of the course was balanced	67/13/20	80/13/7	76/6/18	83/5/12

Future use	**CSS**		**OSS**	
	GIS	RS	GIS	RS
	Y/N	Y/N	Y/N	Y/N
(1)I'll make use of the training contents	20/80	40/60	100/0	100/0

The following abbreviations are used in Tabel 5: Y "Yes"/Neu "Neutral"/N "No". All numbers are in percentages, GIS: Geographic Information System, RS: Remote Sensing

While the pronounced differences pertain to the gained practical experience, hand out usability, and the allocated time for personal contribution, the most striking difference is related to the future use of the course material.

The first three differences can be directly related to the adapted educational methodology and the nature of open source course materials.

A too strict interpretation of the observed differences between the responses to the two questionnaires must however be avoided. Not only did we change different types of software (CSS versus OSS), also the teaching practice was different as described. The latter was partly imposed by the nature of OSS but was also implemented because of its inherent value. Whereas one of the teachers/coaches has been involved in both courses, the second one has not. Also accommodation and facilities were not identical.

CSS was exemplified by ESRI's ArcGIS and Leica's ERDAS-Imagine software packages while OSS was limited to Quantum-GIS and GRASS. The range of CSS4G and OSS4G is of course much wider. The user base in the CSS- and OSS-communities of the packages we used, are however far from negligible. We are confident that the questionnaire's responses are to an important extent generalisable to the larger communities.

The questionnaires revealed that the student's appreciated the importance of the contents of both courses, the CSS course participants pointed to the fact that they would have some limitations on using the software and contents in an effective way back home, mainly because of the limited availability of the CSS and of the training material that depends on it. All participants to the OSS course expressed their intention to make further use of the provided software and content materials either in their own professional practice or by passing them on to fellow colleagues and/or to include it in future teaching activities. Whether they really did so is not known yet. We are currently, 6 months after the closure of the OSS-course, enquiring students by e-mail about the effective use they are or are not making of the materials and hope to be able to report about the outcome soon.

CONCLUSIONS AND RECOMMENDATIONS

The response to and the number of candidates for the presented courses revealed a comparable interest for CSS4G and OSS4G. The post-course evaluations showed that the OSS4G-course is likely to have a larger impact on the educational and professional communities in which the student currently is or will be active in the future.

Geomatics education using CSS remains however important especially for those who are interested to extend their carrier outside the education world. Therefore the combination of CSS and OSS in education must be taken into consideration for undergraduate and graduate students.

A possible approach is to use OSS4G in more basic courses as to allow larger numbers of students to work with the software as a way to support the acquisition of basic knowledge on geomatics. Advanced courses in GIS and Remote Sensing may benefit from a combination of CSS and OSS. CSS is closer to the employment market while OSS provides the opportunity to study in detail the algorithms behind the software interfaces and their software implementation.

The didactic approach adopted for the OSS4G-course is probably as useful for a CSS4G-course. The zero-measurement assessment to establish balanced groups and organise group work, and the quizzes to assess progress and provide feedback can be applied in both contexts. The availability of OSS-documentation and tutorial is of course a strong point which is not always true for CSS. Self-installation of software, participating to and finding help in the web-based user community certainly is more important for the OSS.

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