REMOTE SENSING TECHNOLOGY ONLINE EDUCATION IN AFRICA: A MULTICULTURAL EXPERIENCE

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Abstract

The discussion of environmental issues and sustainable development of society has been growing worldwide in the past decades. The application of remote sensing - the technology of observing, collecting and analyzing the data of planet Earth and its immediate environment from air and space altitudes – has enriched human knowledge of our globe and enhanced our survival therein. Remote sensing continues to be gainfully employed as major tool of international cooperation. Most Remote Sensing education programs worldwide have pointed toward interdisciplinarity, providing a balanced experience for students spanning the domains of engineering, theory, data analysis, applications, and policy. Established in 1984, the Committee on Earth Observation Satellites (CEOS) coordinates civil space-borne observations of the Earth, where the participating agencies strive to enhance international coordination and data exchange and to optimize societal benefit. Within CEOS, the Working Group on Capacity Building and Data Democracy (WGCapD) aims at building upon the CEOS Data Democracy Initiative in an effort to increase the capacity of institutions in less developed countries for effective use of Earth Observation data for the benefit of society and to achieve sustainable development. CEOS Agencies have joined efforts to put forward an e-learning course named International e-learning course on Introduction to Remote Sensing Technology. The objective of this paper is to present the results and lessons learned from this first initiative for Anglophone countries in Africa. With a multicultural perception, the article discusses the online education experience and gives some perspectives on further developments to be implemented in a possible second version of the course. The course was free of charge and targeted at University Lecturers who can enhance the multiplier effect and help preparing the practitioners to use remote sensing in Earth sciences. The students came from various backgrounds and application interest areas. The main goal was to create collaborative learning opportunities, providing the learners with an appreciation of current remote sensing issues, the geologic and human processes that impact remotely-gathered data, and how those processes can be measured using remote sensing. The 19 voluntary instructors came from seven space agencies in different countries including Argentina, Brazil, Austria, France, India, South Africa and the US. Over 70 people signed up, 30 participated (South Africa, Nigeria, Kenya, and Tanzania) throughout the 16 weeks that the course ran, and 16 undertook all assessments and received the certificate. Course materials included well-organized tutorials, selected datasets and internet links. Two live classroom sessions per week were held, recorded and made available afterwards for downloading. Students were exposed to a variety of resources, software tools and datasets, all of open and free access. Follow-up questionnaires were sent to students and instructors seeking at information that would enable assessment of the contribution of the course as well as suggestions for improvement. Overall, this has been a successful multicultural experience for accessing education in Remote Sensing in developing countries. Despite some limitations, the delivery methodology has proved to be efficient and the outcomes of this online course have been encouraging to pursue other courses in the future.

Keywords: Online Education, e-learning, Remote Sensing, Instructional Design, Interdisciplinarity, Multiculturalism, Connectivism.

1 INTRODUCTION

The discussion of environmental issues and sustainable development of society has been growing worldwide in the past decades. The application of remote sensing – the technology of observing, collecting and analyzing the data of planet Earth and its immediate environment from air and space altitudes – has proved to be a powerful tool for environment studies and monitoring. From satellite images it is possible to get a wide variety of information that can be used in different subject areas

(Agriculture, Geology, Geography, Biology, Architecture, Engineering, Urban Planning, Forestry and Cartography), interdisciplinary studies and environmental education [1].

The extraction of accurate information from remotely sensed data takes place best when the image analyst is an expert in his own systematic body of knowledge [2]. Within the process of converting remote sensing data into accurate information, these professionals shall be able to correctly infer about the information and make the right decisions.

The expanded availability of data and software over the Internet, with free access, has contributed to increase the demand for training courses on remote sensing.

Since 1990, when the English engineer Tim Berners-Lee developed the World Wide Web, the Internet has been breaking boundaries and placing people within a global community, providing an authentic environment of communication and redefining the learning paradigms. This tendency of sharing resources over the Internet has contributed to the democratization of knowledge and education in general.

As reported by [3], distance education has changed the way of teaching and learning, making use of tools for rich collaboration among participants, such as, chat, discussion forums, web-conferences, portfolio etc. Online learning systems provide benefits for stakeholders located around the world, including increased accessibility to information, better content delivery, personalized instruction, content standardization, accountability, on-demand availability, self-pacing, interactivity, confidence, and increased convenience [4].

Especially in developing countries, distance learning has become a crucial tool for broadening education outreach making available quality programs and materials to different audiences. However, as [5] pointed out, the quality of distance learning depends on multiple factors ranging from socio-cultural reality of actors involved, their characteristics and habits to the appropriate design of course content and services to students, such as counseling, tutoring and information technology support.

Online programs must take into account thoughtful planning of the proposed objectives of the course, carefully studying profiles, characteristics and needs of the students. Besides, it is crucial to reflect upon the roles and competencies of teachers who plan to deliver courses via Internet. It is not possible to simply transfer to the Web, the material (curricular content) that is traditionally used in the classroom without any adjustment to the media. Each medium requires different approaches to be used. The teachers should be trained to work online and "instructed" so they can achieve their pedagogical goals in a more effective, creative and innovative way [6].

Furthermore, there is a need to address learning that occurs outside of people (i.e. learning that is stored and manipulated by technology). Promoted by Stephen Downes and George Siemens, connectivism is considered the learning theory for a digital age. It seeks to explain complex learning in a rapidly changing social digital world. According to George Siemens, "Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing. Connectivism is driven by the understanding that decisions are based on rapidly altering foundations. New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical."[7]

Remote Sensing education started in 1972 as one of the Brazilian National Institute for Space Research (INPE)´s missions in the Earth Observation Coordination (OBT) when a Master's Degree program was created. More recently, in 1998, a Doctoral program was also established. Since 2004, INPE has been engaged in capacity building activities in Remote Sensing online education, aiming at disseminating the use of this technology highlighting environmental applications. More than twenty e-learning remote sensing training courses have been carried out using the TelEduc environment [9]. Since then, more than 500 students have successfully completed the courses in Brazil and some Latin American countries [1].

The remote sensing courses carried out at INPE have been focusing on lessons that build new concepts from previous knowledge, in familiar and meaningful context for the students with active construction of knowledge. Furthermore, the courses have been engaging students in activities that promote real social interaction [1].

INPE has been a member of the Committee on Earth Observation Satellites (CEOS) since its inception in 1984. CEOS coordinates civil space-borne observations of the Earth, where the participating agencies strive to enhance international coordination and data exchange and to optimize societal benefit [10]. Within CEOS, the Working Group on Capacity Building and Data Democracy (WGCapD) aims at building upon the CEOS Data Democracy Initiative in an effort to increase the capacity of institutions in less developed countries for effective use of Earth Observation data for the benefit of society and to achieve sustainable development [11]. One of the WGCapD´s targets is to provide education and training for enabling end users to gather the information they need, building autonomy and emphasizing open internet resources (open dataset catalogues, software and literature). Given that Education is a tool for wider outreach to the world community, CEOS Agencies have teamed up to promote an e-learning course named International e-learning course on Introduction to Remote Sensing Technology.

Taking into account the long experience with remote sensing e-learning, INPE stepped forward coordinating and organizing this first pilot course. A systematic approach to develop this education program was considered based on the principles of Instructional Design, which included the core elements of analysis, design, development, implementation, and evaluation (ADDIE) to ensure congruence among goals, strategies, and evaluation and the effectiveness of the resulting instruction [8].

The overall goals for the course were: (1) to provide wider and easier access to Earth Observation data, (2) to increase the sharing of software tools such as the use of open source software, and open systems interface, and (3) to enhance data dissemination capabilities, transferring relevant technologies to end users.

In this paper, we present the results of this multicultural and multidisciplinary online learning experiment, compiling information collected by surveys from the students and the instructors, which have enabled us to understand the limitations and the possibilities of online learning in developing countries, assessing the contributions as well as the suggestions for improvement. Thereby, the materials used and the methodologies applied are presented and the results obtained are discussed.

2 MATERIALS AND METHODS

The course was free of charge and targeted at University Lecturers in Earth Sciences, who can enhance the multiplier effect by preparing practitioners to use remote sensing in Earth sciences.

INPE proposed the preliminary syllabus and the course structure and interested CEOS Agencies provided points of contact to be potential instructors for the course. A core team (INPE, National Oceanic and Atmospheric Administration-NOAA, United States Geological Survey-USGS and National Aeronautics and Space Administration-NASA System Engineering Office-SEO) was set up and held several teleconferences until the course was completely assembled.

The 19 instructor volunteers came from nine CEOS Members and Associates: *Centre National d'Etudes Spatiales / Institut de recherche pour le développement* (CNES/IRD*), Comision Nacional de Actividades Espaciales* (CONAE), INPE, Indian Space Research Organisation (ISRO), NASA SEO, NOAA, South Africa National Space Agency (SANSA), United Nations Office for Outer Space Affairs (UNOOSA) and USGS.

The main issue for this kind of course is selecting committed students who could help building knowledge hubs for EO data democracy. This pilot course aimed at developing countries in Africa where there were regional organizations and points of contact that could help identifying target participants.

We targeted at those African countries where there were regional organizations, such as in:

i. Nigeria: African Regional Centre for Space Science and Technology Education - in English Language (ARCSSTE-E), affiliated to the United Nations and National Space Research and Development Agency (NASRDA).

ii. Kenya: Regional Center for Mapping of Resources for Development (RCMRD).

iii. South Africa: SANSA.

This approach has also leveraged the process of linking specialized nodes and information sources, since nurturing and maintaining connections is needed to facilitate continual learning [7].

The pilot course had English as the official language, but future events may consider offering the course in other languages as well.

A website was created at INPE containing information about the course and the form for online applications (http://www.dpi.inpe.br/ceos/e_learning).

In December 2012, the course was widely advertised through CEOS website, CEOS lists, space agencies newsletters and a special list of contact-points in universities of South Africa, provided by SANSA.

The course ran from February 18 to June 10, 2013 and was divided in 4 modules (180 hours total), covering the following multidisciplinary topics:

i. General view of Remote Sensing in the world.

ii. International Coordination and Data Exchange (CEOS, GEO – Intergovernmental Group on Earth Observations and UNOOSA).

iii. Principles of Remote Sensing, Sensors and Platforms.

iv. Datasets Access and Tools.

v. Remote Sensing Applications (Natural Disasters, Agriculture, Fire Mapping and Urban Planning).

vi. Individual Development of a Thematic Project

Course materials included well-organized tutorials, selected datasets and internet links. Using NASA´s license to GoToMeeting (web conferencing and online meeting tool), two live classroom sessions per week were held, recorded and made available afterwards for downloading. Students were exposed to a variety of resources, software tools and datasets, all of open and free access.

Teleduc, a free and open Learning Management System (LMS) developed by researchers at the State University of Campinas –UNICAMP, Brazil, was used to support the course fostering the interaction among instructors and students with different backgrounds.

3 RESULTS AND DISCUSSION

3.1 General Results

Of the more than 70 people who signed up, 30 participated (South Africa, Nigeria, Kenya, and Tanzania) throughout the 4 months that the course ran, and 16 completed all of the requirements and received the certificate. The final grade considered the participation in web-sessions and interactivity using chat, mail and discussion forum tools, access to TelEduc in general and completion of proposed activities and assignments.

It is worth pointing out that, from the 14 Students that failed, we can say that there was a real dropout from 6 of them (they were signed to TelEduc and never accessed the system after March). The other 8 Students kept accessing the system, mainly the Readings Tool and participated in the web-sessions, but never handed out the required assignments. Our hunch is that they were interested in the course but not in the certificates. Some of them might have thought of using the material to study on their own afterwards.

The successful participants received an email to congratulate them. In this email there was also a request to confirm the physical address that they used during the application. This step was necessary to be absolutely certain that the package containing the certificate was sent to the correct address. The package participants received contained: (1) a printed and signed certificate issued by INPE (in Portuguese) and (2) an official translation of the certificate to English.

Although during the course access to materials was placed behind authentication restrictions in the LMS, afterwards, motivated by the Open Educational Resources initiative, it was opened up, following Instructors permissions, into a WIKI of total free access [12].

The initial proposal was to encourage the development of an Application Project, which would help demonstrate Student´s ability to apply the new skills learned to a real-world problem. Unfortunately, due to lack of coordination among Instructors, it was not possible to pursue this idea. One option was given to the Students though: if interested they could develop a project afterwards, in the following 2

months. Out of the 16 approved Students, 7 decided to take this opportunity, in the areas of Flood Monitoring and Urban Sustainability, advised by ISRO and INPE. Instructors contacted them but, unfortunately, there were no responses and no projects were pursued. We believe we lost the momentum by postponing this activity. Students probably went back to their busy lives and activities, and didn´t find time to do it.

Using a free online survey software tool (*SurveyMonkey*), follow-up questionnaires were sent to Students and Instructors seeking information that would enable assessment of the contribution of the course as well as suggestions for improvement. Twenty one Students (15 that successfully completed the course and 6 who did not) and fifteen Instructors completed the survey. There were Yes/No, multiple choices and open questions.

3.2 Students´ Surveys

The Students´ survey was divided into 3 blocks: Personal Information, Course Organization and Structure and Overall Expectations.

The results of our study reveal that most Students (90%) were satisfied by the way the course was organized and 76% of them said it was excellent and 24% said it was good.

It was first online education experience for 67% of them and 90% felt comfortable with it. The main advantage mentioned was the ability to attend the lectures without having to travel to the class to participate in a face-to-face course, thereby saving money and time on transportation: “My online experience was fantastic, in fact amazing. Personally, I was always expectant when we were to have a web-session and felt bad if I wasn´t able to attend. The interaction with instructors during the sessions was nice.” Some Students sometimes faced the challenge of slow internet connection, but since the online sessions were recorded, they could download and watch them later, having the benefit of revisiting the sessions through the recordings.

The course met the expectations of 20 respondents, and the one that answered “No” explained he was expecting have had more some hands-on activities in the areas of RS/GIS software's application to solving environmental issues. Fig.1 compiles some of these results.

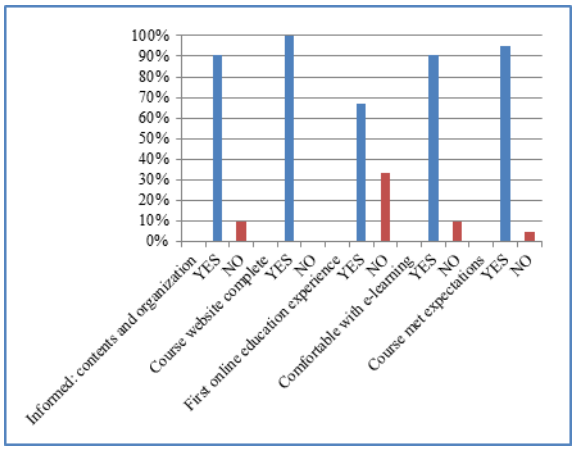

Fig. 1. Results compiled from Students´surveys.

Instructors were well evaluated by Students, mostly with grades Excellent and Good, and the main criticism is related to sometimes late feedback and assignments evaluation. In distance learning, the physical and temporal separation of instructors and students, and between students themselves, can lead to feelings of isolation. Therefore, there must be constant interaction among all participants to avoid this feeling and increase motivation throughout the course: “Activities should be evaluated in time; this will encourage the student to work harder”.

While in general the feedback was positive, participants also had some suggestions and comments. The most commented issues are related to requests for more hands-on activities using a GIS. The suggestions for improvement are described in Table I.

Table I. Suggestions for improvements from Students.

Course Organization	– Arrange web-sessions with more time ahead. – Organize alternative dates for web-sessions.
Hands-on Activities	– Introduce training on application software like the SPRING (Geographic Information System). – Consider asking the participants to formulate and work through a Remote Sensing and Geographic Information System (GIS) project to test mastery of the concepts learned throughout the course. – Include practical classes where there can be demonstrations and if possible computers (from the lecturer) where students can be given access to work in real time and ask questions. – Explore further ways of ensuring practical understanding and applications in image processing and interpretation.

3.3 Instructors´ Surveys

Responses from 15 Instructors were received. The results of our study reveal that all Instructors (100%) answered they were well previously informed of course organization and contents; 87% said they were aware of the commitments as Instructors. This was the first online education experience for 47% of the Instructors. Table II lists the comments of some instructors regarding this e-learning experience compared with other face-to-face courses they had taught.

Table II. Online experience versus face-to-face.

Positive Feedback	– More flexibility in terms of hours – Very useful opportunity to learn without travel and expenses. – It was very new for me but exciting at the same time. – More demanding, but interesting
Negative Feedback	– It is strange for the teacher since we don't have visual feedback on the students. We don´t know if they are listening or not. – As with any online course, we don't have a feeling of how to work with certain underperforming students. – The e-learning increases the possibility of participation from developing countries. The relationship teacher-student is not the same, but it can improve through the time and with the use of multimedia tools – I still feel a little bit more confident about the effective delivery of knowledge in face-to-face courses.

Overcoming all challenges, 100% responded they would be willing to participate in a next edition of the course. Fig. 2 presents some results of instructors´ surveys.

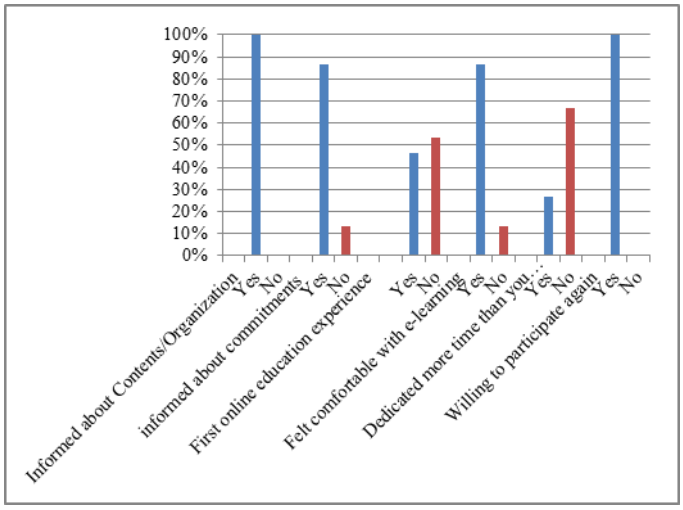

Fig. 2. Results compiled from Students´surveys.

3.4 Lessons Learned

It is important to notice that there were 19 instructors volunteers from eight different countries, with different cultures and time zones, and for some of them, this was their first e-learning experience. Based on the responses to the questionnaires, it would be necessary to invest more time in the preparation of the course, basically improving the following:

i. Have more clear objectives and commitments from instructors, in terms of availability of time during the course.

ii. Have all materials ready and standardized before the course starts. There was a template for tutorials and presentations but some of them did not adopt it.

iii. Have a type of encouragement for instructors: certificates of participation, proposing to write a joint paper etc.

iv. Define beforehand the schedule for web sessions and chat times so students can prepare themselves in advance.

v. Present clear tutorials on how to use TelEduc and GoToMeeting Tools, for both Instructors and Students, before the course starts.

vi. Make sure all topics on the syllabus are covered (e.g., we were not able to take in all that was planned, specially the software hands-on demonstrations and projects).

vii. Coordinate better in designing weekly assignments.

viii. Use more the Discussion Forum tool, trying to identify problems having more to do with Students´ real lives.

ix. Need to be able to overcome real-time Internet problems: further explore Eumetcast Training Channel as a data delivery mechanism. EUMETCast is a multi-service dissemination system based on standard Digital Video Broadcast (DVB) technology. It uses commercial telecommunication geostationary satellites to multi-cast files (data and products) to a wide user community. EUMETCast also delivers a range of third-party products [13].

x. Change Learning Management System, e.g. Moodle (Modular Object-Oriented Dynamic Learning Environment). TelEduc was found old fashioned.

4 CONCLUSION AND OUTLOOK

Overall, this has been a successful multicultural experience for accessing education in Remote Sensing in developing countries.

It was essential to have a person dedicated to organize and interact with instructors and students at all times during the course, to avoid the isolation feeling. The collaboration amongst all partners really made this course a success. Being able to draw from several space agencies' expertise, tools, software, resources and support made this effort possible. It also enriched the experience for the participants by diversifying the tools and skillsets offered and widening their network considerably, increasing possibilities for dialogue both locally and globally by sharing resources. Collecting feedback surveys from the students and instructors at the end of the course is crucial if we are to improve. It also gives participants the opportunity to express their opinions, ask general questions, and reflect on their experience.

In order to find out how this initiative has really lifted up the capacity of the countries where it was held and measure the impact in the communities, we plan to have a follow-up survey in December, 2013, to ask each of the students (graduated or not) if they have used any of the things they learned in the course. It is also important to discover if they have been able to apply the new knowledge in their classrooms with their students, enhancing the multiplier effect.

It would beneficial to include, at the very beginning, a Monitoring and Evaluation Component into the training initiative. Participants, both students and instructors, would be aware that they were going to be part of the process, evaluating their experience during the whole course.

Considering the results of the surveys, most of the students were satisfied with their learning and very grateful for the opportunity. Despite some limitations, the delivery methodology has proved to be efficient and the outcomes of this online course have been encouraging to pursue other courses in the future.

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