IN-SERVICE TEACHER TRAINING IN REMOTE SENSING TECHNOLOGY USING DISTANCE EDUCATION

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ABSTRACT:

The objective of this paper is to present the results of four distance education courses in Remote Sensing Technology highlighting environmental applications. In Brazil distance learning has become a crucial tool for broadening education outreach to its territory and making available quality programs and materials to different audiences. The main goal of these introductory courses is to diffuse the use of remote sensing as part of the curriculum and pedagogical resource to teaching science topics in universities. The objective is to create collaborative learning opportunities through on-line courses for in-service college educators fostering their continuing professional development and reinforcing the importance of applying new technologies.

A free distance education software called Teleduc has been used to support these courses fostering the interaction among students with different backgrounds. Hands-on exercises have been made available through specially well-organized tutorials and selected datasets. Students are encouraged to use SPRING (INPE's image processing free software) and gather data for their own study areas among the several public sources available (CBERS and LANDSAT images, digital maps and SRTM data). The outcome of these on-line courses has been positive. The Distance Education Group at INPE intends to keep improving and encouraging the creation of more advanced e-learning courses.

KEY WORDS: Remote Sensing, in-service teacher training, distance education, TelEduc, CBERS, SPRING.

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1. INTRODUCTION

Remote sensing is a technology that acquires land surface data without instrumentally touching it. It is a too powerful tool to be ignored in terms of information potential and instructional use by different school levels. The synoptic view and multi-temporality of remote sensing images are qualities that cannot be attained in traditional maps and other data sources.

Remote sensing images are valuable data source for environmental 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, and Cartography), interdisciplinary studies and environmental education. Lately, there has been a rapid growth in the use of remote sensing technology in more diverse areas.

Unfortunately few teachers and other professionals have gotten to know about this technology. Few undergraduate courses have a remote sensing required discipline in their curriculum, but recently this has begun to change. With the increasing interest in the use of remote sensing in other fields, the instructional demand on its use has also increased.

The expanded availability of data and software over the Internet, with free access, is also contributing to this increasing demand for more and better training courses on remote sensing. On the other hand, the number of training courses available that covers this subject is still small. As a result of that demand distance education courses were created at INPE.

Remote Sensing education started in 1972 as one of the 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.

In July of 1998, the Remote Sensing Division (DSR/OBT) offered a first forty-hour course for elementary and high school in-service teachers from both public and private schools entitled "The school use of remote sensing for environmental studies". Since then, INPE has been offering this course every year and it has been successful in spreading the use of remote sensing as an educational tool among teachers. The teachers are encouraged to develop a project in their school with their students using remote sensing data to look at and study a local environmental problem.

Since 1999, the Image Processing Division (DPI/OBT), in partnership with SELPER-Brazil (Society of Latin-American Specialists in Remote Sensing), has offered traditional (in-house) short-term courses aimed at supporting the use of geotechnology in Brazil. The students come from various backgrounds and application interest areas such as Geology, Geography, Engineering and Cartography. Most of them work at institutions or companies that need an application of remote sensing at some level (Ferreira et al., 2002).

The demand for courses has been increasing over the past few years and INPE has not been able to match it. There is a limit in the number of instructors available for teaching as well as suited facilities. Additionally, students usually have limited financial resources that preclude them from traveling, since many of the students live in cities faraway from São

José dos Campos (where INPE headquarters is located). Therefore, most of them have to pay not only for the course but also for accommodation, food, and local transport.

Considering this scenario briefly described and the need to provide means of accessing information, the authors of this article formed a group at INPE with the task of redesigning the educational outreach program and defining new methods that could effectively replace traditional classroom learning environments. With the strong belief that e-learning (a combination of education and Internet using different web technologies) is the answer for attending INPE´s demand for effective instruction and material delivery, this group decided to implement distance education courses (Ferreira et al., 2005).

There are several advantages in using this approach to education, such as flexibility of time, independence of geographic location and distance, more cost-effective meaning than person-to-person training, and the adoption of a learner-centered approach where learners control their learning pace and development. The efficiency of distance education must involve constant interaction among teachers and students, students and e-learning environment, and among students themselves. One of the main challenges that our group (and most other groups) faces today is to reach a high quality standard on e-learning courses.

This program started with the undergraduate teachers because they are multipliers and they have easier access to computer laboratories. In the future INPE intends to expand the program to elementary and high school teachers as well.

The first e-learning course created in May, 2004 ("The Use of Remote Sensing for Environmental Studies for Undergraduate Professors") aimed at disseminating remote sensing as part of the curriculum and pedagogical resource to teaching science topics in universities. The main idea was to create collaborative learning opportunities for college educators fostering their continuing professional development, reinforcing the importance of applying new technologies, and encouraging them to spread what they have learned among students and colleagues.

In order to match the increasing demand (not only by undergraduate professors but also by technicians and researchers from environmental institutions around the country), two more courses were offered in 2005: one in May and one in September. Up to this day, four courses have been offered always including suggestions and improvements based on student feedbacks.

In this context, the objective of this paper is to present the materials used in these courses, present the methodologies applied and discuss the results obtained.

2. MATERIALS

The in-service teacher training courses were carried out using a distance education managing system called TelEduc. This software was developed by researchers from UNICAMP (a public university in Brazil). A combined image processing and GIS freeware package called SPRING (www.dpi.inpe.br/spring) with Portuguese, Spanish and English versions was also used. This software is a state-of-the-art GIS and remote sensing image processing system with an object-oriented data model, which provides for the integration of raster and vector data.

The courses utilized selected instructional materials including books, CD-ROM, and specific tutorials that are sent by mail to the students. The book entitled “Satellite Images for Environmental Studies” (Florenzano, 2002) is one of the main sources of remote sensing information. This book provides information on satellites and sensors, image interpretation, remote sensing applications for environmental studies and shows a large potential for classroom activities.

The interactive educational CD-ROM entitled “Remote Sensing: Applications for Preservation, Conservation and Sustainable Development of the Amazon (Dias et al., 2003) provided, is divided in three sections (1) introduction to preservation and conservation, (2) introduction to remote sensing principles and satellite image processing, and (3) Amazon case studies based on LBA-Ecology research. This CD includes high quality graphics, animations, audio, video, interactive exercises and quizzes. Many aspects of this CD-ROM are based on an existing set of CDs developed by Indiana State University under an NASA grant (Mausel et al., 2001).

Specially well-organized tutorials for guiding students on digital image processing techniques including procedures for image registration, enhancement, segmentation, and classification (Mello et al. 2004) were prepared and made available to students. These tutorials include a selected example of satellite images over the Brazilian Amazon (CCD_CBERS images Orbit_Point: 165_112 of bands 2, 3, 4 for 2004/06/24 - http://www.dgi.inpe.br/CDSR) used in the third course and São José dos Campos region used in the fourth and fifth courses, for student hands-on experiences. GeoCover Orthorectified Landsat Thematic Mapper Mosaics were used for geometric correction of CBERS images (Figure 1) during the course (GeoCover Mosaic - Chart S 21-10; https://zulu.ssc.nasa.gov/mrsid/).

The authors are preparing other image sets and examples for future courses. A supplemental video, consisting of a prerecorded lecture, which covers image processing techniques, was included in the last course. This material should provide teachers with sufficient information to explore project development and begin using remote sensing in their classes.

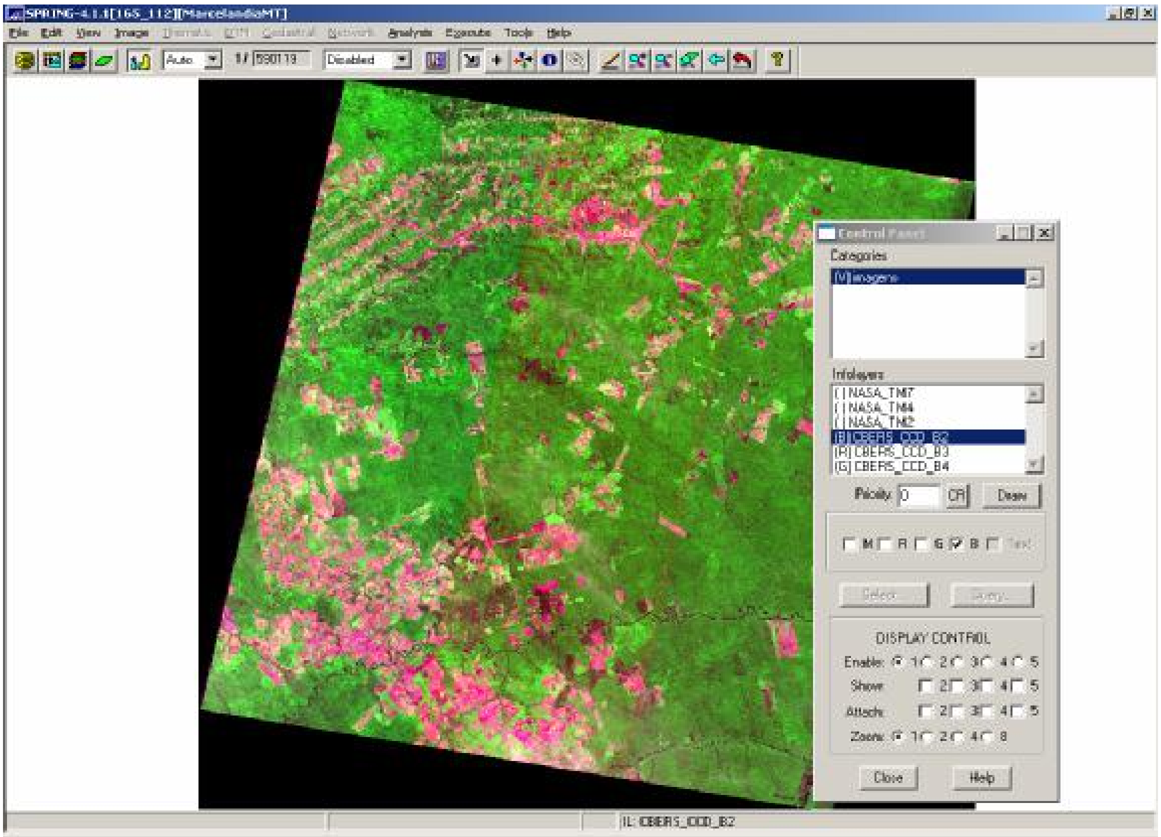

Figure1. Color composite image of the study area processed and displayed by SPRING (CCD_CBERS bands 2, 3 and 4)

3. METHODOLOGY

The first e-learning course (a pilot experience) was implemented during three weeks and included four instructors and fourteen students. The second and third courses ran for seven weeks and had 30 students selected in each one. There were four instructors for the second course and seven for the third. Undergraduate faculty and students with different backgrounds (Engineering – Civil, Agronomic, Agriculture, Environmental and Fishing, Geography, Biology, Architecture, Chemistry, Physics and Geology) were selected.

Student selection criteria included geographic location as one of the most important. Students living far from INPE headquarters had preference, because they have more difficulty in attending courses at INPE and, also, have less access to information.

The first course was structured based on a predicted student involvement of twelve hours per week, distributed between mandatory classes, activities, and complementary and optional readings, as well as weekly chats with instructors. The activities included the development of a project proposal that should incorporate an environmental theme addressed by a remote sensing technique. Students were encouraged to use the software SPRING and gather data for their own study areas among the several public sources available (CBERS and LANDSAT images, digital maps, SRTM data, etc.).

The CBERS program is being developed by a joint effort between Brazil and China. CBERS family of remote sensing satellites brought significant scientific advances to Brazil. Its images are used for deforestation and fire control in the Amazon region and for monitoring of water resources, agricultural activities, urban growth and land cover change. These data are critical for large-scale strategic projects, like SIVAM (Amazonian Surveillance System), and for monitoring and managing landscape occupation associated with environmental projects.

The nine classes (three per week) in the first course covered the following topics: 1) how to use TelEduc and prepare a thematic or educational project proposal, 2) basic environmental concepts, 3) remote sensing principles, 4) image Interpretation, 5) image processing, 6) examples of remote sensing applications, 7) proposal preparation help through distant student advisement, and 8) final evaluation and course assessment.

The content of the following courses was the same as the first course, but with more emphasis on digital image processing, and only two classes per week. The increased duration of these courses, as well as the extended chat sessions in two periods (morning and afternoon) were implemented due to student suggestions received during the evaluation of the first course. Besides these changes made in advance, several small adjustments were made during the courses, such as, adding three more instructors and providing extra chat sessions (some at night). The fourth course had only one class per week during the three-week period when image processing classes were conducted.

The instructors, students, instructional materials and software (TelEduc and SPRING) were evaluated at the end of the three courses by all participants. Students were also asked to make a self-assessment of their performance during the course.

As mentioned before, the fourth course included technicians and researchers from institutions such as INPA (National Institute of Amazonian Research), EMBRAPA (Brazilian Enterprise of Agriculture and Livestock Research) and IBAMA (Brazilian Institute for Environment and Natural Renewable Resources). They often use remote sensing technology applied to environmental studies and many times with an educational focus.

4. RESULTS AND DISCUSSION

Table 1 shows the diversity of student backgrounds. It can be noticed that most participants had Engineering and Geography backgrounds.

Course	Eng.	Geog	Bio.	Arc.	Che.	Phy.	Geol	Comp.Sci.	Econ.	Militar
1	8	2	3	1	-	-	-	-	-	-
2	10	5	1	1	1	-	4	-	-	-
3	7	8	2	2	-	3	2	-	-	-
4	9	8	7	1	1	1	5	2	1	1

Table 1 – Backgrounds of enrolled undergraduate faculty.

According to the literature, the average dropout of distance education courses is near 30%. This percentage was also observed in the first three courses (see Table 2). During courses 1, 2, and 3 teachers were able to test the instructional materials and gather information about the types of difficulties students usually had. Based on their feedbacks, teachers were motivated to adjust and update those materials generating new versions that were used in course 4. Therefore, as Table 2 shows, student's performance clearly improved on that last course achieving 92% approval rate at the end.

Course	Candidates	Selected	Enrolled	Conclusion
1	61	18	14	11 (78%)
2	96	30	22	14 (63%)
3	65	30	24	18 (75%)
4	180	40	36	33 (92%)

Table 2 – Number of students that applied (Candidates), were selected and enrolled, and successfully completed each course.

Table 3 presents some of the results obtained from the courses regarding the widespread participation of students from all regions of Brazil with different backgrounds. From course 3 onwards, it was decided to also accept two Latin-American students for course. In course 4, there was a Brazilian (PhD student at Michigan State University).

Courses/ Regions	N	NE	SE	W	S	Latin-America	USA	Total
Course 1	1	2	7	3	1	-	-	14
Course 2	5	10	4	2	1	-	-	22
Course 3	5	7	3	3	4	2	-	24
Course 4	11	9	3	2	8	2	1	36

Table 3 – Enrollment of students by region.

During chat sessions the average participation was six students. However, most of the instructors were present at all sessions. At the beginning of the third course the students were asked about the best times to conduct the chat sessions considering their own schedules. Based on their answers the best days and times were selected for scheduling the chats. Their relative participation in the chat sessions, however, did not increase significantly (seven students). In the fourth course a schedule was set on the same day every week, with alternating times every week. On week one the chat session was in the morning and on week two in the afternoon. Also following student suggestions evening chat sessions were added. The experience shows that chats are one of the most important tools for e-learning since it provides synchronous interaction among all participants. On the other hand, this tool, according to Otsuka et al. (2003) is the most difficult to use successfully in a distance education environment. The challenge is to explore new ways of improving and encouraging student participation with synchronous activities.
The best student performance was observed in the third and fourth courses due to the introduction of specifically designed image processing tutorials. Students usually have little background in image processing techniques and have difficulty learning these types of software that are usually complex (for example SPRING) in a short period of time.

The courses are designed in a way that interaction among students and teachers are facilitated and motivated. Teachers are able to assist students and monitor their progress firsthand immediately responding to any doubts they might have. The need for personal tutoring was overcome by the nature of tasks students are asked to perform on image processing. In the image classification activity, for instance, the students need to perform a series of tasks predefined by a set of specific steps. If they do not perform satisfactorily they will not obtain the designed outcome. It is very difficult to cheat on obtaining these results (see Figure 2).

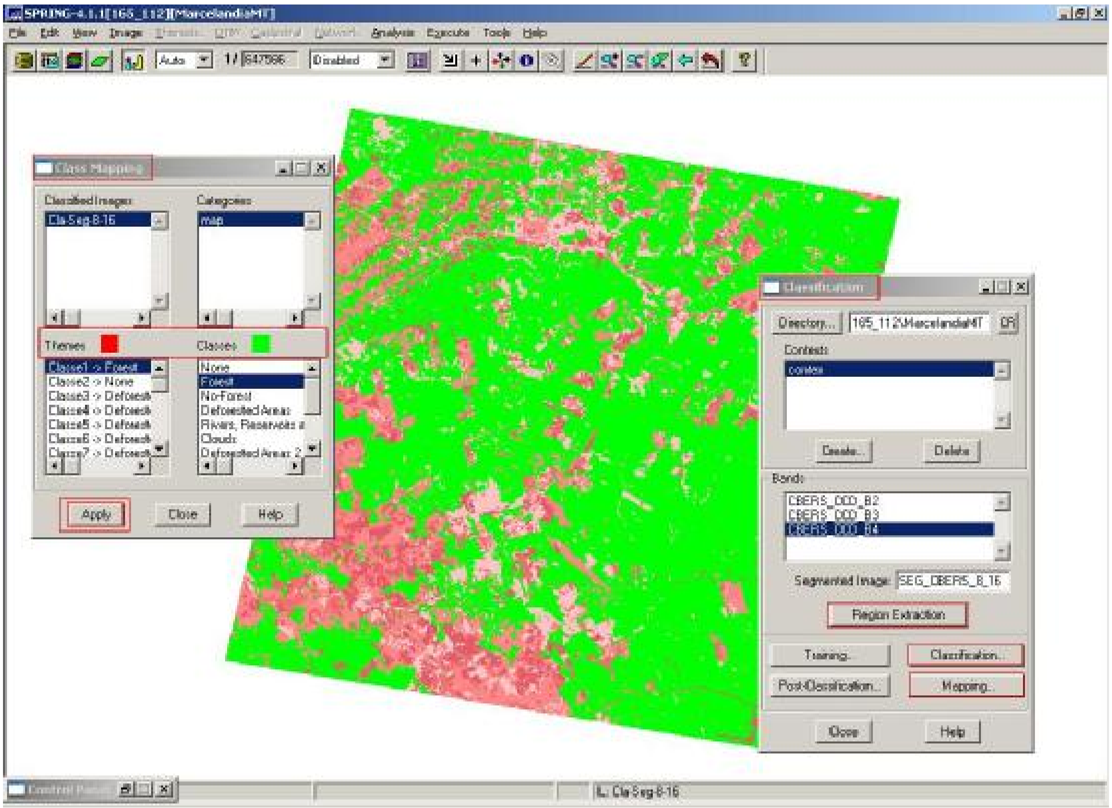

Figure 2: Results of the Mapping Classes for a Thematic Image (study area)

Overall both materials and instructors received good evaluations from most of the students in all three courses. TelEduc proved to be a robust and reliable distance education managing system. It has satisfactorily performed the important role of supporting course development and monitoring course performance during implementation. All students evaluated this system as being efficient and friendly.

5. CONCLUSIONS

Despite of the traditional difficulty in acquiring complex knowledge, such as remote sensing techniques and applications, most students had good performance in the tasks proposed and were able to learn the concepts, principles and processes associated with this technology. The results were even more satisfactory considering the wide range of topics covered, the lack of background by most students (in course 4, for example, 61% students had never worked with remote sensing before) and the diversity of the student population, which usually affects the learning that takes place in distance education courses. Thus, the outcome of these courses is considered positive showing that learning about image interpretation and processing is feasible through e-learning.

We attribute the success of teaching such complex topics by e-learning to the quality of the materials provided to students and the support given to students by each instructor, and, of course, the exceptional dedication to learning demonstrated by most students. High quality material is important not only for students learning but also for the dissemination of remote sensing by the students in their own classrooms and communities.

The unique characteristic of this course is that there is a lot of student-teacher and student-student interaction, which was made possible by the way students learn in an effective e-learning environment. The teachers are able to assist the students in their progress and immediately respond to their learning needs. Even for image processing activities, the results show that personal tutoring can be satisfactorily fulfilled with e-learning.

Additional improvements are needed in order to optimize course performance and student learning, such as tutorial updates and evaluation strategies. Exploring additional tools that frequently become available through new versions of TelEduc released every year is also needed. One of the improvements that will be implemented in the next version of the course is to provide a new session presenting partial hands-on case studies.

The experience gained during the first four courses has encouraged this group to pursue the development of new courses focusing on more advanced topics. The new distance education courses will cover topics, such as remote sensing applied to the hydrosphere, agriculture, and urban analysis.

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