

E-LEARNING IN SPACE SCIENCES AND TECHNOLOGIES

“STATES OF ARTS AND DEVELOPMENT STRATEGIES”

IN AFRICA

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Abstract – In order to reply to the Space Sciences and Technologies training requirements and tools control of this high Technology, we have been interested to analyze the states of arts and to predict development strategies on the subject. Within this context, e-Learning proves out to be very suitable because it permits to bypass infrastructure problems as well as human resources and equipments problems. Besides, while abolishing distances it permits to save on indirect training budgets; to facilitate the access to training; and in short to put give teachers and students tools more effective, more convivial and more adapted to their needs training rhythm. All of which without space and time constraints, be it in initial or in continuous training. In this paper, we propose a solution based on the creation of local and regional training centres in Sciences and Technologies of Space and the setting up of an e-learning platform hosted by the Regional African Centre of Space Science and Technology- in French Language- (CRASTE-LF). So these different centres will have access to all satellite images and geospatial data available at the Centre and will be able to benefit from a tutored training. All this should be put in place in order to distribute the technological knowledge concerning Space Technologies.

Keywords: Technologies of Space, E-learning, learning centre.

1. INTRODUCTION

The Space Techniques became inescapable in many fields of the economic and social life and are undergoing some spectacular developments. Strategic sectors such as Earth Observation Systems, Remote Sensing, Satellite Communications and Satellite Meteorology, with the use of Space Technology, went through a true metamorphosis from both a qualitative and quantitative point of view [1]

However, the specialized institutions are very rare, like for example The Regional African Centre of Space Science and Technology- in French Language (CRASTE-LF), affiliated to UN and established in Morocco and which covers thirteen African States. Because of this regional centralization, only a limited number of candidates can have

access the training since it requires a great investment. Besides, specialists and users of space technology tools need training in the Science and Technologies of Space field.

Various researches conducted to answer this training need and to set up new concepts bound to coexist with a system deeply rooted in our culture and our traditions, suggest an educational, technical and legal innovation at the ICT (Information and Communication Technologies) level. On the professional level, the evolution of the ICT, the need of continuous training with temporal and space flexibility, the evolution of the educational approaches which are more based upon an active implication of learning,... all of this led public and private educational institutions to renew their interest in e-learning.

Offering many advantages, in particular to bypass infrastructure problems as well as human resources and equipments problems, the e-Learning proves out to be very suitable. Besides, while abolishing distances it permits to save on indirect training budgets; to facilitate the access to training; and in short to give teachers and students tools more effective, more convivial and more adapted to their needs training rhythm. All of which without space and time constraints, be it in initial or in continuous training.

The main objective of our project is to achieve the Space Sciences and Technologies e-learning States of arts and Development Strategies in Africa. For that, we structured our paper in three parts:

- The first part will be devoted the existing e-learning structures analysis on the subject,
- The second part, more concrete, will allow us to present the Implementation of application approach,
- The third part presents the Space Sciences and Technologies e-learning evolution perspectives with a case study. Finally, a conclusion will enclose this paper.

2. ANALYSIS OF THE EXISTING E-LEARNING STRUCTURES IN SPACE SCIENCES AND TECHNOLOGIES

This part takes support on the one hand on highlighting the operational e-learning experiences, achieved everywhere in the world. And on the other hand, to sketch the training

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evaluation and including the possibility to deploy in our region an e-learning program in this field.

2.1 Experiences:

In Europe, many French and German universities and engineers schools have developed their e-learning structure in Space Sciences and Technologies field:

- **German experience:** The e-learning structure integration is achieved with the collaboration of the National Government Organisations (NGO), the companies and universities. The example of the International Society for Photogrammetry and Remote Sensing (ISPRS), that is an International organization of cooperation to valorise the knowledge, and the educational development in Sciences and Technologies of Space field. The ISPRS regroups several partners so as: ESRI (Geographic Information System (GIS) & Mapping Software), NASA, LEICA Geosystems...
- **ENGREF Montpellier University experience:** This University developed some special e-learning modules so as: Digital Terrain Model, GIS on line services, Cartography, Spatial Analysis, Global Positioning System, GIS Images and Ortho-Photos, GIS and Open Source Software.

In the United States and in Asia, the e-learning structures in Space Sciences and Technologies field are more developed, as well in initial and in continuous training. Besides, the only countries that consisted of the e-learning stakes on the subject are those of Asia.

- **Japanese Experience:** The Tsukuba University (Japan), the Asiatic Institute of the Technology (AIT, Thailand) and the Malaysia Multimedia University (MMU), have much developed the e-learning structure in Space Sciences and Technologies by Videoconferencing. These Institutions allowing students or the distant site student groups to see themselves and to converse orally from afar in real time while exchanging their animate images, their voices and some various files (texts, digital data, satellite images, graphic, audiovisual documents,..).

In Africa: In addition to the mentioned experiences below, we haven't found any French e-learning training program in Sciences and Technologies of Space field. The only e-learning course credited that we found in these domains entitled Geographic Information System applied to the forestry that is part of management Certificate interuniversity in forestry offered jointly by the e-university and the Laval University. We also found a course none credited titled Introduction to Arc/Info prepared by M. Jean Boivin of the SRNI-urbanization (UQAM: Quebec University-Canada). This course is organized as a set of web documents accessible to all. In English, we found one Remote Sensing course and some GIS programs.

In the circumstances, the Space Sciences and Technologies training offer in our country, will progress with the knowledge exponential development. Otherwise, the e-learning will contribute not only to the offer evolution but also of the training needs.

2.2 Implementation of application approach

Three research methods done to collect some information on the Space Sciences and Technologies e-learning in Africa:

- Documentary research;
- National reports of some African countries; and international reports of the Technology Standards and Guidelines for United Nations Development Projects in Morocco;
- Internet Resources Research,

2.2.1 Documentary Research

Some documentary research allowed us to identify the progress e-learning structures in Space Sciences and Technologies. We mention here only those that offer the specialized programs in Remote Sensing or in GIS [2] or including a large shutter in Space Sciences and Technologies field.

2.2.2 National and International reports

In the aim to collect some statistics -non available otherwise- we consulted research based on national reports from twelve French-speaking Africa countries which are: Algeria, Benin, Burkina, Cameroon, Congo, Coast of Ivory, Gabon, Mali, Morocco, Niger, Senegal and Tunisia. These countries have been selected on the basis of their activity level in Space Sciences and Technologies.

2.2.3 Internet Resources Research

We explored various Internet Resources. We have discovered a postal investigation on the e-learning requirements and motivations about the Space Sciences and Technologies field. This survey dated in 2001 and has been updated in 2006. We will discuss this later in this paper.

3. RESULTS

3.1 Documentary research results

In Africa, the training capacities development efforts have been realized especially in the Space Sciences and Technology Regional African Centres:

- Five Regional Centres of Remote Sensing have been created in the 70 and 80 years, either in Nairobi, Ouagadougou, Island-Ife, Cairo and Kinshasa. The *Regional Centre for Services in Surveying, Mapping and Remote Sensing* (RCSSMRS) of Nairobi offers, in addition to the short sessions, the training programs on six to twelve months that look like e-learning approach, in the sense that they include two short stays in Nairobi in the beginning and at the end of training course and a long period of individual work in the trainee's origin country [3]. Especially serving the East Africa, the very big majority of the RCSSMRS training programs is in English. The Ouagadougou Regional Centre of Remote Sensing (CRTO) offers a training for ten months appointed the CYRETEL (Regular Cycle of Remote Sensing) approved by a DEA or a DESS diploma. This training includes an initial conceptual section and individual practical working [4]. Also, the CRTO

organizes the simply training at Ouagadougou and at the States members (Algeria, Benin, Burkina, Cameroon, Congo, Coast of Ivory, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Senegal, Sierra Leone and Togo). But, this training is elementary for the CRTO human resources, equipments and budgets being very limited. The *Regional Centre for Training in Aerospace Surveys* (RECTAS) in Ile-Ife at Nigeria proposes the training for Photogrammetry, Remote Sensing and Cartography fields. For Remote Sensing domain, RECTAS offers two long programs and one another program post graduated for 12 months, approved by (DSES). All courses can be dispensed in English and in French at RECTAS.

- Lately, two other Regional Centres were created in 1998 specialized in Space Sciences and Technologies. These Centres have the orders to include a training and research shutter. One of these Centres is the CRASTE-LA for the English language located in Nigeria and the other is the CRASTE-LF for the French language in Morocco. This last organizes four specialized training post graduated sessions approved by a Master diploma:
 1. Satellite Communications (ST)
 2. Satellite Meteorology & Global Climate (SM&GC)
 3. Space and Atmosphere Sciences (SAS)
 4. Remote Sensing and Geographic Information System (RS&GIS)
- In addition to these Centres, the Royal Centre for Remote Sensing (CRTS) has been created in 1989 in Rabat. This Centre has the order to coordinate and to develop the training and research actions on Remote Sensing & GIS.
- In parallel, some Space Sciences and Technologies modules integrated in the educational program for some universities in North Africa.

3.2 National and International reports results

The second method consisted to analyze the national and international reports content for various specialized French-speaking countries of Africa: Benin, Burkina Faso, Cameroon, Congo, Coast of Ivory, Gabon, Mali, Morocco, Niger, Senegal and Tunisia. These reports mentioned the training status of Space Sciences and Technologies field in every country [3] [5] [10]. We concluded the following main information's:

- Beyond 5000 person have been trained to various levels in the eleven countries during the last ten years,
- The CRTO, the RECTAS and the CRASTE-LF are the more used regional institutions,
- The National reports confirm the National University low state advancement. At these Universities, the Remote Sensing and GIS courses represent some programs hours during three or four years only[3],
- During the last ten years, the training financing has been ensured principally by the UN organisms and research & educational organisms who are CARTEL&AUPELF-UREF (Centre d'Applications et de Recherches en Télédétection & Agence francophone de l'enseignement supérieur et la recherche).

3.3 Research Internet resources results

The third method uses the Internet resources. We discovered and explored a postal investigation statistics. The survey consists of the e-learning requirements and motivations. The results of the search are based on 12 questionnaires from Remote Sensing and GIS African students at the Sherbrooke University and 360 questionnaires from Remote Sensing African members of the AUPELF UREF[6].

TABLE I
E-LEARNING REQUIREMENTS DURING THE LAST FIVE YEARS

	B	BF	Ca	Co	CI	Ga	Ma	Mo	Ni	Se	Tu
Initiation	75		50	?			50	50		*	
Technicians		*		?	*		*	*	16	*	
Engineers		*	25	?	*	25	*	250	13	*	120
DEA DESS	35	*		?		70	*	*		*	50
Doctors			10	?	*	5		20		*	5
Total	110	120	85	?	400	100	75	420	29	150	175

B:Benin, **BF:**BurkinaFaso, **Ca:**Cameroon, **Co:**Congo, **CI:** Coast of Ivory, **Ga:**Gabon, **Ma:**Mali, **Mo:**Morocco, **Ni:**Niger, **Se:**Senegal, **Tu:**Tunisia.

This table shows that the 420 and 400 people envisaged respectively in Morocco and Coast of Ivory are the result of an extrapolation based on very fragmentary data. To the other extreme, the 85 people of Cameroon are the result of a rather pessimistic scenario. In the centre of this spectrum, we find Mali (75), Gabon (100), Burkina Faso (120) and Tunisia (175). These are forecasts which probably included certain realism. Thus on the whole, we can envisage needs rising between 75 and 425 people per country during five next years.

TABLE II
E-LEARNING MOTIVATIONS TO ATTEMPT REMOTE SENSING AND GIS FIELD
(1=DIM MOTIVATION, 7=HIGH MOTIVATION)

Country or country group	Motivation / 7
Madagascar	6.50
Algeria	6.29
Morocco	6.18
Cameroon	8.16
Central Africa (a part)	8.10
Tunisia	8.09
Whole of the sample	5.90
Sahel (a part)	5.88
Coast of Ivory	5.70
Senegal	5.69
Benin	5.43
Burkina Faso	5.29
Togo	4.60

From table II, It is advisable to note the higher motivation in Madagascar and possibly in Tunisia, and less low motivation significantly in Togo.

Whereas, the table III shows that the e-learning occupy a minor position. But also, we find again there a considerable gap between what the respondents observe and what they wishes. This let foretell interesting opportunities for this medium, even though it is necessary to note that he stays to the sixth position in the ideal grading

With regard to the current place, three institutions dissociate others very clearly. They are the European, North Americans universities and the North specialized centres.

Let us note that we observe significant differences between country or groups of country on the place which currently occupies the universities of your countries: the Burkina Faso, Benin and Cameroon respondents are less severe in their judgement on the place than currently occupies the universities of their country, while it is in both part of the Sahel and Central Africa that we find the most severe judgements. We observe also such judgements (negative) in Madagascar and, as surprising as that can appear, in Morocco and in Tunisia. It is thus not assured only the evaluations which the respondents make correspond to the real situation in their country.

TABLE III
CURRENT AND IDEAL POSITION OF THE
TRAINING INSTITUTIONS AND TYPES
(1=VERY LITTLE IMPORTANT, 4=VERY IMPORTANT)

Training Institutions and Types	Current Position mean/4 (rang)	Ideal Position mean/4 (rang)	Standard deviation a both of them
Your country Universities	1.95 (5)	3.48 (1)	1.53
E-learning	1.64 (6)	3.14 (6)	1.5
Regional Centers African	2.02 (4)	3.43 (3)	1.41
Mail Training	1.61 (7)	2.82 (7)	1.21
Specialized Centres for North Africa	2.83 (3)	3.44 (2)	0.61
European Universities	2.85 (2)	3.27 (4)	0.42
North-American universities	2.86 (1)	3.23 (5)	0.37

TABLE IV
THE RESPONDENTS RESIDENCE COUNTRY
(AFTER REGROUPING OF THE TOO WEAKLY
REPRESENTED COUNTRIES)

Country or country group	Respondents Number	Sample %
Senegal	16	13.8%
Algeria	14	12.1%
Tunisia	12	10.3%
Morocco	11	9.5%
Central Africa (a part)	10	8.6%
Coast of Ivory	10	8.6%
Madagascar	10	8.6%
Sahel (a part)	8	6.9%
Burkina Faso	7	6.0%
Benin	7	6.0%
Cameroon	6	5.2%
Togo	5	4.3%
Subtotal	116	100.0%
Failed data	3	
Total	119	

About the ideal position that the e-learning should occupy, some notorious differences must be underlined on this important variable for our research. Like this, it will be necessary to keep that the Morocco and the Central Africa countries are more positive. While the Burkina Faso respondents are slightly more negative (TABLE IV). Also, it's very important to note that the ideal place assessment that the e-learning should occupy is negatively - and meaningfully - correlated with the importance perception of the teachers interaction with the students: We give the more importance to direct contact between teachers and students for the Space Science and Technologies' training program's success, the less we will be inclined to choose e-learning as a training approach in the residence country.

These results show that even though massive campaigns have been conducted by international organizations to promote this modern formation style which it is still unpopular in Africa.

4. THE SPACE SCIENCES AND TECHNOLOGIES E-LEARNING PERSPECTIVES

4.1 Case study: CRASTE-LF in Morocco

Following our research results and for the next five years, the e-learning proves to be indispensable to fill the Space Sciences and Technologies e-learning requirements in Africa.

In order to answer these needs, the main objective of the CRASTE-LF, institution affiliated at the United Nations, is to promote the Space Technologies training in Africa. Some credible efforts managed by this Centre for the Space Sciences and Technologies e-learning structure integration field, in order to bypass infrastructure problems as well as human resources and equipments problems.

4.2 Project Proposition: Local & Regional learning platforms

In this paper, we propose a solution based on the creation of local and regional centres of training in Sciences and Technologies of Space and the setting up of an e-Learning platform hosted by the CRASTE-LF. So these different centres will have access to all satellite images and geospatial data available at the Centre and will be able to benefit from a tutored training. All this should be put in place in order to diffuse the technological knowledge concerning Space Techniques [7]. The trainee's can easily access the e-learning platform through the internet by registrant username and password. Dependant on their respective study course they can choose the learning modules they would like to work on. The main objectives are:

- Interoperability: Deployment of the content on several learning platforms.
- Reuse: A multitude of situations and trainee's for one same content
- To promote the further development of the higher education structure for e-learning and lifelong learning, and create local and regional learning centers, providing a framework for micro business development (Micro businesses make up a large proportion of all companies and thus of the potential for growth and development in the business community).
- To encourage and support the further development of higher education structure for e-learning and lifelong learning.
- To create local and regional learning centers, suitable for forthcoming national development, with specific emphasis on the promotion of knowledge and skills development for micro business development, growth of lifelong learning and vocational training. All embedded in the Moroccan context.
- To develop a structure of business incubator created by the centres in order to improve the governance in Start-up Firms (Micro businesses).

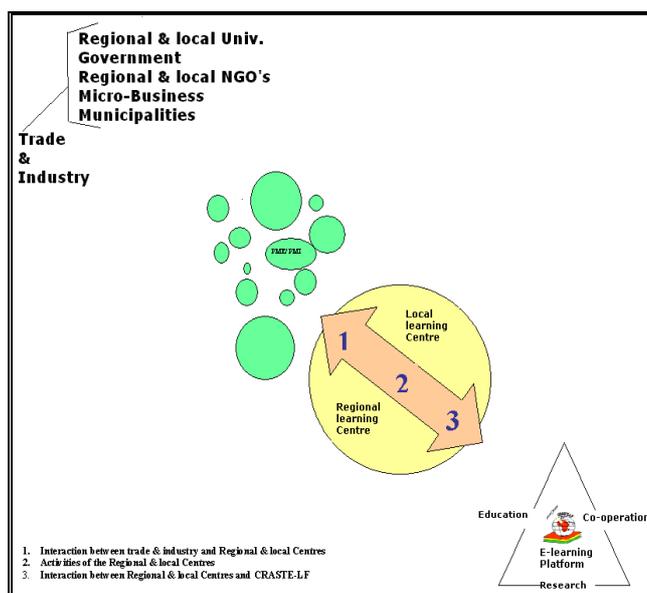
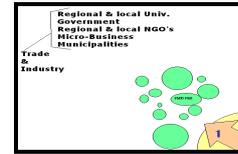


FIGURE 1

Local & Regional learning platforms

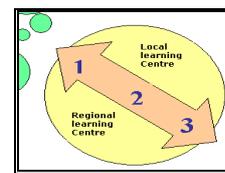
We have three interactions types on figure I:

1. Interaction between trade & industry and Regional & local Centres



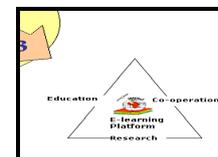
- Development of discussions with certain companies
- Mutual understanding between the University and the Regional & local Centres when visiting companies.

2. Activities of the Regional & local Centres



- Projects in separate municipalities, with emphasis on specific, educational needs in order to reach an increased integration between the municipality's support for competence development and other developmental support to trade and industry.
- Stimulation of the Regional & local Centres visiting work to trade and industry.

3. Interaction between Regional & local Centres and CRASTE-LF



- The CRASTE-LF Centre's focus on co-operation with trade and industry in Africa, via Regional & local Centres, changes from an educational focus to co-operative focus, which also includes development projects.
- The Centre's contact, and the co-ordination in Africa regarding municipality seats of e-learning studies, will be co-ordinated into a mutual function.
- Joint network for development.

4.3 The factors that motivate the setting up of Space Sciences and Technologies e-learning project in the CRASTE-LF/Morocco

Several factors that motivate the setting up of Space Sciences and Technologies e-learning project in the CRASTE-LF in Morocco:

- Geographical situation: Morocco is now the best platform of international & regional investments,
- It is necessary to note that Morocco has been mentioned among the regional Institutions of education in the national reports on four occasions [3] [5] [10],
- The Technological progress in Morocco [8];

- To facilitate the Space Sciences and Technologies training access, of a lot of number trainees for the members countries, without Space and time constraints;

- The most of the Moroccan universities suffer infrastructure and equipments problems;

- The direct formation of the trainees in the countries of the North of Africa being very costly, but it is less and less accessible to the countries of the South Africa.

- To answer the government's needs in the Space Sciences and Technologies staff training within their local, for expertises and national development;

- And finally, our research results show that the Moroccan are very motivate to undertake such studies.

5. CONCLUSION

In short, while combining and analyzing the collected information, we can pull the main findings and make the main following recommendations:

- 1- The Space Sciences and Technologies e-learning is a very carrier crenel;
- 2- The process aiming to establish an e-learning structure should be followed;
- 3- An international and multinational flexible consortium should be formed. The various institutions and the various organisms should be able to adhere there according to several different formulas;
- 4- During next years, the training efforts should be put in priority on the teacher training. On the basis of data collected, the Space Sciences and Technologies training domain would rise between 500 and 800 people per years in French-speaking Africa.
- 5- For the Space Sciences and Technologies spreading, it's necessary to proceed first in the sensitized countries (Morocco case), or a positive perception (Algeria case) and or the enthusiasm countries to undertake such study(Madagascar case);
- 6- The Space Sciences and Technologies e-learning seems promising insofar as:
 - To not try to make of the e-learning a substitute with the traditional training, but rather a complement;
 - To join specialized agencies in place to ensure the diffusion and the follow-up of the e-learning;
 - To put on the flexibility of this type of training and to insist, in the program content, on the practical applications
 - To ascertain to create networks between the trainees registered with the e-learning scheme
 - To pull advantage from the good reputation of the North-American universities to take leader's role in this step

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