



Report

Improving space knowledge in Africa: The ARCSSTE-E



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ABSTRACT

The African Regional Centre for Space Science and Technology Education in English (ARCSSTE-E) was inaugurated in November 1998, with a mandate for the development of indigenous skills, knowledge and capacity, through rigorous theory, research, applications, field exercises and pilot projects that can enhance socioeconomic development. The institution runs a nine-month Postgraduate Diploma (PGD) programme in the areas of Remote Sensing and Geographic Information Systems (RS/GIS); Satellite Communications; Satellite Meteorology and Global Climate; and Basic Space Science and Atmospheric Physics (BSS), as well as short courses and outreach programmes. This paper describes the impact of the space postgraduate diploma programmes in the African region, highlighting the capabilities of the centre. Using a survey of participants in its courses, it notes where changes are needed and makes recommendations to this end.

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1. Introduction

Since the end of the space race, developing countries have picked up interest in space exploration and application. Some of the space activities carried out are: development of satellites (either solely or in collaboration with international partners), space application for socio-economic needs, space education and using space to entice young people to take up interests and careers in science and technology. Furthermore, deliberate efforts have been made by pioneers in space activities, to involve developing countries in space exploration and application. The United Nations (UN), through her Office for Outer Space Affairs (OOSA), has also developed activities involving developing countries. Some of the initiatives of (UN-OOSA) are the International Space Weather Initiative, Basic Space Technology Initiative and Human Space Technology Initiative. UN-OOSA also organizes seminars, workshops, trainings and other capacity building programmes for developing countries. One of the major capacity building efforts of UN-OOSA is the establishment of regional centres for space science and technology education, in the different economic regions of the UN.

This paper discusses the initiative of capacity building in space science and technology in developing countries, the structure and mandate of the regional centres and the Postgraduate Diploma (PGD) programme which is run at the centres. The paper goes on to

analyse and discuss the survey that was conducted on the alumni of the PGD programme at the regional centre in Nigeria.

2. About ARCSSTE-E

Consequent to the approval of the United Nations General Assembly (UN-GA) for the establishment of regional centres for space science and technology in developing countries [1], the United Nations Office for Outer Space Affairs (UN-OOSA) has successfully established five regional centres. The centres are located in Morocco and Nigeria (to cater for Anglophone and Francophone African countries respectively), India (Asia-Pacific region), Brazil and Mexico (Latin America and Caribbean) and Jordan (West Asia) [2].

The centres run common curricula on four thematic areas of space science and technology education, namely: Remote Sensing/Geographic Information Systems (RS/GIS), Satellite Communication, Satellite Meteorology and Global Climate, and Basic Space Science & Atmospheric Physics. Efforts are currently on, for the development of curricula on space law, satellite navigation and space engineering [3,4]. At the conclusion of the PGD programme, participants are expected to carry out a one-year research programme in their countries; this will lead to the award of a master's degree in an affiliated university. The centres also carry out awareness, outreach and educational activities, targeted at students, policy/decision makers and the public (Fig. 1).

ARCSSTE-E was established on 24th November, 1998, by a tripartite agreement among UN-OOSA, the Nigerian government and the Obafemi Awolowo University, Ile-Ife, Nigeria. Each of the

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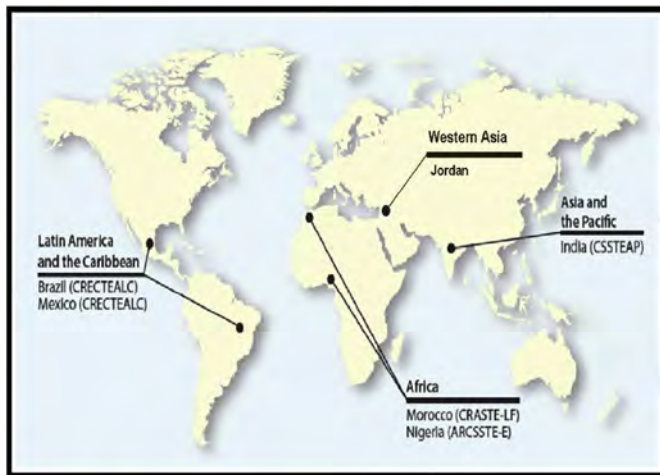


Fig. 1. Map showing location of regional centres. (Credit: UN-OOSA).

signatories to the instrument establishing ARCSSTE-E have different roles to play. Obafemi Awolowo University contributes the facility and initial faculty members for the PGD programme; the Nigerian government manages the day-to-day activities of the Centre; UN-OOSA develops the curriculum and provides the travelling expenses of the participants. This arrangement has been successful for the past 14 years.

Currently, ARCSSTE-E is housed at the premises of the Faculty of Science. Efforts are on by the Nigerian government for the development of a permanent site. Facilities at the site include an administrative block, academic block, space museum and hostels for participants. The academic block will house classrooms for the different course options, laboratories and offices for resident faculty staff. The space museum will house mockups (of astronauts, spacecrafts, launchers, robots), planetarium, and a space shop. A 20-room hostel is already in place; this is currently used for participants from outside Nigeria. More hostels have been planned.

The establishment of ARCSSTE-E has either initiated or encouraged the establishment of space related courses in some tertiary institutions in Nigeria. For example, programmes in Remote Sensing/Geographic Information System were started in Obafemi Awolowo University, Federal University of Technology, Akure, and Regional Centre for Training in Aerospace Surveys. A department of Meteorology was established at the Federal University of Technology, Akure. ARCSSTE-E also led to the establishment of the Nigerian space agency called “National Space Research and Development Agency (NASRDA)”. NASRDA supervises the day-to-day running of ARCSSTE-E and provides the necessary funding and support for the centre. ARCSSTE-E is currently working out affiliations with the Obafemi Awolowo University, Ile-Ife, and the Federal University of Technology, Akure. This affiliation will enable participants who have completed their PGD programme to continue with a masters programme in any of the universities.

2.1. ARCSSTE-E PGD programme

Similar to other regional centres [5], ARCSSTE-E runs a 9-month Postgraduate Diploma (PGD) programme in four thematic areas of space namely: Remote Sensing/Geographic Information Systems (RS/GIS), Satellite Communications, Satellite Meteorology and Basic Space Science/Atmospheric Physics (BSS). This programme runs from January to September each year. Efforts are currently on for the development of faculty members in space law, satellite navigation and space engineering.

The PGD programme at ARCSSTE-E is divided into three modules: Basic, Application and Project. During the basic module, participants take general courses from each of the programmes; this is to give participants some knowledge of each of the programmes, since they are somewhat related. At the end of the Basic module, participants split into their respective chosen areas of specialization. During this module, specialists give in-depth knowledge in the four different options. In the final module, participants apply the knowledge they have gotten in a project and write a thesis. Participants are usually encouraged to do projects that have relevance to their home-countries.

Out of the 275 participants that have participated in the PGD programme from its inception in 2001 till 2012, 185 opted for RS/GIS, 68 opted for Satellite communications, seven opted for Satellite Meteorology while 15 opted for BSS. About 56% of the participants fall within the 25–35 years age bracket, 31% fall within the 35–45 years, while 13% fall within the 45–55 age bracket. Female participation has also increased from one in 2005 to ten in 2012 (Figs. 2 and 3).

2.2. Outreach programmes

ARCSSTE-E carries out several outreach programmes aimed at reaching students, policy makers and the public. The zeronaut programme has produced three young people who have participated in the Zero-gravity flight at the Kennedy Space Center, USA. The participants are selected through a national space science quiz competition. Past beneficiaries are Stella Felix (2006), AdeoluAkano (2007) and Omolola Ibrahim (2008) (Fig. 4).

ARCSSTE-E organizes workshops, conferences and seminars. In 2010, ARCSSTE-E started an annual conference to advance the use of space in the socio-economic development of Africa. The conference is also an opportunity for a re-union of alumni of the centre. The 2nd ARCSSTE-E Regional conference was held from 22nd–24th August, 2012, with the theme “Space for the Economic Growth and Prosperity of the African People.” 24 technical papers were presented under four sub-themes: Security, Infrastructure and Health; Education, Policy and Regional Cooperation; Basic Space Science; and Space Applications. The lead paper was delivered by Prof. Paul van Dijk, on the theme “Cross Border Education in Developing countries – Learning from ITC experience.” The Department of Geo-information Science and Earth Observation (ITC), University of Twente, The Netherlands, has produced several experts from developing countries in geo-information science.

In 2011, the first ARCSSTE-E annual lecture was held with the theme “Space for the revitalisation of Nigeria’s economy”. The lecture was delivered by Dr. Adigun Ade Abiodun, former chairman

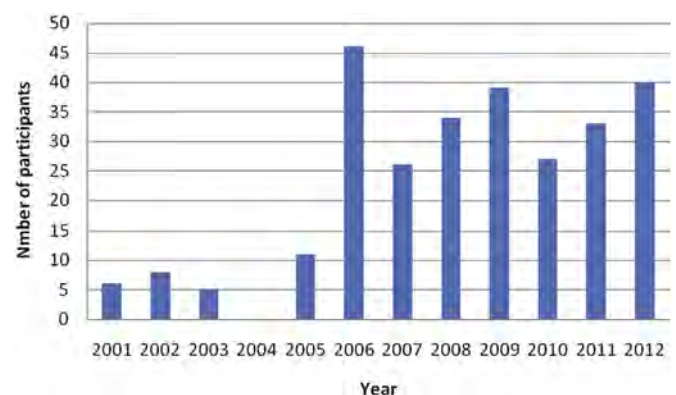


Fig. 2. Annual distribution of participants from 2001 – 2012.

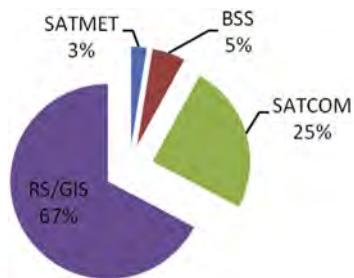


Fig. 3. Distribution of participants by course options.

of the United Nations Committee for the Peaceful Uses of Outer Space (UN-COPUOS). The second annual lecture was held on 11th October, 2012; the theme was “Progressive Technological, Policy and Legal Regime for the Utilisation of Space Solutions for Effective Peace, Human Safety and National Security.” This was in line with the theme of World Space Week 2012 - “Space for Human Safety and Security.” The lecture was delivered by Dr. Gbenga Oduntan, Kent Law School, University of Kent, UK.

In 2012, ARCSSTE-E participated for the first time in the World Robot Olympiad (WRO) in Abu Dhabi, United Arab Emirates. WRO is an international robotics competition for students between the ages of seven and nineteen. Four secondary school students represented Nigeria in the competition.

ARCSSTE-E also promotes awareness and knowledge in international space law. One of this is by supporting the Nigerian team to the annual Manfred Lachs Space Moot Competition, which is usually held during the International Astronautical Congress (IAC).

3. Assessment of impact of PGD programme

A survey was conducted to assess the impact of the PGD programme on the academic development and careers of participants of ARCSSTE-E. Since the alumni are spread all over the world, the best way to reach a large number of them was through an online survey. The survey also served as a feedback mechanism for ARCSSTE-E, so that areas of improvement in programme delivery can be done. It was also used to find out perspectives on some issues pertaining to space development in Africa.

A questionnaire, consisting of 20 questions, was designed and sent to the alumni via their email addresses. The 20 questions were divided into three major sections: PGD experience, work experience and space knowledge. Some questions were open-ended, while

some were close-ended. This made the questionnaire more interactive. Some questions also allowed multiple answers. The questions were designed to be concise and precise. This was to reduce boredom and the time spent in answering the questions. 34 alumni responded to the questionnaire. The small number of respondents may be due to lack of access to Internet facility during the period of survey, use of new email addresses or indifference to the survey.

3.1. Survey questions

The first six questions requested for bio-data; they were optional. Questions 7 to 14 were related to the PGD programme, questions 16 to 18 were related to their work, while 19 to 20 were related to space knowledge. The questions and their relative outcome are shown in Tables 1–3.

3.2. Result and discussion

Q7. Most of the participants confirmed that the programme aided a change in their career (68%). For one of the participants, when his country was seeking to train personnel for her national space programme, he was selected because of his prior participation at ARCSSTE-E. Some participants reported that the programme aided their admission for masters programme while another reported that it opened the door for international collaboration in space science research. This shows that ARCSSTE-E PGD programme has a good impact on the careers and academics of participants.

Table 1

Questions related to PGD programme.

Q7. My experience at ARCSSTE-E has:	
Facilitated my being hired	16%
Given me a change in my career	68%
Has supported my promotion	16%
Did not help me from a work perspective	0%
Q8. Retrospectively I would have liked in my ARCSSTE-E curriculum:	
More lectures	18/34
More practicals	23/34
More field trips	9/34
More policy and law	1/34
More business oriented training	7/34
Content with curriculum as is	1/34
Q9. As far as the PGD programme is concerned:	
The present four options are sufficient as choice	15/34
A second optional research year would have being an asset for me	16/34
I would suggest inclusion of new courses	5/34
Q10. Retrospectively, I would have liked the period of the PGD programme to run from:	
Mid March – mid December	3%
January–September	79%
June–February	6%
September–May	12%
Q11. As far as the one-year research leading to MSc is concerned:	
I prefer the research in Nigeria	73%
I prefer the research in my home country	18%
Other	9%
Q12. As far as the short courses are concerned:	
I'm aware of the short courses and I'm interested	31%
I am not aware of the short courses	69%
I am aware of the short courses but feel I could only participate if the format is different	0%
Q13. Which programmes would you like to see in ARCSSTE-E offerings:	
Short executive courses	15/34
Short refresher courses	18/34
Other	4/34
Q14. As far as the academic degree of ARCSSTE-E is concerned:	
I feel accreditation by a Nigerian university will be an asset	12/34
I feel accreditation by a professional institution will be an asset	17/34
Any accreditation will be an asset	5/34
The reputation of the programmes does not require accreditation	3/34



Fig. 4. Ms. Stella Felix participating in the zero-gravity flight.

Table 2
Questions relating to work.

<i>Q16. Designation:</i>	
Administration	3/34
Scientific	17/34
Technical	15/34
Management	5/34
<i>Q17. Membership of space-related professional body:</i>	
Yes	28%
No	72%
<i>Q18. Membership of non-space professional body:</i>	
Yes	47%
No	53%

Q8. The responses to Q8 shows that the participants want a lot more lectures and practicals included in the curriculum. Since the courses are specialized courses, the participants need more time to assimilate what is being taught. Several field trips are taken during the programme, hence there is not much request for more field trips. Business-oriented modules may need to be introduced also.

Q9. One of the respondents responded that there should be periodic peer-review mechanism among the regional centres. Some new programmes were advocated: Global Navigation Satellite Systems (GNSS), small satellite development, satellite meteorology, and space law. UNOOSA is already developing curricula for GNSS, systems engineering (which will cover small satellite development) and space law. Participants indicated interest in not knowing about applications, but also the science and technology.

Q10. At the onset of the programme, the school year ran from September to May. It was observed that some participants travelled to their countries to spend the end of the year with their folks. To avoid this, the school year was changed to January–September. This serves the participants well as shown in the survey result (79%). However, some participants indicated that they prefer September to May (12%); the reason may be that most university education programmes begin in September, and they wish to start up another programme immediately after concluding the PGD at ARCSSTE-E.

Q11. Most of the participants indicated that they prefer to do their one-year research in Nigeria (73%). Some participants indicated that they prefer to the research in a country other than Nigeria and their home country. For several participants, the PGD programme afforded them the first opportunity to travel out of their country. Due to the unique experience of studying outside one's country, most participants wish to continue the optional one-year research, outside their country.

Q12. Most of the participants are not aware of short courses. This may be because the short courses are not held regularly or the publicity of the courses is not enough.

Q13. Participants would like to participate in regular refresher courses. Some respondents indicated that short refresher courses should not be limited to the four options of the PGD programme; there should be specialized courses like climate change, disaster management, and space education administration. A respondent advocated introduction of visiting researchers.

Table 3
Questions relating to space knowledge.

<i>Q19. Does a country's space activities have a role to play in the socio-economic development of the country?</i>
<i>Q20. The international community has developed some initiatives to encourage space development in developing countries. What should be the focus of the international community?</i>

Q14. Even though ARCSSTE-E is affiliated to the United Nations, and the curriculum was developed by UN-OOSA, participants indicated that accreditation by a Nigerian university and relevant professional bodies will be an asset to their diplomas.

Q16–18. Most of the participants are not members of any space-related organization and/or any professional organization. This shows that participants either don't know the value of joining professional organizations or have a form of handicap in joining their organizations of interest. This will have a negative effect on their current knowledge and performance. Strategies on how to reverse this trend needs to be devised.

Q19. Most of the respondents acknowledged that space science and technology contributes to the socio-economic development of a country. For example, monitoring of environmental conditions and vegetation is best done through satellite technology. Other benefits are in the areas of communication, disaster management, improved food production, security, location-based services. Space has also created job opportunities. Development of space technology will spin off into the development of other areas of technology.

Q20. Respondents advocated that education and training should be the focus of the international community, emphasis should be on environmental monitoring and natural resource management. There should be mechanisms for knowledge transfer. Also, the international community should adhere to international space laws and treaties, strengthen space science related bodies within the African region, create awareness of decision makers and assist developing countries to develop policies that will advance space activities. Other areas include improved data-sharing and provision of scholarship grants and research funding. Areas which are not directly related to space, but will help developing countries include fulfilling commitments to developing countries, fighting of corruption, debt relief, make better playing ground and provision of infrastructure.

3.3. Recommendations

While some of the recommendations can be done by ARCSSTE-E, some will require the initiative and/or support of UN-OOSA. The recommendations are:

1. ARCSSTE-E should speed up the process of affiliation to OAU and FUTA so that participants will be encouraged to partake in the one year optional research leading to the award of a masters degree.
2. To accommodate more lectures and practicals, the period of the diploma programme should be extended from nine months to twelve months. A case in point is the Postgraduate Diploma programme at the International Center for Theoretical Physics (ICTP), Trieste, Italy [6].
3. Participants should be allowed to choose where they want to do their one-year research programmes. However, conditions and/or minimum requirements may be set for such institutions. Participants can then return to Nigeria for a defence and award of the masters degree.
4. ARCSSTE-E should organize short courses more frequently and publicise using her website, alumni network and other media.
5. Space education should be introduced within the secondary school curriculum.
6. Funding is critical for increasing the benefits of ARCSSTE-E to all of Africa. Member countries of the Governing Board (GB), need to be more financial committed. One of the ways to achieve this is to rotate the GB meeting among member-countries.
7. A more uniform, indepth and robust survey should be carried out by the regional centres for their alumni, and the knowledge garnered should be shared. Also, UN-OOSA should set up a peer-review mechanism for the regional centres.

- UN-OOSA should increase her oversight functions of the regional centres. This should include monitoring of implementation of curriculum, assessment of standards and performance, provision and maintenance of facilities and monitoring of terms of tripartite agreement of the centres.

4. Conclusion

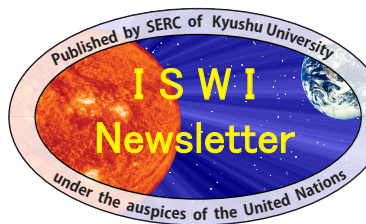
This paper discussed the efforts for formal academic knowledge in space science, technology and applications, in Africa. Beginning as a UN resolution, ARCSSTE-E has made giant strides in education and training of specialists, and also in reaching out to the public and policy makers. The paper also showed the result of a survey conducted for alumni of ARCSSTE-E to assess the impact of the PGD programme on their work and studies. The result of the survey will serve as a feedback for ARCSSTE-E to improve on her PGD

programme. Also, the recommendations deduced from the work will be useful to all the regional centres and UN-OOSA.

The initiative setting up the regional centres for space science and technology education, is a laudable one. While there have been some positive impact, the centres have a lot more potentials.

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