Virtual Science and Research and Its Relevance for Africa

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Abstract

After introducing the role of information technologies (IT) in the transformation and promotion of science and research worldwide and especially in the Third World, the important terminologies are defined, and their relevance discussed. Then the basic concepts, methods, and tools for e-research are put forward, and two important initiatives are compared. The advantages as well as the requirements for the differing scenarios are also outlined. The challenges and recommendations for the establishment of a possible virtual environment for science and research in Africa have come at the end.

IT has changed many areas and domains of modern life; one of them is academia. Learning, Education, higher education, university, research, and in one word, science, has gone through radical changes with the introduction of IT and the Virtual into the area. Important components of research and higher education like Access, Quantity, Quality, Cost, and Relevance are all now variables to the degree, size, type, and extent of IT involved and implemented.

Looking from another perspective; research, higher education, and scientific production have been so far, in a real sense, something out of access for some big parts of the world with great populations. Africa is the most important case in this regard. M. Jensen, in his striking report published in 2003 states that though Sub-Saharan Africa accommodates 10% of the world's total population ,it enjoys only 0.2%(namely one fifth of one percent)of world's telephone lines. It is obvious that within the classic frameworks for knowledge-production and through classic means, instruments, channels, and exchange media, and within the conventional (though modern) paradigms, African research and science will not only keep the gap with the West, but would even suffer from a deepening and widening divide. The advent of IT and its wide-spread introduction into higher education and research has given rise to new hopes to bridge the gap. Through the new IT possibilities--in terms of both hardware and software--alternative avenues have been, and are being, explored and put into practice. We, in the following, mention passingly some of their important features and attributes:

- virtual universities , and e-higher-education, have become advantageous for a lot of individuals and centers, especially in the developing countries.
- science and research intra-networking country-wide has become more viable in the countries with more modest GNPs
- joint mega-projects have become more feasible and can be more successful (specially between developing countries)
- a better situation has been brought about, mainly due to networking facilities, to benefit from the Scientific Diaspora (in the West),to promote the scientific level of their countries of origin
- national and international scientific cooperation is more promising through science parks & islands, and joint research and technology incubators
- easier, quicker, and cheaper channels are opened for the transfer of scientific experience from advanced countries and their scientific centers to those of less developed countries
- electronic journals, e-libraries, e-conferences, and the like, have made possible the transfer and promotion of knowledge and science , which was otherwise impossible for many scientists and students especially in the developing countries
- with the new information technologies it is more likely that developing countries be able to overcome the scientific boycott/embargo/sanction

After indicating the above-mentioned attributes and their possible consequences for the promotion of research in Africa, the paper will embark on the clarification of the key terminologies which, at times, are used interchangeably. They are: e-learning, e-education, virtual education, virtual university, virtual higher education, virtual research, VLE, VRE, and e-science. And here are some of the definitions:

The term e-Science (or e-Science) is used to describe computationally intensive science that is carried out in highly distributed network environments, or science that uses immense data sets that require grid computing.
E-learning is the delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material.

E-education involves e-teaching and e-learning along with the various administrative and strategic measures needed to support teaching and learning in an Internet environment.

The term "virtual university'" characterizes an organization that provides higher education on the Internet.
Virtual campus: cooperation between higher education institutions in the field of e-learning, regarding design of joint curricula development by several universities, including agreements for the evaluation, validation and recognition of acquired competences, subject to national procedures; large–scale experiments of virtual mobility in addition to physical mobility and development of innovative dual mode curricula, based on both traditional and on-line learning methods.

A Virtual Learning Environment (VLE) is a system designed to support and facilitate teaching and learning in an educational setting . "Virtual Learning Environments" are therefore being created by organizing the learning environment in new ways, based on different technological configurations for learning and communicating between peers, teachers, and students (New Perspectives…,1).

Virtual research environments (VREs), comprise digital infrastructure, hardware and software, and services which enable research to take place. The idea of a VRE, which in this context includes cyber infrastructure and e-infrastructure, arises from and remains intrinsically linked with, the development of e-science. As such, VRE helps to realize the popular definition of e-science which itself is to be distinguished from a merely grid-based distributed computing for scientists with huge amounts of data to the development of online tools, content, and middleware within a coherent framework for all disciplines and all types of research (Fraser,1).

An e-research is expected to facilitate:

- access to financial information
- access to funding and research opportunities
- support in working practices
- access to library services on-line
- offers personalised services
- syntheses access to information and services

And now a well established e-research environment;

- provides a supported working environment
- used for finding information
- used for disseminating information
- facilitates collaboration in new ways and across old boundaries
- makes possible the digital collections that preserve and provide access the intellectual output of an institution
- encouraging wider use of open access information assets
- may contain a variety of digital objects
- e-prints,
- theses,
- e-learning objects,
- datasets

(Raym Crow, Quoted in Hubbard,P3)

It moreover provides

- wide dissemination
- rapid dissemination
- ease of access
- cross-searchable
- value added services

(Hubbard,P2&4)

We should make few comments here on the prominent services available through e-research. As Fraser explains: Common to all disciplines is the impetus to publish and for that process to include peer-review. The dissemination of research is frequently undertaken by third-party publishers. There is a growing emphasis on institutional repositories for research publications, an example of an e-infrastructure component with which a VRE must interoperate

He adds; the longer-term research repository is not just about e-prints and research outputs, however. There is an increasingly urgent requirement for the long-term curation and preservation of not only research output but the data resulting from collection, creation and analysis. Indeed, preserving the 'project', comprising data, publications, workflows and the 'grey' material of reports, notebooks and other forms of more nebulous communications is important in a research environment where much of the material is born and raised digital. The development of today's research by tomorrow's scholars depends on it

A VRE framework should be able to expose some combination of resources, data, and tools. The VLE should be able to consume and represent it as appropriate - a direct link in the virtual environment between research and learning. Conversely, in some contexts it may be possible to re-purpose the existing VLE as a presentation layer, if not the framework itself, for a VRE (Fraser;5).

Virtual Research programs can be categorized into different types of initiatives. Ralph Schroeder and colleagues point out two basically distinct alternatives. They say:

If we consider e-Research infrastructures as comprising both the networks and technologies underpinning science systems, as well as the scientific communication which happens on top of or through them, we can broadly identify two categories of initiatives. The first category is those which address the participation of developing countries in what are variously referred to as cyber infrastructure, e-Science, or e-infrastructure initiatives. These differences in nomenclature attest more to different etymologies than that they refer to distinct concepts: Cyber infrastructure is the term used in the United States, e-Science is the United Kingdom's neologism, and e-infrastructure that of the European Union.

The second category of initiatives consists of the dissemination of previously mentioned disaggregated traditional scientific output, whether these take the form of data and/or traditional research publications in their various stages of maturity, complemented by image, audio or video captures. At this point we can map the initiatives for both of the network-level and content dissemination categories within the developing world or Global South, broadly comprising Africa, Latin America, India, and China. Whereas the notion of e-Infrastructure at European level conjures up an image of high-speed networks, when we cast our gaze in the direction of the developing world we are often still confronted with the lo-fi version of the conditions in the developed world (Schroeder et al;4-5).

Related to this categorization is the changing and flexible boundary between Tools and Resources within the framework of virtual research environment:

Tools are the means for manipulating information and data, and these nowadays consist of software as well as of computer processing and storage capabilities. Resources, on the other hand, consist of the information that is accessed for research, and consist, in addition to traditional publications, of digital archives and databases. Both tools and resources can be found on the various levels of these e-Research systems. Not only are they spread across the e-Research system, but it may also be that the networks of data and outputs that constitute current infrastructure developments – which include the development of standards, ontologies, searchable databases and e-print archives - blur the traditional distinction between tools and resources in science.

Tools and resources are both subject to incremental improvement in e-Research; neither tools nor resources are completely fluid or static. And both can be open or "closed"; in terms of input and output (or contributions and access) in the case of resources, and in terms of development (including standards) and access in the case of tools. However (and this will become important later), tools in e-Research are often modeled on open source development and primarily require skills, whereas resources, even if there is an impetus towards open access, require costly networks and access to expensive-to-maintain publications and databases(Fraser et al;4).

Having seen the important aspects of VRE and its conditions and requirements, we should consider the following questions and challenges which are essential if the virtual research is going to be seriously considered as a real policy or put in a concrete plan of action in Africa:

- The question of possibility of application and implementation of e-research (and e-science) in Africa and for Africans
- The question of priorities based on the national and regional, socio-economic needs and realities
- The question of means & methods in application and implementation
- The question of sources and resources, and, sponsors & collaborators
- The question of sustainability
- The question of maintenance
- The question of content
- The question of access & audience
- The question of cost-effect
- The question of challenges (language diversity, priority divergence, geographical/national/ethnic centrality, political imperatives,…)

As far as Africa is concerned there have been remarkable initiatives to realize Virtual Research and Education. The most important of them, chronically, are;1- African Virtual University Project(AVU)--a World Bank distance education project in South Saharan Africa, first phase of which started in 1997.2-Elsevier initiative to increase global online access to science research--in 2002.3-African Virtual Campus, adopted by the African Union, and approved by UNESCO--in 2007.In a similar move the Avicenna Project had started for Mediterranean member states, and 5-Ubuntu Net Alliance link to GEANT2(the world's most advanced pan-European backbone network)--in 2008. Undoutedly these experiences would help Africa to proceed in the road to virtual research quantitatively and qualitatively.

Similar to What VLE Project for Europe has concluded (New Perspectives,3-5) ,we also make the following regarding VRE in Africa.

Policy recommendations at institutional level:

1. The initiation of virtual research environments requires a process of the development of a draft to be, later, revised, finalized, and implemented. Within this process two important points to be deliberated are the choice of the level (1 or 2 explained above) and the costs& necessary funds .
2. Factors to be considered when planning virtual research environments include information selection and design, digital collections and open access digital collections, communication and networking, organisational management, technological realisation, and relevant services and collaborations.
3. The three key factors underlying any virtual research environment implementation policies include infrastructure, training and development ,and organisational culture.
4. The change to be brought about by virtual research environment implementation requires an "organisational development" approach in which resource management, professional development and objective sharing are the key components.
5. In order to adopt virtual research environments, institutions can use a number of events and communication systems to consult any of the following stakeholders - professional bodies; scientific associations; government funding bodies; any bodies associated with the administration of the state or the region that might have an interest in the development of the research, and national governments and African Union policy relating to science and research. Policy recommendations at researchers level researchers need special training for e-research. Research in virtual research environments needs competence in technological (so-called *hard skills*) and organisational aspects as well as new skills in applying relevant research methods(so-called *soft skills*).

7. Support is needed for the development of "innovation units", (consisting of technical groups, academic departments and teams of researchers) to work towards adapting research practice.
8. Research resources and materials must be specifically designed for virtual research environments. Policy recommendations regarding national, regional and international concerns
9. The use of virtual learning environments needs to be coordinated through in-continent and trans-continent collaborations (West and South).
10. The questions of choice of methods, resources, collaboration, as well as, sustainability and maintenance should be taken, bilaterally, serious.
11. The linguistic, ethnic, political, and cultural diversity of African member states must be considered in the organisation of African Virtual Research and training programmes in each country and on a trans-African basis.
12. International and regional virtual research environment activities demonstrate legal and economic problems, and highlight the national interests and priorities

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