Brain Gain Initiative
A digital infrastructure linking African and Arab Region universities to global knowledge
A UNESCO/HP project
Brain Gain Initiative
A digital infrastructure linking African and Arab Region universities to global knowledge
The editors and authors are responsible for the choice and presentation of the facts contained in this document and for the opinions expressed therein, which are not necessarily those of UNESCO and do not commit the Organization.

The designations employed and the presentation of the material throughout this document do not imply the expression of any opinion whatsoever on the part of UNESCO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Published in 2009
by the United Nations Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75352 Paris 07 SP
Set and printed in the workshops of UNESCO

Graphic design - www.barbara-brink.com
Cover photos
© UNESCO/A. Abbe
© UNESCO/K. Anis
© UNESCO/R. Dominique
© UNESCO/P. Lissac
© UNESCO/V. M. C. Victoria

ED.2009/Conf.402/Inf.12
© UNESCO 2009
Printed in France
Introduction

Advances in science and technology enabled through higher education have been largely responsible for economic growth and concomitant improvements in standards of quality of life in developed countries. The project described in this white paper enables universities in Africa and the Arab region to collaborate with experts around the world in innovative education projects. This is done with the help of advanced information and distributed computing technologies (grid and cloud computing). The objective is to contribute to building capacity for sustainable development through advances in science and technology in the region.

Human migration, especially the emigration of highly skilled people, is having a significant impact on education and economic development in less developed countries. For this reason, the project addresses the effects of migration and the deployment of advanced information and distributed computing technologies (IDCT) jointly.

The distinguishing feature of the project is the use of IDCT to mitigate the impact of the circulation of highly skilled people on development and thus enabling students to run innovative technology-based projects in their home countries aided by interaction with experts in the Diaspora. Such digital connection to the Diaspora can strengthen existing local skills and develop new ones, enabling more effective access to knowledge from abroad, and its application to the solution of local problems.

Distributed computing technologies will help bridge the divide in higher education between developing countries and developed ones through remote access to rare or expensive resources including data, computers, and scientific instruments. Digitally
literate young people will be able to learn from and enter into collaboration with leading innovators, independently of their physical location, lessening a motive for migration.

More broadly, the implementation of an electronic infrastructure for education in Africa and the Arab States region may significantly increase capacity-building for economic development.

This paper is organised as follows:

- Section one: This contains general considerations on the relation between higher education, technological innovation, and economic growth. The impact of IDCT and the UNESCO-HP project are described.
- Section two: This contains an assessment of a precursor project by UNESCO and HP in south-eastern Europe and the status of a pilot project in five African countries that began in 2007.
- Section three: This section presents the current project, its objectives, activities and expected results. A discussion of related projects and potential synergies is also included.
- Section four: This section mentions that UNESCO and HP welcome contributions to this project from additional partners. Such contributions will permit the extension of the current project to an ever increasing number of African and Arab States region participants. The ultimate goal being to create an e-infrastructure\(^1\) for higher education covering the entire African continent and Arab States region.

General Considerations on Education and Economic Development

From the argument that higher education has been a major factor behind economic development in highly developed countries and that information and distributed computing technologies can greatly improve higher education in less developed countries (particularly in the context of the migration of highly skilled people), one could assume that the deployment of IDCT may have a significant positive impact on economic development in the less developed countries of Africa and the Arab States region.

---

\(^1\) An e-infrastructure (or cyber-infrastructure in the USA) is the combination of computing systems, data, information resources, networking, virtual organizations and an interoperable suite of software services and tools, complemented by interdisciplinary teams of professionals responsible for its development, deployment and use in education and research.
The report "Rising Above the Gathering Storm", published by the U.S. National Academies\(^2\) references an economic study in the mid 1950s. It concludes that 85% of measured growth in income per capita in the United States during the period 1890-1950 could not be explained by increases in capital stock or other measurable inputs. The unexplained portion is widely attributed to the effects of technological change.

A separately quoted study on capital, technology and economic growth concluded that about half of US economic growth since the Second World War has been the result of technological innovation.

It is clear that the impact of economic growth on quality of life (due to the creation of products and services that characterise modern life in the USA) can be seen from such statistics as a reduction in agricultural labour from 38% of the labour force in 1900 to less than 3% in 2000. However, agricultural yield per acre grew by a factor of 2.5, and output per person-hour increased by a factor of ten in the past 50 years (U.S National Academies, op. cit.).

Further evidence for a tight relationship between technological innovation and education is provided by a study from the US Massachusetts Institute of Technology (MIT) in 1997.\(^3\) This study found that by 1997, MIT graduates and staff had founded 4,000 companies with aggregate revenues of $232 billion. They also created 1.1 million jobs world-wide.

Striking evidence for the correlation between achievements in higher education and growth of gross national income (GNI) for the case of development in the Republic of Korea over the past 35 years is shown in the following chart from a Harvard University web site on higher education in sub-Saharan Africa.\(^4\) At the same time, the chart shows very clearly the current weak state of higher education in southern Africa.

---

\(^2\) [http://books.nap.edu/catalog.php?record_id=11463. See also the follow-up published in 2009](http://www.nap.edu/catalog.php?record_id=12537)

\(^3\) [http://web.mit.edu/newsoffice/founders/Founders2.pdf](http://web.mit.edu/newsoffice/founders/Founders2.pdf)

\(^4\) [http://www.arp.harvard.edu/AfricaHigherEducation](http://www.arp.harvard.edu/AfricaHigherEducation)
General Considerations on Education and Economic Development

Figure 1: Gross national income and university enrolment are strongly correlated, both between countries and over time in one evolving country. This figure shows 2005 data from a sample of 106 countries (excluding only micro-states, major oil producers, and former Soviet republics). Sub-Saharan African countries are shown in dark grey, comprising most of the low income and low-enrolment data points. (The four non-African countries shown here with university enrolments < 10% and per capita income < $2 per day are Cambodia, Pakistan, Nepal and Bangladesh). The evolution of the Republic of Korea from 1970 to 2005 is shown in light grey. All data are from the World Bank education statistics database. The Republic of Korea historical GNI is converted to constant dollars using data from the U.S. Department of Labor Bureau of Labor Statistics.

The study "Higher Education and Economic Development in Africa" commissioned by the World Bank presents evidence that "Expanding tertiary education may promote faster technological catch-up and improve a country’s ability to maximise its economic output". In the forward to the study, the World Bank Education Advisor, Africa Region, Jee-Peng Tan, states that "Higher education … becomes an essential complement to educational efforts at other levels as well as to national initiatives to boost innovation and performance across economic sectors. The World Bank has acknowledged and incorporated this understanding within its Africa Action Plan for 2006-2008."

As seen from the evidence presented above, a major link between higher education and economic development is innovation. A recent paper entitled, "Brain drain or brain bank? The impact of skilled emigration on poor country innovation", analyses the impact of migration on innovation. The authors argue that development prospects depend in part on the capacity for innovation and that access to technological knowledge drives innovation. Innovators must have appropriate skills in order to use available knowledge. Without a critical mass of active local innovators, the benefits of knowledge can only be bought. The authors present a compelling case for the importance of local, domestic innovation, arguing that local knowledge accelerates the international diffusion of technologies, while rich-country innovation may not properly address the needs of poorer countries. In addition, domestic knowledge production may be necessary to create the capacity to absorb foreign technology.

The relationship between information and communications technology and economic development is explored in the report, "The Role of the Information and Communications Technology Sector in Expanding Economic Opportunity". A strong common element between this study and the project presented here is the requirement for "clean and consistent power, a robust, accessible and affordable connectivity network, technical literacy, skilled users and support systems, functional markets, and supportive regulatory and policy frameworks". The UNESCO-HP project, however, goes beyond the scope of the Harvard report to include universities and tertiary education and the establishment of an e-infrastructure using broad-band networking for higher education.

---

5 http://www.arp.harvard.edu/AfricaHigherEducation/Reports/BloomAndCanning.pdf
The fundamental idea behind what UNESCO and HP are doing is to exploit advances in information technology and distributed computing in higher (tertiary) education. In addition to the ready availability of high-performance computing, advances in IDCT include grid computing that enables sharing of resources and supports inter-institutional collaboration, cloud computing that can facilitate elastic expansion of computing and storage on an as-needed basis, and social networking tools that enable rapid and easy interaction between groups and individuals independently of geographical location.

In particular, IDCT provides a new way to enable members of the Diaspora to interact with students and colleagues in universities in their home countries without requiring travel. This interaction can be used for innovative education development, to mentor students, and to involve students and colleagues in distributed projects. Connection to the Diaspora can strengthen existing local skill and develop new skills, enabling more effective access to knowledge from abroad, and its application to the solution of local problems.

The issues of brain drain and the need for collaboration between countries impacted by the brain drain phenomenon and their Diasporas are increasingly high on the agenda of global and regional organisations. Especially those who have developed approaches and models that are being used in various regions of the world, including Africa and the Arab States region. For example, the World Bank has recently launched a "Mobilising the African Diaspora for Development" initiative; the International Organization for Migration has their "Migration for Development in Africa" capacity-building programme; the International Council for Science has the "Africa Diaspora Brain Gain" project; the follow-up to the Association of African Universities 2007 Conference of Rectors, Vice-Chancellors and Presidents of African Universities focuses on the theme "The African Brain Drain - Managing the Drain: Working with the Diaspora".


9 http://www.iom.int/jahia/Jahia/activities/by-theme/migration-development/lang/en/pid/1306;jsessionid=51CEA9D2F9D549EB790892F056B610F2;worker02

10 http://africarecruit.com/diasporainscienceandtechnology/

No geographical region has a monopoly on intelligence or creativity. Virtual classrooms can help remove the educational quality gap between developing and developed parts of the world. Virtual laboratories and remote access to rare or expensive resources can help small, low-budget universities enjoy access to infrastructure of the same quality as large, well-endowed ones. A digitally literate generation of young people will be able to take advantage of the opportunities provided by access to virtual classrooms and virtual laboratories. Blogs, wikis, mashups, and social networking sites will enable gifted individuals to interact with and contribute to the world’s leading innovation communities, without the absolute necessity of migrating.

In conclusion, the development, deployment and regional integration of an e-infrastructure for education in Africa and the Arab States region may have a significant impact on capacity building for economic development. The use of advanced distributed computing and communication technologies represents a significant trend shaping the future of higher education and research and accelerating progress towards building knowledge-based societies.

Precursor Projects

An initial approach to use advanced information and communication technologies to help develop local skills and capacity has been the UNESCO-HP project, “Piloting Solutions for Alleviating Brain Drain in South East Europe”. Participants in this project from 2003 to 2005 were universities in Belgrade (Serbia), Podgorica (Montenegro), Sarajevo and East Sarajevo (Bosnia and Herzegovina), Split (Croatia), Tirana (Albania), and Skopje (FYR of Macedonia). The project provided:

- Computing equipment and financial support for exchanges with the Diaspora
- Up-to-date training and career opportunities for potential migrants
- Improved quality of education through access to resources of foreign institutions with the help of a grid network
- Improved networking through new academic contacts and collaborations with academics in the Diaspora.

The project has raised awareness and encouraged decision-makers to take practical and political measures to reverse brain drain in the region. Both project partners and beneficiaries have expressed their satisfaction. This is no doubt due to the initiative.
succeeding in nurturing a dynamic community that values both the open exchange of ideas and the critical collaborative relations for preventing the negative effective of national and regional brain drain from the region.

As a result of the project, a majority of the participating universities are now qualified sites in the European grid computing network European Grid for e-Science (EGEE) and some are actively collaborating in projects funded by the European Commission through its framework programme. In at least one case, an academic from the Diaspora has returned to his home university from abroad.

The success of the project in South East Europe led UNESCO and HP to consider the possibility of applying similar ideas in Africa. From this, a pilot project for Africa was launched in 2007.

The objective of the two-year pilot project, "Reversing Brain Drain into Brain Gain for Africa" (2007-2008) has helped reduce the negative impact of brain drain in Africa by providing information technology to universities in Algeria, Ghana, Nigeria, Senegal and Zimbabwe. The project facilitated the creation of web sites and establishment of human networks for information and knowledge sharing; the initiation of joint projects and exchange programmes; the strengthening of ties between students and researchers at home with the Diaspora; and the reinforcement of teaching and research capacities. The community of people who work collaboratively form a virtual organisation, pooling and sharing tools and resources including their own skills and knowledge to achieve a common objective.

A notable result of the UNESCO-HP pilot project in Africa has been the creation of the first grid node in sub-Saharan Africa at the University Cheikh Anta Diop in Dakar, Senegal, linking the university to EGEE (European Grid for E-sciencE). The UCAD grid node is the first sub-Saharan African component of the grid infrastructure created in 2004 by the European Union to develop cooperation on a global scale for many scientific applications.

Launching this first link represents an important step in bridging the digital divide between North and South. It will facilitate international scientific cooperation for sub-Saharan Africa as a whole and for Senegal in particular. Thanks to this link, scientists at the University of Dakar now have access to considerable information technology resources.
This achievement was made possible through the cooperation of a number of partners, including notably the French national research organisation CNRS, the European physics research institution CERN, the Italian research organisation INFN, the French foundation "Partager le Savoir" (Sharing Knowledge Foundation), and the French embassy in Senegal.

Internet and distributed computing are key tools for the development of emerging centres of excellence in Africa and the Arab States region and their integration worldwide. This is all the more important in view of the crucial role of digital technologies for development.

Building on the results of the pilot phase and with a view to increase the impact of the project in the next phase, HP and UNESCO will focus on mobilising partners and additional resources. This will help create the first university e-infrastructure for education and research in Africa and the Arab States region.

The Current Project

1. Vision

Create the first African university e-infrastructure as a major tool to strengthen regional and global real-time scientific collaboration and research for development in Africa and the Arab States region. The e-infrastructure will facilitate links with the Diaspora, enhance brain gain and strengthen university teaching and research capacities.

2. Summary

The project will bring together higher education institutions and research centres from the African and Arab States region countries. The goal is to build on recent advances in distributed computing technology and developing an e-infrastructure that is available to faculty, researchers and students. This will enable them to run most innovative projects in close collaboration with experts in the Diaspora.

As a result of the rapid expansion of the tertiary sector in sub-Saharan Africa, public universities doubled from roughly 100 to nearly 200 between 1990 and 2007 and the number of private tertiary educational institutions exploded during the same period.
from two dozen to an estimated 468. Creating an African university e-infrastructure that would bring together these higher education institutions will help them contribute more significantly to the economic and social development in their countries and in the region as a whole.

The e-infrastructure will facilitate innovative teaching and learning, scientific collaboration and research networking within Africa and the Arab States region and to other continents. It will foster the growth of effective national research and education networks (NRENs) or strengthen the existing ones, thus allowing universities to conduct their mission to educate and undertake research as well as to serve their communities and to exchange information with counterparts at the regional and global level.

The project will contribute to the creation of a human network in the area of e-science and technology in Africa and the Arab States region. It will foster the creation of national distributed computing initiatives and promote the creation of e-infrastructures in these regions, etc. with the objective of enabling the countries concerned to increase their capacity to acquire, create, use, and apply knowledge and increase access to resources.

This project will be informed of and will seek synergies and cooperation with similar initiatives implemented on other continents or across continents such as EGEE (launched in 2004, EGEE spans more than 30 countries with over 150 sites); EUMEDGRID (Empowering eScience across the Mediterranean); GÉANT, a pan-European data communications network reserved specifically for research and education use; the EUAsiaGrid and EU-IndiaGrid; ALICE (America Latina Interconectada Con Europa), etc. It will also build on the knowledge and experience acquired by national grid initiatives on the continent such as the South-African national grid.

In addition, the project will link to existing relevant research projects in the regions concerned, including key higher education projects implemented by UNESCO and its partners.

In order for the project to be successful and for the vision formed for this challenging initiative to become reality, it is vital to engage interest and participation from the academic community, governments, and business and development partners.
National support for this project is a prerequisite. It will help to ensure ownership, sensitise national policy makers to the benefits of e-infrastructures and to the need of supporting the creation of NRENs and of national e-infrastructure initiatives. In this respect, the issue of ensuring high bandwidth connectivity to the global internet infrastructure should be given particular attention.

Partnerships will be sought with organisations committed to supporting development cooperation activities at the global, regional and national levels. They will have a special focus on those committed to supporting development in Africa and the Arab States region. Depending on their profile, partners could contribute their expertise in the field of distributed computing; grid and cloud computing technology, training and technical assistance or provide additional funding.

In addition to countries themselves and their higher education institutions and research centres, other main partners in this endeavour could include the African Union, the New Partnership for Africa’s Development (NEPAD), the World Bank, the African Development Bank (AfDB), the Arab Bank for Economic Development in Africa (BADEA), the Islamic Development Bank, the Islamic Educational, Scientific and Cultural Organization (ISESCO), the Arab Gulf Programme for United Nations Development Organizations (AGFUND), the European Commission, the International Telecommunication Union (as part of the follow-up to the World Summit on the Information Society), the Association of African Universities, the Association of Arab Universities, the French National Centre for Scientific Research (CNRS), the French Grid Institute, the European Organization for Nuclear Research CERN, the Italian Istituto Nazionale di Fisica Nucleare (INFN) and the South African Meraka Institute.

As a contribution to this initiative, the UNESCO-HP partnership will build on the achievements of the African pilot initiative (2007-2008) by further developing the steps taken to date to mobilise Diasporas in support of development and to contribute to the creation of an African e-infrastructure and by piloting this model in Arab States region countries. The project will continue to contribute to reinforcing national capacities through the development and strengthening of linkages and networks between experts in the Diaspora and their peers and university students back home, collaborative work, the creation of grid nodes at participating institutions, as well as by promoting mobility schemes.

12 http://web.worldbank.org/WEBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTDIASPORA/0,content
The 2007-2008 pilot project involved higher education institutions and research centres from five African countries (Algeria, Ghana, Nigeria, Senegal and Zimbabwe). The institutions received IT equipment (including servers and grid-enabling technologies), some operational funding as well as training and support.

The current 2009-2011 project proposes a three-pronged approach:

1. Consolidate the achievements of the pilot project to turn brain drain into brain gain for Africa through
   (a) providing further support to the five institutions participating in the pilot project;
   (b) bring in additional partners to significantly increase the number of higher education institutions, faculty and students involved;
   (c) seeking synergies and cooperation with existing e-infrastructure projects in Africa and the Arab States region;
2. Significantly expand the project to more African countries highly impacted by the loss of highly-skilled human resources; and
3. Pilot this approach in Arab States region countries where the loss of human capital, in particular in scientific disciplines, challenges socioeconomic development.

3. Objectives

The main objective of the broader project is to help create a sustainable African university e-infrastructure for science bringing together a majority of higher education institutions and research centres in Africa and the Arab States region. This is to enable them to pursue innovative education projects.

We could envision that at the end of this three-year project, if the required commitment and resources are secured, the African e-infrastructure could span some 20 countries with approximately 100 sites.

The African e-infrastructure could initially focus on renewable energies and biotechnology, two priority areas for R&D identified by the UNESCO-HP project in Africa as well as other key educational topics.
However, long-term goals would include coverage of other scientific disciplines and R&D priorities, as well as making distributed computing facilities available and easily accessible to other domains, including the humanities and other users (including industry) in a reliable and transparent way.

The e-infrastructure will impact the development of the higher education sector in the participating countries enhancing its capacity to contribute significantly to national socioeconomic development. It will also enhance the ability of higher education institutions to acquire, create, use, and apply knowledge and also increase access to resources.

The UNESCO-HP partnership for this initiative aims to:

- Strengthen teaching and research capacities of higher education institutions in Africa and the Arab States region;
- Help participating universities connect to networked resources in Africa and Arab States region and beyond, thus enabling the formation of virtual organisations and effective R&D collaboration independently of the geographical location;
- Facilitate exchange, networking, mentoring, and collaboration with the African and Arab States region Diasporas;
- Expand significantly the African pilot to create the first African university e-infrastructure involving some 35 higher education institutions in at least 15 African and Arab State region countries and experts from the Diaspora to facilitate brain circulation;
- Mobilise additional partners and funding organisations to support the project. Develop a strategy highlighting what additional partners could contribute (i.e. technology, financial resources, training, technical assistance, etc.) and their benefits (such as meeting their own strategic objectives; R&D activities with participating universities in areas of common interest; world-wide communication, etc.);
- Identify existing relevant research projects in the two regions, including key higher education projects implemented by UNESCO in the countries participating in this project, as well as existing national/regional e-infrastructure initiatives and facilitate synergies and cooperation with project beneficiaries;
Conclusion and Call for Action

- Help create a core group of African and Arab States region experts to act as champions of the initiative of establishing an African e-infrastructure through raising awareness among national policy and decision makers of the benefits of distributed computing; building/enhancing capacity in participating universities in the field of distributed computing;
- Help participating universities modernise their IT infrastructure thus creating enabling environments for virtual links, collaborative work and interactions with experts world wide.

Conclusion and Call for Action

The positive experience gained through a precursor project in south-east Europe and the small-scale pilot project in Africa suggest strongly that advanced information and distributed computing technologies can contribute to amplifying positive impacts of migration as well as improve higher education in developing countries. An e-infrastructure for education and research across the whole of Africa and the Arab States region may be expected to make a large contribution to building the human capacity needed to accelerate development. In spite of the generous contribution of HP, however, the project described here is necessarily of limited scope and extent. This paper therefore concludes with a call to all like-minded corporations and organisations to join UNESCO and HP to extend this project and help to include willing participants in all countries in Africa and the Arab States.
