

BUILDING SOFTWARE DEVELOPMENT CAPACITY AND COMPETENCE IN RURAL NIGERIA: PITFALLS AND PROSPECTS

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Abstract: This paper explores issues facing ICT education at the university level and its potential for socio-economic development and job creation. An internationally outsourced student software development project is assessed to find the pitfalls, prospects and lessons learnt on how to better prepare students to develop capacity and competence and attract paying jobs to sub-Saharan Africa to help bring socio-economic development, build a nascent knowledge economy and a new middle class.

Keywords: ICT education, software development, ICT and social-economic development, ICT and job creation

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1. INTRODUCTION

Access to modern software, Internet connectivity, ICT infrastructure and adequate faculty with the appropriate education and training in ICT is scarce in many institutions in sub-Saharan Africa thus affecting the quality and competence of graduates.

This practitioner's report assesses issues confronted and lessons learnt in a software development project undertaken by third year students at the School of Information Technology & Communications through The African Center for ICT Innovation and Training (henceforth, the Center or ACIT) which recognized the value of training a small cadre of very bright, technologically advanced students excelling in ICT courses at American University of Nigeria (AUN) by providing mentoring from ICT faculty and assigning supervised locally relevant software development (such as health informatics) with the expectation of developing products and services, good enough for the internationally competitive market, and for the socio-economic development of rural communities and Nigeria.

2. HOW DO YOU EDUCATE UNDERGRADUATES TO BECOME CAPABLE IT PROFESSIONALS?

Providing the human capital required for ICT-enabled industries is perhaps the best form of intervention to expand employment opportunities for young people, with track record better than subsidies and tax breaks to industry (Kenny, 2006). However, educating undergraduate students to be capable IT professionals poses several significant problems (Scott 2004; Dawson & Newman 2002). According to McGuire and Randall (1998), the growing global economy for software products and services has caused a shift which increasingly necessitates the effective use of information technology. This includes amongst others, communication technology as well as organizing, accessing and generating information. Software professionals are thus confronted with the dynamic, sometimes unstable and complex nature of software development environments and must be able to rise to the challenge of dealing effectively with these situations.

Several authors (Scott, 2004; Dawson and Newman 2002; Noll and Wilkens 2002; Tuttle 2000; Kussmaul 2000) have therefore argued the revolutionary and rapidly changing field of Information Systems places stringent demands on IT/IS educators, which calls for continually revising and changing programs and curricula in an attempt to better equip students for the marketplace. Phukan (2001) is of the opinion determining the exact content required by these curricula is a real problem. Enormous technological advances have brought the global marketplace within reach of even small organizations, creating both enormous opportunities as well as threats. However, to effectively operate in a global environment and escape its negative effects, IS/IT students who will move into their careers by working for international organizations, businesses or governments, need to be equipped with a comprehensive array of skills. A further implication is that IS education across the world needs to provide a basic foundation of skills and knowledge emphasizing effective delivery of information to prepare future IS professionals (Scott, 2004; Phukan, 2001).

Experiential learning has been touted, especially in the development economics field, as a viable strategy to empower students. Dawson and Newman (2002) adopted a strategy of empowerment

by utilizing experiential learning. They created a project environment to motivate and challenge. Therefore, in the School of Information, Technology and Communications (SITC) at AUN and at the Center (ACIT), experiential learning is largely encouraged.

3. ARE STUDENTS PREPARED FOR THE COMPETITIVE ICT SECTOR?

The IT infrastructure in place at AUN is as good as those in campuses and organizations in the USA, India or China that typically attract software work. Further, the technical and programming skills of the students are excellent as a result of a well thought out computer science/software engineering and information systems curricula.

The students' skill sets were developed and strengthened through curricula modeled after ACM/IEEE and ABET guidelines. The faculty members were recruited from top universities in the UK, USA and Russia. The courses emphasized problem solving and applied skills. The class sizes were small and students had access to modern textbooks and each one of them, as well as all students at AUN, were given a wireless enabled laptop with 24/7 Internet access.

The students who were selected to build software applications were third year students who had already taken adequate computer science, software engineering and information systems courses including two programming principles courses using Java, introduction to UNIX and systems administration, data structures & algorithm, discrete structures, systems programming, data base management systems, software engineering, software construction, software process management, user interface design, software architecture & design, software testing & QA, software requirement & specifications, etc. and were equipped with vital and appropriate skills and competencies.

A diverse range of topics were covered in their project management courses such as group dynamics, time management, testing and deliverables. Boot camps were also run by a faculty member at the Center to provide the students with working prototypes, exhibiting advanced programming principles and enabling groups to complete their project in a .NET environment.

4. ICT PROJECTS FOR SOCIO-ECONOMIC DEVELOPMENT

The student's YolaSoft project illustrated in this paper was an attempt at developing an ICT for socio-economic development by becoming involved in a project for the Millennium Development Goals (MDG) in agriculture. The link between the MDGs and agriculture has been well argued by Rosegrant et al (World Bank), 2006, noting that 70 percent of the MDGs' target group lives in rural areas, particularly in Asia and Africa, and for most of the rural poor agriculture is a critical component in the successful attainment of the MDGs. All MDGs have direct or indirect linkages with agriculture, however, the linkage between agriculture and MDG1 (eradicating extreme poverty and hunger) is particularly strong through agriculture-led economic growth and improved nutrition. In low-income countries, economic growth, which increases employment and wages, is the only means by which the poor will be able to satisfy their needs sustainably. Students in rural Nigeria contributed in small part to help their sponsor respond to the challenges facing the MDG in agriculture.

5. TESTING STUDENT'S PREPAREDNESS IN AN MDG AND AGRICULTURE OUTSOURCED SOFTWARE DEVELOPMENT PROJECT

The importance of developing a culture of "techno-preneurship" via the Center's incubator as a mechanism to develop the next generation of ICT companies and leaders in Nigeria and sub-Saharan Africa was put to the test by a team of students tasked to develop a Knowledge Support System for the sponsor, an International organization based in Washington, DC.

A Terms of Reference (TOR) and a Memorandum of Understanding (MOU) were received from the sponsor for collaboration and partnership to work with the Center's faculty associates and students to develop a Regional Strategic Analysis and Knowledge Support System (ReSAKSS) in ICT Environment (RIE). A key element of the knowledge systems management component was the establishment of a YolaSoft interactive website environment with ready access to tools and information, promote mutual learning and peer-review, and facilitate dialogue on future priorities.

6. HOW WAS THE YOLASOFT PROJECT MANAGED AND EXECUTED BY THE STUDENTS?

The students embarked on the project by submitting completed tasks via the web and got responses and feedbacks from the sponsor. This was the first time these students were exposed to a real life project where the work expectations went beyond just a grade from a professor.

Four of the team members were selected to spend a semester at the American University in Washington, DC as exchange students. This opportunity is only reserved for top students at AUN. This provided a huge opportunity for the project since some of the team members were within twenty minutes from the sponsor.

This opportunity also exposed students to the vagaries of software developing from a remote location, with team members distributed, for overseas clients. Working in different time zones, periodic interface with the sponsor, living in a completely new culture, team members working at different pace on expected deliverables were some of the new challenges.

During this period and in collaboration with the remaining team in Yola, a mapping tool was developed with charting capabilities and data administration according to the client's specifications. This was a huge milestone and gave the students and the Principal Investigator (PI) a lot of pride. The YolaSoft Project was executed in three phases. Table 1 below shows the different goals and outcomes for the different phases, Table 2 shows the team members and their responsibilities and Table 3 shows the technology requirements and tools used in the project.

Goals	Outcomes
Phase I – Developing a Prototype	
<ul style="list-style-type: none"> • Sample web sites for different nodes allowing for customization of coloring, logos, and graphics, but also maintain a standard look-and-feel. • YolaSoft websites with a centralized database server serving data to all nodes. • An application for efficient storage and quick access to relevant information. • Platform for information sharing and collaboration between stakeholders. • An application to perform credible and timely analysis on stored information. 	<ul style="list-style-type: none"> • The prototype had sample websites in West, South and East & Central Africa) as well as the Africa-wide YolaSoft website. • Demos of knowledge sharing and information collaboration systems. • Embedded data analytics. • Graphical and geospatial presentation of data. • Analysis of data through Visual, geospatial & statistical tools. • Common data storage. • Access to data from all regions.
Phase II – Geospatial Data Presentation & Mapping Tools	
<ul style="list-style-type: none"> • Reviewing prototype to better understand role of ACIT and needs of the sponsor-YolaSoft. • Looking at real data from sponsor to validate database design. • Deployment of prototype on the sponsor's servers and hand over of source code to the sponsor-YolaSoft team. 	<p>Develop geospatial data presentation of existing YolaSoft website. Develop mapping tool component in the original prototype to embed into the YolaSoft website. Achieved following:</p> <ul style="list-style-type: none"> • Embedded mapping tool with actual data on a single indicator to understand the business needs and benefits of the mapping tool. • Demo of charting tool to allow chart images to be dynamic and connected to a database. • Use Google Docs to share and store data, suggested various database systems to better suit the data needs of the project. • Sponsor required working demo of the mapping tool for presentation in Seychelles, delivered on time by the ACIT team using free hosting to deploy the application. • Required by sponsor as development areas: <ul style="list-style-type: none"> ○ User Interface (UI) improvements, completion of the tool to allow stand-alone view, selection of indicators, years and other parameters. ○ Further improvements to the charting tool. ○ Integrating functionalities from other mapping tools. ○ A back-end administration needed to manage data on chart and map, in a Google Docs-like interface.
Phase III– Completing Systems Requirements	

<ul style="list-style-type: none"> • Mapping tool to incorporate stand-alone mode, selection of indicators, years, zooming by user, improvements to look-and-feel of the map. • Development of back-end administration to manage data. • Migration of database from Microsoft Access to a server-side database system, such as MySQL. • Full development of charting tool, and embedding into the mapping tool. • Deployment of prototype on some stable server hosting solution for demonstration to the sponsor. 	<p>Worked through Summer 08 and Fall 08 to complete the requirements. All needs expressed by sponsor during phase 2 were completed. Stand-alone mapping tool with functionalities completed:</p> <ul style="list-style-type: none"> • Interface was vastly improved. • Incorporated ideas of the sponsor on IMF Data Mapper, MDG Monitor, and Google Maps. • Charting tool incorporated into mapping tool as stand-alone and linked to the database. • Moved database to MySQL. • Working and fully operational prototype of back-end administration site completed. • The PI provided hosting on his website, after the sponsor did not host on their servers. • The full solution-based system was completed.
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Table 1: Yola-Soft Project Goals and Outcomes

Official Role Played	Responsibilities
Phase I - Yola Team	
Project manager, Coding Team	Project Management
Assistant Project Manager, System Design Team	Project Management
Coding Team leader	System Coding
System Designers' Team leader	System Analysis
System Analysts' Team leader	Database Design
System designers' Team member	Database and User Interface Design
System Coders' Team member	Coding
System Analysts' Team member	System Design
System Analysts' Team member	System Testing
Phase II - Washington Team	
Project manager, Coder	Project Management
System Designer, Database Designer	System Design
System Analyst, Database Designer	System Design
System Analyst	System Testing
Phase II - Yola Team	
Analyst	Review new user requirements.
Designer	Review and advising on database changes.
Coder	Coding of new functionalities.
Phase III – Yola Team	
Analyst and Designer	Redesigning database.
Analyst	Reviewing client needs.
Coder	Coding assistance in projects.
Analyst and Designer	Redesigning database, design of backend
Designer	Implementing new database and reviewing functionality of backend.
Coder and Project Manager	Coding all implementations and changes to backend, charting tool, and mapping tool, deployment of product on stable host.
Coder	Coding backend functionalities.
Designer	Review and implementation of database changes.
Project Manager	Overall project manager for student projects, responsible for documentation and assignment of tasks.

Table 2: YolaSoft Team Compositions and Responsibilities for Each Phase

Software	Requirements
CorelDRAW	Graphics Development for the site, in conformance with Web 2.0 standards.
DWebPro	Deployment of Server-based site prototypes on a CD for viewing by the client.
Macromedia Flash	Development of visual appeal of the website based on Flash technologies.
Microsoft Office	Production of reports and other essential documents and project management requirements.
DIY Map	Embedded Flash XML geospatial map.
FusionCharts	Embedded Flash XML charting tool

Table 3: Technology Requirements/Tools Used in YolaSoft Project

7. WHAT WERE THE PITFALLS, PROSPECTS, LESSONS LEARNT AND CONCLUSIONS?

In phase I, some of the issues faced included lack of clarity of the business requirements or how the technology aspects would assist in achieving the MDGs. Limited resources were available to the team to achieve their objectives and there was lack of feedback from the sponsor on progress of the project.

In Phase II, the goals and business needs pertaining to the mapping tool were not made definite and the sponsor looked at other options and developers. The sponsor's YolaSoft team was given the source code of the mapping tool in its entirety, but this was not deployed on their servers and no definite answer was received on hosting the application and the ACIT team never met with the YolaSoft web team to discuss detailed technical aspects of the project and its requirements.

Another challenge faced by the team was not meeting with those in charge of the hosting server and not being able to deploy the product. The sponsor's team opted for hosting the mapping tool on a free host. However, it was made clear to the sponsor that there were risks involved in having this as a solution such as sudden suspension of services, unreliable bandwidth and data privacy concerns.

In phase III, there was a lack of communication from the sponsor about any upcoming crucial deadlines. The sponsor's change in management of the project resulted in an unexpected decision to stop this collaborative work and to outsource to a professional company. *Relationships* and *trust* are essential ingredients in outsourcing models and are as important as technical skills. When these variables change, they can have an effect on the nature, structure and continuance of the outsourced software project.

The students delivered a high-quality finished product, YolaSoft, and the assigned tasks were completed using various mapping tools. As a result of the demands of the project and changing requirements and expectations, the technology learnt and knowledge gained by the students were invaluable and went beyond what is gained in their regular course work towards their degrees.

The knowledge gained by the student members will be valuable as they venture into software development after their graduation in few months - May 2009. The ACIT team proves that there is hope to develop capacity and competence in software development which can attract paying jobs to sub-Saharan Africa and help build a nascent knowledge economy and a new middle class.

The exposure to real-world projects is critical for the development of students into marketable IT/IS professionals. Given the competitiveness of the software development industry, students need to experience deep learning by enhancing not only their technical but interpersonal and project management skills. The opportunity to work in groups and go through the systems development and build process, team work and communication with real world users had a noticeable impact on the confidence levels of students. However, ongoing research on student competencies and the usefulness of the systems developed is essential if the hope of these students becoming more aware of the demands presented in a globalized world and being at par with their peers from other programs and countries is to become a reality.

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