A Ghanian-American Collaboration in Engineering Education

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Abstract: This paper describes a collaboration in engineering education between the University of Science and Technology (UST) in Ghana and the Altoona College of Pennsylvania State University (Penn State Altoona) in the U.S.A. The paper begins with background information regarding the UST Kumasi and Penn State Altoona. Next, the paper describes efforts undertaken by both of the above-mentioned institutions to develop an engineering education collaboration with each other. The paper continues with a detailed description of various aspects of Ghanian-American collaboration. Developmental stages of this collaboration are explained. The learning experiences gained from the Ghanian-American collaborative activities are discussed. The paper also describes the obstacles encountered by both UST Kumasi and Penn State Altoona in carrying out the collaborative activities.

Keywords: international, design, collaborative activities, education

1. Introduction

With the globalization of the economy, it is becoming increasingly important for engineering and engineering technology graduates to have international and cultural opportunities and experiences as a part of their undergraduate curricula. These graduates must be prepared to work in multicultural teams in multinational corporations. Some of the academic preparation they need will come from international collaborative experiences that develop abilities and familiarity with information technology, team work, and engineering design methodologies in a global environment. This paper describes the efforts undertaken by the University of Science & Technology (US), Kumasi, Ghana, to create an early educational awareness of the global implications of engineering education through international collaborations with other educational institutions in the world. These partnerships embrace use of international collaborative student teams and projects, development of common curriculum modules, collaboration with industrial partners in various countries, and joint faculty research projects.

The University of Science and Technology (UST), located in Kumasi, Ghana, focuses on teaching and research in engineering, architecture, pharmacy, and medicine. The School of Engineering in the University of Science & Technology comprises the Departments of Agricultural, Chemical, Civil, Electrical and Electronic, Mechanical, and Geodetic Engineering. These departments provide four-year degree programs leading to the award of the B.Sc. (Eng.) Diploma programs in Civil, Mechanical, and Geodetic Engineering are also provided. These diploma courses are equivalent to the British Higher National Diploma (HND). Programs leading to M.Sc., M. Phil and Ph.D. degrees are also provided in the various departments.

The University of Science and Technology also houses the Institute of Mining and Mineral Engineering which offers degree and diploma courses in Mining & Mineral, as well as, Geological Engineering. The Institute, established in October 1976, replaced the Department of Mining and Mineral Engineering of the School of Engineering and is an autonomous institution.

The Department of Electrical and Electronic Engineering presently offers the following programs:

a) a four-year B.Sc. Degree program
b) a two-year M.Sc. program
c) an M.Phil research program

The undergraduate students in the Department of Electrical and Electronic Engineering can specialize in one of the three main areas listed below by a careful choice of electives:

a) Power System and Machines
b) Electronics and Communications

c) Computers and Control

2. The UST-Penn State Altoona Collaboration

In 1999, the University of Science and Technology initiated a partnership with the Altoona College of The Pennsylvania State University (Penn State Altoona), USA.

Penn State Altoona is one of 24 campuses making up the Pennsylvania State University system. It is the second largest of the 24 campuses and is a full service residential campus located 42 miles from the research campus at University Park.

Penn State Altoona became a four-year college within the Pennsylvania State University system in 1997 and offers baccalaureate degrees in four majors (Bachelor of Science in Business, Bachelor of Science in Nursing, Bachelor of Science in Electro-Mechanical Engineering Technology; and a Bachelor of Arts in Letters, Arts & Science). Penn State Altoona provides the first two years of course work for 182 Penn State undergraduate degrees. The objectives of this collaboration are as follows:

1. To build a multi-faceted collaboration to generate relevant, diverse, and cost effective international engineering and technology experiences for faculty and students at Penn State and University of Science & Technology, Kumasi, Ghana. These experiences will be provided through faculty exchanges, short-term student industrial placements, and joint student team projects.
2. To internationalize the engineering and engineering technology curricula of the above mentioned institutions through joint curriculum development. More specifically, the joint curriculum development activities will embrace joint development of engineering/engineering technology curriculum modules and engineering case studies. These activities will be conducted in technical areas such as electrical power systems, microprocessors & micro controllers, and digital systems.
3. To demonstrate the power of information technology as an effective tool for distance education.

The collaboration involves the following developmental stages:

1. Familiarization with the Institution
   This is a time period to exchange administrators, faculty, and key individuals associated with the anticipated development of the exchange program. The purpose of the exchange is to become familiar with the partner institution, its goals and mission, institutional facilities, and level of commitment to the international partnership. The first friendships are also established.
2. Identification of Common Interests
   This is a period of more in-depth exchanges with specific focus on instruction and/or research activities where commonality exits and an interested faculty has been identified. Additional familiarization activities may take place simultaneously.
3. Development of Cooperative Projects & Activities
   This is a period during which previously identified projects and activities are conducted and evaluated. Additional activities may be identified as a result, or, conversely, activities may be modified or cancelled.
4. Instruction of Common Courses
   This is a period involving the instruction or exchange of selected courses, modules of courses, or common classroom sessions, seminars or workshops.
5. Institutionalization
   This is a period during which successful projects and activities are institutionalized within the home institution. The goal of which is the sustainability of these projects and activities.
6. Cooperative or Common Degree Programs
   This is a culmination period resulting in the development of common curricula and degree programs. In the most developed state this could result in a common or dual degree for the participating students.

The UST-Penn State Altoona collaboration is presently at stage number three.

3. UST-Penn State Altoona Collaborative Activities: Present and Future

The Head of the Department of Electrical and Electronic Engineering, UST Kumasi visited Penn State Altoona in July 1999. A faculty member in the Department of Electrical Engineering Technology at Penn State Altoona visited

UST in August 1999. The purpose of faculty exchanges was to become familiar with the partner institution, its goal and mission, institutional facilities, and level of commitment to the international partnership. During the above mentioned faculty exchanges, the following common interests were identified and it was decided that activities related to these interests should be conducted by UST Kumasi and Penn State Altoona. The common interests are (i) development of common course modules; (ii) common engineering design projects to be conducted by engineering student teams at UST Kumasi and Penn State Altoona; (iii) student exchange; and (iv) joint publications in refereed journals.

During the Fall 1999 semester, a practical engineering design project to be conducted at UST Kumasi and Penn State Altoona was identified by the participating engineering faculty at both institutions. The design specifications of the project were as follows:

A simple soft drink vending machine is to be designed in conformance with the following specifications:

- The machine dispenses only two types of drink, cola and diet cola.
- The machine accepts only quarters and dimes.
- The machine is equipped with an unlimited number of nickels.
- The cost of each drink is $0.35.
- The machine is to display the current input value.
- A reject button is to be present.
- The machine is to give correct change when the input value exceeds the cost of the drink.

During the Spring 2000 semester, student teams, each consisting of two students were formed at Penn State Altoona. These students are currently enrolled in a programmable logic controllers (PLCs) course. The students are making use of Allen Bradley PLCs to implement the soft-drink vending machine controller. The student design teams at Penn State Altoona will complete the project by the end of Spring 2000 semester. Student design teams, each consisting of two students were formed at UST Kumasi in the beginning of Spring 2000 semester. The students are currently enrolled in an undergraduate microprocessors course offered by the Department of Electrical and Electronic Engineering at UST Kumasi. The UST Kumasi student teams are making use of Motorola 68000 microprocessor to implement the vending machine controller. They will complete the project by the end of Spring 2000 semester.

Before the student teams at Penn State Altoona and UST Kumasi started working on the projects, they were provided training in team development skills. The training materials were based on the content presented in [1-5]. Once the projects are completed by Ghanian and American student teams, an evaluation of team performance will be done for each team involved in the project. A comparison of techniques used to conduct the project by Ghanian and American students will be conducted by the participating UST and Penn State Altoona faculty members.

Groundwork for student exchange between Penn State Altoona and UST has been in progress since the Fall 1999 semester. Penn State Altoona Placement Office is working with regional industrial organizations to identify paid internship opportunities for Ghanian students. The UST Department of Electrical and Electronic engineering is working with Ghanian companies to identify paid internship opportunities for American students.

Selected engineering faculty members at Penn State Altoona and UST are working together to develop common course modules on topics such as microprocessors and electrical machines. The common course modules will be used in the microprocessors and electrical machines courses taught at UST and Penn State Altoona. Additional course modules will be developed in other areas of electrical engineering/electrical engineering technology. The course modules will be integrated into the undergraduate electrical engineering curriculum at UST and the EET curriculum at Penn State Altoona. The engineering laboratories at both institutions house all the equipment necessary to support common course modules in many areas. The integration of common course modules into the EE and EET curricula at both institutions will make it possible for exchange students to get academic credit for a course at one institution while studying at the other one.

4. Obstacles

1. Finding external support for funding the above mentioned partnership will require extensive effort by Penn State Altoona and UST Kumasi. At present, the collaborative activities are fully funded by the Office of International Programs, The Pennsylvania State University. Several business organizations in Ghana have expressed willingness to support the international collaborative activities among Ghanian universities and the educational institutions outside Ghana. Penn State Altoona and UST Kumasi will work with these organizations to obtain external funding for the collaborative activities.

2. Many companies in the service area of Penn State Altoona are willing to offer unpaid internships to students from other countries. However, there are very few ones that offer paid industrial internships to foreign students. Penn State Altoona will need to work harder to find paid industrial internships for Ghanian students.
3. Information technology has also been an issue. At Penn State Altoona e-mail and internet are extensively used by students. At UST Kumasi students are beginning to use e-mail and internet.

5. Assessment

A plan for the formal assessment of the Penn State Altoona-UST Kumasi partnership will be developed in the future. The assessment plan will have the following components:
1. An assessment of the effectiveness of common student team projects at both institutions.
2. An assessment of the short-term internships completed by the American students in Ghana and the Ghanian students in USA.
3. An assessment of the other aspects of UST-Penn State Altoona partnership in addition to the ones listed above.

6. Conclusions

The paper described the efforts undertaken by the University of Science & Technology (UST), Kumasi, Ghana to develop international partnerships with The Pennsylvania State University, Altoona, USA. The collaborative activities span team-based design projects, and development of common curriculum modules. The obstacles which still need to be overcome are described. It is expected that despite these obstacles, the international partnership will continue to grow and more collaborative activities will be developed in the future.

References

[1] S. Anwar, and W. J Rothwell, "Implementing Team-Based Collaborative Problem Solving in E[ngineering] T[echnology]: A Case Study." Journal of Engineering Technology 14(2):34-38. (1997). (Principal author.)

[2] D. Dekker & D. Stienstra, "Team-building in the classroom." Proceedings of the 24th Frontiers in Education Conference, November 2-6, 1994, San Jose:309-11 (1994).

[3] J. McGourty, "Designing & Teaching Team Courses for Technology-Based Students." Proceedings of the 1994 ASEE Annual Conference, June 26-29, 1994, Edmonton, Alberta: 2660-66 (1994).

[4] M. T. Bannick, R. M. Roach, & E. Salas. "Understanding Team Performance: A Multimethod Study." Human Performance, no. 6 (1993):287-308.

[5] Ernest Burniston, et al. "Team Teaching in an Integrated Freshman Engineering Curriculum." Proceedings of the 1996 ASEE Annual Conference. CD-ROM publication.