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OPPORTUNITIES AND CHALLENGES IN OPEN DISTANCE POST-GRADUATE STUDENT TRAINING IN CHEMISTRY: UNISA'S EXPERIENCE

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ABSTRACT

The Department of Chemistry at the University of South Africa (UNISA) has a proven track record and culture of research and postgraduate student training dating back to the correspondence era. The practice of offering postgraduate programs in laboratory-based disciplines within the Open Distance Learning (ODL) context as practiced in UNISA is discussed in detail. The authors use their experience to shed light on the models that work well for laboratory-based postgraduate student training within the ODL framework. *[AJCE 4(3), Special Issue, May 2014]*

INTRODUCTION

Universities are uniquely positioned to critically evaluate knowledge, challenge knowledge and extend intellectual boundaries locally, nationally and internationally through global networks for teaching and research. The capacity for countries to adopt, disseminate, and maximize rapid technological advances is dependent on the strength of adequate systems of tertiary education. Improved and accessible tertiary education systems can help a developing country progress toward sustainable achievements that are critical determinants of a country's economic growth and standard of living [1]. Indicators of scientific activity of a nation include: gross national product and its proportion spent on research and development. The mid 1990’s brought a revolution in the history of higher education in SA when the Department of Higher Education (DoHE) changed its focus and funding formula to fund tertiary institutions based on student throughput and research outputs than just student numbers [2]. This paradigm shift compelled UNISA to be transformed from being a dedicated teaching institution to become a research institution with well developed postgraduate programs. Likewise, UNISA evolved from a correspondence institution to modern day Open Distance Learning (ODL) institution with adequate teaching and research laboratories. Open Distance Learning (ODL) is a multidimensional concept aimed at bridging the geographic, economic, social, and communication distance between students and the university, students and academics, students and courseware and students and peers.

Objectives of an ODL institution are:

- To provide education to students deprived of higher education opportunities including those in employment and adults who wish to upgrade their education.

- To provide equality of education through multi-media teaching–learning approach.
- To provide flexibility for enrolment, age of entry, choice of programs, methods of learning, conduct of examinations and operation of the programs
- To promote integration within the educational policies
- To offer degree programs and non-degree certificate programs for the benefit of the working population
- To make provision for research and dissemination of knowledge amongst the populace
- To serve as a source of continuing education

ODL is considered nowadays as the most viable means for broadening educational access while improving the quality of education, advocating peer to-peer collaboration and giving the learners a greater sense of autonomy and responsibility for learning [3]. Although some contact institutions also have distance learning (DL) programs at undergraduate and postgraduate levels, these are restricted to non-laboratory based disciplines. Available information shows that less than ten “ODL institutions” in the whole world offer undergraduate chemistry degrees presumably because of the requirement for routine access to research laboratories and analytical facilities. Generally the training of chemists entails two main categories: professional chemists and chemical technologists. Chemical technologists are trained mainly through the Universities of Technology whereas professional chemists are trained through conventional or comprehensive university programs.

Direct contact with students forms an integral part of any experimental training in disciplines such as chemistry and the training requires routine and sustainable access to adequate laboratory facilities by students. The nature of chemistry experiments and safety aspects, on the other hand, require students to have regular monitoring and support by the supervisors throughout the training. UNISA's Department of Chemistry has a history and culture of research and postgraduate student training dating back to 1960. At the time the modus operandi was mainly correspondence which gradually transformed to the now ODL program. The profile of the students also changed in terms of age and demographics. Nowadays our programs in chemistry in both undergraduate and postgraduate levels have relatively younger candidates with no attachment to industry. The UNISA undergraduate chemistry program is structured as comprising of course work (75%) and laboratory work (25%). The BSc honours programme, on the other hand, is structured as a combination of course work (65%) and limited research work and mini-dissertation/thesis (35%). The course work in both cases may be accomplished in open distance electronic learning (ODEL) mode while the laboratory component demands a face-to-face contact and access to a working chemical laboratory. The MSc and PhD programs, on the other hand, are 100% research based and culminate into dissertations or theses, respectively.

UNISA'S ADMISSION CRITERIA INTO POSTGRADUATE PROGRAM:

The UNISA chemistry postgraduate studies brochure clearly stipulates that for admission into Honours BSc degree in chemistry, students must possess an accredited BSc degree in chemistry or equivalent qualification (within the past five years) and a pass of the four third level chemistry sub-disciplines with a minimum average of 60%. For admission into an MSc program in chemistry a student must possess an honours degree in chemistry with an average of 60% or above. The department may recommend that some candidates register and pass some modules selected from the honours program. The MSc study is a research program (100%) and culminates into a dissertation or thesis and at least one submitted publication to an accredited chemistry journal. A student may be admitted into a PhD programme if he possesses an MSc degree with an average of 60% and above for his/her MSc thesis. The department may recommend that the student concurrently register and pass some selected honours module. The PhD study is a research program (100%) and culminates with a dissertation and at least one accepted or published paper and one or two papers submitted to accredited chemistry journals. In addition to meeting the minimum requirements for admission into MSc and PhD programs in chemistry, it is clearly stated in the Department of Chemistry Postgraduate Brochures that the student must:

a) have a suitable research topic selected in consultation with the Department;
b) agree to utilise the laboratory facilities at UNISA or have access to a laboratory facility suitable for the research work envisaged; and
c) select or have access to a suitably qualified supervisor or joint supervisor (with at least a PhD degree qualification) under whose direct guidance the research work can be carried out.

Final admission into masters and doctoral programs depends on passing research proposal module. The research proposal module requires a student to have secured a research topic and concept paper, research advisor (and co supervisor), and a laboratory facility either at UNISA or accredited laboratory facility which has to be approved by UNISA. This requirement is easily met by students who are currently employed in chemical industries and higher institutions of learning. For the other group of students who don’t have access to laboratory and analytical facilities, the training may be accomplished on full time basis in the facilities of the

Department of Chemistry at UNISA. Two types of programs exist for postgraduate student training in chemistry within the ODL context, namely, the split-site study models and in-house.

Split-site postgraduate training models

The split-site postgraduate student supervision models are applicable to both national and international students attached to either chemical industry or tertiary institution with entry-level infrastructure for research. The arrangement may be between the academic department and industry or between two academic departments from two different institutions. In both cases, the department and student need to be fully aware of available expertise and their track record in student supervision or publication. In principle, this arrangement requires prospective departments from different institutions to first identify their common goals based on their strengths and weaknesses in terms of human resource and infrastructure capacity. Both participating departments are expected to have adequate infrastructure for research and to complement each other in terms of skills and specialized programs. The following issues have to be agreed upon to launch the program:

- The role of the main supervisor and the co supervisor
- Shared outputs in terms of publications
- Consumables and equipment of the total cost
- Accommodation, subsistence and travel costs of researchers visiting a host institution or country as part of their participation in the project
- Number of exchange visits and duration

The arrangement can be reached with or without memorandum of understanding (MOU) between participating partners.

University-industry model

The inception of postgraduate program in chemistry at UNISA was based on this model between the Department of Chemistry and the Council for the Scientific and Industrial Research (CSIR) as well as the Atomic Energy Corporation (AEC, now NECSA). The model is still been continued with SASOL, CSIR, SAPPI, SA Police Forensic Laboratory, iThemba Labs, *etc*., for BSc honours, MSc and PhD student training. Issues such as intellectual property, ethical clearance or joint papers are addressed before the start of the project. Under this arrangement, the student is required to identify a prospective co-supervisor in industry for technical guidance and support.

The Department of Chemistry at UNISA, on the other hand, appoints a supervisor and the two advisors work with the student on a concept paper to lead to the design of a feasible research proposal based on literature survey. The student then executes the laboratory work either in industry and/ or in the department under full supervision by the co-supervisor or supervisor. The costs for consumables and for analytical facility are incurred by the industrial partner with no additional payment to the co-supervisor if experimental work is carried on the other side. In some cases, the academic department may provide additional support in terms of access to instrumentation or laboratory space and consumables. Under this arrangement, the academic department is responsible for quality assurance and assessment of the project as well as accreditation of the degree. This model has been found to work well for the South African-based students working in chemical or agrochemical industry as well as the Police Forensic laboratories with adequate laboratory infrastructure and analytical facility. The students are required to present seminars (face-to-face or through Skype, *etc.*) and also submit written reports to the department periodically as part of progress monitoring, quality assurance and scientific information presentation skill development.

Department-Department model

This model involves a mutual cooperation between UNISA chemistry department and another chemistry department locally or abroad. A prospective student is required to identify a co-supervisor on his/her side and the department appoints an internal supervisor. An agreement is reached between the two participating departments in terms of shared costs and outputs. Under this arrangement, the two departments share co-authorship of publications, eventhough the degree is awarded by UNISA. The costs for consumables and for the co-supervisor, on the other hand, are incurred by the Department of Chemistry at UNISA. The student, on the other hand, is expected to spend some time in both laboratories for hands-on experimentation or for access to appropriate analytical techniques.

This model is also appropriate for academic and technical staffs who are permanently appointed at other institutions locally or abroad with routine and sustainable access to chemistry laboratory infrastructure and entry-level analytical facility. The model is also applicable for our own junior academic and laboratory staff pursuing higher studies in the area/s where we lack capacity. The staff member is encouraged to register the degree with UNISA and to identify a suitable expert elsewhere for possible appointment as the main supervisor. A co-supervisor is then appointed within the department to provide guidance and technical support to the candidate throughout the project. The main supervisor is required to visit UNISA chemistry department for discussions with the student and co-supervisor as agreed upon during the initiation phase. This arrangement should not be confused with external supervision, which sheds all the mentoring responsibilities to an external expert attached to another university or industry. External supervision would probably work well for disciplines that do not require routine supervision of the students. Progress monitoring and quality assurance are achieved through seminars and written reports to the department.

University–university model

This involves a collaborative action between the Department of Chemistry at UNISA and another chemistry department in South Africa or abroad. The arrangement usually involves memorandum of understanding (MOU) between the two participating institutions. To lead to a mutual cooperation (collaboration) and success of this model for masters and doctoral programs, it is imperative for the cooperating departments to engage first to identify suitable expertise and common goals based on their strengths and weaknesses in terms of capacity before the institutions can enter into any agreement. A memorandum of understanding acceptable to the participating institutions and researchers should then be signed and ratified.

UNISA's experience has shown that a number of intra-governmental attempts to launch split-site postgraduate programs in laboratory-based disciplines such as chemistry were not adequately satisfactory. This is because the MOUs are finalized from the top without the involvement of researchers neglecting crucial points such as the admission criteria, capacity on both sides, *etc*.

The MOU's for the UNISA-Ethiopia and the UNISA-University of Lagos (UNILAG) project, for example, were signed before researchers from participating departments could interact (co-option). A perception was created on the other sites that postgraduate chemistry research can be undertaken through ODL as it is applicable to other non-laboratory based disciplines. The misunderstanding of ODL by the co-signatories as applied to laboratory-based sciences created an impression that UNISA could train several hundred Ethiopian chemistry postgraduate students to completion with minimum expense and short time. The proposed number of students to be trained far exceeded the total number of chemistry postgraduates produced by the 21 South African universities in the same period.

The admission criteria and the length of degree programs of South African institutions differ from those of other countries. Progression into MSc degree in Ethiopia, for example, requires a 3 year bachelor's degree whereas we expect our students to have a BSc (3 years) and BSc honours (1 year) for possible admission into MSc program. The four year degree of most universities in other African countries, for example, either incorporates a foundation level in the 1st year or a professional program (teaching/education) not related to chemistry in the 4th year. In our view, the logical progression to the launch of such split-site program involving programs of different levels should have involved collaborative action in the well established course offerings of UNISA at BSc honours level. UNISA has a well established and working model of course offering and assessment procedures for both senior undergraduate (BSc honours) and postgraduate training, which could have been extended to other participating institutions. Moreover, Unisa has several learning centres abroad, eg., the centre in Akaki (Ethiopia) to facilitate communication (video conferencing, Skype, *etc.*) and learning.

Individual scientists are the real actors in research alliances, while institutions play a secondary role. In institution-initiated alliances too, individual scientists are the key actors while the institution provides the support required to realise an alliance. Often individual scientists are the initiators of any successful collaborative action, banking on informal contacts and acquaintances. However, when alliances stem from informal contacts, responsibilities are often unclear; and when commitment is uncertain, collaboration can become stressful. The department-industry model involving postgraduate students employed in chemical industry is the only example of split-site model that has proven to work within the ODL context. This is because the chemical industry is committed towards the costs for the project, laboratory space and analytical facility as well as the provision of the co-supervisor for technical support. Bureaucracy, issues related to ownership of intellectual property and organizational culture on postgraduate student training, on the other hand, have been found to hamper mutual co-operation involving academic department–department or university–university postgraduate student training models. This is also compounded by the lack of commitment by the counter-partners on funds for running costs and provision of adequate infrastructure for research and postgraduate student training.

In-house postgraduate training model

Until recently (2012), only the Departments of Chemistry and Physics had adequate laboratory infrastructure for research and well developed postgraduate programs involving students with access to industrial laboratories. The Department of Higher Education (DoHE) enacted an act in the late 1990s to allow UNISA to offer postgraduate degrees through the contact mode, a monopoly previously enjoyed by the residential or contact institutions. Permission for UNISA to offer in-house postgraduate programs, on the other hand, led to increased influx of young students into the sciences. The merger of former UNISA Faculty of Science and Technikon South Africa to comprise the new comprehensive university offering degree and diploma programs further placed enormous strain on the laboratory infrastructure.

With the goal to become the leading African University in the service of humanity through quality research, UNISA recently erected a completely new Science and Technology campus for research and postgraduate student training at the Florida campus. Moreover, the University Senate approved the request by the Department of Chemistry and related disciplines to focus largely on the training of postgraduate students through the in-house model. The requirement for the in-house model is that the prospective student must be willing to travel to our facility and secure accommodation closest to the university to facilitate routine and sustainable access to the laboratory and library facility. Unlike contact institutions, UNISA has no accommodation facility for students. With adequate infrastructure in place, the question is' *how does UNISA manage to run the in-house postgraduate student training model with success without accommodation facility*?

UNISA has established a strategic project 'Grow Your Own Timber (GYOT) Project' to support the in-house graduate students by offering them temporary employment on fixed-term contract as postgraduate assistants to alleviate the economic burden of the student. The appointed candidates, in turn, are required to render service to the department as tutors, markers or demonstrators for undergraduate practicals as part of skill development. With the generous financial support mechanism in the form of GYOT project in place, the responsibility lies with departments to recruit and admit students into the postgraduate program. It is to be noted that this provision does not cater for all of the graduate students and some students have to source support elsewhere.

The prospective student is assigned a supervisor with proven track record to supervise postgraduate students to completion. Joint- or co-supervision of the student's project is also encouraged as part of skill development and succession plan. Moreover, joint supervision has also been found to circumvent dropout rates due to supervisor-student relationship or lack of proper support. Depending on the availability of expertise, in some cases the department may appoint an expert from outside the institution to serve as the main or co-supervisor. Technical support to the student will be provided by the host institution. Students are required to present seminars and submit written reports to the department as part of progress monitoring, quality assurance and scientific information presentation skill development. The model has been found to increase the success rate and student throughput. Majority of the in-house trained students are able to complete their studies within the minimum prescribed period of 2 or 3 years for MSc and PhD degrees, respectively.

CONCLUSIONS

Direct contact with students forms an integral part of any experimental training in disciplines such as chemistry. The training, on the other hand, requires routine and sustainable access to adequate laboratory facilities by students. The advent of virtual laboratory programs has created a perception that laboratory-based disciplines such as chemistry could offer postgraduate programs through ODL mode with limited or no access to laboratory or analytical facility.

This view led to the creation of generic admission policy for postgraduate studies with the intent of increasing postgraduate enrolment figures and presumably at a cheaper cost. Adequate research infrastructure (laboratory space and analytical equipment), costs for consumables and analysis (service rendering) and availability of expertise constitute the main factors that determine the admission of students into postgraduate program in chemistry and thus their success.

These requirements for postgraduate student training in chemistry within ODL context are easily fulfilled through the in-house postgraduate student training model or the department-industry collaborative action. The models described herein all emphasize mutual cooperation between the stake holders. Mutual co-operation in research is a working relationship which involves equipment and laboratories as well as human beings. This is because science is no longer a centralised activity located in a single place, but is dispersed far and wide. Moreover, scientific activity is an interaction between scientists and their socio-technological environment.

Processes such as collaboration are part of this interaction, having consequences for the production of knowledge and the scientific wealth of nations. Collaboration, domestic or international, accelerates scientific growth and advancement. Some of the split site models tend to fail to achieve the set goals because of several factors as alluded above and the interpretation of collaboration by various stakeholders. To benefit fully from collaboration, the parties (individuals, institutions or countries) need to reach a certain level of scientific absorptive capacity, including the infrastructure of support, communication and research [4]. They need to have a fair idea about the costs and benefits. Meticulous cost–benefit analysis works in multiple ways; it lends the partners the opportunity to assess the worth of their involvement [5]. Bureaucracy, issues of ownership of intellectual property and different organizational culture on research tend to impede on mutual co-operation involving academic department–department or university–university postgraduate student training model. Collaboration, in essence, is between individuals and not institutions [6].

Understanding the personal components in collaboration is not always easy, however, prior knowledge about the cultural and attitudinal dimensions of academic activity can shed light on the human side of collaboration [7-8]. Despite provision of adequate laboratory infrastructure and analytical facility, venturing into postgraduate program in experimental disciplines such as chemistry through ODL mode is costly in terms of running costs and funds for human resource component. In our view, the models discussed above may be adapted to fit the needs of the other laboratory-based science disciplines that plan to venture into the business of postgraduate student training within the ODL context.

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