SKILLS DEVELOPMENT PROGRAMME: The UNISA/CSIR MODEL

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ABSTRACT

Science and technology have advanced to such an extent, that completely new mind sets and areas of investigation and applications, that were once considered fictitious, are now achievable. Techniques are now available for imaging and manipulating materials at the molecular and atomic level. The barriers between disciplines such as Biology, Physics and Engineering are, for all intense and purposes, non-existent. Whole new industries are being created based on these developments. Thus new skills and skills diversities are required to exploit these opportunities.

Many of these advances have originated from Europe and the USA and have been emerging over the past 10 – 20 years. Thus their educational, research and industrial infrastructure has grown concomitantly with these new demands. Africa is on the brink of a renaissance not only politically but also in science and technology and can assimilate best practice from the global experience and adapt these to the needs of Africa.

The CSIR and UNISA are collaborating to address these issues. A unique partnership is developing between these two institutes with the biologically based sciences piloting the initiative. The core of this involves acquiring and maintaining cutting edge equipment, student skills development programmes and industry. A key component will be the use of Information Learning Technology. The skills development programmes are vocational and centred on research and industrial requirements. This programme is modelled on vocational qualifications from the UK and is being adapted to meet South African current and future needs.

BACKGROUND

In July 2009 the South African government published its Medium Term Strategic Framework (MTSF) 2009 – 2014. In this document the government pledged to ensure that all South Africans should benefit from economic growth. Science and technology (S&T) plays a major role and is a driving force in the global economy. Therefore S&T is a strong component in the policies of all governments (HSRC 2008) irrespective of a countries state of industrial development (EU 2005, DACST 1996). The European Union (EU), for example, proposes to spend 3% of its Gross Domestic Product (GDP) on research and development (R&D) by 2010. This means an increase in researchers in its labour force to 8 per 1000, up from 6 persons per 1000 people. In actual terms, by 2010, this is an additional 500,000 scientists (CORDIS 2000). The South African government has recognised the importance of innovation and development in science and technology. She has also recognised that this needs to be coupled to long term high quality human resources and skills particularly in science, technology and engineering. Although significant resources have been devoted to human capital and capacity since 1994 the progress has not been to the extent or scale needed (MTSF 2009 – 2014, 2009). A survey conducted by the HSRC in 2008 identified that there was a major problem with the secondary and tertiary educational systems in South Africa (HSRC 2008). The HSRC Development Review (2008) revealed that the student drop-out rate from Higher Education (HE) was alarming. The main reason they stated for this was economic reasons of not being able to afford to stay at University or Tertiary Institution. Since the end of apartheid, the proportion of African and coloured students has increased significantly such that these two groups represent about two thirds of the total HE enrolments. However, their participation in HE is only 12% for each group. This is below participation level of the coloured and white populations at 15 and 63% respectively. There is also disparity in the success rates which in 2004 was 70% for African, 79% for Indian, 75% for coloured and 84% for white students (Source year). In South Africa there is a problem with producing doctoral scientists capable of participation at an international level. This is relatively low compared to international standards (Source year). An increasing problem is also in the quality of doctoral theses. This decline is linked to the ratio of academics to students, between 2000 and 2003 this ratio worsened. The HE system that was inherited from the pre 1994 era was inequitable, fragmented, unwieldy and inefficient. Thus the government in 2002 announced a restructuring programme for the HE sector. The restructuring process which has lead to the merging of many HE institutions has not progressed as smoothly as hoped. The HE? year report cast doubt over the short term on the ability of the merging institutions to improve to meet the new demands. The investment in education and training that the government has made since 1994 has improved the skills base. However, progress has not been as great as hoped. The targets in the MTSF 2009 – 2014 are a 20% improvement in all key educational indicators. This includes a 95% enrolment into secondary education and a 20% increase in throughput at HE by 2014. The Human Resources Development Review (2008) has shown that the rate of increasing enrolments and graduations in science, engineering and technology has been slower than anticipated. During the period 2002 – 2004 the annual average science, engineering and technology (SET) rate of growth was 6%. However, the share of student enrolment in SET remained at 27% of the total enrolment over the same period. This situation has been highlighted within the National Plan for Higher Education as a national priority. Teaching and research needs to emphasise knowledge transfer linking into practical applications. The MTSF 2009 – 2014 stipulates that 'a diverse mix of sites of learning and types of training providers will be used to deliver post secondary education. Non-government HE training institutions would be encouraged to play an increasing role in the provision of training opportunities of various kinds. The government indicated its wishes to increase basic and applied, single, multi and interdisciplinary postgraduate research. There is a pledge from the government to establish mechanisms to ensure that skills development is integrated and co-ordinated between departments and agencies. The MTSF 2009 – 2014 document identifies that diverse strategies need to be employed which is outside the traditional secondary and tertiary education system. It is generally recognised that adaptations to teaching methods, learning materials and assessment strategies are required to achieve these targets.

In response to the above scenario; the CSIR, pioneered by the Biosciences Unit and UNISA School of Agriculture and Life Sciences driven by the Department of Life and Consumer Sciences are collaborating to address this situation. This article outlines a skills development programme and strategy that is being established between the two institutions. The collaboration of this nature is unique in South Africa.

DEVELOPMENT OF PROGRAMME

The CSIR as a principal research organisation within South Africa has the same problems of building infrastructure and HCD as do other research based institutions in South Africa. A proposed model by which some of these issues are being addressed by the CSIR and UNISA partnership is explained below.

In 2009 UNISA was granted R500 million to establish a research infrastructure such as laboratories and capital equipment. This is a radical departure from the normal activities with which UNISA is associated with that of distant learning educational programmes. However, as the infrastructure to conduct research was not available at UNISA, the University approached the CSIR – Biosciences for assistance. As a result in 2009 a collaborative Memorandum of Agreement (MoA) was signed. This agreement allowed for equipment to be purchased using funds from UNISA whilst the CSIR provided the supporting infrastructure to run and maintain the equipment. The first of which was the acquisition of a 600MHz Nuclear Magnetic Resonance (NMR) research equipment. Along with this, post-graduate students registered with UNISA could now undertake research projects at the CSIR – Biosciences laboratories. Concomitant with this was the realisation that training and skills development programmes aimed at supporting these and a broader pool of students needed to be established.

A central rationale, around which this skills development programme is based, is that the core business of the CSIR is directed on applied research and not primarily in academic offerings in nature. Thus, student researchers at the CSIR are regarded as employees rather than students in the University academic sense. As such the training needs to be provided in a vocational working context. The BTEC Edexel qualifications programmes from the UK have been used as a model for the skills development programmes being established between UNISA and the CSIR - Biosciences. The BETC programmes are vocational qualifications and are programmes that reflect what is occurring in, amongst others, industry that is involved in the applied sciences. These qualifications were developed by BTEC Edexel and could be delivered either in part-time or full-time mode. The part-time mode is used for students who are in full time employment. The assessments and delivery are practical investigative to match the needs of employers and to reflect the relationships between the local and scientific community. One of the principles on which these courses are structured in both the content and application, particularly in the assessment is where learning is achieved by doing and contextualised to make them relevant to local and specialist needs (BTEC 2004). For example employees from Pharmaceutical industry, the Health sector or Biotechnology companies would attend these courses. Therefore the curricula content and assessments need to be relevant for each student. Another principle is that the learners are encouraged to contribute to the programme using their skills, knowledge and resources (BTEC 2004). The course material is produced to be as relevant to the students working environment as possible. To accommodate and make a programme viable approximately 12 students are required. In a number of cases the student population is not sufficient for a self standing course. Therefore the following strategy was adopted. As the core content of many subjects, particularly science based, are common a number of groups from different specialist backgrounds and therefore can be amalgamated. The core subject matter can thus be delivered together. To accommodate the specialisation of each student cohort each cohort can be provided with a specialist topic area. Thus the core of the curriculum can be delivered to a group of viable size. The extra cost of putting on a few specialist modules is then offset by the combined core group size and is thus manageable. For an example of the pathway delivery of a course please see Table 1.

Table 1: Table showing possible specialist pathways under an umbrella programme.

PROTEIN BIOLOGY

<table>
<tr><th>SEMESTER 1</th><th>SEMESTER 2</th></tr>
<tr><td>STRUCTURAL BIOLOGY</td><td rowspan="3">OPTICS / SPECTROSCOPY / IMAGING TECHNIQUES.
PHYSICS
PRACTICAL UNIT</td></tr>
<tr><td>BIO-PROSPECTING (small molecules)</td></tr>
<tr><td>PHYSICS OF BIOLOGICAL SYSTEMS</td></tr>
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BIOPHYSICS

<table>
<tr><th>SEMESTER 1</th><th>SEMESTER 2</th></tr>
<tr><td>STRUCTURAL BIOLOGY</td><td rowspan="3">OPTICS / SPECTROSCOPY / IMAGING TECHNIQUES.
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</table>

BIOPHOTINICS

<table>
<tr><th>SEMESTER 1</th><th>SEMESTER 2</th></tr>
<tr><td>STRUCTURAL BIOLOGY</td><td rowspan="3">OPTICS / SPECTROSCOPY / IMAGING TECHNIQUES.
CELL BIOLOGY
PRACTICAL UNIT</td></tr>
<tr><td>BIO-PROSPECTING (small molecules)</td></tr>
<tr><td>PHYSICS OF BIOLOGICAL SYSTEMS</td></tr>
</table>

CELLULAR BIOPHYSICS

<table>
<tr><th>SEMESTER 1</th><th>SEMESTER 2</th></tr>
<tr><td>STRUCTURAL BIOLOGY</td><td rowspan="3">OPTICS / SPECTROSCOPY / IMAGING TECHNIQUES.
CELL BIOLOGY
PRACTICAL UNIT</td></tr>
<tr><td>BIO-PROSPECTING (small molecules)</td></tr>
<tr><td>PHYSICS OF BIOLOGICAL SYSTEMS</td></tr>
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[1] An Hons. Course of 6 modules. Each module having 20 credits = 120 credits.

With the organisation of the pathways in this manner the aim is to achieve a balance between the academic and vocational aspects of science.

For our purposes we have adopted the part-time mode as the attendees on these programmes are in a working environment.

With the MoA in place, the purchase and housing of the 600MHz NMR research projects have become established. (names of projects? Martin!!!). This has lead to the recognition, opportunity and need to establish skills development and training programmes which take advantages of the synergies offered by the collaboration of these two institutions.

The CSIR has access to state of the art research equipment and facilities. Along with this is a cohort of highly experienced practitioners who operate the equipment. UNISA, though, is an internationally accredited Tertiary Training Institution rather than the more traditionally academically orientated Tertiary Educational Institution. A third aspect to the strategy is involvement of information learning technology (ILT). This is to enhance and broaden the learning experience and opportunities for students who are not located within easy commuting distance of the CSIR Campus in Pretoria. Thus we aim to establish a virtual learning environment. Within this environment the vision is to establish as near real simulations of experiments of the apparatus available at the respective institutions. Here we will approach the vendors or manufacturers of the equipment to help develop the software programmes. With this facility available to the programme a learner can gain some initial exposure to how a particular piece of apparatus operates before they have access to the actual equipment. Coupled to this will be an on-line assessment which will provide a screening system of student progress. These, then underpin the vocational nature of this training.

Figure 1 outlines that overall strategic thinking and planning under which these courses will operate. There are three critical factors in the strategic thinking. One is that the skills development and training is centred on the individual student. A second is that the programmes are pro-active in nature rather than reactive. The third is that practitioners and the potential end user i.e. industrial or commercial organisations are actively involved in the development of the curricula and delivery of material. In Figure 1 the student is central and the red arrows identifies the pathway a student will take through the programme. Along the pathway there are a number of inputs identified with blue or green lines. There are also feedback and regulatory processes which are indicated by the yellow lines.

In the first part of the pathway identified by the 'student' box, this represents an individual student amongst a student pool. Here the inputs are from a variety of organisations. These represent organisations where the student may originate from, or, who provide some form of support for the student or the skills development programme. Once the student is in the programme a skills assessment is undertaken of the project / work that the individual is engaged in and of the current skills set of that student. From these two assessments the skills gaps are identified. Based on this an individual learning plan (ILP) is drawn up. The individual learning plan identifies how, where, when and in what manner the skills development and training activities will be provided. The circle represents the training programme and the inputs are the various modes of delivering the required skills. One of the main training programmes are the short learning programmes (SLPs'). All the SLP's that will be developed are required to have proper academic accreditation hence, the partnership between the CSIR and UNISA.

As can be seen from the diagram (Figure 1) there are feedback mechanisms from all interested stakeholders. The feedback is two way. One line of feedback is input from the stakeholders in to the design and content of the SLPs' as to what they stakeholders wish to have as part of the learning. This makes this type of course proactive and responsive to real requirements of employers rather retrospective reactive to what an academic institution preserves as being relevant.

Figure 2 represents the engine that is driving the development of the short learning programmes (SLPs'). These are the UNISA – CSIR research projects. From these in the business model currently being drafted and four SLPs' are being developed. The four SLPs' are i) Magnetic Resonance Spectroscopy, ii) Optical Spectroscopy, iii) Optical Microscopy and iv) Chromatography. These will act as a pilot for the development of further SLPs' not only within the CSIR – Biosciences but also to transpose to other CSIR Units and, potentially, research based institutions.

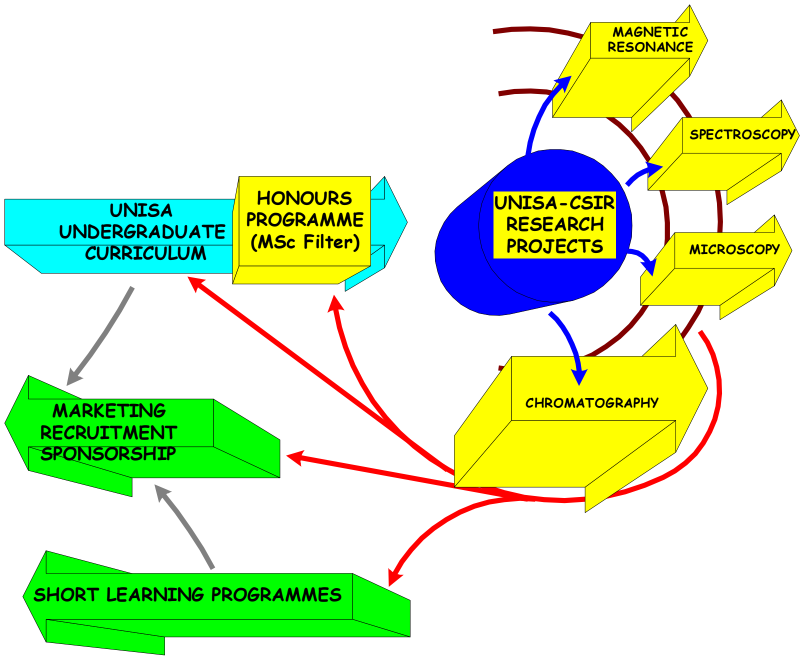
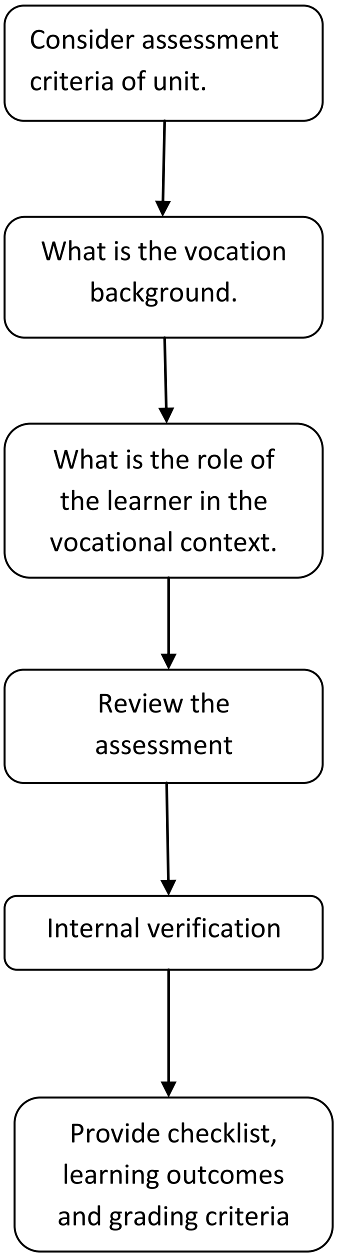


Figure 2. Diagram illustrating the relationship between the UNISA – CSIR research projects and the SLP's being developed.

The development of the design of assessments is also based on the BTEC Edexcel model. Figure 3 outlines the procedures used in drawing up an assessment for the SLPs'.

Within the framework of the course a robust system of quality assurance is embedded. This is both for the assessment material delivered during the course and for the assessed work presented by the students. In the construction of an assessment we employ the process similar to the one recommended by BTEC (BTEC 2004) as shown in figure 3. Once an assessment has been compiled an internal verification process is performed in which the assessor and an internal verifier verifies that the assessment planned complies with the curriculum content, the learning outcomes and the grading criteria as expressed in the curriculum course documentation. As these courses are being delivered in a working environment with learners who are employees rather than students in the traditional sense we would in principle aim to derive all the learners' assessments from their own research project or normal work load. This is, an idealised situation which we recognise may not be possible in practice. Once the assessment has been under taken by the student the assessed material is signed by the student as to being their own original work. The assessor then evaluates the work ensuring that this is aligned with the grading criteria specified. The assessed pieces of work is filed in the students' portfolio for the overall internal and then external verification process. At the end of the course when all the assessments have been completed and evaluated the course supervisors and the internal verifier undertakes a holistic view of the students work. In this process the verifiers and the tutors present a recommendation for an overall grade for each student. The final stage is an inspection of the assessment process and grades recommended by an externally appointed verifier. The role of the external verifier is primarily not to evaluate the students work but rather the process of assessment and that the assessors have adhered to an appropriate standard for the assessments and their evaluation. With the completion of the inspection by the external verifier the grades are for the students are confirmed.

Figure 3. Flow diagram outlining the process for designing an assessment.



CONCLUSION

To date the business model of the short learning programmes has been formulated. We are currently engaged in the process of establishing the academic accreditation for these programmes. In the next few weeks assembling the course material in the form of a Tutorial Course Booklet will begin. Contact and discussions have been initiated with overseas Universities for support and to share best practice in establishing these programmes. This particularly includes developing virtual learning environments for on-line learning and assessment as well as identifying internationally recognised experts to assist with delivery of the SLPs'. It is anticipated that the first SLP will be ready for delivery at the start of the next academic year.

REFERENCES

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