Distance Assisted Training

for Nuclear Medicine Technologists

in Anglophone sub-Saharan Africa

By

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SYNOPSIS

Background

Five of the seventeen countries with Nuclear Medicine facilities in Africa have training programmes for Nuclear Medicine Technologists (NMT's). Four of the countries are in Northern Africa (Algeria, Morocco, Tunisia, and Egypt) and only one in Southern Africa (South Africa). The training programmes vary from country to country and therefore there is no common basis to facilitate regional co-operation.

Nuclear Medicine Technologists working in sub-Saharan countries do not have formal training in Nuclear Medicine and have mostly been recruited from related fields of Radiological Technology. A number of NMT's in these centres have enjoyed International Atomic Energy Agency (IAEA) fellowship training in other countries or have attended regional training courses. Knowledge and skills, learned in well-established Nuclear Medicine departments with supportive infrastructure, are on the whole difficult to transfer to a local situation without such support. Because of the nature of the specialty the numbers required for training are small and it would therefore not be cost-effective for Higher Education Institutions in these countries to set up training programmes. There is also a lack of expertise in this field in Africa. Training was initially supported outside the countries with loss of personnel to the departments and in many instances loss of manpower as these trainees leave their countries and do not return.

Under an IAEA/African Regional Co-operative Agreement (AFRA) project; "Establishing a Regional Capability in Nuclear Medicine", the following related to training of NMT's:

1. Harmonisation of training programmes for Nuclear Medicine Technologists in AFRA countries
2. Assess the feasibility of running a Distance Assisted Training (DAT) programme for Nuclear Medicine Technologists

It was hoped that in this way, full use could be made of available expertise and facilities in the region, the cost of training could be reduced and the standard of patient health care improved.

Distance Assisted Training Pilot Study

Developing skills-based training using distance education (DE) methods offered the possibility of training technologists, already employed in Nuclear Medicine departments, in their own departments with all its local complexities. The materials for the Distance Assisted Training programme were developed in Australia and tested in Asia. The Anglophone countries with Nuclear Medicine facilities in Africa were invited to participate in a Pilot Study for the DAT programme for NMT's. It was also decided that Co-ordination of the training would be from the Peninsula Technikon in South Africa, as they had established expertise in Nuclear Medicine Technology programmes. Of the seven countries nominated, only three centres in two countries; Sudan and Tanzania, had the infrastructure to support training.

The aims of the pilot study were to:

1. Develop a model for training nuclear medicine technologists using distance education in underdeveloped countries of Africa.
2. Determine the success of the first attempt at this method of training nuclear medicine technologists in Africa.

3. Determine the impact of altered service delivery patterns or modifications of existing practice.
4. Provide a model for use in the Francophone countries of Africa.
5. Provide a model for use for the advanced material.

Students received the first modules in November 1999 and completed the course in December 2001. All students were examined in their own departments and received "IAEA Certificate of Achievement" at the end of the course.

Programme Evaluation

An end of programme survey was carried out, and interviews held with supervisor and students from the three centres. Analysis of this and other data indicated that the conceptualisation and design of the material was excellent. There were however problems regarding the implementation of the programme, notably the lack of preparedness of the supervisors, limited resources and inadequate range of Nuclear Medicine investigations for clinical competency. The course was seen to have a positive impact, as it not only developed skills necessary for the profession, but also encouraged critical thinking and problem solving and developed reflective practitioners.

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ABREVIATIONS

AFRA: African Regional Co-operative Agreement

ANSTO: Australian Nuclear Science and Technology Organisation

APEL: Accreditation of Prior and Experiential Learning

ARCAL: Regional Co-operative Agreement in Latin America and the Caribbean

AusAID: Australian Agency for International Development

CCFO: Critical Cross Field Outcome

DAT: Distance Assisted Training

HPCSA: Health Professions Council of South Africa

IAEA: International Atomic Energy Agency

INMO: Institute of Nuclear Medicine & Oncology (Wad Medani)

ITLC: Instant Thin Layer Chromatography

MCQ: Multiple Choice Questions

NAP: New Academic Policy

NMT: Nuclear Medicine Technologist

OBE: Outcomes Based Education

ORCI: Ocean Road Cancer Institute (Dar es Salaam)

OSCE: Objective Structured Clinical Examination

QC: Quality Control

RCA: *Regional Co-operative Agreement in Asia*

RIA: Radio-Immuno Assay

RICK: Radioisotope Centre Khartoum

RLS: Rectilinear Scanner

SAQA: South African Qualifications Authority

SCANS: *Secretaries Commission on Achieving Necessary Skills*

SPECT: Single Photon Computed Tomography

WIL: Work Integrated Learning

1. INTRODUCTION

1.1Background

Africa has traditionally been the beneficiary of international aid and assistance in the field of Nuclear Science and Technology, largely importing specialized knowledge and skills. The international development community and, more importantly, the African community, have now recognised that it is essential, for sustainable development that Africa itself should take charge of meeting the many challenges of the region.

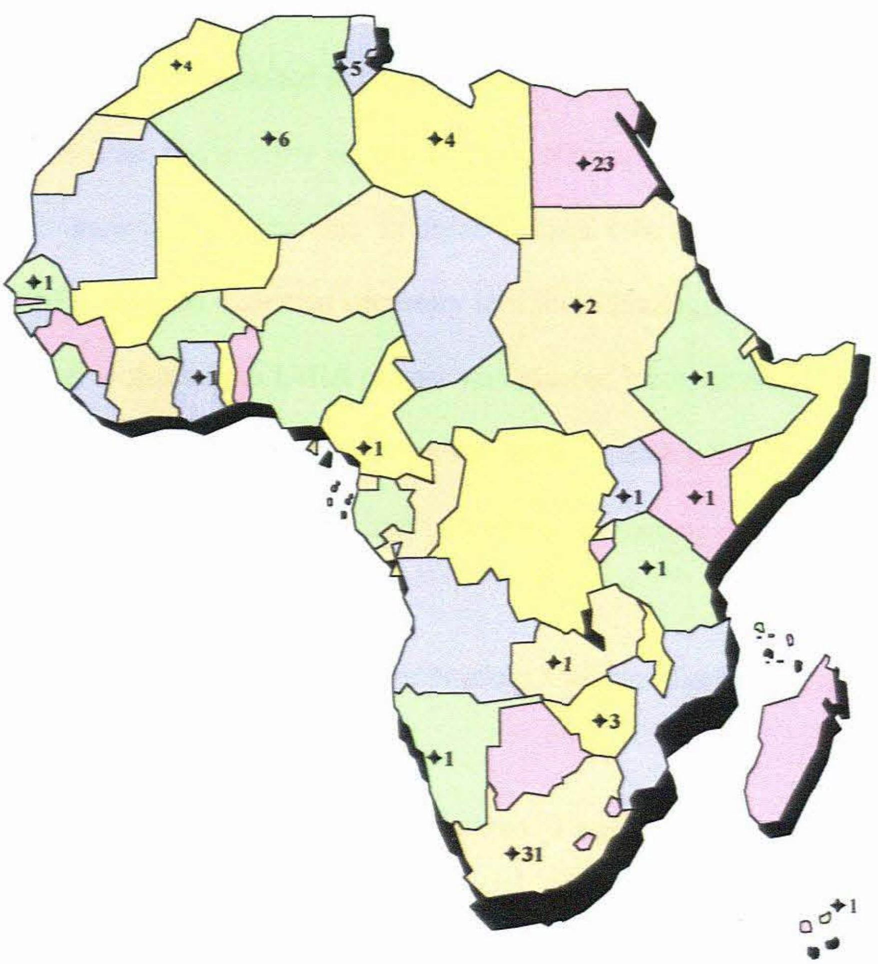
The inter-governmental "African Co-operative Agreement for Research, Development and Training related to Nuclear Science and Technology" (AFRA) was established in 1990 and is a branch of the International Atomic Energy Agency (IAEA). Its aim is to fully exploit regional capabilities based on regional collaboration and technical co-operation among developing countries.

Twenty-seven of the 30 countries in Africa are signatories to the African Regional Agreement and although resources in Africa are limited, 27 member states do engage in Nuclear Medicine activities, most of them *in-vitro* only. There have been an increasing number of countries with facilities for *in-vivo* Nuclear Medicine activities, situated mainly in Northern Africa and Southern Africa. Figure 1-1 shows the current status of the distribution of these facilities. The Nuclear Medicine departments are mostly linked to Oncology or Radiology units at University or Teaching Hospitals in the main centres.

Of the 18 countries with *in-vivo* Nuclear Medicine facilities, 5 have training programmes for NMT's. Four of the countries are in Northern Africa (Algeria, Morocco, Tunisia, and Egypt) and only one in Southern Africa (South Africa). The training programmes vary from country to country and therefore there is no common basis to facilitate regional cooperation.

Technologists working in Sub-Saharan countries have no formal training in Nuclear Medicine and have mostly been recruited from related fields of Radiological Technology. A number of technologists in these centres have enjoyed IAEA fellowship training in other countries or have attended regional training courses. Knowledge and skills, learned in well-established Nuclear Medicine departments with supportive infrastructure, are difficult to transfer to a local situation without such support.

Figure 1-1. Current distribution and number of Nuclear Medicine facilities in AFRA member states



1.2 IAEA/AFRA Projects

The IAEA, in its stated aim to assist developing countries in the field of Nuclear Science and Technology, has helped to establish Nuclear Medicine departments in African countries who are signatories to the African Regional Agreement. This has created a need for qualified personnel in all categories of multidisciplinary Nuclear Medicine practice and in particular, Nuclear Medicine Technologists. According to AFRA reports, the greatest need for training was seen to be in the sub-Saharan countries where there is a lack of expertise in this field. Not only are there no training programmes for Nuclear Medicine Technologists in these countries but also, because of the nature of the specialty, the numbers required for training are small and it would therefore not be cost-effective for Higher Education Institutions in these countries to set up training programmes. The lack of structured training; lead the IAEA to support "Fellowship" training for short periods outside the countries. This resulted in a loss of personnel to the departments for the duration of the fellowship, and in many instances, a loss of manpower as many of these trainees left their countries after training. In order to sustain the Nuclear Medicine capability within the AFRA region it seemed necessary to train technologists within the countries themselves and to this end an IAEA project was planned incorporating a programme for training. This project; "Establishing a Regional Capability in Nuclear Medicine" incorporated four sub-projects of which two related to training of technologists:

1. Harmonisation of training programmes for Nuclear Medicine Technologists in AFRA countries
2. Assess the feasibility of running a Distance Assisted Training programme for Nuclear Medicine Technologists

Such a programme, it was hoped would make full use of available expertise and facilities in the region, reduce the cost of training and improve the standard of patient health care.

1.2.1 Distance Assisted Training Pilot Study (Phase 1)

Developing skills-based training using distance education (DE) methods offered the possibility of training technologists already employed in nuclear medicine departments, in their own departments, with all their local complexities. Material for such a distance assisted training (DAT) programme was developed in Australia, under the auspices of the IAEA and sponsored by the Australia Agency for International Development (AusAID). It was initially tested in countries belonging to the Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology in Asia (RCA). Students had reportedly benefited greatly from the course, developing questioning attitudes with enough expertise to revise departmental protocols and implement new techniques. A recommendation coming out of the mid-course workshop in Mumbai, India, requested that a similar approach be adopted to run a Distance assisted Training programme in Africa, where the need for Technologist training was perceived to be as great as that in Asia. This was based on information from African students, who had undertaken the fellowship-training programme at the Radiation Medicine centre in Mumbai. The same interest was expressed by the AFRA member states during the 8th Technical Working Group meeting.

At the planning and implementation meeting held in Harare, Zimbabwe in March 1998 it was decided that the Anglophone countries with Nuclear Medicine facilities in Africa be invited to participate in a Pilot Study for the DAT programme for Nuclear Medicine Technologists. It was also decided that Co-ordination of the training would be from the

Peninsula Technikon in South Africa as they had established expertise in Nuclear Medicine Technology programmes. Applications for Inclusion in the Pilot Study questionnaires were sent out to all these countries (see Appendix A). Replies were received from Tanzania, Zambia, Zimbabwe (2 departments), Namibia, Uganda, Sudan (2 departments), and Kenya who all expressed a desire to be part of the project. Pre-course multi-country team missions to these seven countries were carried out in May 1999.

The intention of the visit was to meet with prospective students, supervisors, Heads of departments, teaching institutions and government regulatory bodies.

The following objectives were achieved:

- Introduced personnel of the Nuclear Medicine departments to the AFRA project and its objectives.
- Supplied them with an overview of the course, its design and format and an example of the teaching materials.
- Explained the mechanism of implementation of the course.
- Assessed the nuclear medicine facility's capacity to support the training.
- In departments that were functional and had the infrastructure to support the training, prospective supervisors were provided with guidelines regarding their role and prospective students were identified and interviewed.
- Met with hospital management/ medical director/superintendent and in some cases Ministry of Health to elicit commitment from institutions to support the training.
- In Sudan, Zambia and Namibia, met and briefed relevant University or College Dean/Officer for Curriculum Development regarding the programme to encourage participation of Radiography Tutors in the programme.

Despite information given in the "Application for Inclusion" questionnaire, the departments in Kenya and Uganda were not operational and their students could not be included in the pilot study. Zambia could also not be included, as a continuous supply of radiopharmaceuticals essential for daily practice could not be ensured, due to Health budget restrictions. Namibia had the infrastructure to be included but unfortunately even though they had a potential student, there was not a post for that student in the Nuclear Medicine department. Therefore, of the seven countries visited only three had centres that could be included in the pilot study.

The final participating centres and student numbers at the start of the course are shown in Table 1-1.

Table 1-1: Participating Centres and Students

Country	**Centre**	**No. of Students**
Zimbabwe	Bulawayo* Harare	4 3
Tanzania	Dar Es Salaam	4
Sudan	Khartoum Wad Medani	6 4
Total	**5**	**21**

* A physical visit was not done; all arrangements and interviews were conducted telephonically.

Following completion of the first module, the students in Zimbabwe could no longer continue with the course due to gamma camera breakdowns and cessation of radiopharmaceutical supply. The economic problems in that country had resulted in a lack of foreign currency to purchase ^{99m}Technetium generators. Thus a continuing nuclear medicine service could not be guaranteed and the practical objectives of the course could not be met. The department in Harare tried to keep going with week-old generators donated to them by a private-practice but the situation was further exacerbated by the break down of the gamma camera.

1.2.2 DAT material and Harmonisation of Training in Africa:

Only 6 countries in Africa, Algeria, Egypt, Morocco, South Africa, Sudan and Tunisia offer formal structured programmes in Nuclear Medicine Technology. In the case of Sudan, only theory is offered with no clinical component. These programmes vary considerably from country to country. In order to encourage technical cooperation within the region it was seen as necessary to reconcile or 'harmonise' the various training strategies.

To this end a Task Force was set up in Bloemfontein in July 1999 with a second meeting in Sousse, Tunisia in March 2000 to discuss the Harmonisation of Training of Nuclear Medicine Technologists in the AFRA region. Representatives from the six countries drew up recommendations for training regarding:

- Competency guidelines
- Assessment criteria
- Training paths
- Entry points

It was agreed that the academic training should be supplemented with a strong element of experiential training in a nuclear medicine department and that the DAT training programme was a useful means of achieving an integrated academic and experiential training.

South Africa is the only country in Africa offering a de nova qualification in Nuclear Medicine Technology, allowing for a vertical progression from diploma to Bachelor's, Master's and Doctoral degrees. These qualifications had recently gone through a process of curriculum renewal, in order to bring them in line with Government policy for an Outcomes Based Educational (OBE) model. The Nuclear Medicine qualification in South Africa fulfilled all the recommendations as laid down in the AFRA "Nuclear Medicine Technologist Competency Guidelines" (see Appendix B). However it was necessary to introduce all Higher Education (HE) institutions involved in Nuclear Medicine Technology training in South Africa to the DAT material. To this end a workshop was held at Witwatersrand Technikon, Johannesburg, in October 2000 with the objective of disseminating information on the DAT material to the other training institutions in South Africa, and encouraging its use.

Algeria adopted the DAT material as the basis of their new curriculum. They had their first intake of students using this curriculum in September 2002.

Although Tunisia have not revised their curriculum, the DAT material is used for the in-service training component of their Technologists' course. All students are also supplied with the competency guidelines as drawn up by the Task Force, which they find useful as a benchmark for their competencies.

1.3 Expansion of the DAT programme

1.3.1 Translation of DAT material

Algeria has taken the initiative to co-ordinate the translation of the material into French with the help of Morocco and Tunisia. The material can thus be used to undertake a similar DAT project in the Franco-phone countries of Africa. Algeria is currently using the French version in their formal course.

Sudan has expressed a willingness to translate the material into Arabic, which would be beneficial for use in Egypt and Morocco as well.

1.3.2 Advanced Modules (Phase 2)

Representatives of AFRA and Regional Co-operative Agreement for Research, Development and Training related to Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) were invited to an Advisory Board meeting of the RCA Coordinators in Shanghai July 1999. At this meeting five further modules were designed to add to the syllabus. These included modules in Human Biology, Behavioural Sciences, Non-imaging techniques, Literature Review and advanced techniques in Emission Computed Tomography.

At that stage the centres in Africa involved in the DAT programme only had planar gamma cameras, so it was decided to restrict the pilot study to the first seven modules. Tanzania has since had a Single Photon Emission Computerised Tomography (SPECT) system installed at the centre in Dar es Salaam and will be in a position to proceed with the advanced modules. Wad Medani in Sudan is also scheduled to receive a SPECT system donated by Ireland in the near future. The case study to be evaluated in this research will only involve Phase 1 (i.e. the first seven modules), as this will be sufficient to determine the feasibility of conducting a distance-learning programme in the region.

1.3.3 Thematic programme on Health Care in Nuclear Medicine for Africa

The mandate of this proposed programme is to accelerate and enlarge the contribution of Nuclear Medicine for health and prosperity in Africa. The Nuclear Medicine Technologist plays a critical role in routine practice of Nuclear Medicine since the quality of work and care taken during study execution determines the ultimate diagnostic capability of the test being performed (IAEA Resources Manual in Nuclear Medicine 2003). Continuity of training of Nuclear Medicine Technologists is an objective of the five-year Thematic Health Programme (2002-2006) drawn up in Sousse, Tunisia in March 2000, and is important if the clinical objectives are to be met. Results of the first round of training using the DAT programme are therefore important when considering further training in this five year period.

1.3.4 Inter-Regional Collaboration

RCA, AFRA and ARCAL Coordinators involved in the DAT programme, view the opportunity for inter-regional collaboration to be extremely useful. In particular it allows the three regions to have a valuable input into the overall project planning, encouraging uniformity of implementation that greatly aids in standardising the project. The three regions have a fairly unified view of the overall project issues and maintain links in monitoring overall project progress. The continuation of the inter-regional project is considered an important stimulus to the project in all three regions.

1.4 Aims and Objectives of the Research

Although the training programme hopes to establish a basic standard of professional practice in developing countries, Africa has its own unique problems that might constrain this happening:

- Africa's debt and resulting health budget cuts could lead to constraints in the nuclear medicine service provided in the individual countries.

- Most countries in Africa, with their limited resources for Health have a Primary Health Care priority and Nuclear Medicine is viewed as Tertiary Health Care service.
- Lack of expertise in maintenance of equipment causes down time, with a resulting interruption in continuous practice.
- Radionuclides essential to Nuclear Medicine practice can only be imported from South Africa or Europe; countries not on a direct flight path experience delivery problems, exacerbated by poor customs handling at the country of destination.
- Poor telecommunications limit the support from the coordinator in South Africa.
- All study materials have to be sent by courier, as the postal system is unreliable.
- Nuclear Medicine practice is not well known by the medical community in Africa, and therefore referral patterns do not offer the student a range of investigations to establish good practice.
- Support for the students from Medical Physicists and Radiopharmacists is lacking.

The aim of the research is to use the initial pilot study in Africa as a case study to determine the feasibility of using the DAT programme for Nuclear Medicine Technologists in Africa, and to develop criteria for its future use in the region. The specific objectives related to this aim are as follows:

1. Develop a model for training nuclear medicine technologists using distance education in underdeveloped countries of Africa.
2. Determine the success of the first attempt at this method of training Nuclear Medicine Technologists in Africa.
3. Determine the impact of altered service delivery patterns or modifications of existing practice.

4. Provide a model for use in the Francophone countries of Africa.
5. Provide a model for use of the advanced DAT material.
6. Analyse the cost-effectiveness of distance-supported training, compared to training out of the country.

2. REVIEW OF RELATED LITERATURE

2.1 The Nuclear Medicine Technologist

In South Africa the Nuclear Medicine Technologist is referred to as a Nuclear Medicine Radiographer. The terms Technologist and Radiographer are interchangeable, and in this study the more common international term Nuclear Medicine Technologist will be used. Both the nature of the profession, and the training of Nuclear Medicine Technologists, varies greatly across the globe. The range of tasks permitted of the technologist varies from country to country and there is a considerable overlap with other professional groups.

The role of a Nuclear Medicine Technologist as defined by the European Association of Nuclear Medicine (EANM) in July 1998 is:

> *"Nuclear medicine is a medical speciality in which radioactive materials are used for diagnosis by imaging and non-imaging techniques and for therapy of many disease processes.*
>
> *The Nuclear Medicine Technologist is a health care professional who is able to undertake the whole range of nuclear medicine procedures. He/she is part of a team of health care specialists which may include doctors, physicists, radiochemists, other clinical scientists, technologists, nurses and others who support and care for the patient during diagnostic and therapeutic procedures, under the direction of a Nuclear Medicine Physician.*
>
> *The responsibilities of the nuclear medicine technologist are to maintain the highest possible standard of results in procedures carried out, which may include*

imaging, non-imaging, labelling and therapeutic procedures, to maintain the highest standards of patient care and deliver the lowest radiation dose to patients, staff and public that is compatible with valid results" (EANM, 1998: 5)

The situation regarding training of nuclear medicine technologists in Africa is as heterogeneous as that in the rest of the world. Much like Europe, national laws may prevent technologists in one country from carrying out tasks that are required of a technologist in another. In sub-Saharan Africa however there is a fairly uniform approach.

In order to safe guard the public and, indirectly the profession; Nuclear Medicine Radiographers in South Africa are required to register with the Health Professions Council of South Africa (HPCSA). As registered Health Care Professionals, they operate within the stated "Scope of the Profession". The "Scope of the Profession" is a broad definition of the purpose and intent of the profession and is utilised mainly to restrict unregistered persons from transgressing within the domain of a regulated profession. The "Scope of Practice" correlates with training outcomes for newly qualified practitioners. The professional acts within the ambit of the profession are thus determined by that practitioner's training and experience. (HPCSA, 2000). A Professional career choice not only exposes one to a specialised learning environment but in addition, one becomes a member of a reference group of peers who share a "professional mentality" (Kolb, 1984). This professional orientation shapes the style in which Nuclear Medicine Technology students' learn through habits acquired in professional training and pressures involved in becoming a competent professional.

In the competency guidelines drawn up by the AFRA Task Force for the Harmonization of Nuclear Medicine Technologist Training in Africa, the roles and functions of Technologists working in a Nuclear Medicine environment, under the direction of a Nuclear Medicine Physician were identified as:

- Administration and Management of the Nuclear Medicine environment
- Care of the patient undergoing a Nuclear Medicine procedure
- Radiation safety practice
- Operation and QC of Nuclear Medicine instrumentation
- Effective functioning in a Radiopharmacy Laboratory
- Performance of Nuclear Medicine Imaging procedures
- Performance of Nuclear Medicine *in-vitro* procedures
- Performance of therapeutic Nuclear Medicine procedures

Competencies associated with these functions were defined along with assessment criteria. Knight (2002: 57) points out that competency in Nuclear Medicine is not a dichotomy (a person is either competent or incompetent), but rather a fluid continuum from incompetence to competence, the concept being both dynamic and multifaceted. Furthermore competence is "domain specific"; competence in one area does not lead to competence in another. An Expert would be situated at the competence end of the continuum and a Novice at the opposite end. An expert will have "domain knowledge"; textbook knowledge plus the insight gained from experience. The DAT programme was designed with practitioners in mind, who were practicing in Nuclear Medicine without much of the academic knowledge base necessary. Although they had been recruited from related disciplines and therefore had academic knowledge, which overlapped with that required in the field of Nuclear Medicine. In order to assess all pieces of the competency puzzle (Knight, 2002) a variety of assessment tools were used and assessors, supervisors, coordinator and ultimately the IAEA, all shared the responsibility of assessing competence.

2.2 Distance Education

In a world where there is an increased demand for multi-skilled, flexible life-long learners, traditional teaching can no longer meet the expanding needs of adult learning. Traditional face-to-face teaching is characterized primarily, by the transmission of information from teacher to learner in a campus-based setting. This type of learning poses barriers that result from geographical isolation, personal or work commitments or financial outlay. In the 1960's distance teaching/education emerged, where teacher and learner were separated and instruction was indirect through printed matter, audiovisual, radio or television. This trend continued in the 1970's with subtle changes and a shift of paradigm from distance 'teaching' to distance 'learning', with the activity of learning rather than teaching being central to the process. Although distance education had benefits that traditional teaching systems lacked, it also had limitations and weaknesses, such as not providing an environment where interaction and communication with other learners can take place. Since the 1980's the perspective of distance education has transformed and broadened towards the more 'constructivist'/ 'learner-centred' approach of Open learning.

Grant (2000) of the Open University Centre for Education in Medicine (OUCEM) reflects this shift in paradigm when describing and defining distance learning, by stating what it is not.

Distance learning is not just:

- Self-instructional packages
- 'How-to-do-it' manuals
- Correspondence courses
- Courses delivered by electronic media
- Sending educational materials across a distance

Schön (1987) would categorise these approaches as "technical rationality", leaving little room for "professional artistry". These types of learning packages were written for earlier models of information transmission coming from a behaviourist approach to teaching. In the last decade, there has been a paradigm shift in educational theory to that of a constructivist learning approach based on cognitive theory, where it is assumed that the learner constructs their own knowledge on the basis of interaction with their environment. Gagnon & Collay (1999) have defined six important elements that a "Constructivist Learning Design" should typically have:

1. A defined **situation** for students to explain
2. **Groupings** of materials or students
3. Building a **bridge** between the known and unknown
4. Guided **questions** to keep active learning going
5. Students **exhibit** or record their thinking /explanation regarding the given situation.

6. Students' **reflections** about their learning.

A constructivist approach for distance or open learning, therefore, requires the design of specially prepared learning materials, usually in print, for individual study that is supplemented by integrated learning resources, other learning experiences, feedback on learning, and support of students (Grant, 2000).

Distance education is referred to by Rowntree (1994) as both "Open" and "Flexible" learning, whereas Thorpe (1993) considers distance learning to be a subset of open learning. Open learning being an umbrella term, which refers to a whole series of varied educational initiatives and provisions. The goal of "Open" learning being to:

1. Increase the participation in education and training among groups with low participation hitherto.
2. Improve quality and extent of learning by those who do participate.

Hu (1995) sees distance learning and open learning as being different concepts in some aspects but by no means opposing concepts. The conceptual scope of open learning being broader, distance learning describes the means by which the education is achieved i.e. separation of teacher and students, while open learning describes the character of the educational process i.e. openness where learners have control over their learning.

Table 2-1 summarizes the main characteristics of distance education, open learning and the DAT programme, which can be best, described as "distance open learning".

Table 2-1. Characteristics of Distance Education, Open Learning and Distance Open Learning

Distance Education	**Open learning**	**Distance Open learning (DAT programme)**
Transmission Paradigm	Constructivist Paradigm	Constructivist Paradigm
Materials based dissemination of knowledge (home-based learning)	Flexible design, mixed mode learning approach (campus-based, home-based, work-based)	Integrated learning resources and other learning experiences, (work-based)
Occasional meeting and indirect communication replace face-to-face teaching	Support determined by different needs of the learner (usually adult).	Mentor support meeting individual needs and expert networking
Institutions play important role in offering different courses with restrictions and exclusions (institution centred)	Open access to flexible learning opportunities (removal of barriers)	Deinstitutionalised development: access for specialised group with specific needs
High quality learning materials are needed to ensure effective learning	Learners take responsibility for their own learning	Active learning rather than passive; co-inquiry; self assessment

As is shown in Table 2-1, open learning is a flexible, mixed-mode learning approach incorporating campus-based, home based, work-based, resource-based learning whereas distance learning is more materials and input based. Open learning is a multifaceted concept, which is suitable for adults as it provides them with open access without the barriers that thwart them from participating in formal education. More than this it offers them the best possible chance at success, which Hu (1995) considers to be the characteristic that sets open learning apart from distance learning. The DAT programme is designed to offer a fair chance of success. The final "Certificate of Achievement" reflects the competencies attained in specified subject units, which can be upgraded at a later stage if the desired competency was not attained. Thus the participant's "scope of practice" is determined by the subject units or clinical objectives in which they have attained competency but can still satisfy the learners expanding needs in the future.

The essential ingredients of Open learning materials are 1) information and 2) action. The design of the particular materials used, fits into Rowntree's (1994:14) "type" of open-learning material as a "Reflective Action Guide" where learning and activities are related to the learners own situation and requires them to think critically and evaluate outcomes. Rowntree (1994) describes it as "just in time" use rather than "front loading". Beckett (2000) defines "just-in-time" (JiT) learning as "learner generated immediate skill formation" or "situated learning" i.e. the way workers accomplish understanding through practical inference. The aim of a "Reflective Action Guide" is not so much in mastering an existing body of knowledge but developing individual insights, or practice towards practical competence. This is a more time-consuming approach to learning but the activities are related to the learner's own situation and allow them to see their world in new ways and learn to act upon it in new ways, a lot of the time gathering their own feedback.

The study material modules used are structured in a logical sequence developing from *Basic Sciences to more complex clinical applications with sequenced activities* throughout, thus they "learn by doing" which according to Race (1993) is the heart of open learning. It embodies the concept of "learner centeredness", which Kolb (1984) sees as the integrative process that links education, work and personal development.

Race (1993) sees open learning as allowing learners to have a choice or control over the way they learn. This can refer to:

1. Entrance criteria – dispensing with strict pre-requisites
2. Pace at which they are going to work
3. Place – students can choose where to learn
4. Time – students can choose when to learn
5. Process – students can choose how to learn

Open learning can in this way accommodate directly the ways people learn naturally and can thus be defined as learner-centred. There is a looser structure to space-time in distance education and therefore less control over where and when the learner undertakes their learning (Edwards, 1994). Students exercising this degree of control will take ownership of their success giving them positive feelings about themselves. Furthermore, open learning is a way of conserving human skills. The human support, (in this case the on-site supervisors and coordinator) can devote their energy to all those things that need human skills and sensitivity. In this way they can be a "resource" rather than a "transmitter of information" (Race, 1993).

Designing materials for open or distance learning is a time-consuming and costly exercise. The advantage of adapting and using existing materials is that you save time and expense, and gain valuable feedback to enable improvement of the material. This was the rationale for using the DAT material developed in Australia, originally for use in the Asia region, together with the fact that it was developed under the auspices of the IAEA and as such has no copyright to member countries. The difficulty would be whether it could be used in the technologically less advanced developing countries of Africa, with its limited resources, to the same effect that it was used in Asia.

2.2.1 Instructional Design of Distance learning

Gupta (1989) sees "course planning" as being synonymous with "instructional design" and alludes to the shift of emphasis in the last two decades from "correspondence" to "distance" education. This has come about with the desire to maximise learning outcomes into effective alternatives to conventional education. Instructional design is a characteristic of "Open Universities" and their techniques have contributed to worldwide recognition of the potential of distance education. Gupta (1989: 173-176) however warns of some of the pitfalls in Instructional design:

1. Despite claims that open learning is "learner-centred", the learners are not included in the process of instructional design and therefore do not have a 'voice' in the process of learning.
2. The quality of interaction between learner and organisation is usually poor as students seldom take the initiative to communicate. Communication thus is largely one-way and irreversible.

3. Higher order learning goals such as developing experimental attitudes, generating fresh knowledge and engendering discovery learning, are difficult to achieve in media orientated communication.
4. Instructional design is carried out in advance without reliable data regarding the *prospective students, their characteristics, expectations and orientations.* If it is not acceptable to the student, no matter how elaborate the design it will be worthless.
5. Open learning proclaims learner autonomy in the student having the choice of where, when, how and at what pace to learn. The reality is that the learner usually has to adhere to strict scheduling of modules designed in a specific sequence. Thus autonomy is sacrificed.
6. Instructional design based on the assumption that there exists no communication gap between course-developers and course-takers will have no regard for the heterogeneity of learners, their different backgrounds and differing experiences.
7. Instructional design should not be based on the incorrect premise that the learner has enough free time and exclusiveness for studying. As adult learners there are likely to be heavy constraints of time due to work and family commitments.
8. The quality of the instruction depends on support and implementation from involved, competent persons for it to be successful.
9. The ideal media-mix for instructional design has not evolved. The quality of the design will suffer if a particular media is chosen which has little benefit to the learning process.
10. Instructional design is a costly and time-consuming exercise.

10. Instructional design is a costly and time-consuming exercise.

11. Because instructional design is time-consuming, it needs a team approach but with a team approach there are likely to be conflicting views. Compromise might lead to lowering of standards and quality.

Cognisance of all these possible pitfalls will be taken into account when evaluating the first attempt at using the DAT material in Africa. Based on the recommendations of the outcomes of this course, adjustments will be made for further training and before it is used in the Francophone countries of Africa.

Distance Education has special features, which have been exploited to good use with the DAT material. Lewis (1989:230-231) identifies them as:

- The materials used are both permanent and public, in direct contrast to classroom and lecture hall, where most teaching happens through the spoken word and behind closed doors.
- Permanent materials lend themselves to detailed course design in a way that traditional teaching does not.
- The objectives, methods and content can be systematically linked with the possibility of being improved upon through field trials and feedback.
- Public availability also lays it open to public critique and accountability, a powerful incentive for good work.

The DAT materials remain the property of the IAEA for use by any of the member countries as part of a designated project. They are available on CD or on the website and as such are permanent, public, and subject to continuous refining, monitoring and updating.

2.2.2 Learning Media

Learning media for distance learning should be a rich integration of resources enabling distance-learning courses to be self-sufficient. Whatever the media selected, the learning path must be clear. Core materials are usually in print with clear aims, instructions and timings. A conversational style genre is used which best simulates a tutorial. Use is made of short sections with clear page lay out, in-text exercises and opportunity for feedback. In this way "active learning and not passive reading" (Grant 2000) is encouraged. The learner does not construct knowledge by passively receiving it (Burge 1989).

With distance learning the student should be offered other experiences for support and richness of learning, such as:

- On-line tutorials
- Workshops
- Student discussion groups
- Field work
- Face-to-face tutorials
- Telephone discussions
- Supervisor/mentor support

All these constitute 'the course'.

Grant (2000) contends that in order to minimize feelings of isolation students might experience, it is of utmost importance to "maintain a presence". Although it is easy to talk of the learner-centred view in distance education, Burge (1989) points out that in reality it is difficult to establish and maintain over a whole-course. Restraining and driving forces will act like "force fields" (Burge, 1989), their strength differentials causing both positive and negative movements. Driving forces are the rewards in learning such as; fast tutor and peer responses that correct or confirm feelings of connectedness with the course content, enhanced self-esteem and mastery. The restraining forces may emerge from initial cognition, gender, age, environmental issues, anxiety related to expectations, inability to cope with communication technologies, lack of support, frustration and anger at peers or organisation of course and fears of the unexpected (Burge, 1989).

2.2.3 Mentor Support

A "Tutor" or "Mentor" provides the human support necessary in distance learning, exercising human qualities to enhance learning. In the case of the DAT course, the appointed Supervisor is both mentor and tutor lending moral and content support. Supervisors also had the role of assessor with tasks ranging from inspecting workbooks to signing competency for various clinical procedures. Assignment monitoring is a function of the supervisor and as such is one of the key means of finding out how learners are progressing. Submission rate of assignments is an indicator that something is going wrong (Thorpe, 1993). The type of supervision afforded to the students on the DAT course is best described by Race (1993) as "corridor" mentoring. Corridor mentoring is an informal sort of mentoring which works well for people who meet often anyway in a normal workplace. They have the benefit of knowing the learner, responding uniquely to them (Boud, 1989) and can thus smooth the way for them and prevent them from backsliding. This human support is necessary as learners often get "mid-course blues" (Race, 1993), when the novelty has worn off and the subject matter gets more difficult. They feel pressurised, alone and start doubting themselves, losing sight of their original goals. At the end of the course students tend to feel frightened and wonder whether they will manage. The mentor is a resource, providing relevant feedback that gives the student insight into his/her progress, rather than just a transmitter of information.

Thorpe (1993) identifies the key issues surrounding supervision as:

- Counselling on study skills
- Problems in understanding the course
- Students lagging behind with work
- Examination preparation
- "Drop-out"

Although he considers attrition as not always a negative situation as learners should be free to stop when they choose, it was found to be greater in those who did not receive special support (Thorpe, 1993: 121). The key times when support is needed is in:

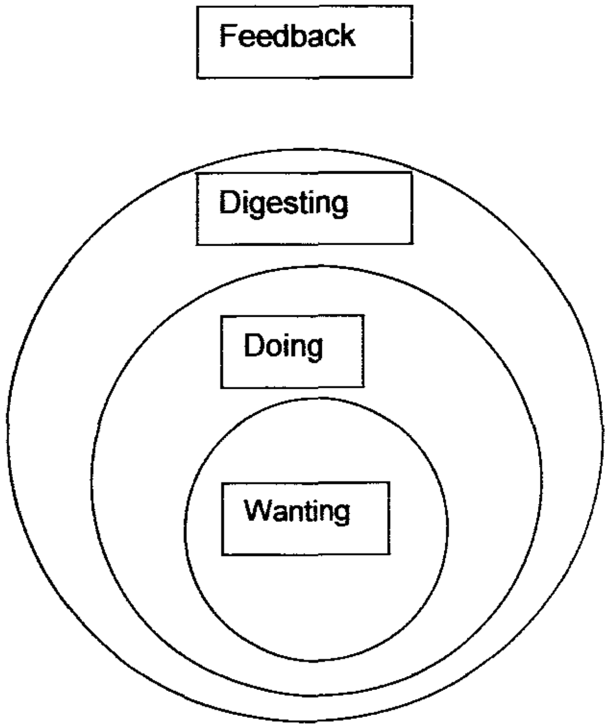
1. The initial weeks when students are overawed or having difficulty with material.
2. The period between the 1st and 2nd assignment, if the performance is poor.

Supervisors should be encouraged to document all counselling and be continually aware of issues of reliability and turnaround, such as getting assignments back quickly, discussing "expectations" and giving helpful and encouraging feedback.

2.2.4 Feedback

Race (1993) sees Feedback as one of the key overlapping processes in "Open" learning. He describes the "ripple" effect of wanting to know, doing, digesting what has been learnt and feedback as illustrated in Figure 2-2.

Fig.2-2 Ripple Effect



Packham, Roberts & Bawden (1989), caution that Feedback needs to be timely and interactive to be most effective. This basic learning theory presents a difficulty when you have long-distance communication in any Distance learning course.

Feedback is equally important when evaluating the whole course. Evidence of learner performance will be available from tests and assessments but feedback is a necessary dimension in monitoring improvements. Validation of learning is a vital element in the process and can be gathered from the following sources:

- Feedback as seen from patients' reactions to learners approach
- Reflection by the learner themselves as to what the course has meant to them in terms of personal growth
- Feedback from the staff
- Feedback from peers on their role as group member

2.3 Experiential learning and the Reflective Practitioner

The term "experiential" learning, has elements of "open", "flexible" and hence "distance" learning. Weil and McGill (1989) suggest we keep a broad interpretation of experiential learning, but see the structured approach essentially as "action learning within work organisations". Experiential learning can succinctly be described as; "knowledge for use and learning from doing" (Hutton, 1989). The DAT programme for Nuclear Medicine Technologists is in fact a combination of all three "types" of experiential learning that Jane Henry (1989) has suggested should be categorized in the following way:

1. Non – Traditional: a combination of independent study, prior learning, and open and distance study methods.
2. Work Placement: working in the relevant environment.
3. Learning by Doing: activity based structured learning.

Whatever the involvement in experiential learning approaches, the student will have prior experience, which is valued and used as a resource for further learning. The learning is active, meaningful and relevant to "real-life" agendas (Weil and McGill 1989).

Boud (1989) states that a programme could be legitimately described as "experiential" if it shows significant characteristics of at least one of the following dimensions:

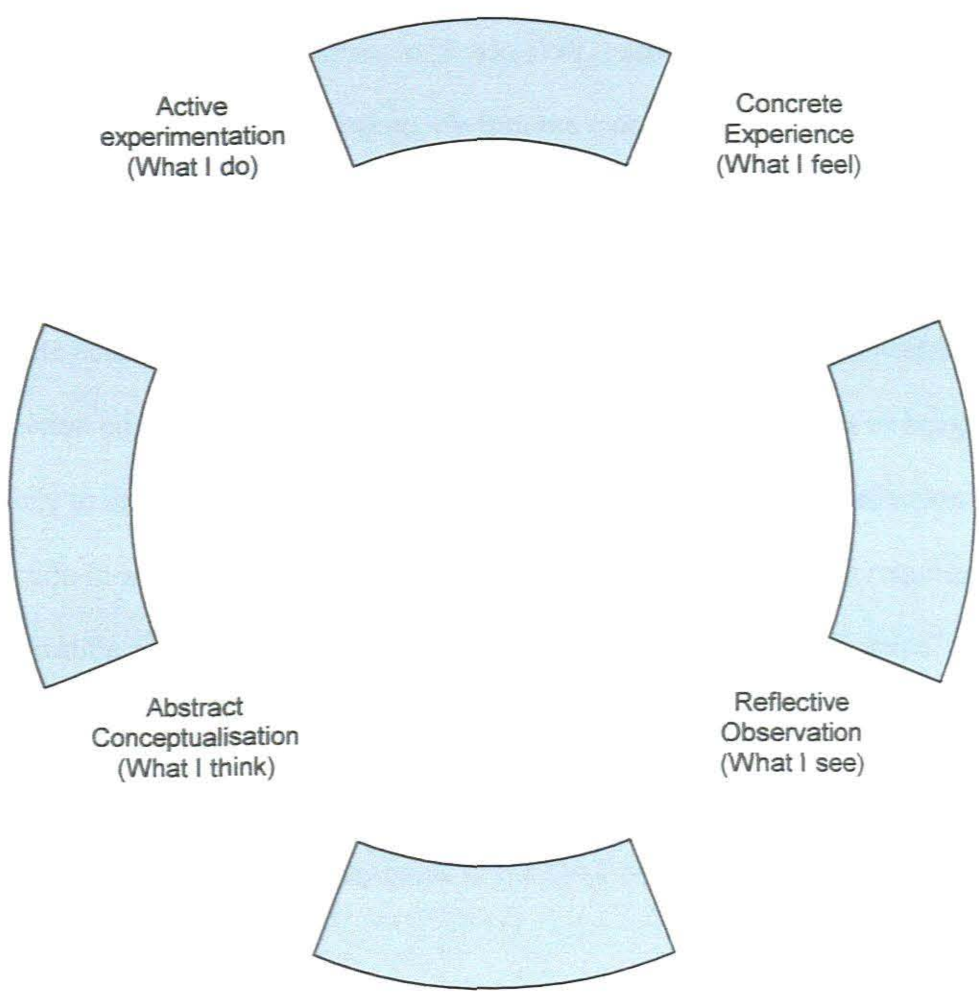
- Degree of learner control
- Degree of learner involvement of self
- Degree of correspondence of learning environment to real environment

Commonly experiential activities show a mix of all three. Learners need a highly supportive and respectful environment where they are valued and the whole person is involved and not just the intellect. Boud (1989) considers autonomy and self-direction as central concepts to experiential learning. The DAT programme can be seen as essentially experiential as it embodies the following salient components (Mellish, 1998):

1. Experience – embracing knowledge, skill or both
2. Reflection – students reflect on experience
3. Action – opportunity to practice (as recorded in their Workbooks)
4. Revisiting – more acute awareness of original experience (e.g. students are requested at regular intervals to revise protocols)

Kolb (1984) sees experiential learning as an integrative process that links education, work and personal development. It begins with (1) the here-and-now **experience** followed by (2) the collection of data and **observation** about the experience. The data is then (3) **analysed** with resultant (4) modification in **behaviour** for choices and new experiences. Immediate concrete experience is thus the basis for observation and reflection. Observations are assimilated into "theory" from which new implications for action can be deducted. This is demonstrated as a four-stage cycle in Kolb's "Learning Cycle" (1975) illustrated in Figure 2-3.

Figure 2-3. Kolb's Learning Cycle



At the developmental stage of a specialization, which we can consider the Nuclear Medicine Technologist to be, Kolb (1984) defines Concrete Experience as having self-awareness of values, Reflective Observation as giving observations personal meaning, Abstract Conceptualisation as concrete symbolic operations and Active Experimentation as development of clear goals and longer-range.

Reflection has emerged as a key concept in the cycle of learning activity in experience based learning. The outcomes of this experience based learning being both personal development and practical relevance. Schön (1987) sees the challenge in educating the Reflective Practitioner as helping people become more competent in the "indeterminate zones of practice"; times where there is uncertainty, situations of confusion, or the nature of the problem is not known. In order to bridge this gap between theory, technique and concrete action it is necessary to carry out a processes of "reflection-in-action" and "reflection on reflection-in-action". "Reflection-in-action" he describes as being the capacity to respond to surprise through on the spot improvisation. "Reflection on reflection-in-action" on the other hand, is an intellectual process which requires verbalization and symbolization. Schön views this "epistemology of practice" as being the nature of professional knowledge. Reflection is thus influenced by experience, linguistic distinctions and theory (Swenson, 1999). Developing "reflective practitioners" was not an intended desirable outcome of the DAT programme.

2.4 Working Knowledge

Mellish (1998) states that experiential learning is increasingly accepted as being fundamental to professional development and work-based learning. The issue of professional development is central to this case study as all student participants are actively engaged in working in Nuclear Medicine departments having come in with skills from related fields and without any qualification in the discipline within which they practice.

2.4.1 Training and Work based learning

The nomenclature selected by the course developers to describe the learning package as DAT, embodies the concept of training as it was originally intended for on-the-job training. The term "Training" is a concept with blurred boundaries however the core usage is connected with the idea of learning to do something in a confident way. Beckett (2000) suggests that a richer understanding of the term "training" is required and should rather be seen as "organic learning". He argues this on the basis that as well as the technical skill formation, there is an emphasis on the cognitive and the affective and the social dimensions of work-life that therefore involves the whole person. The value of the practice thus lies beyond the practice itself, as there exists reflexivity between "knowing how" and "knowing why". This reflexivity is intentional action and is a rich source of experientially based understanding. Billett (2000) recognises in work-based learning a "co-participative" engagement between the workplace and the individual. Co-participation comprises an interaction between how the workplace affords activities and guidance and how individuals engage with work practice. Activities undertaken in the workplace not only shape the development of the individual but also expose them to a range of compounding variables that influences effective task completion. There is a shift away from "application" towards exploring the variations and relationships between situations. In work-based learning most situations are unknown. Bowden and Marton (in Boud 2000) identify two features of learning for unknown situations; one is to be able to discern those aspects of situations that vary from what has previously been encountered and to be able to integrate the disciplinary and professional frameworks of knowledge. Disciplinary knowledge is rarely constructed in a way that can link it to working knowledge. The challenge is thus to make existing disciplinary study units available in a professional work-based setting. Boud (2000) suggests the need to "disaggregate" conventional courses and make them available in different ways and combinations to suit the flexibility of work-based settings.

Most western governments have identified key generic skills or workplace competencies necessary for success in the working world. In South Africa they have been identified in the New Academic Policy (NAP) documents as Critical Cross Field Outcomes (CCFO's). In the UK these are known as Core Skills, in the USA, identified in the Secretary's Commission on Achieving Necessary Skills (SCANS) report and in Australia as the Mayer Key Competencies (Cornford 2000, Knight 2002). They all embody much the same concepts, and by way of example the 5 competency domains identified in the SCANS report are:

1. Resources – identifying, planning, organising
2. Information skills – acquiring, evaluating, communicating

3. Technology Utilization skills – selecting, applying, trouble shooting
4. Systems skills – understanding complex inter-relationships
5. Interpersonal skills – contributing to group effort

These competencies are closely related to what people actually do at work and sufficient attention should be paid to these elements to ensure effective workplace learning. To work competently in the patient-centred field of Nuclear Medicine all these factors come into play.

2.4.2 Evaluation of Work-Integrated learning

In order to evaluate whether Work-based learning (WBL) is efficient and effective, Reeders (2000) suggests adopting a scholarly approach and explore what he considers to be the five challenges facing WBL:

- *Cost-effectiveness:* looking at both costs, not only in monetary terms but also the cost in terms of time and in-put from supervisors and coordinators, as well as the effectiveness of learning.
- *Control:* because work-based learning utilises a variety of settings, there is a higher degree of unpredictability and therefore a need for control. The role of the supervisor as a "resource" (Race 1993) will be an important factor in ensuring a stable "process" rather than a fixed "outcome". (Hutton 1989)
- *Collaboration:* what is the extent of the collaboration across occupational and organisational boundaries necessary for the smooth implementation and running of the course? Klein (1996) refers to this as "boundary-crossings".

- *Capacity*: does the educative potential of the workplace match the needs of the curriculum?
- *Customisation:* respecting what learners bring with them in the way of "symbolic interactionism" and matching our means to our goals. Murphy (2001) gauges this social psychology construct as being critical to learning new technologies.

The term Work Integrated Learning (WIL) has been more recently adopted to encompass the increasing diversity in modes of WBL (Reeders 2000). This term seems to more accurately reflect the type of learning taking place in the distance-learning package used in the case study and so will be referred to as such. Reeders (2000), further contends that "good practice" in WIL should embody the following:

- Appropriate preparation of students
- Assessment of a continuous nature
- Generic learning goals should encompass a large portion of the activities
- Feedback and reflections will drive improvement in activities whilst lack of staff time and resources will inhibit improvement
- Partnership of collaboration should be demonstrated (i.e. between all role-players)
- Capacity building

The quality of the learning experience in the workplace relies heavily on the need for time dedicated to learning plus the commitment, support and feedback from knowledgeable persons at many levels within the organisation (Cornford, 2000). Curran and Murphy (1992) caution that because distance education involves less face-to-face communication, there is less direct information regarding students, performance. There should thus be regular and systematic evaluation of students' progress and other aspects of the programme. The pressures existing in a workplace environment where there is concern for productivity ("patient through-put" in the Nuclear Medicine environment) often limits the attention to learning. With the expansion of technologically advanced, complex Nuclear Medicine imaging devices, a need has arisen for individuals who are proficient in the use and quality assurance of such devices. Such skills require a very pragmatic application-orientated view of appropriate knowledge (Fink, 1991).

2.4.3 Workshop learning

An important and characteristic feature of the DAT programme design is the Workshops where students from the different countries come together. Workshop learning incorporates features of activity theory (Daly & Mjelde, 2000). Learning occurs socially, inductively and in an integrated process that is different from the individualistic, concept-orientated, deductive learning of the academic classroom. Students experience the dynamic of working in a team and learning from one another in this interpersonal social learning process. This interaction with other learners helps alleviate feelings of isolation and is scheduled for when they are likely to experience "mid-course blues" (Race 1993) when the subject matter gets harder and they feel intimidated and pressurized. A pre-course workshop is also held in each country to introduce students to the learning material and course structure and also to induct them into the concept of "self-directed" and "open" learning approaches which will be different to their educational experience up to that point.

2.5 Distance Education in Africa

In most of Africa, experiential learning is part of the lifeblood of transforming society; it has become a tool to empower people.

> *"For those of us from Third World countries experiential learning is not about picking up credits and bits of knowledge. It is about survival. For us, experiential learning is not a methodology; it is not a technique. It is education"* (Weill & McGill, 1989:1)

Fay Chung (1992:1) the Minister of Education for Zimbabwe at the time had this to say;

> *"The greatest challenge facing African countries is how to design a system or learning package that both meets individual country's priorities and also maximises learning in a cost-effective way using the resources available"*

2.5.1 Economics and Distance Education

Distance education costs are characterized by high fixed costs of developing and producing materials but unlike formal education, have the economic advantage of lending itself to "economies of scale" (Chung, 1992), once the initial capital outlay has been made and materials produced, unit costs decrease with expansion. However many operational costs in distance education are less predictable than conventional education, influenced by the extent and quality of the support services (Curran & Murphy, 1992). In a large number of sub-Saharan countries, the predominantly agricultural economies have not sustained the per capita income and development is hampered by a chronic shortage foreign exchange (Chale, 1989). Africa's debt is thus a major constraint in the delivery of Health and Education. The World Bank's policy study of education in Sub-Saharan Africa has identified the importance of distance education in this region (Murphy and Zhiri 1992). Distance education goes a long way toward alleviating the problems of inadequate access to formal education, rising costs, and poor quality education that plagues Africa. The pace of technological advances worldwide has outstripped the capacity of Higher Education and the economies to meet the needs of training. With the fundamental problems already facing education in Africa this problem is exacerbated.

2.5.2 Negative Perceptions of Distance Education

Dodd (1994) in his description of efforts in Africa to provide distance education cites early programmes as having offered satisfactory opportunities for working adults to upgrade their academic qualifications and thereby improve their career prospects. However because distance education was cheap and could cater for large numbers, quality of administrative and pedagogic supervision declined and the phrase "education for failure" was used to describe the distance education system. The reality is that people regarded non-formal avenues of education as being "second-rate" as they traditionally provided a second chance for those who had dropped out or been pushed out of the formal system. According to Chung (1992) there are two important challenges facing those wishing to use distance education in Africa:

> *The first challenge is how to obtain parity of esteem between distance education and the formal system of education in the eyes of the technocrats and general*

public. The second is to develop effective and implementable strategies that will improve overall quality of distance teaching in all its various facets.

The perception of distance education as second-rate is deep-rooted and widespread in Africa. It has affected each of the partners in education, governments, communities and educators. Murphy and Zhiri (1992) put forward the following suggestions for changing that perception:

- Students should come from similar backgrounds and have equal ability
- Quality should be regularly monitored
- Internal evaluations and research should take place
- There should be political support and commitment
- Adequate resources should be provided, especially in initial stages
- There should be a clear target group
- Instructional material should be of a high quality
- DE staff should have appropriate training

This case study will hopefully illuminate whether the DAT course fulfils the criteria in order to contribute to changing perceptions regarding distance education in Africa.

Dodd (1994) advocates that there are three lessons to be learnt from the past experiences of distance education in Africa:

- Distance education/self-study methods are more appropriate for working adults.
- Considerable saving could be achieved by sharing course development costs between countries or utilising course materials already in existence.
- An appropriate curriculum should include vocational and technical subjects.

All of these elements are satisfied in the first attempt to train Nuclear Medicine Technologists in sub-Saharan Africa, which forms the basis of the case study. In the countries selected for inclusion in the pilot study, there are insufficient resources or demand to justify local training courses.

The benefits of distance education go beyond the immediate benefits of the specific course itself. Educated people get more out of life, are better consumers, can absorb and process information more effectively. To developing countries that need to develop socially, politically and economically, these benefits are considerable (Chung 1992).

2.5.3 Economics and Nuclear Medicine

Sachs (2001) attributes the widening gap between rich and poor countries to the differential that exists in the application of science and technology to solving human problems. He talks of the "Quadruple Bind" as being the four elements that are responsible for this gap between rich and poor countries:

1. Science and Technology – rich countries because of their large markets give lots of incentives for research and development whereas poor countries cannot.
2. Returns to scale – scientists in developing countries move to rich countries and end up solving the problems of rich countries rather than poor countries
3. Imported technologies – rich countries are mainly in temperate eco-zones and technologies in health and food production do not always translate well to different parts of the world.

4. Anthropogenic climate change – increasing temperature and changes in precipitation patterns are more likely to impact on the tropical world than the temperate world and exacerbate the problems of the low-income world.

Health technologies related to diseases in poor countries are far from adequate and Sachs (2001) contends that we cannot rely on globalisation itself to solve the problems of the poorest countries. The poor countries simply lack the economic means to make use of the technologies that do exist. This leads to poor health and poor health contributes to the continuing spiral of poverty and social instability. Mobilization of international donor support and the mobilization of international agencies such as the IAEA are needed to help the challenges facing the poorest of the world.

There is an incorrect perception by the Health authorities of many of the countries of Africa that Nuclear Medicine is a tertiary health-care modality and as such has no place in a restricted budget directed towards primary health-care needs. African countries need both preventative care and high-technology medicine; the two groups are not mutually exclusive in a sustainable health-care system. Nuclear Medicine has developed a diagnostic niche in secondary and tertiary health care (Kachienga et al, 1999), diagnosis being the first step in health care. Early and accurate diagnosis of disease reduces the cost of health care. Many Nuclear Medicine techniques both in-vivo and in-vitro have been identified by the IAEA as having a potentially significant impact on the management of common disease states found in Africa. In many countries in Africa Nuclear Medicine languishes behind due to lack of equipment, specialists and training programmes. The IAEA has thus committed its help to the support expansion and development of expertise of Nuclear Medicine in the region.

2.5.4 Anglophone sub-Saharan Africa

Distance education continues to play an important role in globalisation and space-time compression. It is the space-time compression through the use and speed of new forms of communications, which enhances the distance education's contribution to globalisation. No longer is it necessary for educators and learners to be in the same place or even in the same country. This has the paradoxical effect (Edwards 1994) of enabling people to be 'kept in their place' and yet enables them to be brought together across great physical distances through the use of communications. Distance education thus satisfies the contemporary call to "think globally, act locally" (Edwards 1994, p.15). Because of the potential global outreach of distance education, it needs to assume a multicultural discourse. Edwards (1994) questions the extent to which it can "universalise" or "homogenize" curricula. In this case, can Nuclear Medicine students in Africa study materials produced in Australia for use in the Asia region? Learners have identities that are subject to different experiences and we need to take cognisance of this when engaging them in learning.

Students learn at different rates and in various ways. They bring with them their own past experiences and their particular social positions. We cannot assume a "shared perspective" but need to be mindful of "[1]symbolic interactionism", a social psychology construct, which Murphy (2001) gauges as being critical to learning new technologies.

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[1] Symbolic Interactionism Theory: The self is established, maintained and altered in interactions with others

In order for any distance-training course to be successful we need to consider the characteristics of the individual students. Reeders (2000) considers "customisation" of the learning programme to be one of the challenges facing work-integrated learning. We need to consider the educational background of the learners and whether it prepared them for learning new technologies. Was there anything in their cultural backgrounds that either constrained or enabled learning? Independent learning will in general be influenced by the following factors:

- Social or demographic factors: Age, gender, maturity, socio-economic background and occupation
- Personal factors: level of self-confidence, self-motivation, intelligence, expectations, and physical/emotional limitations.
- Academic factors: educational background, previous achievements, reading level, learning style, media preferences, and current knowledge of discipline.
- Learning conditions, physical and emotional environment and access to resources.

To the academic factors can be added "language". When the language of instruction differs from that of the mother tongue or even the language of the workplace, it will possibly have an effect on the outcome. The language of the DAT course material used in the pilot study was English and none of the students were English mother-tongue speakers. There are certain sub-Saharan countries in Africa where English has assumed a special status –in particular where it has been chosen as an official language. In Tanzania English has the status of a co-official language, but its use is limited to the educated elite (Chale, 1992). By giving official status to English, an outside language, all the indigenous languages (of which there might be many) are placed on an equal footing.

Everyone then becomes equally disadvantaged (Crystal, 1990). However, looking at it from a different perspective, the population can be considered to be advantaged as they now have access to a world of science, technology and commerce, which otherwise would not be available to them. In the underdeveloped countries in Sub-Saharan Africa, with limited educational opportunities, only a fraction of the population will learn English. In Sudan, English no longer has official status but is still learned in schools and institutes of higher education as a foreign language. The motivation for this is that English has become the dominant language of world communication. Three quarters of the world's scientists write in English (Crystal, 1988). The importance of this to the Nuclear Medicine Technology students is the considerable availability of textbooks and reference material written in English.

3. METHODOLOGY

3.1 Case Study

Research in distance learning has in the past relied on positivist paradigms (Burge, 1989) with little attention given to the naturalistic and inquiry methods. Case Studies, on the other hand, are a research tradition, which draws on naturalistic observation (Walker, 1980). In essence they are an intensive investigation of a single unit, demanding a close study of individual events, institutions and people.

The customary argument against case studies is that generalisations cannot be drawn from them, as very often the case studies are not representative and only apply to a specific instance in a specific context. However there will be transferability (Lincoln & Guba, 1985) i.e. while it might not be possible to generalise without problem, lessons learned in the case study, can be transferred to other contexts. Insight gained from the DAT programme in the African context would be transferable to other developing world countries.

In order to increase the reliability and validity of the data generated from this case study, comparisons will be made as far as possible with data collected from the project in the Asia region. Notwithstanding the sponsorship of this programme by the IAEA and the fact that findings have formed the basis for many reports to the IAEA, this case study is intended as a participatory evaluation including students, supervisors and coordinators, concerning the educational characteristics of the programme. Because educational case studies, within a participatory mode, take on the commitment to feed back information to the participants in the situation under study (Walker, 1980), information gathered would be accessible to the sponsors and programme participants who require knowledge regarding the programme.

3.2 Programme Evaluation Framework

The overall purpose of the research is to provide a comprehensive evaluation of the DAT pilot study conducted in the AFRA region. It is intended to be illuminative (Thorpe, 1993), *bringing in quantitative principles from the natural sciences as well as qualitative* assessment methods in order to evaluate the process, outcome and efficiency of the pilot study. The overarching framework is based on Babbie and Mouton's (2001) four questions that they consider need to be addressed in programme evaluation:

1. Does the Conceptualisation and Design of the DAT course meet the needs of the beneficiaries?
2. Has there been proper Implementation of the DAT programme in Africa to ensure future sustainability?
3. What was the Impact and Outcomes of the pilot study so that we may establish the relative success of the programme?
4. Were the outcomes achieved in the most Cost-Efficient manner?

While answering these questions the methodology will at the same time attempt to explore the extent to which the perceived challenges to this type of Work-Integrated Learning (WIL) as suggested by Reeders (2000), affected the programme as a whole.

1. *Cost-effectiveness*; looking at both cost and effectiveness of learning. The concern of the evaluation is the quality of the learning experience and the extent to which the learners developed as a consequence of the learning experience. The issues of subject content here is less important than whether learners developed into what Schön (1987) calls 'Reflective Practioners'.
2. *Control;* because distance learning takes place in a variety of settings, there is a higher risk of unpredictability. The role of the supervisor as a resource (Race, 1993) is important in ensuring a stable process rather than a fixed outcome. (Hutton, 1989). Mapping the type of supervision offered is necessary to gauge its effectiveness.
3. *Collaboration;* What was the extent of the collaboration across occupational and organizational boundaries involving the IAEA, the DAT Management team, Regional Coordinators, Hospital Management and National bodies?
4. *Capacity*; did the educative potential of the workplace match the needs of the learner and the curriculum? Were there sufficient resources in terms of equipment, radiopharmaceuticals and patient referrals?
5. *Customisation;* respecting what learners bring with them in the way of past experiences and their particular social positions. We cannot assume a shared perspective (Polgar and Thomas, 2000). Were we able to match our means to our goals? Mapping the participants profile is important to discover whether their educational backgrounds prepared them for learning in this way. Home language would also be an issue if they completed the course in a second language.

3.3 Data Sources

The data available is both qualitative and quantitative. The data was generated from a number of sources, which can be divided into pre-operationalisation of the research framework (i.e. available documentation on the project before realisation of the research or its methodology) and post-operationalisation of the research framework (data sources designed with the research methodology in mind). Essentially all data can be considered to be summative as it was only analysed at the end of the programme, although some sources of data were designed to be formative.

3.3.1 Pre-operationalisation data

1. *Application for Inclusion in Pilot Study* (Appendix A)

   At the planning meeting in Harare 1999, an "Application for Inclusion" questionnaire was adapted from a similar questionnaire requesting an audit of departments. Demographical information on departments concerning staffing, qualifications and training of staff, available imaging and accessory equipment, in-vivo studies performed, in-vitro studies performed, radiopharmaceuticals used and therapeutic procedures performed was requested. This was necessary to assess whether the requesting department had the infrastructure to support training.

2. Student Feedback Forms (Appendix C: sample)

   Following each Module, students were requested to complete a Questionnaire on each Unit of study. Questions related to every section and every exercise of the Unit, and covered a range of aspects; level of understanding, subject coverage, availability of materials for exercises, time allocation and suggested changes. The data was captured and the forms analysed in order to ascertain which Units presented difficulties for the students and what those difficulties were. The Feedback Forms were also used as a formative (Thorpe, 1993) tool in order to make recommendations for changes and amendments to the course developers. The Questionnaires were scrutinized and student suggestions were taken into consideration when designing the programme for the Mid-Course Workshop (Appendix E)

3. Supervisor Feedback Forms (Appendix D: sample)

   Supervisors were required to complete Feedback Forms at the end of each Module. These provided necessary triangulation (Polgar & Thomas, 2000) of the data to establish the nature of the perceived difficulties the students experienced and to crosscheck observations and interpretations.

4. Mid-Course Workshop Feedback Forms (Appendix F)

   Students were required to complete questionnaires at the end of the Mid-Course Workshop related to the tutorials and the clinical observations at each of the three Teaching Hospitals in the Western Cape. Responses to questions were analysed for common recurring themes to establish the perceived value and/or shortcomings of the Workshop and whether it contributed to the overall learning experience.

5. Regional Cardiology Training Workshop Pre-and Post-Test (Appendix G)

   The final Module of the DAT material deals with Nuclear Cardiology Techniques. At the time of study, none of the departments were performing cardiology studies.

All students were therefore invited to the IAEA Regional training workshop on Nuclear Cardiology Techniques. Students were required to challenge a Multiple Choice Question Test before the Workshop and the same test at the end of the Workshop. Analysis of the results of these tests will determine the effectiveness of this workshop and how it contributed to the overall learning experience of the DAT programme as a whole.

6. Course Documentation

   Workbooks, assessment tasks, assignments, data related to clinical/practical examinations and field notes were surveyed and analysed.

3.3.2 Post-Operationalisation Data

1. Student Survey Questionnaire (Appendix H)

   The survey questionnaire was designed as an end-of-programme evaluation. Similar questionnaires were used for students in the Asian countries and are still to be used for students in Latin America and the Caribbean. Considering the number of participants in the DAT course throughout these three regions, a survey questionnaire was the most reasonable method of gauging perceptions of all participants. Although efficient for large numbers, survey questionnaires suffer from only obtaining broad meanings. Therefore two types of question were used; those that required a ranked response and those that required a free form response. For the ranked responses participants were required to respond to a statement using the 'Rensis Likert' (Babbie & Mouton, 2001) scale: strongly disagree, disagree, agree, strongly agree and don't know. The data was captured and analysed quantitatively. The free form responses on the other hand required a response in the participants' own words to an open-ended question. These were analysed qualitatively and provided more detailed feedback. Consideration was given to the appearance and design of the questionnaire which Thorpe (1993) considers to be as important as phrasing the questions. In formatting the questions care was taken to minimise the effort demanded of participants so they would not suffer from questionnaire fatigue (Patton, 1982) and to avoid the following:

- Asking more than one question at a time
- Using jargon
- Using complicated grammatical constructions
- Asking questions that are open to misinterpretation
- Negative items. Respondents tend to read over negative words in a sentence and answer accordingly (Babbie & Mouton, 2001)
- Translation into other languages would need a lexical equivalence (literal word meaning) as well as conceptual equivalence (the meaning in context). This was not a consideration for this initial case study in the AFRA region, as all participants were responding in English, but will be a consideration for the other regions and for Africa when the Francophone countries are included.

2. Supervisor Survey Questionnaire (Appendix I)

In order to get a balanced picture, supervisors were requested to complete similar questionnaires. As the supervisors occupy positions of different status and role, the questions differed slightly but retained the same overall framework and structure.

3. Focused Interviews

   Semi-structured (Rubin & Rubin, 1995) interviews were held with two students and one supervisor. Interviewees were treated as conversational partners (Rubin & Rubin, 1995) and allowed to describe their experiences and views, with the interviewer participating in the interview relationship. The interviews were taped, transcribed and analysed.

3.4 Data Analysis

3.4.1. Issues regarding the Conceptualisation and Design of the DAT material were evaluated by:

a) Analysis of Student and Supervisor Feedback forms from each unit and module.
b) Analysis of Feedback from the Workshops.
c) Analysis of comments on Workbooks in the Feedback forms of both supervisors and students.
d) Analysis of Students', Supervisors and Coordinator's responses to items related to design of course material on survey form.
e) Exploring issues of language and *customisation* in the focused interview with students.

3.4.2 Issues regarding Implementation of the DAT programme were evaluated by:

a) Analysis of Student, Supervisor and Coordinator's responses in the survey form related to *control* in order to map the type of supervision and whether it hindered or constrained the process.

b) Exploring issues related to supervision in focused interviews with Supervisors and Students.

c) Analysis of students' and supervisors' responses in the survey questionnaire and interviews related to issues of *collaboration* to assess the role of IAEA, National Coordinators and Hospital managements in the smooth running of the course or otherwise.

d) Assessment of the educative potential of the Nuclear Medicine facilities involved by a comparison of the details supplied in the "Application for inclusion" form (Appendix A) and resource constraints reported by the students.

3.4.3 Issues regarding Impact and Outcomes were evaluated by:

a) Documentation analysis of all workbooks, assignments and examination results.

b) Analysis of students and supervisors' responses to items related to effectiveness of learning in the survey questionnaire.

c) Exploring gains in knowledge, attitudes and practice (KAP) as perceived by Supervisors and Students in the focused interview.

3.4.4 Issues regarding Cost-Efficiency:

a) *Ex Post* cost-effectiveness (Rossi, Freeman, Wright 1979) analysis. Analysing the effectiveness in reaching given goals related to the monetary value of the resources required for the programme.

b) Comparison of the costs of offering training by Distance Assisted Training methods and that of training by IAEA sponsored Fellowships.

3.5 Ethics Approval

The Science Faculty Research Ethics Committee, Peninsula Technikon, granted ethics approval for the research, at the proposal stage on 18 September 2002.

Consent to use the data generated was received from; Mr Mokdad Maksoudi, Regional Projects Coordinator at the IAEA, as well as supervisors and students interviewed; Drs Maunda, Mselle, Mr Osmen Abdelbagi and Mr Ally Busiry.

4. CONCEPTUALISATION AND DESIGN

4.1 Conceptualisation

4.1.1 Background

In 1992 the Australian Government (through its AusAID programme) agreed to fund a project entitled "Strengthening of Nuclear Medicine in RCA Countries" which included a sub-project on the development of a scheme for the education of Nuclear Medicine Technologists. This project was approved as a Regional Cooperative Agreement (RCA) project to be administered by the International Atomic Energy Agency (IAEA) through the Australian Nuclear Science and Technology Organization (ANSTO). The project commenced in early 1994. During the project a set of materials was developed, intended for use by students or departments, to provide individual students with a basic practical understanding of Nuclear Medicine. Originally intended to provide a programme for in-service training, the materials are also suitable for use in formal courses in Nuclear Medicine as a complement to face-to-face teaching. Technical writers of the materials were practicing technologists and scientists in Nuclear Medicine. The course coordinator in Australia undertook editing for publication into the desired instructional format. The course was tested with an initial set of students in Malaysia, Indonesia, Sri Lanka and India in 1995-6 and the materials were subsequently refined and improved for final use, based on this initial experience. This constituted the first phase, comprising seven modules. In 1999 further funding from the Australian government permitted the development of more advanced subjects and implementation of the programme in other countries in Asia. The material meets International standards of Nuclear Medicine practice and therefore was considered transferable to other developing countries in Africa and South America.

The first attempt to use these materials and provide a distance assisted training programme for Nuclear Medicine Technologists in Africa commenced in November 1999 and was concluded in December 2001. This involved students in Tanzania and Sudan at three different centres and was supported and coordinated from South Africa. The course was conducted under the auspices of the IAEA and is included in the objectives of three ongoing projects: "Establishing a sustainable regional capability in Nuclear Medicine", "Thematic programme on Health Care in Nuclear Medicine for Africa", "Inter-Regional collaboration on distance assisted training for Nuclear Medicine Technologists".

The project was then further extended to include Latin America. As of mid 2002 the course materials have been used through formal courses in 9 countries in Asia (300 students), 12 countries in Latin America (90 students) and 2 countries in Africa (13 students). This has also involved translation of materials to Chinese, Korean, Spanish and Portuguese with translation into French in progress.

4.1.2 Course Aims

The goal of the course developers was not only to produce training materials but also to assist in the implementation of training programmes based on the materials. The material has been specifically designed to assist individuals to develop basic Nuclear Medicine skills that enable them to perform good quality studies, while highlighting the relevance of underlying theory so that students are better able to identify problems, which may occur in their daily work. The material content itself provides a valuable manual for practicing

Nuclear Medicine Technologists and contains practical detail, which is also of use to both scientists and physicians in the field of Nuclear Medicine.

4.1.3 Course Objectives

The objectives of this programme include:

- Providing training in countries where none exists
- Providing assistance to present training courses
- Providing a basis for future indigenous training programmes
- Promoting quality improvement in the Nuclear Medicine service
- Forming the basis for a homogeneous standard in developing countries

4.2 Design

4.2.1 Intended Exit Level Outcomes:

This course of instruction is intended to produce graduates with the following attributes:

- A sound scientific understanding of nuclear medicine imaging.
- An appreciation of the properties of ionising radiation, its hazards and appropriate protective measures that will enable its safe use and application in a clinical setting.
- The ability to produce nuclear medicine images of maximum diagnostic quality, consistent with minimizing radiation dose to the patient.
- An understanding of the technologist's role within the professional working environment and with capability to meet the requirements and responsibilities of the profession.

- Humanitarian attitudes and patient handling skills, as well as an appreciation of responsibilities towards the patient.
- A problem solving approach when performing nuclear medicine duties.

4.2.2 Course Materials

The training material was designed so that it could be delivered and studied in two different ways.

a) Monitored and coordinated in-service training

   There are several subjects (units) within each module and the time for study can vary to accommodate part-time in-service to full-time study. The time taken to complete the course material is dependent upon the student's abilities and study time available. Additional activities such as tutorials, workshops and formal lectures can be arranged at the discretion of the individual departments in which the students work.

   Students have to be working full time in a Nuclear Medicine department and must have access to basic Nuclear Medicine equipment. It is also essential that students have a local supervisor within their department to assist them and provide support when necessary. This model was used in this particular case study with 13 students from 3 different centres in Anglophone countries of sub-Saharan Africa and Coordinated from South Africa.

b) Formal training courses.

The materials can form the basis for new courses being developed or as complementary study materials in existing formal education courses. Algeria has adopted the course for a diploma qualification, with their first intake of students in September 2002. Tunisia intends to follow the same route when they re-new their curriculum. In South Africa, several Technikons are now using the material as complementary study material to their existing courses.

The order of subject delivery, as defined in the syllabus, is carefully arranged so that the information flows in a logical learning sequence. The course commences with an introduction to Basic Sciences and progresses to clinical subjects. The clinical applications are also arranged in a progressive sequence from static planar imaging to more complicated Emission Computerised Tomography. There are a total of twenty-one subjects although several topics have multiple sections (see: Course Syllabus Appendix J). The 21 units / subjects require a total of approximately 500 hours of study and include more than 150 exercises.

Students involved in the pilot study in Africa were only committed to the first 7 modules (approximately 216 hours of study and 84 exercises) as they only had access to basic equipment in their departments and the content in the advanced modules dealt with sophisticated advanced instrumentation. As most students were working full time, five hours of study per week was considered reasonable over an 18 month period. As it turned out because English was a second language and the lack of resources hindered practical exercises, the study time took longer and all students extended the course to 2 years.

A courier delivered course material in the printed form and the recommended textbook for each student, to the supervisors. The supervisor distributed the material one module at a time on the instruction of the coordinator in South Africa. The supervisor was given a CD containing all the study materials plus a guide to the answers of the workbooks.

4.2.3 Study Unit Layout

Each study unit followed the same or similar format. Appendix I, is an extract of the "Renal" study unit and serves as an example. The following typifies the layout:

- **Outline:** The outline defines the content of the whole learning unit, providing an orientation to the topic. The outline also refers to related learning units or topics. A flow chart maps the content and flow of information.
- **Introduction:** An introduction at the beginning of each section identifies the content in general.
- **Objectives:** The objectives are statements clearly identifying what the student should be able to do, in order to demonstrate that they have learnt something.
- **Main body of text:** The main body of the text is written in the style of a tutorial. The text is simply written with appreciation for the fact that English is the second language of most of the students.
- **Summary:** The summary reiterates the themes of the learning unit and helps clarify parts of the text.
- **Key points:** The key points reinforce the important points of the subject matter.
- **Questions:** Throughout the learning material, there are a series of questions which relate to the topic. These questions help the students establish whether or not they

have understood the text. Answers to these questions are provided at the end of the learning unit.

- **Activities:** Activities involve problem solving activities and questions, and/or practical exercises related to the material provided in the learning unit. Some of the activities do not have immediate answers and are provided to stimulate thought.
- **Icons:** In order for the students to recognise different activities and regular sections within the text, a range of icons is used throughout the course material. These icons identify the following:

Activity: Prepare for a practical exercise

Look closely and take special note

Time Check: This allows the student to plan and allocate a certain amount of time for a certain activity

Refer to a textbook and read the allocated section.

Go To your workbook and answer questions

Important point

Key points: *These are important things to remember.*

Remember an important statement or point.

If you need assistance or advice ask your supervisor. It is better to be sure and prepared before commencing an exercise

Always wear protective gloves when handling radioactive material.

4.2.4 Workbook

For each unit/subject there is a workbook to which the student is continually directed throughout the study of the material, to answer questions, complete practical exercises, design protocols and record case studies. Regular checking of the workbooks by the supervisor gives students feedback necessary for them to gauge their own progress.

A completed workbook is thus not only a record of results but also a manual of relevant data, which can be used as a reference at any time. In the case where the student undertakes a formal training course using all the course material, then their completed workbook is an important component of their final assessment.

4.2.5 Workshops and Expert Visits

An initial workshop was held in each selected Nuclear Medicine department in order to introduce prospective participants to the concept of the training course and to identify students and supervisors.

A week long mid-course workshop was held in Cape Town attended by all students and supervisors on the course. All students had completed the first 4 modules at this stage. Feedback from the modules influenced the design of the programme (Appendix H) to include tutorials in areas where the students had experienced difficulties. All participants were given the opportunity to observe specific procedures in the three teaching Hospitals in Cape Town. The Nuclear Medicine physicians at these centres also gave them 'pattern recognition' tutorials. The workshop afforded the opportunity to monitor course effectiveness, student progress and understanding. The student's real or apparent isolation

(Race, 1993) experienced with this type of learning could be alleviated through contact with other students, supervisor and the course co-ordinator.

An additional workshop on Nuclear Cardiology Techniques was held in Cape Town, as students required extra help with the final module dealing with this subject. The programme included sessions lead by two visiting experts in the field, a nuclear medicine physician from the UK and a physicist from America, as well as local experts.

4.2.6 Communications

Throughout the course communication between the regional coordinator in South Africa and the students and supervisors through e-mail, the DAT website http://www.cchs.usyd.edu.au/mrs/iaea/, fax or posted mail was encouraged. The DAT website has a Bulletin Board where students can pose questions. Either one of the regional coordinators in South Africa, Australia or Uruguay answer these questions. Wherever possible, face-to-face interactive meetings were arranged locally for students, to provide encouragement, motivation and to help solve problems. These were arranged on an ad hoc basis by the supervisors.

4.2.7 Student Assessment

Students who completed the course and all assessments were issued with an IAEA 'Certificate of Achievement' *(See example* Appendix L*)*.

The IAEA certificate was awarded based on the following criteria:

- Satisfactory **completion:**

The course Workbook and return of regular assignments were all used as indicators of completion.

- Evidence of **clinical experience:**

  For each of the clinical subjects the student was directed to record details of at least five patient studies in their Workbook. Supervisors were required to sign the recorded case studies for competent completion. Evidence of these case studies was reviewed during the Workbook assessment.

- Testing **understanding:**

  This was monitored through the results of regular Multiple Choice Question (MCQ) tests or assignments for each subject studied at the completion of each module.

  Two final examination papers; a multiple choice question paper and a general paper both contributed to the mark for the level of understanding.

- Assessment of **practical capabilities**.

  A practical examination was conducted by the regional coordinator and an external moderator in each home department in the form of an Objective Structured Clinical Examination (OSCE), and included aspects of 'Hot Lab' technique, clinical imaging, instrumentation quality control (QC) and digital processing.

4.3 Issues emerging from the evaluation of the Conceptualisation and design of the DAT course

The main function of distance teaching is the dissemination of knowledge through self-instructional material along with tutoring, counselling and assessment. Hu (1995) sees this as an example of 'dissemination orientation open learning'. Added to this, the function of the DAT material was to provide practical and clinical skills training. Student and Supervisor perceptions on whether the design of the material met their needs were gathered from a number of sources:

The supervisor interviewed had this to say about the programme

> *"The thing about the programme is that it is very user friendly, you can follow easily. It is only in small areas where you may need help……… "*
>
> *"I think it had everything in there...it was relevant and all things are important for any nuclear medicine technologist to know. And it will be fitting to adapt that programme to fit an individual country...because after all something may not be there (resources) today but tomorrow if you get the equipment you may be able to do so...it was a good idea that it included many things some of which they could not practice but again it prepared them for the future"*

One of the two students interviewed was of the opinion that

> *"The language of the course is not difficult, so it is easy to understand what you are reading and in general the DAT course is good and useful and helps us more in our field."*

Students expressed appreciation for being given the opportunity to study the course in their home country at no cost. The concept of self-directed learning in a distance mode was different to any previous educational experiences they had had. The students interviewed saw no problem in this mode of study, however the supervisor thought:

"I think it was difficult for them particularly that self-discipline......but in the end it was a good thing... (but) I think also there is a need maybe of having students from different countries together for formal type of teaching for 2 or 3 weeks or so. I mean that could help to first of all harmonise, although they are having the same material, but also to interact. I trust that that formal type of lecturing (with students) coming together has a role?"

This comment reveals the supervisor as coming from a behaviourist educational paradigm and indicates that the supervisors as well as the students need to be better introduced to the constructivist approach which is used in this method of study.

4.3.1 Analysis of results from the survey questionnaire

At the end of programme, supervisors and students were requested to complete questionnaires in order to evaluate the course (Appendices H and I).

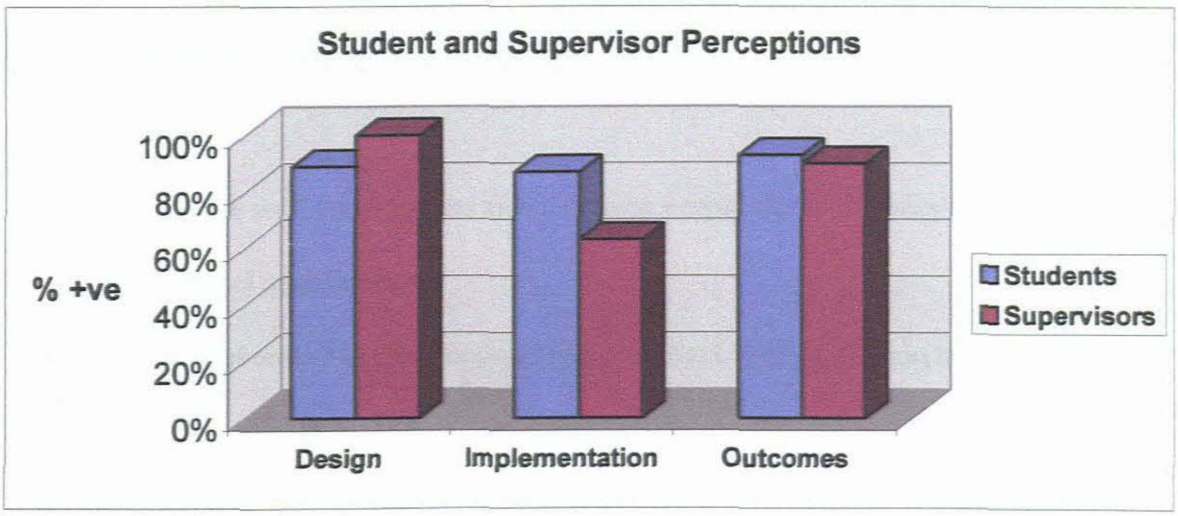
Results of the rated responses to statements on the survey questionnaire, showed that overall; both students and supervisors were positive regarding aspects of conceptualisation and design of the DAT course.

Seventy percent of students were in strong agreement that the course added value to their original qualification. Ninety percent responded positively to the statement that the course material developed skills needed by professionals in the field of nuclear medicine and 80% strongly agreed that the course material had encouraged them to reflect on their clinical practice and had encouraged them to work independently.

Supervisors were more strongly positive. Although only a small sample of two supervisors, they were both in strong agreement that the course was well-designed, well-organised and encouraged students to reflect on their clinical practice. They also both strongly agreed that the material encouraged students to link theory to practice and that the workbooks and presentation of materials at workshops greatly assisted student learning.

Figure 4-4 compares the distribution of the rated responses from students and supervisors. Statements regarding issues of course design, implementation and impact were grouped together and the mean of the scores reflected on the table. The rated responses were scored accordingly; 'strongly agree'= 4, 'agree'= 3, 'disagree'= 2, 'strongly disagree'= 1 and 'don't know'= 0. (Students; N=9, Supervisors; N=2)

Fig. 4-4. Student and Supervisor Perceptions regarding Design, Implementation and Outcomes of DAT programme



Student comments indicated that the design of the material itself aided their studying as well as the tasks in the Workbook and the material presented during the workshop. The course introduction handbook, which explained everything about the course, was useful in preparing them for the programme.

The fact that they could study in their home country at no cost was convenient for students who had many other responsibilities. There was a lack of agreement regarding the length of the course, some students viewed it to be suitable, while others found it was too long. Importantly the students found that the course developed independent or self-study skills, which are necessary for life-long learning. In general it gave them confidence in their work, improving their practical skills by providing them with more knowledge and organizing their existing knowledge. Interestingly, students commented that the course provided them with insight into the scope of Nuclear Medicine practiced internationally.

There were constraining factors reported, however:

- Some modules were found to have insufficient explanation, notably the computer module.
- The modules on Rectilinear scanner and Film processing were not relevant to their practice.
- The module on Basic Sciences was felt to be a repetition of Physics already covered in their original qualification.
- No Aerosol units were available to complete the Lung Ventilation exercises in the Pulmonary module.
- Students had to cope with the normal workload of their departments and found that they had insufficient time for studying and completing practical exercises.
- Students from the centre in Khartoum found the language to be a constraint to their learning
- Repetition of hot lab techniques in the modules was seen as unnecessary.
- Modules covering studies not done in their departments e.g. Cardiac studies.

- Lack of resources and poor equipment posed a problem.
- There were no predetermined dates for examinations and assessments.

4.3.2 Analysis of Feedback Forms

Following completion of each module, students and supervisors were requested to complete a comprehensive Feedback form (Appendices B and C). Students were requested to document their assessment of each section regarding ease of understanding, problems encountered and time taken to complete the section. Likewise supervisors were asked to feedback on how the students coped and comment on the material.

The responses to questions relating to each section and every exercise of the study units were scored as follows; 3 for a positive response, 2 for a neutral response and 1 for a negative response. The median value was then obtained for each study unit.

Detailed feedback obtained from the forms, revealed an overall positive response from students and supervisors alike.

As each of the three centres differed in resources and support, the results are presented separately. The three centres were: Ocean Road Cancer Institute, Dar es Salaam (ORCI), Radioisotope Centre Khartoum (RICK) and Institute of Nuclear Medicine & Oncology (INMO). It is evident from the tables, which subject units the students had difficulty with. Comments from supervisors corroborated the reasons for the difficulties.

Table 4-2. Analysis of Feedback Forms from ORCI

(Students: N=3, Supervisor; N=1). A return of 95% was achieved.

Module	Study Units	Students' Rating	Supervisor's Rating
1	Basic Physics	3	N/R*
1	Radiation Safety 1	3	N/R
1	Radiopharmacy	3	N/R
2	Radiation safety 2	3	3
2	Radiopharmacy –QC	3	2
2	Instrumentation- Dose Calibrator	3	3
2	Instru-Scintillation Counter	1	2
2	Endocrinology- Thyroid Uptake	3	3
3	Instru-Rectilinear Scanner	3	N/R
3	Instru- Gamma camera	3	N/R
3	Instru- Imaging Techniques	3	N/R
3	Computers 1	1	N/R
3	Endocrinology-Thyroid imaging	3	N/R
3	Gastro- Liver/Spleen Imaging	3	N/R
4	Instru- Gamma Camera QC	3	3
4	Instru- Flim Processing	N/R	1
4	Endocrinology-^{131}I therapy	3	3
4	Pulmonary- Ventilation/Perfusion	3	3
5	Computers 2	3	3
5	Skeletal Imaging	3	3
5	Brain Imaging (Planar)	3	3
6	Renal	3	3
6	Gastrointestinal	3	3
7	Cardiovascular	2	3

*N/R: not returned, supervisor out of the country on IAEA Training course.

Ratings of 2 and less indicate the study units that presented a degree of difficulty. Scrutiny of the accompanying comments revealed the reason/s for these difficulties:

- Radiopharmacy QC: One of the exercises required the counting of Instant Thin Layer Chromatography (ITLC) strips. Their dose calibrator, at the time, was not functioning efficiently for this small amount of activity to be measured.

- Instrumentation – Scintillation detector: Difficulty with this unit was due to the fact that students did not have access to a working scintillation probe or well counter at the time of doing the module. Practical exercises could therefore not be done.
- Introduction to Computers: The level of understanding was deemed to be too difficult in this study unit. Extra lectures were given during the Mid-Course Workshop and as the difficulty of this unit had also been reported in the RCA region as well, amendments have been made to this unit already. Students were given extra tutorials and help on this section at the Mid-Course Workshop.
- Cardiac: Cardiac studies are not done in Dar es Salaam, so students had difficulty performing the required exercises. A cardiac workshop was held for Technologists in Cape Town, October 2001. This afforded students an opportunity to observe cardiac investigations.

Table4- 3. Analysis of Feedback Forms from RICK

(Students: N=6, Supervisor: N=1. A return of 86% was achieved)

Module	Study Units	Students' Rating	Supervisor Rating
1	Basic Physics	3	N/R*
1	Radiation Safety 1	3	N/R
1	Radiopharmacy	2.75	N/R
2	Radiation safety 2	3	N/R
2	Radiopharmacy –QC	1.5	N/R
2	Instrumentation- Dose Calibrator	3	2
2	Instru-Scintillation Counter	3	2.5
2	Endocrinology- Thyroid Uptake	3	3
3	Instru-Rectilinear Scanner	2	N/R
3	Instru- Gamma camera	3	N/R
3	Instru- Imaging Techniques	3	2
3	Computers 1	2	2
3	Endocrinology-Thyroid imaging	3	3
3	Gastro- Liver/Spleen Imaging	3	2.5
4	Instru- Gamma Camera QC	3	N/R
4	Instru- Flim Processing	2	N/R
4	Endocrinology-^{131}I therapy	3	N/R

Module	Study Unit	Students' Rating	Supervisor Rating
4	Pulmonary- Ventilation/Perfusion	3	2
5	Computers 2	2	N/R
5	Skeletal Imaging	3	N/R
5	Brain Imaging (Planar)	3	N/R
6	Renal	3	N/R
6	Gastrointestinal	3	N/R
7	Cardiovascular	2	N/R

*N/R: not returned. Supervisor regularly out of country doing locums in Qatar, which coincided with end of modules when the Feedback forms were sent

Difficulties were experienced with the following subject units:

- Radiopharmacy QC: ITLC paper was not available and so chromatography exercises could not be done. During the workshop, students were shown simple methods of chromatography using filter paper, which they could use instead of the ITLC paper.
- Instrumentation-Dose Calibrator: The supervisor commented that the exercises on quality control testing of the dose calibrator could not be done (presumably no calibration sources were available), but arrangements were made with the Sudanese Atomic Energy Commission to help the students with these exercises.
- Instrumentation-Imaging Techniques: The supervisor reported that the exercise on 'Referral forms' posed difficulties, as clinicians in Sudan, are not used to supplying complete clinical histories. The exercises on "count density" required liver images which are rarely performed at this facility and no ^{57}Cobalt marker was available for anatomical marking on images. Students thus needed some help with alternatives.
- Computer 1 & 2: Students found the level of these study units to be difficult. The module assumed a level of understanding that the students did not have. The

students needed the fundamental aspects of general and digital computing to be made more explicit.

- Instrumentation – RLS: Rectilinear Scanning is not available in Sudan. This is an optional module for those countries that still have Rectilinear Scanning devices and students should not have been required to complete it.
- Instrumentation- Film processing: Film is not used for recording images in this department as the chemicals for automatic film processing are too expensive. Therefore some practical exercises could not be done.
- Pulmonary: The limiting factor to this study unit, as reported by the supervisor, was that Lung Ventilation studies are not normally performed in this department. During the Mid-Course workshop, students were given tutorials on how to set up a simple nebulising system.
- Cardiac: As was the case in Dar es Salaam, nuclear cardiology is not practiced and the students were unable to do the practical exercises and log the requisite number of studies.

Table 4-4. Analysis of Feedback Forms from INMO

(Students: N=3, Supervisor: N=1. A return of 79% was achieved)

Module	Study Units	Students' Rating	Supervisor Rating
1	Basic Physics	3	N/R*
1	Radiation Safety 1	3	N/R
1	Radiopharmacy	3	N/R
2	Radiation safety 2	3	3
2	Radiopharmacy –QC	3	3
2	Instrumentation- Dose Calibrator	3	2.5
2	Instru-Scintillation Counter	3	3
2	Endocrinology- Thyroid Uptake	3	N/R
3	Instru-Rectilinear Scanner	N/R	N/R
3	Instru- Gamma camera	3	N/R
3	Instru- Imaging Techniques	3	N/R

Module	Study Units	Students' Rating	Supervisor Rating
3	Computers 1	3	N/R
3	Endocrinology-Thyroid imaging	3	N/R
3	Gastro- Liver/Spleen Imaging	3	N/R
4	Instru- Gamma Camera QC	3	N/R
4	Instru- Flim Processing	3	N/R
4	Endocrinology-^{131}I therapy	3	3
4	Pulmonary- Ventilation/Perfusion	3	3
5	Computers 2	3	3
5	Skeletal Imaging	3	3
5	Brain Imaging (Planar)	3	3
6	Renal	N/R	N/R
6	Gastrointestinal	N/R	N/R
7	Cardiovascular	3	2

*N/R: not returned. There was a change of supervisor early on in the course. The second supervisor did not consistently returned Feedback forms.

As can be seen, students reported minimal difficulties with all subject units. The students at INMO, Wad Medani had the advantage of having a Radiopharmacist in their department who helped them with the module on Radiopharmacy QC. Even though cardiac studies were not done at this facility, one of the students had previously enjoyed a Fellowship in Cape Town and so had expertise to help his colleagues.

It appears that the students from Khartoum seemed to have experienced the greatest difficulties. This seems to have been influenced by the fact that the supervisor was away for an extended period in the middle of the course and there was no Radiopharmacist to help with the accessory equipment needed for the Radiopharmacy modules. Meeting the clinical objectives of the course was difficult for the two Radiography Tutors from the Radiological College as there were logistical difficulties in spending enough time in the department. Both these tutors fared well with the theory however, one dropped out at the very end of the course as he lacked the confidence to challenge the practical examination.

4.4 Evaluation of Conceptualisation and Design

4.4.1 Evaluation of Conceptualisation

The primary goal of the DAT programme was to address the gap between the growth and expansion of Nuclear Medicine in developing countries and the advancement of the Nuclear Medicine Technologist as a professional group. This gap is evident by the many technologists working in Nuclear Medicine world-wide who have little or no formal training in this speciality.

In order to reach as many untrained technologists as possible in the most cost-effective way, the concept of distance training was an appropriate decision. The number of untrained technologists working full-time in Nuclear Medicine in Africa is not accurately known, but according to information gathered at the taskforce meeting in Tunisia in April 2003, the estimated number in countries where no training exists is some 33 personnel. Eleven students have successfully completed the DAT course, which represents a 33.3% improvement in the status.

An important component of professional development has been the establishment of mechanisms for recognising competence in Nuclear Medicine (IAEA's Resources Manual in Nuclear Medicine, 2003:242). Accreditation usually involves the relevant professional society or licensing body. Not all countries have this mechanism of recognition in place; at best there would be acknowledgement of the course. The course provided individuals already working in Nuclear Medicine, an opportunity to integrate academic education and work-based training for accreditation or acknowledgement in their country. The students at ORCI in Tanzania have had their 'IAEA Certificate of Achievement' recognised as an additional qualification by their Hospital management and received promotion with a salary notch increase.

Foster & Stephenson (1998) point out that much work-based learning development has focused on identification and accreditation of work activity, either to facilitate entry into to degree level studies as accreditation of prior and experiential learning (APEL) or to translate the work-based experience into direct academic credits. The IAEA acts in partnership with the AFRA member states in making this programme available but is not in a position to award qualifications. This is an inherent weakness of the programme, which inevitably leads to issues of parity of esteem between this programme and an academic qualification. The University of Sydney accepts candidates who have completed the DAT course to sit an independent examination. A faculty diploma with credit towards further study is awarded to successful candidates. Students from the AFRA member states are not likely to take advantage of this and so, are dependent on local societies or regulatory bodies accrediting the programme. Recognition of student achievement is thus a national responsibility. If there is no such mechanism in place, students will not be motivated to undertake the training in the future.

4.4.2 Evaluation of Design

The DAT material fulfils the criteria of a "Constructivist Learning Design" (page 17) as it has the essential elements of:

1. **Situation:** Activities are related to the students' own situation. All topics, even the Basic Sciences have a Nuclear Medicine focus with all theory related to practical situations.

2. **Groupings:** Material is grouped into modules with varying numbers of study units; Basic Sciences are grouped into subject units and the Clinical units according to Anatomical or Physiological systems.
3. **Bridge:** There is a logical flow of information from basic investigations to more complex. Students are continually directed to information covered in previous modules to ensure a flow from known to unknown.
4. **Questions:** Students are continually directed to answer guiding questions in the Workbooks, to support them to think for themselves.
5. **Exhibit:** Students are required to provide; a formal record of practical exercises and results, evidence of clinical studies performed.
6. **Reflections:** Students are encouraged throughout the course to reflect on their practice. They are required to develop protocols and offer guidelines for further protocol building.

Thus the DAT programme involves the learners in an active process of constructing understanding rather than the passive receipt of knowledge. Furthermore, as reported by the students and supervisors alike in the Feedback Forms, the actual layout of the study material and the workbooks enabled learning.

The predominant constraining factors that hindered learning were; limited resources and poor equipment, studies not done in the home department and workload. As the DAT material is designed in most part as a 'Reflective Action Guide' (Rowntree, 1994) where activities are related to students' own situation, it would be more meaningful if the modules are restricted to those that matched the educative potential of the workplace.

5. IMPLEMENTATION

5.1 Project Management Structure

In order to coordinate planning and implementation there were several 'Key Players' in the management team. The team is managed in Australia by the Project Manager and the Course Coordinator who liase with Advisory Boards, technical writers, assessors as well as the Regional DAT Coordinators in AFRA and ARCAL regions. The management arrangement initiated the title Distance Assisted Training (DAT) for Nuclear Medicine Technologists.

Each country involved in the project in Africa has a Project Coordinator who liases with the AFRA DAT Regional Coordinator and the participants in their country. Project Coordinators are typically in a position to elicit commitment from other institutions and organisations that can assist with course input, such as the local Atomic Energy Authority, Universities and local Societies. The Project Coordinators are mostly Nuclear Medicine Physicians and in Africa also perform the duty of student Supervisor. For the duration of the programme, the AFRA DAT Coordinator coordinated the course from South Africa, liasing with the IAEA in Vienna, the country Project Coordinators/Supervisors, students and the management team in Australia.

5.2 Time Frame

Funding was received from the IAEA in October 1999 for printing and distribution of the course material. A complete set of the materials plus a textbook for each student was forwarded in November 1999 by airfreight to the supervisors in each centre. Disposable

Lung Ventilation systems donated by AEC-Amersham for use in Module 4 were also included.

Students were requested to complete "Statement-of-Ownership" forms on receiving the first module and forward them to the Coordinator in South Africa. These forms effectively registered the student for the course. The course ran over two years as shown in Table 5-5.

Table 5-5. Time Frame of Course

1999/2000	Module 1	Module 2	Module 3	Workshop	Module 4
December	↓				
January	↓				
February	↓				
March		↓			
April		↓	↓		
May			↓		
June			↓		
July				W	
August					
September					↓
October					↓
November					↓

2000/2001	Module 5	Module 6	Workshop	Module 7	Final Assess-t
December					
January					
February					
March					
April					
May					
June					
July			W		
August					
September					
October					
November					A

The course was designed for the first 7 modules to run over 18mnths. However this had to be extended to accommodate a long period of Ramadan in December and a slow start to module 4 following the Mid-Course Workshop. Students set their own pace, which was slower than the stipulated period for each module but coincidently all centres completed modules at more-or-less the same time.

Even although the course extended beyond the original planned 18mnths to 2yrs, the length of the course was viewed by most students and supervisors, as being suitable.

5.3 Communications

Throughout the course communication between the regional coordinator in South Africa and the students and supervisors through e-mail, the DAT website http://www.cchs.usyd.edu.au/mrs/iaea/, fax or posted mail was encouraged. The DAT website has a Bulletin Board where students can pose questions and which are then answered by either one of the regional coordinators in South Africa, Australia or Uruguay. The supervisors were encouraged to invite experts to provide tutorials for students in order to help in solving problems. These were arranged on an ad hoc basis and were not consistent at the three different centres. Mainly these tutorials happened in the early modules, with help coming from the local Physicist.

5.4 Issues emerging from the Implementation of the DAT course

Analysis of the rated responses relating to issues of implementation in the survey questionnaire (Figure 1, Chapter 4) showed supervisors and students alike to be slightly less positive regarding issues of implementation than those of design or outcomes of the course. The weakest aspect, according to the students, and corroborated by the supervisor was that they did not have the academic benefit of regular meetings and discussions. The survey questionnaire and semi-structured interviews were structured to examine the challenges to work integrated learning (Reeders, 2000) of Customisation, Control, Collaboration, and Capacity. Cost-effectiveness, which Reeders sees as a further challenge, will be the subject of a later chapter.

5.4.1 Customisation

It could be said that the course was customized for Nuclear Medicine Technologists as the content reflected standard Nuclear Medicine practice, which should have been readily transferable. However mapping the participants' profile is important to discover whether their educational backgrounds prepared them for learning in this way. The entrance criteria stipulated that:

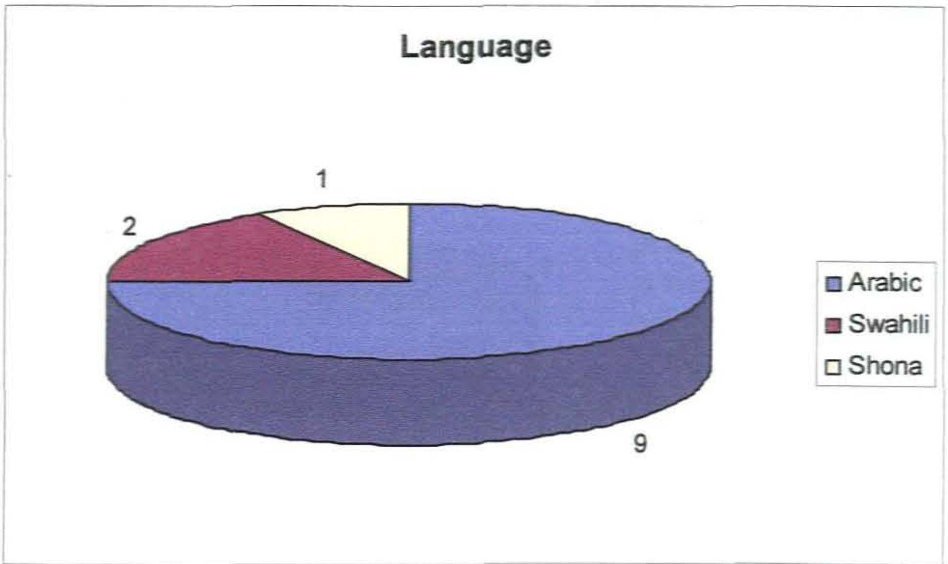
1. Participants should be working in a Nuclear Medicine department for the duration of the course.
2. Participants should have a related qualification in Radiography, Radiation Therapy, Medical Laboratory Technology or General Science.
3. For countries who train school leavers, the participants should have a school leaving qualification with a university entrance plus two years experience.

5.4.1.1. Language

None of the participants of the course spoke English as their first language. However English is the official language in Zimbabwe, a co-official language in Tanzania and is the language of higher learning in Sudan. Figure 5 reflects the mother tongue of the participants (N=12).

The Zimbabwean and Tanzanian students spoke English fluently and the students from Sudan less so. To accommodate English second language students, the study material was written in simple language and all assignments were of the Multiple Choice Question (MCQ) type, and therefore did not require essay type answers. Workbooks required short paragraph answers, as did the final summative assessment paper.

Fig. 5-5. Language of Participants



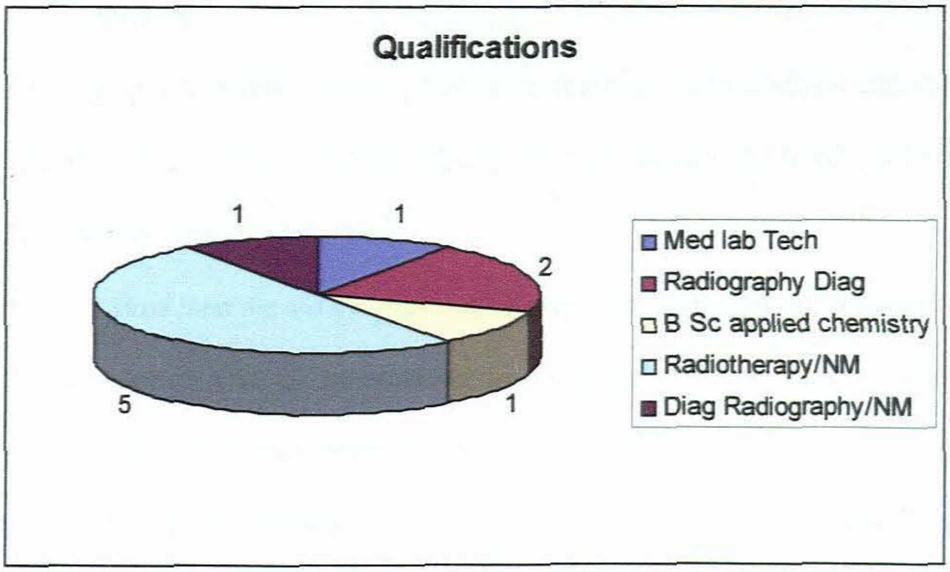
Some students had difficulty with the language of instruction, reporting that, when difficulties were encountered, they had to seek help from the supervisors with interpretation and clarification of language.

5.4.1.2 Educational background

The participants in Africa were mature adult learners with a mean age of 37yrs ±5yrs. Their maturity manifested itself in their commitment to challenge the course and succeed. Participants had a mean experience in Nuclear Medicine practice of 6.7yrs ±3.1yrs. Figure 5-6 represents the types and spread of their various qualifications.

It is important to note that the curriculum of the Radiological Technology Diplomas and Degrees from Sudan with Nuclear Medicine, include only a relatively small portion of Nuclear Medicine with no clinical or practical component to it.

Fig.5-6. Participants' Educational Backgrounds. (N=10)



The analysis of the Free Form responses on the survey questionnaire reflected that students found that their previous qualifications and practical experience prepared them for studying on the DAT programme. A number of the students had enjoyed IAEA fellowships in other countries before being on the course. These Fellowships, IAEA expert visits and IAEA regional training courses all helped to prepare them for the DAT course. The Supervisor interviewed, described the past Nuclear Medicine training experiences of the students in his department as follows

"Two technologists had undertaken one year IAEA fellowships, one in Cape Town and another in Austria. The other one had had no training at all in Nuclear Medicine."

To further illustrate the diverse educational levels of the participants the student interviewed reported that:

"I did my certificate and diploma course in Medical Laboratory Technology, specializing in Haematology/Blood Transfusion and I had a specialised certificate

in RIA. I went sponsored by IAEA to Pakistan and all my studies were in English."

In response to questions probing their study methods, both students interviewed reported that although they did study individually, they got together with their colleagues and did the practical exercises together.

"Most time we did the practical together but the study, we did our own study."

Practical exercises needed some effort in setting up, and it seems a sensible and mutually beneficial arrangement if students worked together on them.

How well students adapted to distance education and in particular self-directed learning (Boud, 1989) can be gauged from comments made regarding their desire for face-to-face tuition. In general students were of the opinion that the aspects of the course which could have been taught more effectively on a face-to-face basis were notably those where practice was involved; computer analysis, Radiation Safety, Radiopharmacy practice and certain imaging techniques.

Their desire for face-to-face interactions for whole subjects e.g. Instrumentation, showed some difficulties with the concept of self-directed learning (Boud, 1989). Students found the workbooks helpful in this regard, as they where required to answer questions and reflect on practical exercises, which helped to reinforce learning. The face-to-face interactions of the workshops were often cited as having benefited the students most. Supervisor opinion in the survey regarding face-to-face tuition concurred, and it was felt that although it was seen that face-to-face interactions were important for practical work, the text was written in such a clear and simple way that it enabled learning without difficulty with the support of a supervisor.

The student from Zimbabwe only completed the first module in the Harare department and had to complete the rest of the course in South Africa. Although she was studying away from her home department and did not have the support of colleagues on the same course, commented that she had benefited from introductory tutorials prior to the start of each module.

5.4.1.3 Workload

One of the main difficulties the students experienced was studying and working at the same time, as reported by the student interviewed:

> *"The main problem is the time. You do not find the time to read and do the practical because you are busy with other things."*

Students were all in full-time employ in busy departments, and had to find time for the various practical exercises needing equipment, radiopharmaceutials and patient studies. The supervisor interviewed, when questioned on how the students coped with the course, said:

> *"Let me say they felt there was a pressure and it was a bit too demanding to them. Yes that feeling."*

As empowering the country to adopt its own training was one of the goals of the project, two of the students from Khartoum were radiography tutors from the Radiological College. They had the additional pressure of getting enough clinical time in the department over and above their teaching load.

The supervisor interviewed from Dar es Salaam when asked if he considered supervision to be an extra workload had this to say:

"Not really as I had no fulltime attachment to it [supervision was shared] ……but otherwise it was not too demanding because after all we knew that out of it would come a better training"

5.4.2 Control

As the DAT course took place in three different centres with some five different Supervisors there was a high degree of variation and unpredictability regarding control. It is important to look at what sort of control there was, and establish the type of supervision the students received.

5.4.2.1 Supervisor Profile

All supervisors were Nuclear Medicine Physicians. By virtue of their position they were familiar with the course content, if not the actual course material, as it contained widely used Nuclear Medicine techniques and protocols. The course material was available to supervisors on CD, with answers to workbooks to help them in their supervisory duties. The department in Khartoum has only one Nuclear Medicine Physician, and he was the supervisor for the entire duration of the course. In the middle of the course however, he was absent for a protracted period while doing a locum in Qatar. The students were left without supervision for this period. Fortunately, during this time students attended the Mid-Course workshop in Cape Town, which provided them with the motivation to persist. At INM&O in Wad Medani, the original supervisor left early in the course and the students were without supervision for the duration of Module 3. It is a tribute to the maturity and commitment of the students in both centres that they were able to continue, despite breaks in supervision. The students in Dar es Salaam were in a more fortunate position as the supervision was shared by two physicians, which ensured continuity when any one of them was absent.

Presentations during the pre-course expert missions had given some insight into the challenges of supervision, and one supervisor had also acquainted himself with the Asia experience through the Internet.

5.4.2.2 Type of mentorship

All students were known to Supervisors. The benefits of knowing the supervisor helped to "smooth the way" for the students and thus provided a human resource for the students (Race, 1993). From the analysis of the Free Form responses in the survey questionnaire, it is clear that supervision took place with the supervisor in the role of "corridor mentor" (Race, 1993) i.e. informal mentoring, which works well for those who meet often anyway in the normal workplace. Help was sought when the students experienced difficulties, but in the main students took responsibility for their own learning, having discussions with their peers when they felt the need for clarification.

> *"If there is anything that one of us didn't understand then it was just a matter of asking some of us or we just consult our supervisor."*

Rated responses on the survey questionnaire, reflected that 90% of students found the supervisor was helpful at all times and 80% thought that there had been sufficient support from supervisors necessary to carry out the practical exercises.

One Supervisor was of the opinion that supervisors needed to be committed to the success of the programme and suggested that setting up a communication network with other Supervisors in the AFRA region should be considered.

5.4.2.3 Workload

One of the Supervisors found the workload associated with supervision was difficult to meet and the help of another physician would have been useful. He felt that the workload required of him had not been made clear to him. This supervisor had replaced the original supervisor and had thus not had the benefit of the initial orientation visit and had very much been thrown in at the deep end. Despite being disadvantaged in this way he showed admirable commitment to the task.

In response to statements regarding supervision on the survey form, supervisors responded positively; considering the number of students to have been manageable and were clear of their role as supervisor. One supervisor found that the students needed more help than he was able to give.

Students comments on supervision was generally that it was good when help was needed

> *"Actually they tried their level best, because you know the supervisors are very busy with patients, but if we have a problem we contact them and they help us. They give us full support."*

5.4.2.4 Planned meetings and tutorials

Students generally felt that there were not enough structured meetings and discussions and expressed the desire for additional tutorials and lectures. Lack of timetabled planned meetings is a weakness of this type of "corridor mentoring" (Race 1993) that took place. Most students felt they would have benefited from group discussions not only with their immediate peers but also with students from other centres as well as other professionals in Nuclear Medicine. They needed more supervisory help, particularly with; practical exercises, during image acquisition time and investigations that they had not seen before.

The supervisor from Wad Medani felt he was able to give the students the help they needed without the necessity of arranging extra tutorials. He did concede that he did not hold meetings with the students on a regular basis. Forty percent of the students indicated that additional tutorials had not been organized and no discussions with fellow students were scheduled. Supervisors also encountered difficulty finding additional resources for the students.

5.4.2.5 Feedback

The supervisor is an important "human resource" (Race, 1993) to enhance learning and needs to give regular feedback.

Workbooks were not checked regularly and students would have liked more feedback following completion of Workbooks. Feedback is a key process in distance education (Grant 2000) and supervision could have been improved by more frequent meetings and discussions and reviewing of workbooks.

Students felt the least helpful aspects of implementation of the course were that more help was needed from the supervisors; this was a contributing factor to the course taking longer than originally intended.

5.4.3 Collaboration

The DAT programme involves a wide range of players across organizational and occupational boundaries. It is necessary to determine whether there was sufficient and effective collaboration in ensuring the smooth implementation of the course for its future sustainability.

5.4.3.1 IAEA support

The collaboration with the IAEA under the various AFRA and Inter-regional projects has been documented in the introduction. Students expressed their appreciation of the role the Agency played:

> *"Actually the IAEA played a big role because; first of all they are the one who introduced nuclear medicine department in my country. They've trained (staff), the expenses which they have spent on us on the DAT course and other training. Finally we managed to qualify as nuclear medicine technologist. Actually they play big role."*

The IAEA funded the pre-course missions, the Mid-course and Nuclear Cardiology Techniques workshop in Cape Town and the final assessment visits. Over and above this a budget was supplied to the Regional coordinator in Cape Town to cover costs of printing and delivery of study materials. All other expenses e.g.[1] forgone opportunities were born by the counterpart institutions.

All supervisors and 90% of the students regarded the organisation of workshops and assessment visits to be good. Students requested more Training courses and workshops as they felt that these had been very useful in meeting course objectives.

Supervisors deemed the limited resources as being a constraining factor to students not meeting course objectives and wished for additional IAEA help in procuring necessary equipment and accessories.

The majority of students expressed a desire for more collaborative support in being able to observe clinical studies not done in their home departments. This support would have

[1] Foregone opportunities: earnings foregone while person participates in project (Rossi, Freeman & Wright, 1979)

to come from the IAEA as the students would only be able to acquire a broader clinical experience outside their home country as Fellowship training.

5.4.3.2 Local support

The rated responses on the survey questionnaire showed that all students and supervisors had received encouragement and support from their Hospital Management and departments. The Supervisor from Dar es Salaam pointed out that local management support was critical to the success of the programme.

The study material had been delivered in bulk to the supervisors in each centre. The material was given to the students, one module at a time, on the instruction of the Regional coordinator in Cape Town. All supervisors thought the logistics of delivering study material had gone smoothly, however 20% of the students reported that the study material had not been made available to them on time, indicating a loss of time between completing a module and progressing to the next.

Generally participants would have liked more support from their departments in the way of work relief for studying and supervising, as the course had to be done while meeting normal workload commitments. All supervisors indicated that they were able to allow students time off for study, complete assessments and attend workshops when necessary. However, 20% of the students felt that they were not given enough time to study. Although all supervisors felt that students had been given sufficient camera time, 30% of the students felt that they had not been allowed sufficient camera and laboratory time to complete the practical tasks required.

More specifically students needed collaborative help from Physicists with the Basic Physics and the Computer modules. Additional help was given by physicists in the early modules, as reported by the student interviewed:

> *"Yes in our case during the computer module. Yes......it is a problem, but we get support from our physicist."*

The supervisor at one centre reported:

> *"There were key areas where students sought formal lecturers and these were mostly on nuclear physics...... [the students received] the formal teaching in nuclear physics from our colleagues who are Medical Physicists."*

> *"Actually there is a continuing education programme where there is a programme of teaching involving all technologists so......they identified specific areas where they thought they were weak and the time that (was) allocated for the normal medical physics lectures were now utilized to solve these problems."*

Some accessory materials for practical exercises were not available in the home departments and supply of these materials was seen as a necessity for meeting course objectives. The student interviewed from Ocean Road Cancer Institute in Dar es Salaam was of the opinion that extra funding for consumables should come from the Health budget and was the responsibility of the ministry:

> *"They (the patients) are being treated free. So we need support from the ministry to buy radiopharmaceuticals. If we get their support we*

can do these (nuclear medicine) studies routinely. We have enough patients the problem is financial."

5.4.3.3 Regional Co-ordinator support

All supervisors strongly agreed that the Regional DAT Coordinator in South Africa had been supportive; communication had been regular and the coordinator was able to sort out problems encountered by liasing with the IAEA in Vienna and the project coordinators in Australia.

Students found the lack of feedback from Supervisors as limiting and conceded that they should have communicated with the Regional Co-ordinator in South Africa far more. The Regional Co-ordinator marked assignments, and detailed feedback was given wherever possible. Unfortunately the website "bulletin board" was a communication tool that was not used. Internet access was not readily available to all the students and they did not feel comfortable with this type of communication. The fact that students seldom take the initiative to communicate and communication is thus one-way, is seen as one of the pitfalls in Instructional design (Gupta 1989).

5.4.4 Capacity

Limited resources presented many difficulties and were a source of frustration for the students on the course. Limited investigations done in the departments were seen as an additional constraint, especially cardiovascular investigations.

The basic requirements of the course, regarding the departments, were that trainees should be situated in operational departments that had the following minimum equipment and infrastructure:

- Gamma camera and associated computer, dose calibrator, survey meter
- Designated "Hot-Lab" area
- Access to probe or well counter
- Regular supply of radionuclides
- Access to a SPECT camera (for completion of phase 2)

In addition it was required that the students should operate under the control of a Nuclear Medicine physician.

As the DAT material is designed in most part as a "Reflective Action Guide" (Rowntree, 1994) where activities are related to students' own situation, it is necessary to determine whether the educative potential of the workplace matched the syllabus objectives.

An analysis of the information on the departments requesting inclusion in the pilot study is shown in Tables 5-6a to 5–6e. As can be seen from the Table 6a reflecting the status of the equipment, all centres met the criteria except for the Ocean Road Cancer Institute whose well counter was not functioning at the time. Table 5-6b shows that there was good support in terms of personnel, all centres having a Nuclear Medicine physician and physicist, with one centre being in the fortunate position of having a radiopharmacist. Table 5-6d indicates there was a reasonable spread of routine investigations, with availability of commonly used radiopharmaceuticals as shown in Table 5-6c. Adequate therapeutic procedures are performed in all three departments (Table 5-6e).

Key for the centres:

INMO: Institute of Nuclear Medicine & Oncology, University of Gezira, Wad Medani.

ORCI: Ocean Road Cancer Institute, Dar es Salaam, Republic of Tanzania.

RICK: Radioisotope Centre Khartoum, Sudan.

Table 5-6a: Equipment

Centre	Gamma cameras	SPECT	Dose Calibrator	Survey meter	Probe/well counter
INM&O	1	0	1	2	2
ORCI	1	1 (installed 2000)	1	2	1 (not functioning)
RICK	2 (1 not functioning)	0	1	2	1

Table 5-6b: Personnel

Centre	NM Technologists	NM Physicians	Medical Physicist	Radiopharmacist
INMO	3	1	1	1
ORCI	3	2	2	0
RICK	5	1	1	0

Table 5-6c: Radiopharmaceuticals

Centre	Radionuclide Generator	Iodine-131	Pharmaceutical 'cold' kits per week
INM&O	99mTc 8000MBq/week	5mCi/week	• MDP x 3 • DTPA x 3 • DMSA x 2 • Sn Colloid x 2 • HIDA x 1 • MAA x 2
ORCI	99mTc 18.5 GBq/mnth	Therapy capsules on demand	• MDP x 1 • DTPA x 1 • DMSA x 1/mnth • Sn Colloid x 1/mnth • Myoview x 1/mnth
RICK	^{99m}Tc 75GBq/week	7mCi/week	• MDP x 6 • DTPA x 2 • DMSA x 2 • Sn Colloid x 1

Table 5-6d: Investigations

Centre	Type of Investigations per month
INM&O	• Skeletal imaging x 10 • Renal studies x 12 • Thyroid x 30 • Liver x 6 • Hepatobiliary x 3-5 • ERNA x 5
ORCI	• Skeletal imaging x 15 • Renal studies x 30 • Thyroid x 28 • Retrograde Cystography x 2 • Liver x 4 • Brain x 3 • Oesophageal Transit time x 4
RICK	• Skeletal imaging x 24 • Renal studies x 17 • Thyroid x 22 • Liver x 4 • Brain x 4

Table 5-6e: Therapeutic procedures

Centre	Radiopharmaceutical	Procedure	Number/mnth
INMO	^{131}I 10mCi/week	Thyrotoxicosis	2
ORCI	^{131}I on demand	Thyrotoxicosis Ablative dose	3 1
RICK	• ^{32}P 1.85GBq/week • ^{131}I ablative 7.39GBq/week • ^{131}I therapy 7400MBq/week	• ^{32}P injection • ^{131}I Ablation dose	12 2

5.4.4.1 Equipment limitations

An important aspect, which is stipulated as a minimum requirement for the establishment of a nuclear medicine department (IAEA R/6/022 project document), is an un-interrupted power supply. Poor quality of electrical power is recognized as a major cause of equipment malfunction and failure (Kachienga et al, 1999). Unreliable power supply systems and power failures are common problems in many countries of sub-Saharan Africa. For the duration of the course, camera "down-time" was not significant at any of the three centres and did not hold up the progress of the students.

From the information given it can be seen that the minimum requirements for inclusion were met in all centres except for ORCI who did not have a functioning scintillation well counter or probe at the time. Thus students at this centre had difficulty in completing the Instrumentation study unit dealing with scintillation detectors and were unable to perform the exercises as reported in the Feedback forms for that unit.

Despite the fact that on paper, the equipment met the criteria for the course, students' perceptions were that they had difficulty in fulfilling course objectives because of limited resources and equipment. Gamma cameras supplied by the Agency are generally reconditioned Mediso cameras from Hungary, which are not very sophisticated in their design and operation; students might have seen this as a limitation.

5.4.4.2 Range of investigations

All centres had a continuous supply of radiopharmaceuticals and a reasonable range of routine investigations being performed, with the exception of Lung ventilation and Cardiac studies. Nonetheless 40% of the students surveyed found that there was not a sufficient range of investigations done in the home departments, which were necessary for completion of the greater part of the clinical applications, required in the course. This was corroborated by one supervisor who indicated that there was not a sufficient range of investigations in his department to meet the outcomes of the course.

5.5 Evaluation of Implementation of the Programme

5.5.1 Evaluation of Customisation

The language of the course materials posed some difficulties for students, as English was a second language. The students from Sudan had the greatest difficulties. The fact that they had been working in Nuclear Medicine for a long time with an average experience of approximately 7 years, helped in their understanding of the material, as they were familiar with the discourse of the discipline. A supervisor acting as mentor is required, to help those having difficulty in understanding the text and questions in the workbook, if they are not studying in their mother tongue.

The educational backgrounds of the students were appropriate to the course and ensured a meaningful progression from their original qualifications. Participants (i.e. students and supervisors) were used to a more traditional approach to teaching and learning, but coped well because of their maturity and commitment to the course. The motivating factor was that they aspired to achieve an international standard, and the material gave them an appreciation of the standard of Nuclear Medicine practiced globally.

In an effort to empower the countries to set up their own indigenous training, the Radiological College in Khartoum were invited to participate in the course; the rationale being, to train the prospective trainers. Flexibility was exercised regarding the requirement that participants should be in full-time employ in a Nuclear Medicine department, to include those who were not in full-time employ, but had sufficient access to a department. The two participants from the Radiological College fared very well with the theory and assignments but did not get enough clinical experience to fulfil the practical requirements and thus attain clinical competence. The instructional design therefore, only accommodates those students in full-time employ.

The course expectations regarding time for study and meeting clinical objectives was unrealistic for busy departments. This was exacerbated by the fact that the full staff complement in each centre, was engaged in the course, and everyone experienced the pressure of time. If future students are to be enrolled they would need some measure of work relief to adequately cope with the demands of a course which is designed as a "Reflective action Guide", which this course is.

5.5.2 Evaluation of Control

The supervisors were busy Heads of Departments and thus were unable to give the task of supervising the necessary time it required. They functioned well as "corridor mentors", helping the students in and informal way. The weakness of this type of mentoring, which happened in this case, was that no time-tabled meetings were planned. Discussions happened on an ad hoc basis either with the supervisor or with other students.

There was not sufficient or even adequate feedback on Workbooks, despite the fact that supervisors had the workbook answers available to them on CD.

The supervisor is a key person in the implementation process and the initial pre-course discussions were not enough to induct them into this important role. To ensure success a "train-the-trainer" approach should be adopted during a pre-course workshop.

5.5.3 Evaluation of Collaboration

The IAEA has been instrumental in establishing the Nuclear Medicine facilities at the participating centres, and as such were committed to sustaining the Nuclear Medicine service by developing the expertise. Previously training had been done by sending Nuclear Medicine personnel out of the country for Fellowships to other departments. These Fellowships resulted in learning by observation and were unstructured with no clear objectives. Participants were grateful for the IAEA in giving them the opportunity to undertake a structured course in their home country. This made training more accessible to those who had family commitments and could not leave their homes for an extended period. At the Inter-regional meeting in Cape Town a decision was taken to support and give preference to those students who had been successful on the DAT course to undergo short periods of Fellowship training at [2]"designated centres", in order to attain competence in those investigations not done in their home departments. This will facilitate the selection process for fellowships and also afford the fellowship more focus. It was established in the pilot study that Workshops are an important part of the programme; not only from a learning perspective but also for the opportunity it gave the students to interact with each other and share experiences. The initial pre-course visit would have been more beneficial as a workshop where both students and supervisors

[2] Designated Centre: A term replacing a centre previously referred to as "Centre of Excellence"; a department signalled out by the IAEA for its expertise in the field of Nuclear Medicine.

could have been comprehensively inducted into this method of leaning. The number of workshops was insufficient to meet the needs of the students. The essential period where the students needed extra help was in the initial Basic Science modules. Extra local support is needed from physicists, pharmacists and physicians.

More Workshops need to be planned if the course is to run over 2 years; at least four altogether:

1. Orientation Workshop; to introduce them to the method of study, the materials and expectations of the programme.
2. Basic Science Workshop; to give students extra support to help with fundamental concepts and practical exercises with the necessary accessory equipment.
3. Clinical Application Workshop; to provide a forum for discussion of alternative methods to accommodate the local situation.
4. Final Assessment Workshop; to allow students to reflect on performance and feedback following assessment.

The Regional Coordinator was a necessary person in the whole process, as the countries themselves did not have the expertise or the infrastructure to attempt the programme without outside support.

Regular and efficient communication is essential in distance education and in this pilot study it was not encouraged sufficiently. Postal communication in Africa is out of the question because it is unreliable and inefficient for quick responses. Communication with the supervisors was sporadic, especially Khartoum, as all communications was sent via fax, which was frequently not connected. Students did not communicate with the

Regional Coordinator as they did not have Internet access to communicate via e-mail or through the website "bulletin board".

5.5.4 Evaluation of Capacity

Participants felt a sense of frustration at not being able to meet all the practical and clinical course objectives. There was however the basic instrumentation available and a reasonable range of routine investigations. The design of the material is such that students are continually directed to exhibit evidence of exercises performed. The question arises whether they should be limited to the study units of direct relevance to their daily work or should they be required to complete all study units. The value in the design of the material is that there are aspects of the study units, such as developing protocols (Appendix I, page 46) which will stand them in good stead if they have to set up any of these studies in the future.

An inventory of accessory equipment needed for exercises should be made available to the Hospital Management before the start of the course and a commitment that it be supplied, should be elicited. Generally the IAEA does not supply consumable equipment such as chromatography paper, so this has to be supplied by the department.

Responses to the survey questionnaire indicated that the course was viewed, as being important to the country and training should continue with more students being trained in order to build capacity.

6. IMPACT AND OUTCOME

Henry (1989) talks of the shift from the industrial to the information age leading to an altered educational emphasis from retaining knowledge to developing the "knower". The challenge in this changing world is to develop competent individuals who have initiative, confidence, insight and skill to act effectively. Assessing the impact and outcomes of the DAT course will uncover whether the learning methods used developed self-motivated situation improvers.

6.1 Student Assessment

Students who completed the course and all assessments were issued with an IAEA "Certificate of Achievement" *(*Appendix J*)*.

For each subject "Completion" is indicated and clinical experience where appropriate. Understanding and Practical Skills are assessed using a combination of continuing assessment and final examinations both written and practical.

The IAEA certificate was awarded based on the following criteria:

- Satisfactory **completion:**

  The course Workbook and return of regular assignments were all used as indicators of completion.

- Evidence of **clinical experience:**

  For each of the clinical subjects the student is directed to record details of at least five patient studies in their Workbook. Supervisors were required to sign the recorded case studies for competent completion. Evidence of these case studies was reviewed during the Workbook assessment.

- Testing **understanding:**

  "Understanding" was scored from the results of the tests or assignments at the end of each module as well as the results of the two final examination papers; a multiple choice question paper and a general paper.

- Assessment of **practical competencies.**

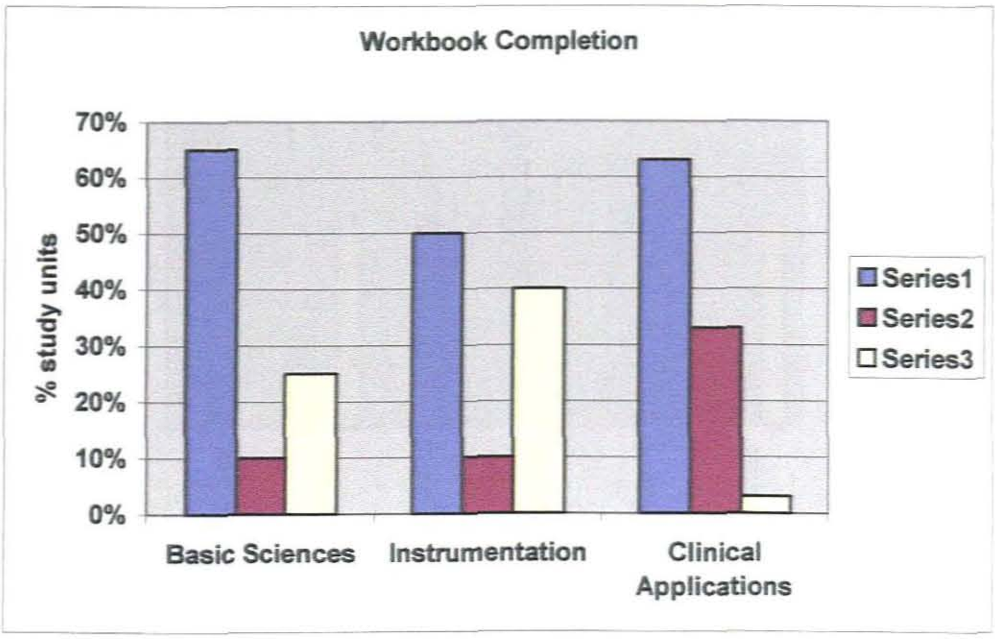
A practical examination was conducted by the regional coordinator and an external assessor in each home department in the form of an Objective Structured Clinical Examination (OSCE), and included aspects of "Hot Lab" technique, clinical imaging, instrumentation QC and digital processing.

6.2 Student Results

6.2.1 Completion:

Each unit of each module had an associated Workbook. While studying the material students were directed to perform tasks in the Workbook. The workbooks were assessed for % completion as shown in Figure 6-7, (Units are grouped accordingly; Basic Sciences comprising the workbooks on Physics, Radiation Safety and Radiopharmacy. Instrumentation comprising workbooks on all instrumentation units and computers and Clinical Applications comprising of all other workbooks related to the various systems.)

Fig.6-7 Completion of Workbooks



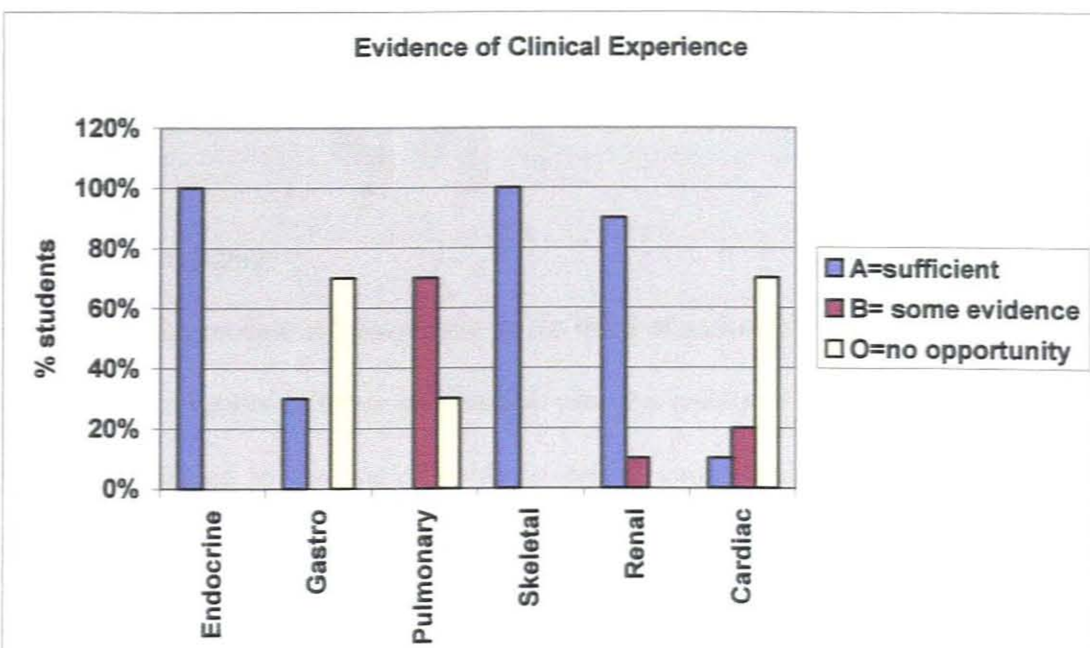
Commentary:

Students had greater success in completing workbooks related to Clinical Applications with only a small percentage i.e. 3% of these workbooks being <60% complete. In comparison 40% (n=8)of Instrumentation workbooks were <60% complete and only 50% (n=10) were>80% complete. Sixty-five percent (n=13) of the Basic Sciences workbooks were <80% complete and 25% (n=5) <60%.

6.2.2 Clinical Experience:

At the end of Workbooks related to Clinical applications students were required to log up to 5 investigations of the relevant investigation/s. Case studies recorded in this way indicated evidence of clinical experience (Figure 6-8).

Fig. 6-8. Evidence of Clinical Experience



Commentary:

Examination of the graph yields the following information:

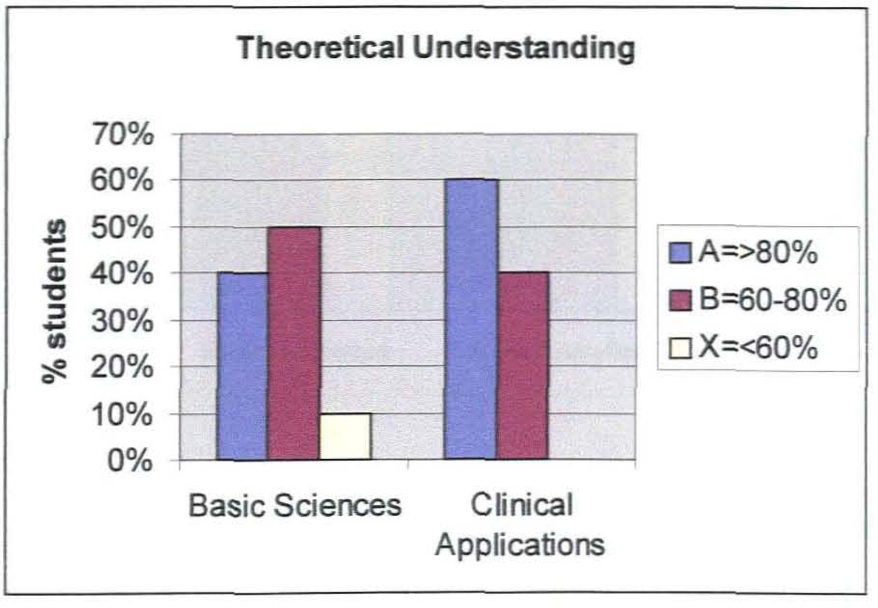
- There was good evidence of clinical experience in the Endocrine units dealing with thyroid imaging, thyroid uptakes and iodine therapy procedures.
- In the workbooks related to the gastrointestinal system, there was sufficient evidence of Liver studies from students at ORCI and INM&O but no evidence from students at RICK.
- No lung ventilation studies were performed at any of the centres hence only some evidence of lung perfusion studies was recorded.
- All students showed sufficient evidence of having done skeletal scintigraphy.
- Most students recorded sufficient renal studies.
- There was no evidence of cardiac studies having been performed by most students. Students from INM&O were able to show limited evidence. One student showed sufficient evidence as he had been on a fellowship to Cape Town and performed those investigations there.

6.2.3 Understanding:

Following each module an assignment in the form of a closed book test was given to the students. The results of these assignments plus the results of the two final examination papers contributed to the marks for their overall understanding shown in Figure 6-9. Scores were grouped under the categories of Basic Sciences (including instrumentation) and Clinical Applications.

It can be seen from the graph that students scored best in the test questions related to clinical applications.

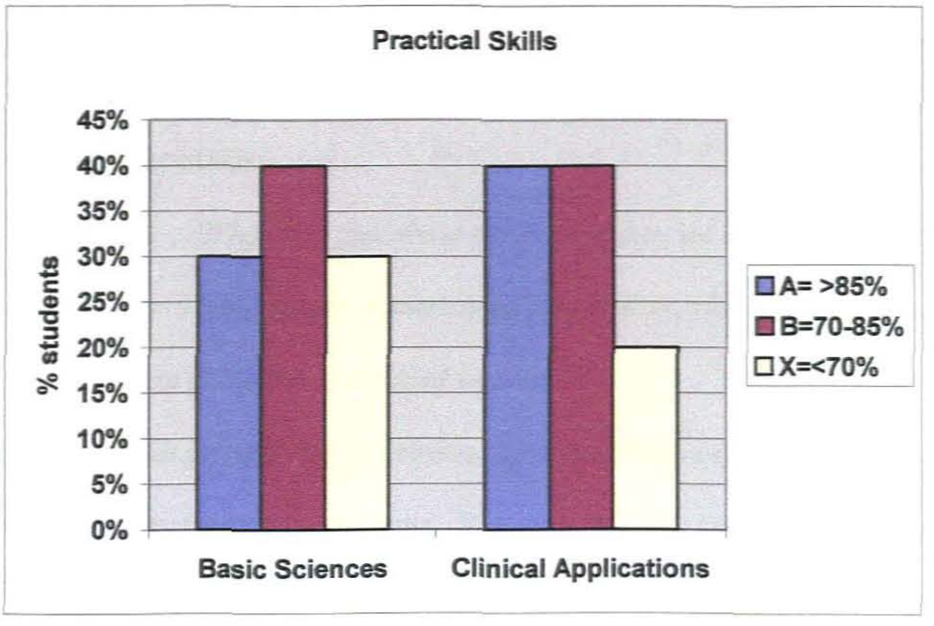
Fig 6-9. Results of Understanding of underlying theory



6.2.4 Practical Skills:

The Regional Coordinator and an external assessor assessed practical skills. The practical examination took place after the students had completed Module 7. Results shown in Figure 6-10 are grouped according to Basic Sciences, which included "Hot Lab" techniques and Instrumentation QC, and Clinical Applications.

Fig.6- 10. Practical Skills



Commentary:

Once again students fared best in tasks related to clinical practice. The two students who experienced problems with the practical assessments were notably those who either did not have a background of clinical experience (the medical laboratory technologist who had only been involved with RIA work prior to starting the DAT course) or did not get sufficient opportunity to practice (the Radiography Tutor from the Radiological College in Khartoum). The second Radiography Tutor on the course, who managed to complete all 7 modules, declined to challenge the practical examination as he lacked the confidence, which comes from daily experience.

6.3 Training Workshop on Nuclear Cardiology Techniques

Because none of the students had the opportunity to develop competency in nuclear cardiology techniques, they were invited to attend a Training Workshop in Cape Town sponsored by the IAEA. Unfortunately the students from Sudan were unable to attend. However the students from Tanzania and Zimbabwe who attended found it helpful in preparing them for future practice in nuclear cardiology. The student interviewed from Tanzania voiced this:

> *"When you talk about cardiovascular, we are lucky we came here [Cape Town] for the workshop as it helped us a lot. Actually we don't do it there (ORCI) but it helped us a lot."*

A pre-test was given to the students at the start of the workshop in order to asses their level of understanding on the topic. The same test was given to them at the end of the workshop. The average difference between the pre and post score testing was 30%, indicating a significant gain in knowledge (Appendix F).

6.4. Perceptions of Impact and Outcomes

The results of the survey questionnaire showed both students and supervisors to be positive regarding the outcomes of the course (Figure 4-4).

6.4.1 Student Perceptions:

Eighty percent (n=8) of students surveyed felt strongly that the course had encouraged them to work and learn independently with 60% (n=6) in strong agreement that it had improved their ability to solve problems in clinical practice. Seventy percent (n=7)gave a strongly positive response to being willing to assist future students on the programme. All respondents were in agreement that they now performed Quality Control more regularly and considered that the course should have national recognition in their country.

However 20% (n=2) of respondents found that they had not been given greater responsibility in their job as a result of completing the course.

Analysis of comments showed that importantly the students found that the course developed independent or self-study skills, which are necessary for life-long learning. In general it gave them confidence in their work, improving their practical skills by providing them with more knowledge and organizing their existing knowledge.

More specifically they found that the course gave them the opportunity to revise relevant Anatomy and Physiology, made them aware of the importance of instrumentation QC, and increased their awareness of Radiation Safety. They felt the course had helped them improve their "Hot Lab" skills, as repeated emphasis was placed on correct handling and dispensing of radiopharmaceuticals, and had aided them in the development of data analysis techniques for processing data related to the various procedures.

Interestingly, students thought that the course provided insight into the scope of Nuclear Medicine practiced internationally. Students expressed a strong willingness to assist future students studying on this programme.

6.4.2 Supervisor Perceptions:

The rated responses from the survey questionnaire showed all supervisors in agreement that the course had encouraged students to work independently, developed their ability to analyse and think critically and improved their problem solving ability.

The supervisor interviewed reinforced these sentiments:

> *"......for instance, if a patient comes for a booking and they (the students) think the clinician who requested a study which is not relevant*

that they at least now see that they can question, which is something which was not done before."

Since taking the course supervisors observed that the students' attitude to radiation safety had changed. Surprisingly, 20% (n=2) of students felt that their attitude towards radiation safety had not changed which is contrary to what was indicated in the free form responses; perhaps due to the fact that they considered their radiation safety techniques were good to start off with and didn't need to change. Supervisors were of the same opinion as the students regarding the perception that they were now more involved in reviewing departmental protocols.

> *"Their practice has changed as well. Now they are more organised in their work and also they assist in the (data) processing as well. And even, I am seeing, they are very much interested in what happens."*

The Supervisors in general reported a gain in knowledge, attitudes and practice and particularly saw the benefits to the student in providing techniques and protocols for practice and building student confidence in implementing new techniques. Furthermore they considered that students were now encouraged to explore educational and career opportunities for self-development.

When questioned on the possible link between improved practice and changes in referral patterns, the student interviewed said:

"I think nowadays the physician is getting aware of nuclear medicine, so you find that nowadays you get a lot of cases like renograms. Before there are some doctors are not aware of these things. ....Most of the workshops for the Medical Association of Tanzania, there are a lot of presentations on nuclear medicine. So these doctors are getting awareness. That's why more patients are coming."

At ORCI the supervisor reported that:

"The SPECT gamma camera arrived in February 2000; it was installed and commissioned two months later. Since then the number of studies and the type and range of studies has increased significantly."

6.5 Evaluation of Impact and Outcomes

The objective of the assessments was not to indicate a pass or fail situation but rather to evaluate the participants' competencies in the various aspects related to Nuclear Medicine practice. Documenting the process by completing the workbooks was therefore an important aspect of the course. Fifty six percent (n=61) of all workbooks were >80% complete, and 23% (n=15) <60%complete; the instrumentation workbooks being the ones most difficult to complete. As was stated in the previous chapter, in the section relating to the capacity of the departments, resources in terms of instrumentation were limited, making these workbooks difficult to complete. This included the workbooks on Computers, which students found too difficult.

There was sufficient evidence of most of the Nuclear Medicine investigations covered in the course, with only a few showing no evidence documented, notably Lung Ventilation and Cardiac studies.

The educational gains are evident from the test scores, with half the students scoring >80% and only one student scoring <60%.

The course structure was such that all exercises both practical and clinical were work-based. Thus participants who were not working full-time in a Nuclear Medicine department were unable to develop the necessary competencies and fared the worst in the final practical assessment.

Both students and supervisor were positive regarding the outcomes of the course. Since taking the course the students' attitude to radiation safety had changed, they performed more computer analysis and were involved in reviewing departmental protocols.

The course had encouraged those participating, to work and learn independently and improved their ability to solve problems in clinical practice and had developed their ability to analyse and think critically.

The Nuclear Medicine service offered by the participating departments has benefited from the development of reflective practitioners. However, changes in referral patterns cannot strictly be related to the gains in expertise of the participants in the DAT programme, as these were also influenced by a heightened awareness of Nuclear Medicine by referring physicians and in some instances, the installation of new equipment.

7. COST-EFFECTIVENESS

Effectiveness of learning is gauged by the areas the students found helpful in altering their existing practice and was discussed in the previous chapter. Thorpe (1993) contends that it is the efficiency, validity or worth of the learning that matters. The concern of this evaluation is the quality of the learning experience and the extent to which the learners developed as a consequence of the experience. In order to measure the efficiency of a programme economic factors have to be considered as well as the resultant effectiveness of the learning experience. The efficacy of a programme in achieving goals measured against programme costs, will determine its cost-effectiveness.

The estimated programme costs should be seen in the light of the following:

- Development and production costs of study materials were not included in the estimation. These costs were carried by the RCA project with a budget of ~US$425 000. Production costs were estimated to be 32% of that figure.
- Only implementation costs were considered.
- Implementation costs, unlike production costs, increase with increasing number of students.

7.1 Cost Analysis

The US$ - Rand rate of exchange fluctuated greatly between 1999 and 2003. The average rate shall be thus calculated at R8.5 per US$.

Basis of Cost Calculation	**Totals**
Course Materials	
Textbooks	R14 111
Printing of materials	R14 800
Courier costs	R15 457
Sub-Total	**R44 368**

Basis of Cost Calculation	**Totals**
Initial Expert Mission 2 airfares @ R13 000 2 x 12days subsistence @ US$ 135	 R26 000 R14 580
Sub-Total	**R40 580**
Mid- Course workshop 15 participants: Total cost $US 50,000	 R425 000
Sub-Total	**R425 000**
Final Assessment 2 airfares @ R13 000 2 x 12days subsistence @ US$ 135 per diem	 R26 000 R14 580
Sub-Total	**R40 580**
Forgone Opportunities (Course duration 74wks) Regional Course Coordinator 1hr/wk @ R140/hr Supervisors 5hrs /wk @ US$10/hr (based on Tanzanian estimate of 10,000 Tanzanian Shillings/hr) x 3	 R10 360 R94 350
Sub-Total	**R104 710**
TOTAL	**R610 870**

Given the eleven students who successfully completed the course, this translates into R55 534 per student or ±US$ 6 533 per student for the course.

7.2 Comparative Costs

Basis of Calculation	1 **Total**
1year Fellowship: Host Institute average charges $US550 per month Monthly allowance @ R7000 x 12mnths Average airfare Forgone Opportunities (Tutoring)	 R56 100 R84 000 R7 000 R13 050
Sub Total	2 **R160 000 (±US$ 18 841)**

The comparative cost shows that in this case study, it was more cost-effective to conduct the course by distance (US$ 6 533 per student), than as a Fellowship placement (US$ 18 841).

7.3 Cost Benefits

The net outcome effects of the programme, is that 33.3% of untrained Nuclear Medicine Technologists in Anglophone sub-Saharan Africa, have now undertaken professional training. The foreseen cost benefits related to this are the following:

7.3.1 Improved work efficiency

The Technologist with their improved skills will:

- Provide better quality studies of more diagnostic value, thus reducing the chances of false positives or false negatives for the reporting physician or other life threatening or costly errors.
- Result in more effective patient assessment and diagnosis, leading to improved or more effective treatment and ultimately prolonging life.
- Have the ability to review departmental protocols to perform optimum studies resulting in more efficient patient throughput with concomitant benefits to the departmental budget.

7.3.2 Improved Nuclear Medicine service

- Improved quality of Nuclear Medicine investigations will result in a greater degree of confidence being placed in the Nuclear Medicine service by the referring physician. They in turn will request more studies, which will lead to better utilisation and cost efficiency of the facility. In those countries where the patient is billed for the service, this will translate into increased revenue for the department.

- Improved diagnostic service will contribute towards the improvement in the countries health care budget.

7.3.3 Quality Assurance

- More effective use of gamma camera and other instrumentation will result, as the technologist has a better understanding of Quality Control tests. This will reduce the potential for damage of the equipment with a greater awareness for troubleshooting and correcting problems, thus reducing the demand on engineer and repair services.
- Improved radiation safety practice will reduce hazards to staff and patients and the costs related thereto.
- Improved practice of radiopharmaceutical Quality Control will result in less wastage and will reduce the cost of radionuclides and labelling agents.

7.3.4 Course Certification

- A uniform level of standard of practice and competency throughout the region will enable technologists to exchange ideas and experiences, thus further improving work efficiency.
- Once the certificate has been recognised within the country for accreditation there will be greater opportunities for promotion leading to increased salary/income.

7.3.5 Other Benefits

- Material development is a costly exercise requiring manpower and expertise. Availability of the course material to the IAEA member countries to incorporate into their own training courses; developed or not yet developed, will be a huge saving in time and money.
- The widespread use of the material within the region will assure a uniform level of competency.

8. CONCLUSION

There is a pressing need to tackle current and emerging health challenges in general worldwide and in particular on the African continent. The focus of most governments in Africa is on primary health care and treating infections. Because of the poor socio-economic situation in most African countries, Nuclear Medicine facilities are either non-existent or not funded sufficiently. Nuclear Medicine has the potential to impact on health care, but has a low priority. Africa is the only region with poorly developed Nuclear Medicine facilities, with only islands of expertise in some areas on the continent. The advantages of Nuclear Medicine are well established and there is a drive to fully integrate Nuclear Medicine techniques in health care to benefit the people of Africa. To this end the commitment of the IAEA to train Nuclear Medicine personnel and specifically Nuclear Medicine Technologists is an important priority. The DAT programme is an efficient tool for capacity building of Nuclear Medicine Technologists within the AFRA member states. One third of untrained Nuclear Medicine Technologists in Africa have now benefited from this method of training.

8.1 Discussion

The conceptualisation of the course is commendable, offering technologists in Nuclear Medicine practice who do not have a qualification, the opportunity to study and acquire professional skills, within their own departments in their own countries, which would not have otherwise been possible. The aims of the course to provide training where none exists and to promote quality improvement have therefore been met. However, successful participants in the programme receive a certificate of achievement from the IAEA and not a recognised qualification. This is an inherent weakness in the conceptualisation of the programme, as parity of esteem becomes an issue. The certificate does nonetheless provide a basis for a competency standard of Nuclear Medicine practice, not only within Africa but also throughout the developing world. The IAEA as an organisation is regarded highly by the countries of Africa and as such, regulatory bodies might recognise or accredit the certificate.

The design of the material both in content and format is highly acclaimed by all participants. The structure and style effectively enabled learning and developed skills essential to the profession. The 'constructivist'-orientated (Gagnon & Collay, 1999), 'self-directed learning' approach (Boud, 1989), cultivated 'reflective practitioners' (Schön, 1987) and introduced them to Nuclear Medicine of an International standard. The downside of this was that students experienced frustration with the limited resources in their departments, despite the fact that the materials were designed for less developed countries, and technical writers had made every effort to provide alternative perspectives to accommodate all situations wherever possible.

For the *successful implementation* of *the course, the following criteria relating to student* entry, departmental infrastructure and supervision should be adhered to.

Student entry requirements

- The minimum requirement for entry should be a related qualification in Radiography, Medical Laboratory Technology or a Degree in Science. In the case of countries employing school leavers, a University entrance school leaving certificate plus 1 years experience in a Nuclear Medicine department.

- Participants should be proficient in the language of instruction.
- Participants need to be working in an *imaging section* of a Nuclear Medicine department for the duration of the course.
- Students should have the support of the hospital management and be granted some measure of work relief.

Basic requirements in departments where students are located

- Gamma camera and associated computer, dose calibrator, survey meter
- Designated Hot-Lab area
- Access to probe or well counter
- A regular supply of radionuclides and availability of essential cold kits
- Commitment from hospital management to supply sundry consumable items e.g. chromatography paper.

Requirements of supervision

The supervisor is a key person (Race, 1993) and could be a physician, physicist, radiopharmacist or senior technologist working in the *same* department as the student. They act as a human resource for the students and need to be in a position where they can be available for consultation when needed, assist with access to necessary equipment and procedures and generally facilitate the process. They are not required to have any teaching experience or even to provide individual advice on course content; their role is essentially that of facilitation. To do this, supervisors need to be well inducted into the methodology of the course and have an understanding of the importance of feedback and support. There needs to be regular communication with the Co-ordinator and a commitment to schedule planned meetings and tutorials for extra support where needed.

Necessity of collaboration

Although one of the objectives of the pilot study was to empower countries to develop their own indigenous training, the lack of significant infrastructure of this small speciality in sub-Saharan Africa necessitates the support of International organisations such as the IAEA. Assistance is necessary to establish the necessary network for conducting the course and projects need to be identified within which funding is granted. Because of the lack of expertise in the region, coordination and assessment has to take place from those countries that have stronger resources and expertise.

Workshops are an important and integral part of the DAT programme and provide students with the opportunity to interact with cohort learners. As with any distance learning programme where students are separate from instructors, they benefit from this type of social and integrated process of learning.

A budget is required for the following necessary activities (minimum level of implementation):

- Printing ~2,000 pages from CD, plus suggested textbook.
- Initial coordination or orientation workshop
- Ongoing tutorials arranged locally
- One regional workshop per year, which should incorporate interactive practical sessions and provide a forum for checking workbooks and assessing student progress.
- Travel costs and fees for short fellowship placements to access practical training of clinical studies not available in student's home department.

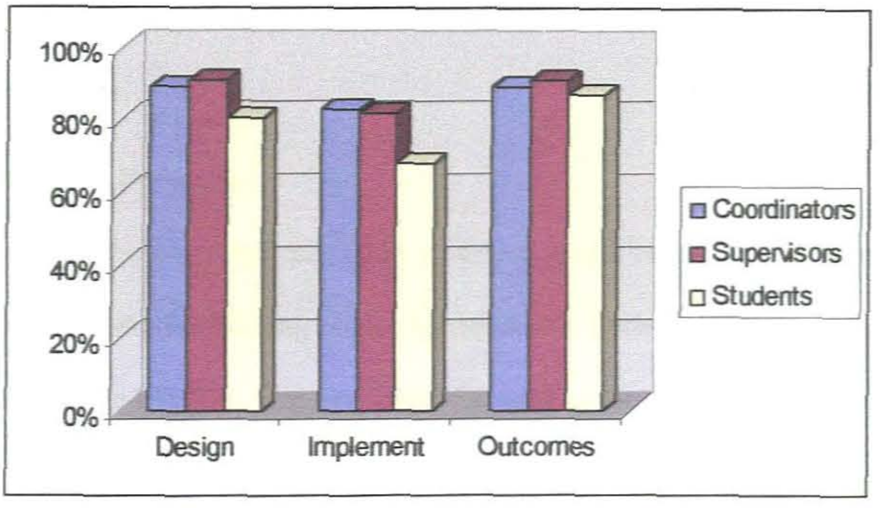
- Final assessment by external coordinator in student's home department.

The impact of the pilot study alone is that one third of untrained Nuclear Medicine Technologists working in Africa have now received a structured on-site training. They have been part of >400 students in 24 countries across three continents, who have undergone training in this way, thus bringing Africa in line with International standards. The cost of production of the learning material aside, this has been achieved in a more cost-effective way than sending students out of the country for training. The Nuclear Medicine departments have benefited as the training has been accomplished without loss of manpower. An improved Nuclear Medicine service of an International standard will ultimately benefit the patient.

8.2 Comparison with the Pilot study in Asia

The survey questionnaire was also circulated to participants of the DAT programme in the RCA region. Analysis of the forms returned by11 coordinators, 59 supervisors and 158 students showed a similar spread of scores for the rated responses shown in Figure 8-11. Overall participants responded positively regarding items reflecting conceptualisation and design, and the impact and outcomes of the course and slightly less positively regarding issues surrounding implementation.

Fig.8-11: Participants' perceptions of the DAT programme in Asia



Analysis of the free form responses showed similar recurring themes (Appendix K pg. 25-26) as was revealed in the analysis of the AFRA survey. In summary, the factors that enabled learning were the material content, design and layout, as well as the workbooks and workshops. Prior experience in Nuclear Medicine added to student success and a desire for an International standard was a motivating factor.

The factors, which presented a barrier to learning, were limited resources, studies not done in the home departments and no work relief for students and supervisors. Some difficulties were experienced with the concept of self-directed learning as students were used to more traditional teaching methodologies. As in Africa, it was found that the supervisor was a key individual in the process and needed to be better prepared for the task. Language difficulties, had less of a negative impact on students in Africa than students in some countries in Asia, as English is a second language or language of higher learning in the countries involved in Africa.

Positive feedback on student performance and attitude indicated that a degree of higher-order learning took place with a resultant positive impact on the Nuclear Medicine service.

8.3 Way Forward.

Having shown the efficacy and cost-effectiveness of the DAT programme, it remains to be seen whether training of Nuclear Medicine Technologists is sustainable in Africa. The role of the IAEA in Africa is crucial because of the poor socio-economic situation in many countries. However, the focus of IAEA projects has shifted from 'capacity building' to 'problem solving', limiting their involvement in future training programmes. Once the existing untrained Nuclear Medicine personnel have been trained, it will be up to the countries themselves to consider how they will continue technologist training in the future. This requires a national commitment, and whether training takes place on an ad hoc or continuous basis will depend on the country's needs. The complete training package including assessment materials and instructions, are freely available to the member states. The DAT programme has offered an infrastructure, which gives the countries an opportunity to sustain training as well as a benchmark for standardisation of training. In countries where there continues to be an acute shortage of personnel, support will still be needed from neighbouring countries who have the resources and expertise. It is encouraging that in Algeria, the course has been fully adopted as the standard national training course for all Nuclear Medicine Technologists.

Ongoing IAEA projects have made provision for those original participating departments who now have SPECT facilities, to progress to the advanced modules and for additional countries to be included in the next round of training starting in 2004. Insights gained from the programme evaluation of this case study will be invaluable for further training.

GLOSSARY

AFRA

African Co-operative Agreement for Research, Development and Training related to Nuclear Science and Technology; an inter-governmental agreement established in 1990, a branch of the International Atomic Energy Agency (IAEA).

ARCAL

Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology in Latin America and the Caribbean; a branch of the IAEA.

Bulletin Board

The DAT website http://www.cchs.usyd.edu.au/mrs/iaea/, has a Bulletin Board where students can pose questions, which are then answered by either one of the regional coordinators in South Africa, Australia or Uruguay.

Capacity

The educative potential of the workplace in terms of resources required matching the needs of the learner and the curriculum.

Constructivism

Constructivist learning paradigm is based on cognitive theory, where it is assumed that the learner constructs their own knowledge on the basis of interaction with their environment.

Collaboration

The extent to which there was collaboration across occupational and organizational boundaries involving the IAEA, the DAT Management team, Regional Coordinators, Hospital Management and National bodies.

Control

The type of supervision afforded to the students

Course Coordinator

The overall coordinator of the DAT programme, situated at the Westmead Hospital in Sydney, who is responsible for liaison with the project manager, technical writers, country coordinators and regional coordinators.

Customisation

Respecting what learners bring with them in the way of past experiences and their particular social positions.

DAT

Distance Assisted Training programme for Nuclear Medicine Technologists. Developed by AusAID under the auspices of the IAEA in 1994.

Designated Centre

A term describing a department singled out by the IAEA for its expertise in the field of Nuclear Medicine

Distance Education

An expectation of learner independence, and the physical separation of instructor and student by place.

Domain Knowledge

Knowledge related to the discipline within which the individual works.

Dose Calibrator

An ionisation chamber used to assay radioactive doses for patient administration

Experiential learning

A structured learning approach, which is essentially; "action learning within work organisations".

***Ex Post* cost-effectiveness**

Analysis of the effectiveness in reaching given goals related to the monetary value of the resources put into the programme.

Fellowship Training

IAEA sponsored training, which takes place in a different country at a counterpart institution.

Flexible Learning

A mixed-mode learning approach, incorporating campus-based, home based, work-based, resource-based learning.

Forgone Opportunities

Earnings foregone while person participates in project (Rossi, Freeman &Wright, 1979)

Formative assessment

A type of assessment, where the primary objective is that of feedback on performance.

Harmonisation of Training

An agreement on the minimum competencies necessary for Nuclear Medicine Technologists as a basic standard of practice, for adoption by member states of AFRA.

Hot-Lab

A designated laboratory in a Nuclear Medicine department, for dispensing radiopharmaceuticals used in Nuclear Medicine investigations.

Likert Rating Scale

Responses rated according to: strongly agree, agree, disagree, and strongly disagree

Objective Structured Clinical Examination

A practical examination within a clinical department using objective using objective scoring methods to assess students

Open Learning

Open learning describes the character of the educational process i.e. openness, where learners have control over their learning.

Project Coordinator

A nominated individual, who is responsible for the smooth running of any IAEA project, within their country.

Protocol

A documented departmental method for performing a Nuclear Medicine investigation.

Quality Assurance

An overall departmental programme, consisting of Quality Control tests, to assure quality of investigation and safety of patients and staff.

RCA

Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology in Asia.

Regional Co-ordinator

The co-ordinator responsible for co-ordination of the DAT programme within a region, i.e. AFRA, ARCAL or RCA.

Scintigraphy

A Nuclear Medicine investigation producing and image referred to as a scintigram.

Self-directed Learning

Learning where individuals take the initiative, with or without the help of others, in diagnosing learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing learning strategies and evaluating learning outcomes. (Knowles, 1975:18)

Sub-Saharan Africa

Those countries on the African continent, lying between Northern African countries and South Africa.

Summative Assessment

An assessment, usually at the end of a course or section of a course, to which a mark or a score is assigned.

Symbolic Interactionism

A social psychology construct, asserting that the self is established, maintained and altered in interactions with others.

Transmission Paradigm

A fall back position taken by educationalists such as Vygotsky, Piaget and Fosnot, to describe teaching which had its roots in a behaviourist paradigm, where teachers transmitted knowledge to students.

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Appendix A

Application for inclusion in Pilot Study

A DISTANCE ASSISTED TRAINING PROGRAMME FOR NUCLEAR MEDICINE TECHNOLOGISTS

APPLICATION FOR INCLUSION IN PILOT STUDY

I INFORMATION ON CENTRE REQUESTING INCLUSION

I-1 Identifying Information

I-1 Name of the Institution: ……………………………………………………
……………………………………………………

I-2 Address of the Facility: ……………………………………………………
……………………………………………………
……………………………………………………
……………………………………………………

I-3 Telephone: ……………………………………………………
Fax: ……………………………………………………
email: ……………………………………………………

I-4 Name and qualifications of senior contact personnel:

Nuclear Medicine Physician
Name:………………………………………
Degree:………………………………………
Certification:…………………………………
Experience:…………………………………
……………………………………………………

Radiation Medical Physicist
Name:………………………………………
Degree:………………………………………
Certification:…………………………………
Experience:…………………………………
……………………………………………………

Radiographer/NM Technologist:
Name:……………………………………………
Degree/Diploma:…………………………………
Certification:………………………………………
Experience:…………………………………………
……………………………………………………

I-5 Name and qualifications of the Radiation Protection Officer if not the Radiation Medical Physicist.

Name:………………………………………
Degree:………………………………………
Certification:…………………………………
Experience:…………………………………
……………………………………………………

II RADIATION SAFETY

a) Supply information on Radiation Safety Equipment

Table II(a)

Type	Manufacturer	Functional Yes	No

III INFORMATION ON CLINICAL PRACTICES

III -1 IN-VIVO INVESTIGATIONS

a) Supply information on personnel:

Table III-(a) Personnel Information

Name	Profession	Qualifications	Experience(yrs)

b) Supply information on Equipment:

Please indicate type of scintillation camera: planar or SPECT. List computer imaging systems as well.

Table III-(b) Available Imaging and Non-Imaging Equipment (Scintillation camera or thyroid uptake system)

Type	Manufacturer	Functional	
		Yes	No

c) Supply information on Radiopharmaceuticals

Table III-(c1) Radiopharmaceuticals including generators used for in-vivo studies

Type	Manufacturer	Activity ordered MBq / week

Table III- (c2) Labelling Kits used for in-vivo studies

Type	Manufacturer	kits used per week

d) Supply information on Procedures

Main Fields of Referral:……………………………………………………………

Table III-(d) Types of Investigations performed

Investigation	Written protocol available?(Y/N)	No. of investigations per month

III - 2 THERAPEUTIC PROCEDURES

a) Supply information on Personnel

Table III - 2 (a) Personnel Information

Name	Profession	Qualification	Experience

b) Supply Information on Equipment

Table III - 2(b) Available Equipment
(Source Calibrator)

Type	Manufacturer	Functional (Yes/No)

c) Supply Information on Radiopharmaceuticals

Table III - 2(c) Radiopharmaceuticals

Type	Manufacturer	Activity used MBq/week

d) Supply Information on Procedures

Table III-2(d) Therapeutic Procedures

Procedure	Written protocol available?(Y?N)	Number procedures per month

IV - INFORMATION FOR INCLUSION IN DISTANCE ASSISSTED TRAINING PROGRAMME

a) Identify Personnel willing to embark on the 18mnth Distance Assisted Training Programme starting June 1999.

Personnel should meet the following criteria:

- have some tertiary education/qualification and have been working in a nuclear medicine department for at least one year, or be a qualified radiographer or medical laboratory technician with some nuclear medicine experience;
- presently working in a nuclear medicine department where a scintillation gamma camera and associated computer is in use as well as radiation monitoring equipment;
- understand written English and where possible speak it well but not necessarily fluently; and

Table IV-(a) Trainee Personnel

Name	Profession	Qualification	Experience(years0

b) Identify Personnel who will act as Supervisor to the students (preferably a senior technologist, but could be a scientist or a physician)

This should be a person who will;

- identify the participants;
- be available for the duration of the course (June 1999-Dec 2000);
- provide feedback to the course co-ordinator;
- be available for the final assessment;
- be committed in terms of time and support ;
- be the liaison with the course co-ordinator and the country co-ordinator.

Table IV-(b) Departmental Supervisor

Name	Profession	Qualification	Experience(yrs)

V - Information regarding Audit

a) Has your department, through AFRA, requested an audit by an Auditing Team?

(Yes/No)……………………

If "Yes", please supply the following information:

Table V- Departmental Audit

Date Requested	Date Performed	Date due to be performed

Appendix B

Competency Guidelines

NUCLEAR MEDICINE TECHNLOGIST
COMPETENCY GUIDELINES

PURPOSE STATEMENT

Following training, the Nuclear Medicine will be competent to perform Nuclear Medicine investigations in order to facilitate the management of the patient with regards to diagnosis and treatment.

Under appropriate supervision the roles and function of the Nuclear Medicine Technologist are identified as:

1. Administration and management of the Nuclear Medicine environment
2. Patient care in the Nuclear Medicine environment
3. Radiation Safety
4. Operation and maintenance of Nuclear Medicine Instrumentation
5. Operate in a Radiopharmacy Laboratory
6. Perform Nuclear Medicine imaging procedures
7. Perform Nuclear Medicine non-imaging procedures
8. Assist with Nuclear Medicine therapeutic procedures
9. Perform *in-vitro* Radio-assays

The following are the Exit Level Outcomes, Specific Outcomes and Assessment Criteria for the identified roles and functions of Nuclear Medicine Technologists under the supervision of a Nuclear Medicine physician and/or medical physicist.

1. **ADMINISTRATION AND MANAGEMENT OF THE NUCLEAR MEDICINE ENVIRONMENT**

Exit Level Outcome:
The Nuclear Medicine Technologist will be able to successfully administer and manage the Nuclear Medicine environment in terms of Quality Assurance, Radiation Protection and Management to provide a safe environment for the patient and ensure an optimal diagnostic and therapeutic procedure.

Specific Outcomes	Assessment Criteria
1.1. Develop and implement Quality Assurance programmes in the Nuclear Medicine department	• Quality Control tests are completed according to procedure manuals and standards are maintained. (This includes procedure protocols, instrumentation, auxiliary equipment, patient satisfaction and administration Q.C.)
1.2. Adheres to existing Radiation Protection regulations.	• All equipment relating to radiation safety and radioactive substances are correctly handled in accordance with Radiation Protection regulations.
1.3. Applies organisational skills to coordinate patient through-put in the department.	• Adequate supplies of consumables are maintained • Patient studies are optimally scheduled, ensuring appropriateness of study. • Good liaison and communication within Nuclear Medicine team is maintained. • Appropriate records are kept.

Underpinning knowledge:

Basic principles and practice of management
Quality Assurance
Rule and regulations regarding Radiation Safety

2. PATIENT CARE IN THE NUCLEAR MEDICINE ENVIRONMENT

Exit Level Outcome:

The Nuclear Medicine Technologist will provide patient care before, during and after the investigation within the Nuclear Medicine department.

Specific Outcomes	Assessment Criteria
2.1 Applies knowledge of pathological conditions and clinical practice to provide physical care for the different clinical examinations.	• Physical condition of patient assessed correctly (vital signs etc.) • Comfort is provided before, during and after the procedure. • Intravenous fluids, oxygen and other life support systems are maintained. • Emergency conditions are recognised.
2.2 Applies knowledge of clinical Nuclear Medicine investigations to provide psycho-social support.	• Patients receive adequate explanations concerning the Nuclear Medicine investigation. • Good communication with patient is maintained throughout the procedure.
2.3 Applies knowledge of radiation safety practice throughout the procedure.	• Information regarding pregnancy and lactation obtained and acted upon. • Patient fully informed before, during and after Nuclear Medicine procedure regarding radiation.

Underpinning knowledge:

Psychodynamics of patient care
Semiology (signs and symptoms of common disorders)
Rules and regulations regarding radiation safety.

3. RADIATION SAFETY

Exit Level outcome:

The Nuclear Medicine Technologist will carry out all functions within the Nuclear Medicine environment in line with Radiation Safety regulations for the safety of themselves, colleagues, patients, public and the environment.

Specific Outcomes	Assessment Criteria
3.1 Operates in compliance with local or national regulations on Radiation Safety.	• Appropriate records are kept. • A designated protocol governing receipt, storage and disposition of radionuclides is adhered to. • Protection equipment to meet regulations is utilised.
3.2 Follows appropriate protection procedures	• Personnel monitoring devices are used at all times. • Appropriate protection methods are used to keep exposure as low as reasonably achievable. • Radioactive materials are stored using proper methods. • Radionuclides that pose special hazards are identified and handled appropriately.
3.3 Performs surveys to monitor equipment, areas and personnel.	• Surveys of designated locations are conducted periodically. • Wipe tests are performed where designated/indicated. • All data is recorded in standard format.

Specific Outcomes	Assessment Criteria
3.4 Performs decontamination procedures.	• Appropriate methods are used to remove contamination or reduce it to acceptable levels. • Personnel and area are monitored. • Contaminated material is identified, stored or disposed of according to regulations. • Records concerning clean up are maintained.
3.5 Disposes of radioactive waste	• Waste is properly disposed of according to regulations. • Appropriate records are maintained
3.6 Participates in teaching programmes to instruct others of radiation hazards.	• Instruction on appropriate radiation safety measures is provided. • Instruction on proper emergency procedures is provided.

Underpinning knowledge:

Radiobiology
Basic physics
Radiation physics
Rules and regulations regarding radiation safety
Teaching fundamentals

4. OPERATION AND MAINTENANCE OF NUCLEAR MEDICINE INSTRUMENTATION

Ext Level Outcome:
The Nuclear Medicine Technologist will optimally operate and ensure quality function of all Nuclear medicine instrumentation in order to provide the best performance of the instrumentation.

Specific Outcomes	Assessment Criteria
4.1 Evaluates performance of planar gamma cameras	• Require quality control tests are regularly performed and records kept. • Hard copy recording devices are checked. • Corrective action initiated where necessary. • Required records for quality assurance programmes are kept.
4.2. Evaluates performance of SPECT cameras	• Required quality control tests are regularly performed. • Corrective action initiated where necessary. • Required records for QA programmes are kept.
4.3 Evaluates the performance of Na(I) scintillation probes and well counters	• Required calibration and quality control tests are regularly performed. • Corrective action initiated where necessary. • Required records for Q.A. programmes are kept. •
4.4 Operates survey meters correctly	• Required routine checks according to regulations are performed. • Required records are kept
4.5 Evaluates the operation of a dose calibrator	• Required quality control tests are performed regularly. • Corrective action initiated where necessary. • Required records are kept.

Specific Outcomes	Assessment Criteria
4.6 Operates and maintains hard copy devices and auxiliary e.g. film processor	• Replenishment chemicals are adequate and available. • QC checks on film and processor are carried out at regular intervals. • Preventative maintenance is regularly provided.
4.7 Evaluate performance of associated computers	• Required quality control tests are performed regularly. • Corrective action initiated where necessary. • Required records are kept

Underpinning knowledge:

Basic physics
Counting statistics of radioactivity
Computers in Nuclear Medicine and application software
Nuclear Medicine instrumentation
Dark room procedures

5. OPERATE IN A RADIOPHARMACY LABORATORY

Exit Level Outcome
The Nuclear Medicine Technologist will demonstrate the ability to be fully functional in a Radiopharmacy laboratory (Type "B" laboratory)

Specific Outcomes	Assessment Criteria
5.1 Operates and maintains radionuclide generators	• Radionuclide generators are correctly sited and checked with various quality control tests. • Generators are eluted according to directions. • Quality control on eluate is performed. • Records are kept of all generators.
5.2 Applies knowledge of radiopharmaceuticals and their properties to enable accurate preparation of various radiopharmaceticals.	• Al radiopharmaceutical preparations are identified and labelled. • Aseptic techniques are correctly applied. • Radiopharmaceuticals are made up according to manufacturers instructions. • Correct radiopharmaceutical doses are selected, prepared measured and labelled. • Correct standard solutions are prepared and measured. • Records are kept of patient doses.
5.3 Administers the laboratory correctly	• Adequate laboratory supplies are maintained. • Required records are kept. • Pharmaceutical kits are stored appropriately.
5.4 designs or organises laboratory layout to ensure efficient function.	• Space and equipment is optimally utilised. • Effective radiation safety procedures are used.

Underpinning knowledge:

Basic chemistry
Radiopharmacology
Good laboratory practice
Nuclear Medicine instrumentation
Rules and regulations regarding radiation safety

6. PERFORMANCE OF NUCLEAR MEDICINE IMAGING PROCEDURES

Exit Level Outcome
The Nuclear Medicine Technologist will be able to perform the various clinical Nuclear Medicine investigations using optimal techniques in order to benefit the diagnosis and/or management of the patient.

Specific Outcomes	Assessment Criteria
6.1 Prepares, positions and explains the procedure to the patient in order to obtain an optimal study	• Premedication is used and administered when prescribed. • The appropriate instrumentation and auxiliary equipment is used. • Examination protocol is interpreted correctly • Patient receives adequate explanation regarding the investigation. • Positioning, immobilisation and technical aids are used correctly • The room id adequately prepared
6.2 Applies knowledge and principles to perform routine procedures, including interventional studies (e.g. diuretic renograms)	• The type and amount of activity is double checked before administration. • Radiopharmaceuticals are appropriately administered if permitted. • Due precautions are taken when collecting specimens to ensure personal safety. • Instrumentation and accessory equipment are used correctly. • Anatomical landmarks are appropriately marked. • Artefacts, including contamination is correctly identified and corrective action taken. • Imaging protocol is correctly performed according to prescribed protocol. • Special and additional views are performed when necessary.
6.3 Critically evaluate technical aspects and diagnostic content of the scintigraphic image produced.	• Patient is correctly identified • Image is correctly recognised • Views are correctly labelled. • Information density is correctly evaluated. • Patient position is clearly marked • Additional views are determined.
6.4 Process the acquisition data in order to obtain maximum diagnostic information	• Images are displayed in logical sequence. • Data is accurately quantified. • Quantification parameters are logically displayed.

Underpinning knowledge:
- Anatomy, physiology and pathology
- Clinical Nuclear Medicine practice
- Nuclear Medicine instrumentation
- Radiation safety
- Radiopharmacology
- Computer applications
- Patter recognition

7. PERFORMANCE OF NUCLEAR MEDICINE NON-IMAGING PROCEDURES

Exit Level Outcome:
The Nuclear Medicine Technologist is expected to function effectively in a type "C" laboratory to perform various non-imaging procedures.

Specific Outcomes	Assessment Criteria
7.1 Manages and administers the laboratory effectively	• Adequate supplies are maintained • Patients are correctly scheduled • Appropriate records are maintained
7.2 Prepares patient correctly for procedure	• Patient's identity is verified • Correct and clear instructions are given to patient and nursing staff regarding specimen collection. • Patient's history is checked for contra-indications.
7.3 Laboratory equipment is used accurately.	• Q.A. on laboratory equipment is performed. • Pipetting devices are correctly used. • Temperatures of water baths and refrigerators are checked and maintained.
7.4 Correct specimen collection and handling	• Appropriate equipment for specimen collection is selected. • Due precautions are taken when collecting specimens to ensure personal safety. • Venipuncture is performed at correct time intervals. • Correct anticoagulants and haemolysers are added when necessary. • Specimens are correctly stored. • Accurate aliquots of specimens are prepared. • Correct separation and labelling of cells are performed.
7.5 Ensure sterility and aseptic practice as required	• Sterility of all appropriate devices is ensured. • Correct aseptic practice used throughout.
7.6 Critically assess results	• Results are critically assessed for errors. • Appropriate correctional steps are taken.

Underpinning knowledge:

Anatomy, physiology and pathology
Psychodynamics of patient care
Clinical Nuclear Medicine practice
Radiation safety
Radiopharmacology
Good laboratory practice
Statistics of counting radioactivity

8. PERFORMANCE OF THERAPEUTIC NUCLEAR MEDICINE PROCEDURES

Exit Level Outcome:
The Nuclear Medicine Technologists should be able to function effectively in the Nuclear Medicine team when performing therapeutic procedures.

Specific Outcomes	Assessment Criteria
8.1 Manages and administers therapeutic procedures	• Treatment protocol is verified with Nuclear Medicine physician and/or medical physicist. • Patient is appropriately identified, scheduled and pregnancy excluded. • Appropriate records are maintained.
8.2 Prepares therapeutic dose	• Ensures that physician/physicist verifies patient dose. • Correct procedures and radiation safety precautions are followed in dose preparation.
8.3 Administers therapeutic dose	• Patient correctly identified • Patient and staff are given instructions regarding procedure and necessary precautions. • Dose is administered in a designated area observing all safety precautions and under the supervision of a physicist/physician. • Patient is monitored for an appropriate time interval following administration. • Patient's understanding of instructions is verified before discharge from department.

Underpinning knowledge:

Radiation safety rules and regulations
Anatomy, physiology and pathology
Psychodynamics of patient care
Clinical Nuclear Medicine practice
Radiopharmacology
Radiobiology
High activity laboratory practice
Mathematics
Psycho-social aspects of patients habits and habitat

9. PERFORMANCE OF IN-VITRO RADIO-ASSAYS

Exit Level Outcome:
The Nuclear Medicine Technologist is required to function effectively in a type "C" laboratory in order to perform various in-vitro radio-assays.

Specific Outcomes	Assessment criteria
9.1 Effectively manages and administers the laboratory	• Adequate supplies are available • Appropriate records kept.
9.2 Uses laboratory equipment and counting devices accurately	• Quality control of laboratory equipment is performed regularly. • Pipetting devices are correctly used.
9.3 Manages reagents, buffers, stock solutions effectively	• Adequate supplies are maintained. • Dilutions are accurately performed. • Kits are correctly stored. • Antibodies and antigens are radiolabelled correctly. • Buffers and stock solutions are made up correctly. • Appropriate records are kept.

Specific Outcomes	Assessment criteria
9.4 Prepares specimens correctly	• Patients and specimens correctly identified. • Specimens correctly handled, labelled and stored. • Due precautions are taken in handling specimens to ensure personal safety.
9.5 Performs assays correctly	• Correct use of reagents • Sets up specimens correctly for assay run. • Adds relevant reagents in correct sequence. • Utilises correct separation techniques. • Correctly counts all specimens. • Confirms that standard curves and controls conform. • Checks acceptability of duplicate counts. • Compares results against normal range. • Records all results.

Underpinning knowledge:

Physiology and pathology
Immunology
Radiation safety rules and regulations
Radiopharmacology
Laboratory practice
Computers and software applications
Radioactivity counting statistics

GLOSSARY

Exit Level outcome
: The competency expected of a person exiting at the final level

Specific Outcome
: Competencies related to specific tasks

Assessment Criteria
: *Criteria by which competencies can be measured*

Type 'B' laboratory
: Laboratory where medium levels of radioactivity are handled

Type 'C' laboratory
: Laboratory where low levels of radioactivity are handled

Appendix C

Student Feedback Form

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

FEEDBACK FORM
for
Students

Note: Please complete the following questionnaire and return all feedback forms to the course coordinator.

SUBJECT: Skeletal Imaging

About how many Bone Studies does your department perform each

week,________ or month?________

General Introduction - Anatomy, Physiology & Clinical Indications

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Do you think subject coverage adequate? Yes ☐ No ☐

Did you understand all the questions? Yes ☐ No ☐

What changes do you suggest?

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....

Exercise: Interpreting Referral Forms

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Did you think the exercise was useful? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....

Radionuclides & Reconstitution - in Bone Imaging

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Name the bone agent which your department normally uses____________________

Is the allocated time correct? Yes/No Enter actual time taken ....

Preparing the Gamma Camera:

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Does your department normally perform

A. Total body spot views? _________

or

B. Wholebody eg. moving bed?______

or

C. Either A or B depending which gamma camera is available?______________

Is the allocated time correct? Yes/No Enter actual time taken ....

Wholebody Imaging:

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Wholebody Imaging Quality Control

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

if your department has a wholebody imaging facility is it:-

single pass?____________ or double pass?____________

Any comments:-

....

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....

Bone Scintigraphy:

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Does your department perform 3 phase bone imaging routinely when clinically indicated as described in the text? Yes/No

Is the allocated time correct? Yes/No Enter actual time taken ....

Considerations: Positioning and Normal scan appearance

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....

Exercise: Developing a protocol for acquiring a 3 Phase Bone Study

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

What changes do you suggest?

....

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....

Exercise: Performing a Bone Study

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

Were you able to perform the 2 procedures successfully? Yes ☐ No ☐

Please record any problems and difficulties which you may have had during the exercise.

____

____

____

Comparison of protocols and suggested changes

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

Is there sufficient explanation? Yes ☐ No ☐

Did you find this exercise useful? Yes ☐ No ☐

What were the major differences in the suggested protocol to that of your departments usual bone imaging protocol?

....

....

....

Is the allocated time correct? Yes/No Enter actual time taken ....
How did you perform the bone study exercise:

A. Wholebody plus extra 'spot' static views?__________

or

B. Total Body 'spot' views *ie. all static views*?__________

Please describe any differences or changes to your department's present protocol for bone imaging procedures ____

____

____

Assessment of questions and workbook:

Did you have any problems following the Workbook Yes ☐ No ☐

Comment on any specific problems.

....

....

What changes do you suggest..

....

Overall assessment:

A.

Did you have enough previous basic knowledge to find that this unit was:-

a) Fairly easy and like a revision exercise ☐

or

b) Quite difficult and you would have preferred to have had some tutorials prior to commencing the subject? ☐

B.

By taking into consideration the following points please comment on your assessment of the presentation of this subject.

1. Style and ease of understanding, layout, useful or confusing, questions, diagrams, images, equipment, etc.
2. As you are working as well as participating in this course - did you have enough time to study? Yes / No

Good points:

Poor points:

Student Name.. **Department/Hospital**..

Appendix D

Supervisor Feedback Form

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

FEEDBACK FORM

Supervisors

SUBJECT: Endocrinology - Thyroid Gland and Uptake

General Introduction - Anatomy and Physiology

How do you think the student found the

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐
If you had time to read the material

Do you think subject coverage adequate? Yes ☐ No ☐

Have you any comments or suggested changes?

....

....

....

Clinical Indications for a Thyroid Investigation

How do you think the student found the

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

If you had time to read the material

Do you think subject coverage adequate? Yes ☐ No ☐
Have you any comments or suggested changes?

....

....

....

Thyroid Uptake Investigation

How do you think the student found the

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐
If you had time to read the material

Do you think subject coverage adequate? Yes ☐ No ☐
Have you any comments or suggested changes?

....

....

....

Exercise: Consistent measurements at a constant distance

How do you feel the student found this exercise

easy ☐ difficult but achievable ☐ too difficult ☐

On what type of equipment was this exercise performed?

Scintillation Probe ☐ Gamma Camera ☐

Were there any specific problems?
and have you any comments or suggested changes?

....

....

....

....

Protocol for ^{131}I Thyroid Uptake

How do you think the student found the

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

If you had time to read the material

Do you think subject coverage adequate? Yes ☐ No ☐

Have you any comments or suggested changes?

....

....

....

....

Protocol for ^{99m}Tc Thyroid Uptake

How do you think the student found the

Level of understanding: easy ☐ mostly understood ☐ too difficult ☐

If you had time to read the material

Do you think subject coverage adequate? Yes ☐ No ☐

Have you any comments or suggested changes?

....

....

....

Does your department normally perform Thyroid Uptakes using:

^{131}I ☐ or ^{99m}Tc ☐

a) scintillation detector - probe___________

or

b) gamma camera - pinhole collimator_______ or parallel hole collimator_____

c) were the students able to follow the methods of uptake calculations? YES / NO

Assessment of questions and workbook:

Did your students have any problems following the Workbook? Yes ☐ No ☐

Comment on any specific problems.

....

....

....

What changes do you suggest..

....

....

....

Overall assessment:

Good points:

Poor points:

Supervisor Name..

Department/Hospital..

Appendix E

Programme for Mid-Course Workshop

Mid-Course Workshop: DAT for Nuclear Medicine Technologists
RAF/6/022
24-28 July

Group A:	Group B:	Group C:	Group D:
Rasha Mangoushi	Awad Adlan	Suliman Salim	Prof Bouyoucef
Buthina Ahmed	Abd Mohammed	Ally Busiry	Dr K Maunda
Sabah Alkier	Hosam Alamin	Hamisi kaseleko	
Neamat Mohammed	Abdelbagi Osman	Innocent Kijah	

MONDAY 24 JULY:

9:00-9:30	Welcome and Introduction: R/T classroom	Head of Radiation Division, Prof Werner Dean Faculty of Health Sciences, Dr Gihwala Head N.Med Dept. GSH, Dr Fataar		
9:30-10:00	Explanation of programme Groups Hand in of Workbooks	Mrs G Philotheou		
10:00-10:30	Tea School of Radiography			
10:30 – 11:30	**Group A,B,C**	Instrumentation Overview	J. Boniaszczuk	R/T classroom
10:30 – 13:00	**Group D**	Supervisors meeting	School of Radiography	
11:30-13:00	**TUTORIALS:** N.Med Dept.	**Group A** **Group B** **Group C**	Dose Calibrator QC gamma camera Thyroid processing	G.Boltman J.Boniaszczuk P.Freedman
13:00-14:00	**Lunch**			
14:00-15:00	**TUTORIALS** N.Med Dept	**Group A** **Group B** **Group C**	QC gamma camera Thyroid processing Dose Calibrator	J.Boniaszczuk P.Freedman G.Boltman
15:30-16:30	**TUTORIALS**	**Group A**	Thyroid processing	P.Freedman

N.Med Dept.	**Group B**	Dose Calibrator	G.Boltman
	Group C	QC gamma camera	J.Boniaszczuk

TUESDAY 25 JULY:

8:30-9:30 Psychodynamics of Patient Care G M Philotheou R/T classroom

9:30-10:30 Radiopharmaceutical QC S Rubow R/T classroom

10:30-11:00 Tea

11:00-11:30 Travel to Tygerberg and Red Cross Childrens Hospital

11:30-15:30 **Group A** Tygerberg Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Ellmann
Group B Red Cross Hospital Clinical Observation and Pattern Recognition Tutorial; Prof Mann
Group C Groote Schuur Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Fataar
Group D – join Group A and B

WEDNESDAY 26 JULY:

8:30-9:30 **Group A,B,C** Renogram Acquisition Mrs P Freedman N.Med Dept.

9:30-10:30 **Group A,B,C** Renogram processing J Boniaszczuk N.Med Dept.

8:30-10:30 **Group D** Supervisors discussion of Workbooks G Philotheou N.Med Dept.

10:00-10:30 Tea

10:00-10:30 Travel

11:00-15:30 **Group B** Tygerberg Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Ellmann
Group C Red Cross Hospital Clinical Observation and Pattern Recognition Tutorial; Prof Mann
Group A Groote Schuur Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Fataar
Group D – join Group A and B

THURSDAY 27 JULY:

8:00-9:00	**Group A,B,C**	Lung Imaging principles	G Philotheou	R/T Classroom
9:00-10:00	**Group A,B,C**	Nebulizers	J Boniaszczuk	N.Med Dept.
10:00-10:30	Tea			
10:30-11:00	Travel			

11:00-15:30 **Group C** Tygerberg Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Ellmann
Group A Red Cross Hospital Clinical Observation and Pattern Recognition Tutorial; Prof Mann
Group B Groote Schuur Hospital Clinical Observation and Pattern Recognition Tutorial; Dr Fataar
Group D – join Group A and B

19:00 Evening Function: Devil's Peak restaurant, Medical School

FRIDAY 28 JULY:

8:30-10:00	Hot Lab practices and principles	G Philotheou and G.Boltman	N.Med Dept.
10:00-10:30	Tea		
10:30-12:00	Return of Workbooks, Discussion, Group Time	G Philotheou	R/T classroom
12:00-12:30	Closure		

Afternoon Free

Appendix F

Mid-Course Workshop Feedback Form

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

Mid-Course Workshop
Cape Town 24-28 July

FEEDBACK FORM

TUTORIALS :

1. List the Tutorials you found particularly helpful.

....

....

....

....

2. What useful points did you learn in these particular Tutorials?

....

....

....

....

3. Could you implement any of the above points in your own department?

....

....

....

....

4. Comment on how the tutorials helped your understanding of the DAT course material.

....

....

....

....

Student Name..

Date...

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

Mid-Course Workshop
Cape Town 24-28 July

FEEDBACK FORM

CLINICAL OBSERVATION GROOTE SCHUUR HOSPITAL:

1. List the procedures you observed.

   ....
   ....
   ....
   ....

2. What useful points regarding the investigations did you learn?

   ....
   ....
   ....
   ....

3. Could you implement any of the above points in your own department?

   ....
   ....
   ....
   ....

4. Comment on the interesting or useful aspects of the Pattern Recognition tutorial.

   ....
   ....
   ....
   ....

Student Name..
Date..

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

Mid-Course Workshop
Cape Town 24-28 July

FEEDBACK FORM

CLINICAL OBSERVATION TYGERBERG HOSPITAL:

1. List the procedures you observed.

   ....

   ....

   ....

   ....

2. What useful points regarding the investigations did you learn?

   ....

   ....

   ....

   ....

3. Could you implement any of the above points in your own department?

   ....

   ....

   ....

   ....

4. Comment on the interesting or useful aspects of the Pattern Recognition tutorial.

   ....

   ....

   ....

   ....

Student Name...

Date...

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

Mid-Course Workshop
Cape Town 24-28 July

FEEDBACK FORM

CLINICAL OBSERVATION RED CROSS CHILDRENS' HOSPITAL:

1. List the procedures you observed.

   ....

   ....

   ....

   ....

2. What useful points regarding the investigations did you learn?

   ....

   ....

   ....

   ....

3. Could you implement any of the above points in your own department?

   ....

   ....

   ....

   ....

4. Comment on the interesting or useful aspects of the Pattern Recognition tutorial.

   ....

   ....

   ....

   ....

Student Name..

Date..

Appendix G

Nuclear Cardiology Workshop
Pre- and Post-test scores

COURSE EVALUATION

Name	Pre-Test	Post-Test	Score Difference
Adjoa Sam Anaman	13	19	6
Jacob Agoe Komieter	12	19	7
Hanadi Said Mohammed Abdalla	9	21	12
Hassan Ebrahim Elhassan	7	22	15
Ally Mohammed Said Busiry	19	27	8
Innocent Kijah	2	26	24
Hamisi Kaseleko	13	22	9
Mercy Nachalwe Chipampe	4	22	18
Nchebe Chitashi Sindaza	6	22	16
Cilia Tifuh Mbuta	2	17	15
Tamer Boyomy	20	28	8
Ibrahim El-Sayed Saad	30	35	5
Takele Degefu Mijena	0	12	12
Tariku Wordofa	18	26	8
John Mwangi Kamau	7	22	15
Jacob Muasya Kioko	14	30	16
Feistus Mawisire	11	29	18
Faith Mazarura	5	27	22
Edwin Mahala Ndlovu	4	15	11
Naomi Myedziwa	31	32	1
Diana Kunda	3	19	16

Scores were out of a possible 41 points.
Average difference in pre and post score testing was 30%

Appendix H

Student Survey Questionnaire

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

SURVEY for COURSE EVALUATION

STUDENTS

December 2002

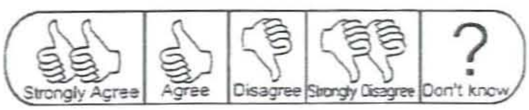
Introduction:

The current stage of Distance Assisted Training Programme (DAT) in the AFRA region is now complete and there are plans to continue assistance to participating countries for further courses as well as introduce DAT to new countries in the region. We wish to evaluate the effectiveness of the DAT project, as well as the process in which it was implemented and any impact it had on the Nuclear Medicine service in your department. We require YOUR valuable input to assist with this evaluation.

This questionnaire is designed to help assess your opinions and YOUR feedback is **VERY IMPORTANT** for the future of the DAT programme. The results of the evaluation survey are to be presented at an IAEA / DAT co-ordinators meeting in 2003 and the analysis will form part of a Masters Thesis. You are requested to complete this questionnaire and return it to your supervisor/ DAT co-ordinator as soon as possible.

Please follow these instructions:

- Read each section and question carefully
- Indicate your genuine opinions with each answer



- Where you are required to give your own 'free response' please write or print clearly
- Return the completed survey form to your supervisor/ DAT Co-ordinator **IMMEDIATELY**.

We appreciate your co-operation and time taken to complete this survey. Feedback is being sought from all students, supervisors and co-ordinators and following analysis of the valuable information received the DAT programme can be evaluated for its significance, appropriateness, merit, sustainability and limitations in the training of nuclear medicine technologists within the AFRA region.

Thank you

Geraldine M Philotheou
DAT (AFRA) Co-ordinator

Questionnaire for: ***STUDENTS***

SECTION 1:

In this section we would like to know a little bit about yourself and your educational background.

1. Country		**2. Institution**	
3. Highest Qualification			
4. Age		**5. Number of years working in Nuclear Medicine**	
6. Home Language			
7. Language in which DAT material was studied			
8. Predominant language used in the department in which clinical work was undertaken			

Free Form Responses:

9. In your opinion, what prepared you best for studying on the DAT programme.

10. What made it difficult to study on the DAT programme?

SECTION 2: In this section we wish to assess the effectiveness of learning in a distance situation.

Indicate one 3 for each of the following questions	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't Know**
1. The course is well designed					
2. The course is well organised					
3. The course adds value to my original qualification					
4. The course material develops skills needed by professionals in this field					
5. Satisfying the requirements of the course was easy for me to achieve					
6. It was easy to link theory to practice					
7. Presentation of material during workshops assisted greatly					
8. Course material encouraged me to reflect on my clinical practice					
9. Tasks in the Workbooks assisted my learning					
10. This course encouraged me to work and learn independently					
11. This course improved my ability to solve problems related to clinical practice					
12. The course encouraged me to reconsider many of my former viewpoints and practices.					
13. The course developed my ability to analyse and think critically.					
14. Since undertaking the course my attitude to radiation safety has changed					
15. Since undertaking the course I perform quality control more regularly.					
16. Since undertaking the course I perform more computer analysis.					
17. Since undertaking the course I am involved in reviewing departmental protocols.					
18. I am encouraged to explore educational and career opportunities.					
19. I am given greater responsibility in my work as a result of completing the course.					

SECTION 2: [cont'd]

Free Form Response:

15 List three points that **best** illustrate how the course helped you.	16. List three aspects of the course you found **least** helpful?
1.	1.
2.	2.
3.	3.

SECTION 3:

In this section we wish to establish the type of supervision you received.

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. The supervisor was helpful at all times.					
2. There was sufficient support from the supervisor to carry out the required practical exercises.					
3. Regular discussions were held with the supervisor.					
4. The supervisor organised additional tutorials when necessary.					
5. Organised discussions were held with fellow students.					
6. Assessments and examinations were well organised.					
7. The supervisor examined my Workbooks at regular intervals.					
8. The supervisor helped me to access other resources when needed.					
9. If supervisor support were reduced it would be difficult for me to cope.					

Free Form Response:

10. What aspects of the supervision did you find helpful?
11. Where would you have liked more help?

SECTION 4: In this section we wish to establish how effectively the course was run.

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. My department was supportive while I was studying.					
2. The workload required for successful completion of the course was made clear to me.					
3. All study materials were made available to me on time.					
4. Workshops and final assessments were well organised					
5. I received sufficient feedback regarding my progress from the supervisor / co-ordinator					

Free Form Responses:

7. Where / How would you have liked more support while doing the course?

SECTION 5: In this section we wish to establish how your working situation contributed to the course.

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. I was provided with sufficient reading material to meet the outcomes of the course.					
2. I was allowed enough time to study the course material.					
3. I was given sufficient camera time/laboratory time to complete the practical tasks required.					
4. There was a sufficient range of nuclear medicine investigations done in my department to complete the greater part of the clinical applications required in the course.					
5. More than 80% of the study material was relevant to my everyday practice.					
6. The workshops helped my understanding of the course material.					
7. I consider that the course certificate should have national recognition in my country.					
8. I am willing to assist further students who undertake the course					

Free Form Responses:

9. In your opinion, which aspects of the course could be taught more effectively on a face-to-face basis?
15. What was the single most important factor that causes you difficulty in meeting the course objectives?
NOTE: If you have any other comments please add in this space.

Appendix I

Supervisor Survey Questionnaire

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

SURVEY for COURSE EVALUATION

SUPERVISORS (in conjunction with Head of Department)

November 2002

Introduction:

The current first stage of Distance Assisted Training Programme (DAT) in the AFRA region is now complete and there are plans to continue assistance to participating countries for further courses as well as introduce DAT to new countries in the region. We wish to evaluate the effectiveness of the DAT project as well as the process of implementation and the impact on the Nuclear medicine service in your department. We require YOUR valuable input to assist with this evaluation.

This questionnaire is designed to help assess your opinions and YOUR feedback is **VERY IMPORTANT** for the future of the DAT programme. The results of the evaluation survey are to be presented at an IAEA / DAT co-ordinators meeting in 2003. You are requested to complete this questionnaire and return it to your DAT co-ordinator as soon as possible.

Please follow these instructions:

- Read each section and question carefully
- Indicate your genuine opinions with each answer

- Where you are required to give your own 'free response' please write or print clearly
- Return the completed survey form to your DAT Co-ordinator **IMMEDIATELY**.

We appreciate your co-operation and time taken to complete this survey. Feedback is being sought from all students, supervisors and co-ordinators and following analysis of the valuable information received the DAT programme can be evaluated for its significance, appropriateness, merit, sustainability and limitations in the training of nuclear medicine technologists within Africa.

Thank you

Geraldine m Philotheou
DAT (AFRA) Co-ordinator

Questionnaire for: ***<u>SUPERVISORS</u>***

SECTION 1: Customisation

1. Country		**2. Institution**	
3. Highest Qualification			
4. Relationship to students (Were all students known to you?)			
5. Position held in Nuclear Medicine department			

Free Form Responses:

6. How familiar were you with the course material before the start of the course?

7. To what extent were you prepared for the work involved in supervising students?

SECTION 2: Cost - effectiveness

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. The course is well designed					
2. The course is well organised					
3. The course adds value to the students' original qualifications					
4. The course material develops skills needed by professionals in this field					
5. Satisfying the requirements of the course was easy for the students to achieve.					
6. It was easy for the student to link theory to practice					
7. Presentation of material during workshops assisted student greatly					
8. Course material encouraged students to reflect on their clinical practice					
9. Tasks in the Workbooks assisted student learning					
10. This course encouraged students to work and learn independently					
11. This course improved the students' problem solving abilities.					
12. The course encouraged students to reconsider many of their former viewpoints and practice.					
13. The course developed the students' ability to analyse and think critically.					
14. Since undertaking the course the students' attitude to radiation safety has changed					
15. Since undertaking the course the students perform quality control more regularly.					
16. Since undertaking the course the students perform more computer analysis.					
17. Since undertaking the course the students are involved in reviewing departmental protocols.					
18. Students are now encouraged to explore educational and career opportunities for self development.					
19. The course material has been useful for other Nuclear Medicine personnel					

SECTION 2: [cont'd]

Free Form Response

19. What three aspects of the course do you think benefited the students most?
1.
2.
3.

20. What three aspects of the course, in your opinion were not beneficial to the students?
1.
2.
3.

SECTION 3: Control

Indicate one 3 for each of the following questions	**Strongly Agree**	**Agree**	**Disagree**	**Strongly disagree**	**Don't Know**
1. The students needed more help than I was able to give.					
2. Additional resources to help students were easy to find.					
3. It was necessary to arrange extra tutorials for the students.					
4. Meetings were held with the students on a regular basis.					
5. The number of students made it difficult for me to supervise.					
6. I was unsure of my role as supervisor					
7. I provided feedback on each module with the student Workbook					
8. All materials were made available on time.					

Free Form Responses:

7. What made the task of supervising the students difficult for you?

SECTION 3: Control [cont'd]

8. What suggestions do you have to improve supervision?

SECTION 4: Collaboration

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. My department/Hospital management was encouraging and supportive in my role of supervisor.					
2. The workload required of me for supervision of the students was made clear to me.					
3. The logistics of delivering study material to students went smoothly.					
4. There was a good co-ordination between the Co-ordinator and myself.					
5. The Co-ordinator was able to help me sort out problems encountered.					
6. Workshops and assessment visits were well organised.					
7. The AFRA DAT project co-ordinator was helpful and supportive.					

Free Form Responses:

8. What extra support (and from whom) would have made your task easier?
9. Was there any factor that presented as a barrier to good collaboration between yourself and the Co-ordinator / Regional Co-ordinator / IAEA?

SECTION 5: Capacity

Indicate one 3 for each of the following questions	Strongly Agree	Agree	Disagree	Strongly disagree	Don't Know
1. There were enough resources to help the student meet the objectives of the course.					
2. We were able to allow students time off to study/attend workshops/complete assessments when it was necessary.					
3. Students were allowed sufficient camera time/laboratory time to complete practical tasks.					
4. There was a sufficient range of investigations for the students to meet the outcomes of the course.					
5. Inputs with regard to number of staff and time spent was more than expected.					

Free Form Responses:

15. In your opinion, which aspects of the course could be taught more effectively on a face-to-face basis?

16. What was the single most important factor that caused the students difficulty in meeting the course objectives?

NOTE: If you have any other comments please add them in space below.

Appendix J

Course Syllabus

Table 2

Distance Assisted Training Programme for Nuclear Medicine Technologists

Course Subjects and Sequence of Learning

Module	Unit	Basic Science	Unit	Clinical
Basic Level				
1.	1	Basic Physics		
	2a	Radiation Safety 1		
	3a	Radiopharmacy 1		
	12	Behavioural Science		
2.	2b	Radiation Safety 2		
	3b	Radiopharmacy QC		
	4a	Instrumentation 1	6a	Thyroid Uptake
3	4b	Instrumentation 2	4b	Imaging Techniques
	5a	Computers 1	6b	Thyroid Imaging & Therapy
			7a	Liver/Spleen
4.	4c	Instrumentation 3	8	Pulmonary Vent/Perfusion
5.	5b	Computers 2	9	Skeletal
			13	Brain (planar) & Cerebrospinal Fluid
6.			10	Renal
			7b	Gastro – dynamics
7.			11a	Cardiac – Gated, First Pass, Hot spot
			11b	Myocardial (planar only)
8	14	Non-Imaging Studies	15	Paediatric Techniques
Advanced Level				
9.	16a	Intro. To Human Biology	17	Infection & Tumour Imaging
10.	18	Medical Literature Review		
11.	19a	Understanding SPECT	20	Brain & General SPECT
	16b	Intro to Sectional Anatomy		
12.	19b	Emission Tomography (Advanced Topics)	21	Myocardial SPECT and planar

Appendix K

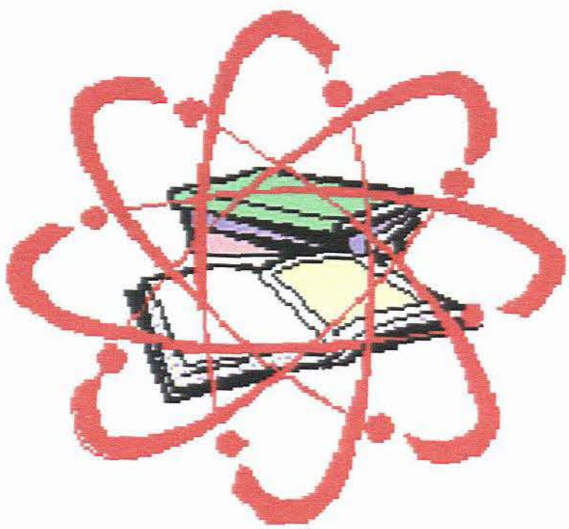
Example of a Study Unit

REGIONAL COOPERATIVE AGREEMENT

INTERNATIONAL ATOMIC ENERGY AGENCY

Distance Assisted Training Programme for Nuclear Medicine Technologists

Edited By: Heather E. Patterson, Brian F. Hutton



Renal Imaging

Author: Patricia Sinclair

Module 6 Unit 10

Renal Imaging

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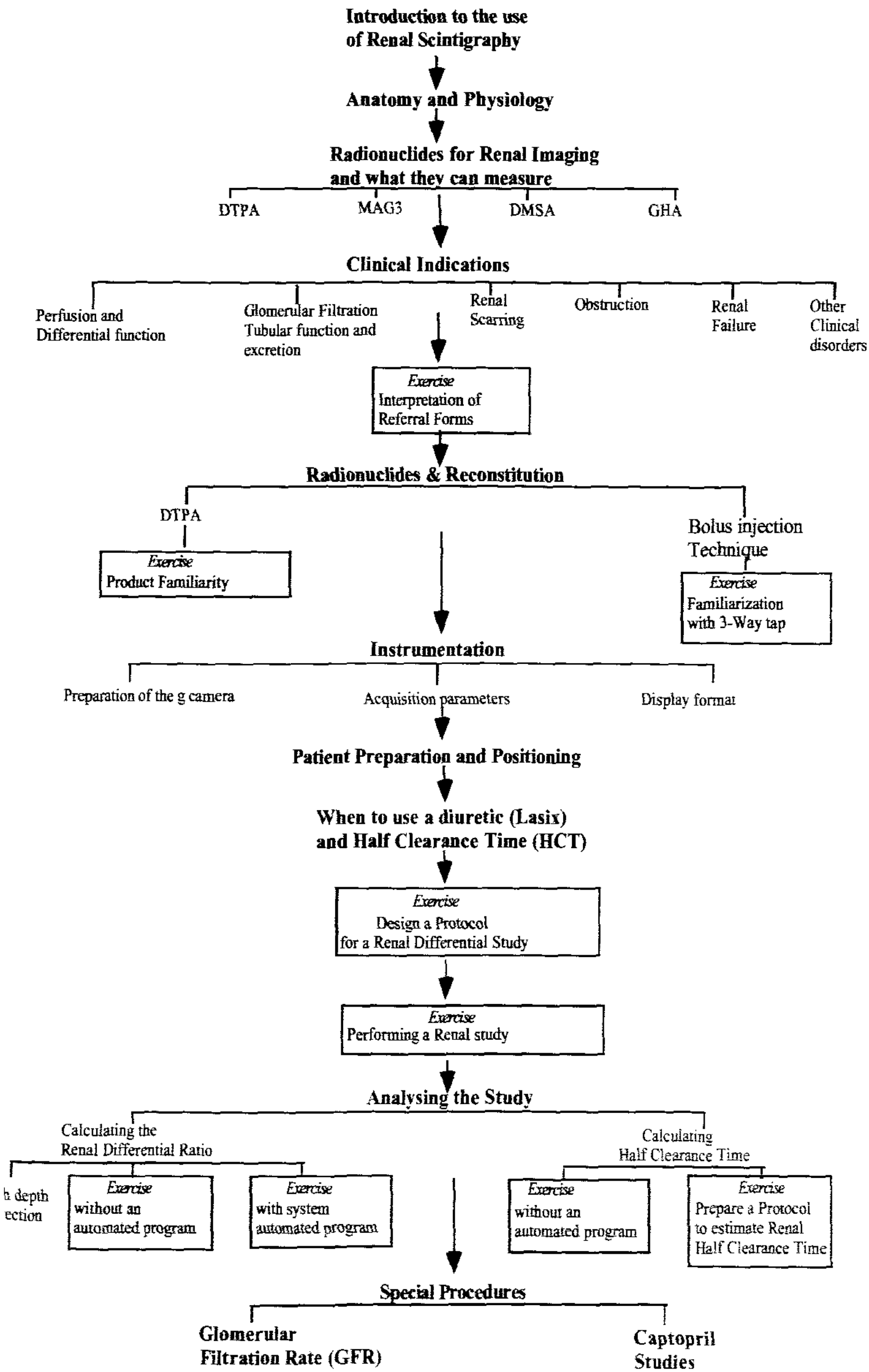
Renal Imaging



Renal Imaging

Technical Writer: Patricia Sinclair
Production Editor: Heather Patterson

Outline:

This unit will introduce the technologist to the role of Nuclear Medicine when imaging the kidneys. There is currently a range of radiopharmaceuticals that allows for the investigation of many renal pathologies. These include renal artery stenosis, renal hypertension, and space occupying lesions.

This unit will describe how renal anatomy, physiology and pathophysiology will affect the uptake and excretion of radiopharmaceuticals, with emphasis on the useful information necessary for successful renal studies. There will be a focus on the Renal Differential Study and its associated data along with diuretic washout calculations. There are other types of genitourinary studies which will be discussed briefly. You should read the recommended chapter of the textbook, where indicated, in order to more fully understand information given in these notes.

Introduction:

Nuclear Medicine studies are used to image and measure renal function and so we must understand the physiology of the kidney, the features which can be identified using each of the available radiopharmaceuticals and how the measurements relate to renal disorders. This needs a more thorough understanding than most other organ systems. The subject is quite difficult as there is quite a lot to understand. This chapter is therefore organised as follows:

a) A general introduction to what a renal study can be used to measure
b) Some renal anatomy
c) How the kidney functions
d) The radionuclides and what they can measure
e) Clinical Indications
f) Protocols and procedures
g) Computer data analysis

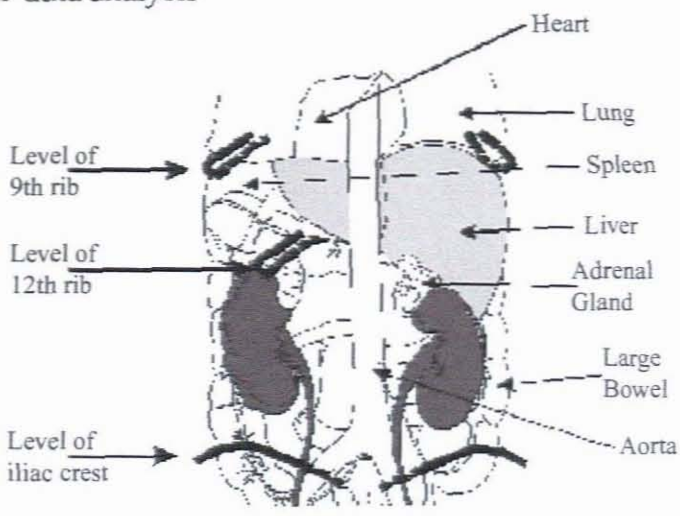


Figure 1. Relative position of the main abdominal structures with respect to the kidneys from the posterior view.

An Introduction to the use of Renal Scintigraphy

Nuclear Medicine studies are commonly used to assist in the diagnosis of clinical conditions that are associated with the kidneys. These studies display kidney function in the form of images. The use of computers enables the calculation of numerical indicators from the image information.

Such pathologies include

- obstructive uropathy
- urinary reflux
- renal failure
- tumours and cysts
- infection
- renal hypertension.

In order to understand what actually occurs in the genitourinary system when any of these pathologies interrupts normal function, we need to discuss how the blood is filtered within the kidney to form urine. The following figure displays 16 rapid serial posterior images of the torso of a child.

Note: The first 8 images are 2 seconds per frame while the following 8 images are 2 minutes per frame.

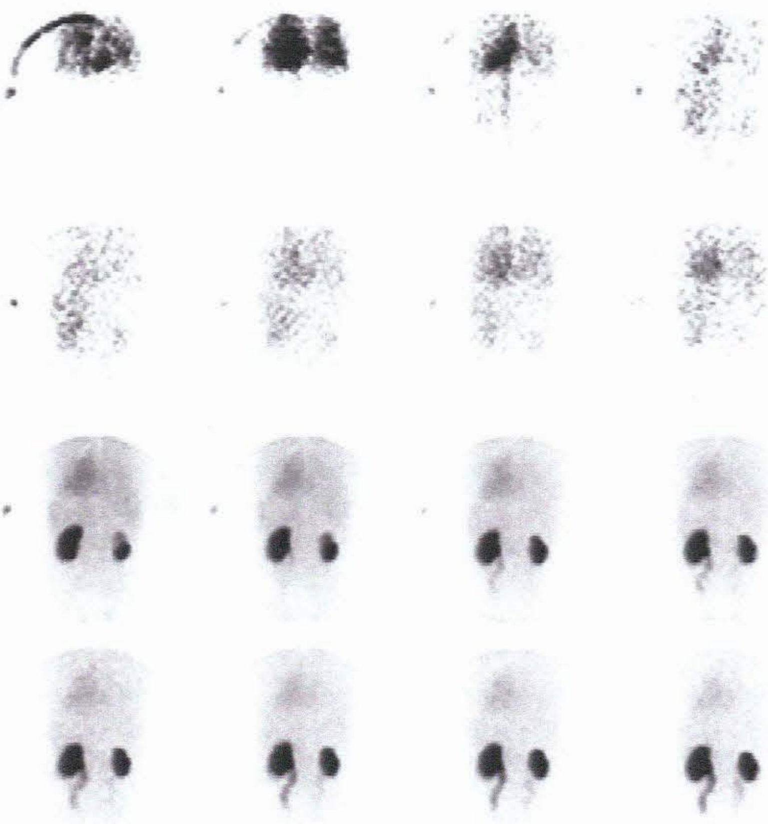


Figure 2

The child was intravenously injected with the radiopharmaceutical technetium-99m DTPA which is filtered from the blood by the kidneys. The images demonstrate the passage of blood by a dynamic imaging technique.

erence: This technique will be discussed later in this unit.

The following sequence of events will help you interpret the images.

Look at the images from left to right across the rows of posterior images.

- The first image shows the blood entering the Superior Vena Cava from the injection in the arm.
- The second image shows the blood entering the right ventricle of the heart.
- The third image shows the radiopharmaceutical being carried into the lungs in the blood.
- The fourth image and in particular the fifth image shows the blood in the left ventricle of the heart.
- From the left ventricle the blood enters the aorta and proceeds to the kidneys which can be seen as two paired, progressively brighter, oval areas in the middle of the image.
- By image 10 the bladder may be faintly seen at the bottom of the image.

2 - 3 minutes post injection the kidney is already filtering the radiopharmaceutical from the blood and concentrating it into the urine.

The complete process can be viewed as having three components

1. Supply of blood
2. Extraction of waste products (or, radiopharmaceutical from blood)
3. Excretion to the bladder

Note: The passage of radioactive substance demonstrates all three phases of the process and can therefore also demonstrate problems associated with each stage, which may reflect a particular medical condition such as:

- reduced flow (arterial stenosis)
- poor uptake of the tracer in the kidney (poor function)
- delayed excretion (obstruction)

We will look at this further later in the chapter.

Objectives

Upon completion of this study unit the you will be able to:-

1. describe the mechanism of uptake and excretion of ^{99m}Tc labelled radiopharmaceuticals for renal imaging.
2. correctly position the patient for a renal study;
3. acquire a renal differential study;
4. interpret the renal study in order to adapt the protocol to suit the patient's clinical history;
5. analyse the computer data to obtain renal differential function and diuretic (lasix) induced washout times ;
6. discuss the implications of the qualitative and quantitative results of renal studies;
7. recognise that reproducibility of the study is an important aspect of quantitative Nuclear Medicine.

Materials:

Read the section on Renal Scintigraphy in your Nuclear Medicine Textbook: ***for example:*** *Nuclear Medicine Technology and Techniques Bernier, Christian and Langan. Chapter 14*

- Workbook

Appendix L

Certificate of Achievement

(IAEA / AFRA Logo)

Certificate of Achievement

This is to certify that

____

has undertaken training in Nuclear Medicine through the

Distance Assisted Training Programme
for
Nuclear Medicine Technologists

2001

Basic Science	**Completion**	**Clinical Experience**
Physics and Radiation Safety		
Instrumentation		
Computers		
Radiopharmacy		
Behavioural Science		
Intro. Human Biology		
Clinical		
Endocrinology		
Gastro-intestinal		
Pulmonary		
Skeletal		
Renal		
Cardiac Blood Pool		
Myocardial (planar)		
Brain Blood Flow & CSF		
Paediatric Techniques		
Non-Imaging Studies		
Advanced		
Medical Literature Review		
Sectional Anatomy		
SPECT Physics		
Brain & General SPECT		
Myocardial SPECT		
Infection & Tumour		

Completion:
A = > 80%
B = 60 – 80%
X = < 60%

Clinical Experience:
A = sufficient evidence
B = some evidence
O = no evidence or
no opportunity

Understanding:
A = >80%
B = 60 – 80%
X = <60%

Practical Skills:
A = >85%
B = 70 – 85%
X = <70%
O = no evidence or
no opportunity

N/A (not applicable)

	Understanding	**Practical Skills**
Basic Science		
Clinical		
Advanced		

____
Mokdad Maksoudi
Regional Projects Coordinator
IAEA
Date:__________

____
Supervisor
Date:__________

____
Geraldine Philotheou
AFRA DAT coordinator
Cape Town
Date: __________

Appendix M

Asia Survey Analysis

DISTANCE ASSISTED TRAINING FOR NUCLEAR MEDICINE TECHNOLOGISTS

RCA SURVEY ANALYSIS

The survey questionnaire was designed primarily to evaluate:

1. The Conceptualisation and Design of the DAT material in order to assess whether it met the needs of the beneficiaries.
2. The processes of the Implementation of the DAT programme in order to judge its future sustainability.
3. The Outcomes not measurable by traditional assessment methods in order to establish the relative success of the programme.

RATED RESPONSES

Students, Supervisors and Coordinators responded to statements and questions according to the 'Likert' rating scale of; strongly agree, agree, disagree and strongly disagree. Items reflected:

1. Issues regarding the conceptualisation and design of the DAT material.
2. Implementation issues i.e. supervisory control, collaboration with the various stakeholders and resource capacity.
3. Impact or outcomes of the programme i.e. more knowledgeable students, attitudinal changes and better Nuclear Medicine service.

Conceptualisation and Design:

Overall, respondents were positive regarding aspects of conceptualisation and design of the DAT course: Coordinators 89%, Supervisors 91% and Students 80.5%.

All Coordinators thought the course was well designed, well organised and the material useful for other Nuclear Medicine personnel. All supervisors were in agreement and considered the workbooks assisted student learning. 94% of students found that both the tasks in the workbooks and the workshops assisted their learning. However 72% of the students found that they took considerably longer than the time indicated to complete subjects.

Only 54% of the Coordinators believed that satisfying the requirements of the course was easy for the students to achieve. Students were a bit more positive and 61% agreed with this perception.
To be noted is that 52% of students found the 'self-directed' or 'independent' learning approach difficult.

Implementation:

Regarding issues related to implementation of the course, both Students and Coordinators responded positively: 83% and 82% respectively.

Supervisors on the other had were not as positive: 68%. This seems to indicate that they carried the greater burden of implementation. 54% indicated that the students needed more help than they were able to give them. 42% found that they were not able to give regular feedback on the workbooks and an equal percentage indicated that it was not easy for them to find additional resources for the students. A fairly high percentage, 47%, considered the number of students under their supervision made it difficult for them to supervise and an even higher percentage, 60%, considered the inputs with regard to number of staff and time spent was more than expected.

All Coordinators experienced good liaison between themselves and the Supervisors. They regarded the organisation of the assessment visits and workshops as being good and found the demonstrators at the workshops knowledgeable and helpful. Furthermore Coordinators were in a 100% agreement that the RCA DAT Coordinator was helpful and supportive and together with the encouragement and support they experienced from their own departments Hospital managements. were thus able to sort out most problems. However, 64% of the Coordinators indicated that there were not enough resources to help students meet the objectives of the course.

Student problems with implementation were; they were not given enough time to study (26%), not given sufficient camera/laboratory time for practical tasks (29%) and 24% did not have the academic benefit of organised discussions with fellow students.

Impact:
Here again Coordinators, Supervisors and Students were overall, all very positive regarding the outcomes of the course; 89%, 91% and 87% respectively.
Coordinators, Supervisors and Students alike were in >90% agreement that the course added value to the students' original qualification and encouraged students to work and learn independently.

All Coordinators were in agreement that not only was the course particularly useful for in-service training but that the material had been useful for other Nuclear Medicine personnel.

It was agreed by 96% of Supervisors that competencies such as; problem solving, critical thinking and analysis were all improved and that the course encouraged students to reconsider former viewpoints and practices.

The Students' responses concurred, with 90% indicating that the material had encouraged them to reflect on their clinical practice and a similar percentage indicating that they had been given greater responsibility in their work following completion of the course.

More than 94% of the students indicated that they were willing to assist students on further courses and felt that the course should have National recognition in their country. 98% of the Supervisors considered that further training of technologists could be initiated in their country. However 73% of Coordinators felt that further courses would be best undertaken by a teaching institution.
All Coordinators indicated that continuation of courses requires funding with 55% in strong agreement with this statement.

FREE FORM RESPONSES
As experiences differ from country to country, analysis of additional comments for each country separately, follows. Responses were grouped according to Rheeder's '5 challenges' to the implementation of this type of Work Integrated Learning i.e. Customisation, Cost- Effectiveness, Control, Collaboration, and Capacity.[1]

Bangladesh: (Centres = 6)
Student Profile: N=13
Age: 35.8yrs +/- 6.4
Experience: 11.5yrs +/- 7.3
Home language: Bengali
Qualification: School leaving certificate: 38.5%
Tertiary qualification: 53.9%
Tertiary qualification in Nuclear Medicine: 0%
Supervisor Profile: N=5
All supervisors were Directors, Chief Medical Officers or held senior positions. All students were known to most of their supervisors except one who only knew some of the students and one who knew none at all. The benefits of knowing the supervisor helps to 'smooth the way' for the students and thus provides a resource for the student.[2]

Coordinator Profile:
One Coordinator, who was a Senior Scientific Officer and also acted as a supervisor at one centre (INM). The only constraint to good communication with other supervisors was the lack of e-mail facility in one centre at the start of the course.

Customisation:

It is, unfortunately, not possible to draw conclusions from students' responses regarding how they coped with this type of 'Open Learning' i.e. having control over the way they learn[1]. However self-motivation and the ability to work and learn independently were cited.
The two main factors making it difficult for students to study in this manner was routine departmental workload while studying and fulfilling DAT commitments. Language was a constraint as the material was in English and they were all Bengali speaking. Supervisors willing to translate (see 'Control') and lectures offered with translation provided were helpful in overcoming these language difficulties.
It is also apparent that they had difficulty with the concept of 'Open' or 'Independent' learning as they found the absent or limited traditional teaching methodologies such as classes, semester examinations and experienced guide (tutor/teacher?) added to their difficulties.
The reflection of there being 'too many subjects' is a perception, which conveys the students' difficulty with the workload. Although workload is not straight forward to measure, there is a strong correlation between 'perceived workload' and 'perceived difficulty' [3]

Supervisors with medical backgrounds were knowledgeable with the clinical aspects whereas the supervisor who was a physicist was more familiar with the instrumentation. By virtue of their position, and their knowledge of the discipline they were familiar with content but on the whole were not familiar with all aspects of the course material, its design and its implications before the start of the course. It seems that 4 of the 6 supervisors had expertise as supervisors whereas the supervisors from Mymensingh and Chittagong were less comfortable and ill prepared for the task. (See; 'Control') The supervisor from Chittagong was studying himself at the time of the course and therefore must have felt the pressure of this extra workload.

Cost-effectiveness:
A cost benefit analysis is not in the scope of this survey but we can consider the cost in terms of time and input and the resultant effectiveness of the learning experience. Comments such as; 'lack of time' and 'routine workload while studying', conveys that the input required was difficult to meet.
The areas the students found helpful in altering their existing practice gauge effectiveness of learning. Two thirds of respondents found that the course had helped them with SPECT imaging and analysis. The next most frequently mentioned areas were; Radiation Safety and Protection practice followed by computer analysis, Instrumentation QC and 'Hot lab' techniques. Other interesting comments were that it increased their conceptual view of Nuclear Medicine technology and encouraged them to reflect on their practice. Developing 'reflective practitioners' [4] is not an overt goal of the course but nonetheless an intended desirable outcome. Students found the course had increased their problem solving abilities, improved their critical thinking and analytical skills and gave them a good standard of work performance.

The aspects of the course that were found least helpful were noticeably those aspects which were not relevant to their particular practice such as; Non-Imaging Techniques, Film Processing and studies not done by them. The Medical literature review was also cited as not being helpful. Not seeing this as relevant no doubt reflects the limited scope within which they are expected to operate in their department. Further comments reflected not so much aspects that they did not find helpful but rather areas where they needed more help such as computer processing and practical exercises and demonstrations, notably in instrumentation.
Of note is the fact that 3 respondents out of 13 found everything in the course material helpful and were unable to identify areas where they needed more help.

Supervisors felt students benefited simply from the material supplied and the Workbook tasks they were required to do. All face-to-face interactions such as workshops and assessments were beneficial. The design of the material in the way it linked the theory to practice was seen as beneficial. The IAEA's assistance was an overall benefit. The fact that the supervisor from Chittagong was unable to identify any benefits suggests again that the task of supervising was an extra burden for him. Other than Film processing and Non-Imaging procedures supervisors generally found all aspects of the course to be beneficial to students and to Nuclear Medicine practice in Bangladesh.

Coordinators found that the effectiveness of the course was demonstrated in the key areas of improving Radiation protection, Quality Control, computer analysis and clinical studies.

No aspects of the course were seen as not being beneficial. The Nuclear Medicine centres within Bangladesh can now provide a more efficient service with the increased expertise of the Technologists. The DAT teaching material itself is of such a nature that it can be used for future programmes and other existing courses in Bangladesh.

Control:
It is clear that the supervisor as a 'corridor mentor' [2] works well and was much appreciated by the students especially when they needed help with interpretation and clarification of language. The arrangement by the supervisor for face-to-face interactions such as workshops, tutorials, practical demonstrations and classes was identified as being helpful. Regular examination of workbooks when it happened was an effective form of feedback on progress.
The volunteer Australian Nuclear Medicine Technologists sponsored by the Australian Youth Ambassador programme (AusAID) were seen as helpful as supervisors. Some students were unsure or ambivalent about the type of supervision they had received.

Supervision for some Supervisors was smooth and no difficulties were mentioned. There was a change of supervisor during the course at Rajshahi.
Where there was no SPECT facility, difficulties were experienced in supervision. Having no Medical Physicist available was a problem as well as the additional time required for supervising.
Lack of motivation and initiative of some students posed a problem to supervision. Logistical problems were encountered in organizing equipment and isotopes for practical tasks as well as arranging extra time for these learning activities during the course of the working day.
Feedback is a key process in distance education [2] and supervisors felt this could be improved by more frequent meetings and discussions and reviewing of workbooks. Continuous assessment was cited as a tool to improve supervision. This is a good strategy, as it would also provide the students with important feedback to their progress.
The supervisors who were uncomfortable with their role felt they needed training and extra manpower support. These supervisors need to be identified for any future 'Train the Trainer' programmes.

The Coordinator identified that supervision was hindered by the lack of e-mail communication at one centre. Efficient communication is essential for smooth coordination.
Supervisors need support themselves in order to be an efficient resource to students. They need to be inducted into supervision for it to be meaningful for themselves and the students. Incentives should be provided as recompense for their input and not rely solely on their good will or directives to perform the task.

Collaboration:
The DAT programme involves a wider range of players than would be found in traditional class based learning. The greatest requests from students were for more workshops, tutorials and the like. This requires the involvement of developers of the material along with the IAEA for planning funding and arrangement. It was apparent that shortfalls in meeting course objectives were in part due to lack of equipment in the home departments.
In the departments themselves they needed help with practical tasks in their workbooks. Here the volunteer Youth Ambassadors were of assistance and were seen as an excellent resource.

Supervisors would have liked the assistance of an experienced Nuclear Medicine Technologist and in Chittagong, a Medical Physicist. Better communication with Coordinators was needed as well as supervisor study material to help with Workbook answers (perhaps a more detailed explanation of answers in workbook).
The only barrier to collaboration was a communication barrier and that was the lack of e-mail facilities at one centre during the start of the course.
Collaboration between all the players seems to have worked well in this initial phase.

Capacity:

Students' reflections on resources were limited to comments on the course material. A fairly wide range of activities were found to be helpful, notably SPECT acquisition and analysis and Radiation Safety as well as instrumentation and QC and clinical applications. In fact one student was unable to identify the most helpful activity as they found;" all the course material helpful". Limitations in meeting course objectives were once again limited access to SPECT, studies not performed in the students' home departments, and constraints of time.
Suggestions for future courses were once again a call for more workshops, practical demonstrations and tutorials. There was a strong request for interactions with students from other countries.

In one centre (INM) all subjects were taught on a face-to-face basis. However extra input was needed in much the same areas identified by other centres as needing face-to-face tuition i.e. Basic Physics, Radiation Safety, SPECT, Quality Control, computer analysis, and Workbook practical activities.
Supervisors recognized difficulties where specific equipment like SPECT was not available. Time management and workload of the students made it difficult for students to complete DAT commitments. SPECT and Later modules, notably Human Biology, Behavioural Science and Medical Literature Review were seen as being more difficult for students but nonetheless of benefit. There is a change of language genre In the Behavioural Science and Medical Literature Review modules, which second language students already struggling with language could have found difficult. Course material was thought to be excessive. Suggested improvements for future courses would be to have more lectures and workshops. Improvement areas identified were in Basic Sciences and computer software.
Supervisors believed that a salary or promotional incentive for students on future courses was seen as a necessary motivation and also better coordination between supervisors and course developers was necessary.

Coordinators identified departments without equipment such as SPECT, fell short of the curriculum needs of the course. As the DAT material is designed in most part as a 'Reflective Action Guide' [5] where activities are related to students' own situation, it would be more meaningful if the modules are restricted to those that match the educative potential of the workplace.
The single most important factor that was seen to hinder the students' performance was the language. If the DAT material can be translated into Bengali it will be of greater benefit to Nuclear Medicine in Bangladesh.

CHINA (Centres=68)

Student Profile: N=62 respondents

Age: 35.1yrs +/_ 7.5

Years experience: 12.2yrs +/_ 7.9

Home language: Chinese

Qualification: School leaving certificate: 8

College for professional training: 32

University qualification: 21

Masters: 1

Supervisor Profile: N=33

All supervisors were senior people and regarded the students as colleagues.
Their feelings about the course material were that it was sophisticated and they were able to familiarize themselves with the material prior to the start of the course. By virtue of their status, the supervisors were no doubt familiar with the course content and were also familiar with 'every detail' of the teaching materials. (Perhaps some were involved in the translation of the material and therefore would be intimately knowledgeable with material).
The students were referred to as colleagues and as such supervisors are better able to offer 'human support' as a resource [2].

Coordinator Profile: N=6

There was one senior person coordinating each of the six regions with between 4-20 centres (mean=11.3) under their control and an average of 5 supervisors in each region. There were an average number of 20 students in each region.

Customisation:
At least 2-3yrs practical experience in Nuclear Medicine before starting the course was thought to be beneficial to those students studying on the course. Departments should be equipped with the necessary equipment and students should have permission and departmental support.
A lack of a Chinese textbook for Nuclear Medicine Technologists as a resource was a significant limitation. Students seem to prefer 'front loading' approach to learning and appreciated materials arriving on time for them to study beforehand. Possibly students' were not properly inducted into this modularised approach to 'just in time'[5] learning. Students appear o have felt a sense of isolation and would have liked more communication with other students. Their difficulty with this 'learner centred'[6] approach is born out by the fact that not having a 'face-to-face supervisor' (tutor/teacher?) made it difficult for them.

Communication is essential to smooth coordination and so e-mail and fax facilities were seen as being helpful to the Coordinators as well as the workshops which afforded a forum for discussion and was an effective 'transaction spaces' [7].
Financial support (from IAEA?) helped the coordination process.
However coordination was difficult as it was an additional workload to an already full schedule and did not allow coordinators sufficient time to supervise. Students had hoped that the certificate would be accredited in China but this has not happened.
Coordinators had to rely on the good will of instructors (?) who fulfilled the task without pay. Lack of incentive for these instructors will be a constraint to future sustainability.
Different cultural backgrounds in the various regions made coordination difficult and the vast area served made it logistically difficult for students from the different regions to meet and discuss problems.

Cost-Effectiveness
The areas the students found helpful in altering their existing practice gauge effectiveness of learning. These were notably in the areas of Radiation Safety and QC. They felt they had gained sound understanding of the theory and the style of learning improved their 'self directed learning' ability.
The workbook task of developing and standardizing protocols was helpful.
Once again it was stated that not having a Chinese version of the required textbook was a constraint. Lack of communication and tutoring made learning in this way difficult.

Supervisors felt students benefited specifically from Basic Physics modules and QC. In general it was felt students benefited in their conceptual understanding of principles underlying investigations. Some topics they found were not detailed enough. Perhaps if they had had sufficient additional reference material in Chinese they might not have felt the same.

Coordinators felt that the benefit of the DAT course was primarily that it brought Nuclear Medicine training to China. The course material is now available to China as a much-needed resource given that no reference material in Chinese is available at a Technologists level.
The coordinators in China as not only advanced but a methodology, which develops critical thinkers, see the methodology.
The aspect of the course that was of no benefit to China was the section on rectilinear scanners. No doubt no scanners are around in China anymore.

Control
Students found the Supervisors were helpful with clinical practice and in traditional classroom situations. It was felt that more supervisory help was needed with Basic Physics, Instrumentation and imaging techniques. More information was needed on SPECT and PET. SPECT and PET is covered in the advanced modules which is planned for the second phase of the project

Supervisors felt that their task was made difficult by time constraints of fitting in supervision along with daily workload. They also observed that Students experienced difficulties in meeting course objectives in departments without the required instrumentation. They felt strongly that Chinese textbook for technologists would be helpful for themselves as well as students.

Coordinators indicated that communication had been a problem where no e-mail facility was available and the regular postal system had to be used. Because of the vast area covered it was logistically difficult to arrange for students to meet for discussions. This aspect is important as with this type of methodology students often feel lonely and isolated.[2]
There were financial and economic implications, which posed problems and needs to be addressed for future sustainability. Luckily the economic advantage of distance education is that unlike traditional higher Education, it lends itself to economies of scale [7] for once the initial capital outlay has been made i.e. producing a Chinese version of the material, unit costs decrease with expansion of the course.
Their suggestions for improvement:

- More opportunities for regional coordinators to meet
- Regional funding for regional coordinators to arrange their own programme
- Formal certificate from IAEA for each Regional coordinator and Supervisor
- Internet IAEA course

It seems that Certification of the course at a National level did not happen as planned. This is important for student motivation and should possibly be spearheaded by the Chinese Nuclear Medicine society, as the course does not come under the control of any institute of Higher Learning at this stage.
As mentioned before a 'Train the Trainers' approach needs to be implemented as supervisors as a 'Human Resource'[2] is essential for the success of the student.
Supervisors need to be identified and given work relief to carry out the task effectively.

Collaboration
Students found the lack of additional resources a limitation in meeting objectives. The DAT programme involves a wider range of players than would be found in traditional class based learning and this network should be widened to include professional bodies such as the Chinese Nuclear Medicine Society. They would be in a position to address the problem of the lack of additional study resources, notably a Chinese textbook. In some aspects the study material itself was seen as not meeting the curriculum needs of Nuclear Medicine in China. To be noted is that students have only completed the first phase and there are advanced Modules still to follow. Regular training sessions were a request from students.

Supervisors felt there was a need to provide training for supervisors and a 'Train the Trainer' project should be considered for China. Supervisors felt that the lack of time was a barrier to effective collaboration with coordinators and IAEA.

The overall feeling from Coordinators was that there was not a wide enough network of players to aid collaboration and they would have benefited from the support of other Nuclear Medicine Physicians, Radiation Safety Engineers, Computer Engineers and the Chinese Society of Nuclear Medicine.

Capacity
Lack of additional study resources to compliment the course material was a severe limitation. In light of the fact that most of these students have been working in Nuclear Medicine departments for an average of 12yrs, such a course is long overdue and highlights how Higher Education has not kept up with technological advancements in China. The course allowed them to gain insight into the underlying principles of Nuclear Medicine studies giving them a sound understanding of related theory. The importance of QC both in Instrumentation and Radiopharmacy was brought home to them and the standardized protocols improved their methodology. They felt that QC, computer analysis and practical aspects would be better taught in a face-o-face situation as these presented them with some difficulty. They also experienced difficulty in coming to grips with Nuclear Physics. Limitations in meeting course objectives were; lack of equipment in some departments, lack of study resources and constraints of time.
Suggestions for future courses were;

- Regular workshops or training sessions
- Imaging analysis (pattern recognition?)
- SPECT and PET

Supervisors felt that Quality Control, Computer Analysis and Clinical Practice activities could be taught more effectively in a face-to-face situation.

Self directed learning was difficult for the students, as they would have liked some traditional classroom teaching. A creative mix of methodologies would perhaps suit the students better in future courses. The lack of a Chinese textbook exacerbated the situation (See; Collaboration).
Difficulties were experienced with Basic Physics and imaging analysis while standardizing protocols and QC both in Instrumentation and Radiopharmacy was helpful.
Supervisors were in agreement with views of students regarding future courses.

The Coordinators had a sense of being let down, as certain promises made at the beginning of the course were not forthcoming. It was hoped that the IAEA certificate would be accredited in China but this is now in doubt. This would be a de-motivating factor for future students and a threat to sustainability of the course. There were also promises made that top achieving students would have the opportunity to take advantage of the credits offered for the IAEA course and challenge the Sydney University diploma and now doubtful whether it will happen.

India: (Centres =7)

Student profile: N=13

Age: 34.8yrs+/- 5.5

Experience: 9.8yrs+/_4.2

Language: Hindi 8

English 3

Telugu 1

Bengali 1

Qualification: School leaving certificate: 1

Dip. in Radiological Technology: 1

University qualification: 10

Masters: 1

Supervisors profile: N=8

NM Physicians: 2

Technical/Scientific Officers: 6

All students were known to Supervisors as they were either in their employ or co-workers.

Customization:

The majority of the supervisors although they were familiar with the discipline, was not familiar with the course material at all and first saw the material only when students received their first Module. However by virtue of their position and knowledge of the discipline, they committed themselves to supervising as one supervisor put it; "as if I am the student". Some noted how they had enjoyed the experience and that the quality of work in the department had improved.

Most students confined their reflections on what prepared them best for the course to comments on the course material and in some instances guidance from supervisors. Others recognized the quality of work in their department, the cooperation from staff members and previous experience as being helpful.

Cost-Effectiveness:

Generally, Students felt that because the design of the DAT course was systematic, analytical and easy to understand their knowledge and practical skills had improved. More specifically it had helped them with Radiation Safety. Attitudinal changes were that they were now able to reflect on their practice[4], produce quality work and were more self-confident. Of note is that 9 of the 13 students could list nothing in the course that they found least helpful. One mentioned Fourier Transformation another cited labeling Radiopharmaceuticals and QC as being least helpful. One student was insightful enough to mention that the least helpful aspect of the course was that it was not nationally recognized. In their eyes, they felt that national recognition would prove it to be a 'valid' qualification for future job prospects. One of the challenges of distance education is that it is seen as 'second-class'[5] to formal systems of education and this accreditation is essential for the perceived esteem of the course and future sustainability.

Supervisors agreed that students benefited from the design of the material in the way it linked the theoretical to the practical, especially in the workbook tasks. They also felt that students benefited from the interactions at Workshops and assessments.

Control:
It appears that the students were fortunate to have good support from their supervisors who gave them encouragement, motivated them and were always available for discussions and explanations. Their help with setting up the practical tasks was appreciated by the students. They indicated that they would have liked more help with the practical tasks especially with SPECT and QC of the gamma camera and at centres where Technical Officers were supervisors, more help was needed with the clinical part of Nuclear Medicine.

About half the supervisors indicated that they had experienced no difficulties in supervising. Others mentioned the time constraint of supervising along with managing their own workload. What is apparent is that inducting supervisors better into the task of supervision and offering support during the course is necessary. Suggestions were; providing (better?) guidelines or quite simply having their own copy of the material. It is clear from the comments that they need to meet regularly with fellow supervisors and the Coordinator for discussions. Developing a strategy to have the course accredited in India is necessary.

Collaboration:
Students would have liked more support at a practical level with time off and an interchange of students between centres. They felt they needed more frequent workshops and of longer duration, especially well before the final assessment in order that they could have prepared more effectively. There was a suggestion that the course be divided into 4 semesters with a workshop, primarily for feedback on 'unsolved' exercises followed by an assessment. Continuous assessment allows the students to monitor and evaluate their own progress.

Supervisors indicated a need for collaboration and interaction with other supervisors. Additional financial support was needed over and above the help from the IAEA to run workshops. In the centre where the Medical Physicist was the supervisor, help was needed from clinical colleagues. Extra support was needed from the National Coordinator and the Hospital Management at the centre in Hyderadabad. Once again it was pointed out that accreditation of the course by the National Regulatory Agency would have resulted in more complete and enthusiastic participation. In order to assure sustainability in India, the course needs parity of esteem [8] with courses offered at Tertiary Institutions in that country.

Capacity:
Aspects of the course that students considered would be more effectively taught in a face-to-face situation were:

- QC of gamma camera
- SPECT and other advanced topics
- In-vitro
- (The dreaded) Fourier Transform!
- Instrumentation and Computers
- WBC labelling
- Radiopharmacy
- Radiation surveillance
- Safe handling of therapeutic doses

Some institutions had the capacity to organize contact lectures and other institutions not. This underscores the need for better collaboration between supervisors to decide on a relatively uniform approach so that no group of students feel compromised in anyway. More than half the students reflected that they had no difficulty in meeting course objectives. In some centres the heavy workload posed a time constraint and at the one centre (Dehli), there was not enough support from the supervisor. Difficulty was experienced at the centre in Kolkata as they did not have an 'advanced' gamma camera.
Students viewed the fact that the course is not nationally (or Internationally) recognized as being the main limitation of the course, as well as the time constraints of having to contend with a heavy workload in their

departments while studying. The Supervisors echoed this sentiment. Suggestions for future courses were; more opportunities for interaction with other students and a workshop on Radiation Protection involving the Atomic Energy Regulatory Board.

Coordinators felt that practical tasks should be handled as a tutorial especially where instrumentation, software, and radiopharmaceuticals and the like were not available. Non-availability of instrumentation and software for processing data posed difficulties for students. SPECT, Hot Lab procedures, computer processing were all work activities where Coordinators felt the course seemed to have provided the most help.
Suggested work activity enhancements to the course were:

- Allied medical imaging i.e. CT, MRI and Ultrasound
- SPECT and PET
- Radiopharmacy QC
- At least 4 workshops over a two year period
- In-vivo/in-vitro quantitative studies and Compartmental analysis
- Supervisors to provide more feedback and take on a role of mentor.

There was a strong plea that the course should continue as it is done presently as the personal development of the students into able 'situation improvers'[9] benefited the Speciality and its quality.

Korea: (Centres=12)
Student profile: N=48 (4 English respondents)
Age: 34.3yrs+/- 3.4
Experience: 9.2yrs+/_3.8
Language: Korean
Qualification: (mostly? Radiological Technologists)

Supervisors profile: N=7 (2 English respondents)
Position: Chief Technologists

Coordinator profile; N=1
Position: Chief Technologist

Analysis of the Free Form Responses is limited to the 4 students, 2 supervisors and Coordinator who responded in English. It therefore cannot extract shared meanings but serves as interest only.

Customisation:
Students found what prepared them for learning in this way was their previous experience, background knowledge in Physics, Instrumentation and Computer Science and the fact that departments had the necessary equipment and set-up.
Supervisors had heard about the course from the National Coordinator and were familiar with about 80% of the course content. The Coordinator observed that because they had to communicate with each other it brought those involved closer together.
Language was undoubtedly a problem and the students' normal departmental workload made it difficult for them to complete course objectives.
The Coordinator found his task difficult because of the long distances (between centres) and the fact that there was no incentive for the students to do the course and this affected their motivation and attitude.

Effectiveness of Learning:
Students felt the course helped them most with Basic Physics, Radiation Safety, Radiopharmacy, Instrumentation and QC, Brain and Cardiac SPECT. The design of the material with its practical exercises reinforced their learning thus improving their practical skills. Least helpful aspects were:

Radioimmunoassays, design protocols detailing operational procedures and too many methods using single headed analogue gamma cameras.
The Supervisor thought students benefited from understanding the importance of the role of the Nuclear Medicine Technologist, reviewing techniques in a systematic way and refreshing their practice. As with the students they considered the material to contain obsolete topics, Instrumentation and studies no longer used.
The Coordinator felt that the course took too long and it was difficult for him to arrange time, locations and equipment.

Control:
There was a 50% student drop-out rate. The Coordinator attributed this to the language problem, lack of incentive and lack of cooperation from Directors of some Institutes.
Supervisors reported that Senior Technologists complained that they had to relearn material they had already studied.
The Supervisor at SNUH was helpful as he too was studying the course.

Collaboration:
Students pointed out that there was not enough information and feedback from the Advisory Board member. Group sessions were used successfully by the students to learn the material.
One student pointed out that the course material should be a resource for the Health Sciences College.
(It appears that perhaps this course has been used for the wrong purposes for which it has been designed. If most students already had qualifications from the College of Health Sciences and there was a Nuclear Medicine component to that course, then it would have been far more sensible to construct short refresher courses around selected modules. The students could then choose to select the modules relevant to their needs. Given recognition of their prior learning, choice and relevance of material, there would not be such a high drop-out rate.) The material would necessarily have to be translated into Korean.

Capacity:
Students had difficulty with Human Biology and Behavioural Science which would not be surprising if they already were having difficulty studying in English. Advanced topics on Emission tomography also posed problems.
Consulting manuals and tutors was helpful.
Suggestions for enhancement of course were:

- PET/CT
- Radioimmunoassay techniques
- Radionuclides for PET and their application
- Cyclotron production

Despite time constraints and language problems, students found that completing the DAT course had given them confidence in what they were doing.

Pakistan: (Centres=8)
Student profile: N=10
Age: 38.9yrs+/- 4.5
Experience: 10.7yrs+/_5.8
Language: Urdu 5
Punjabi 2
Sindhi 1
Qualification:
Dip. in Chemical Technology: 1
University qualification: 7

Supervisors profile: N=6
NM Physicians: 3
Scientific Officers: 3

All students were known to Supervisors except at one centre where the students were not known to the supervisor. Some supervisors were familiar with the course materials others were not. What was helpful was the brief introduction to the structure and design of course beforehand. All Supervisors were prepared or had experience in supervision.

Coordinator profile: N=1 Head of Medical Physics Dept.
Coordination went smoothly, all materials arrived on time, and there was adequate communication and collaboration with DAT coordinator as well as cooperation from Supervisors. Encouragement was received from the Advisory Board member and assistance from the department.

Customisation:
Students were motivated to challenge the course as no formal course in Nuclear Medicine is offered in their country. They only had on-the-job experience and wished to increase their theoretical understanding to bring them in line with International standards. Supervisors were encouraging and the course material itself was an incentive.
Two students found no difficulties in studying this way. Others cited factors such as departmental workload and fulfilling practical components as being difficult. Students experienced feelings of isolation in departments in remote areas with lack of communication with Coordinator, and being the only student at a centre. More specifically problems were encountered where the equipment did not match the needs of the curriculum.

Cost-Effectiveness:
Most Students and Supervisors agreed that the design of the course material in the way theory is linked to practice best illustrated how the course helped the students, with Workbooks and Workshops specifically being most helpful. Student felt that it increased there understanding of underlying principles and gave them confidence in their practice especially in the areas of Radiation Safety and Hot Lab procedures. Inability to complete workbooks and practical exercises due to lack of resources appeared to be a frustration. Clinical aspects not relevant to their practice such as PET and computer basics were seen as not being helpful. Time constraints added to their frustrations. More interactions between students would have been appreciated.
Supervisors observed that the course increased the students' understanding of clinical investigations, QC and radiation safety. It involved the Supervisors in an active way and was instrumental in improving students' morale. However there was a sentiment expressed that the level of the course was too high. Of least help generally was studies not done in their department and specifically; Medical Literature Review, Emission Tomography advanced Topics and CSF imaging.
The Coordinator felt that exposing students to up-to-date techniques, improving their efficiency and making then aware of QC benefited Nuclear medicine practice in Pakistan.

Control:
Students seem to have benefited from the excellent supervision with discussions, guidance and help with practical demonstrations. In one centre the whole course was taught. More help was needed with practical tasks, computer modules and developing new protocols. In the centres where Medical Physicists were supervisors, students felt they needed the help of a Nuclear Medicine Physician to increase their clinical understanding, especially interpretation of scans.
Supervisors experienced difficulties with investigations not done in their departments. No mechanism was in place to send these students to other centres where these investigations are done. Only having one student to supervise was seen as a difficulty, as there was no opportunity for students to learn from each other and the student was thus totally dependent on the supervisor. Heavy student workload and lack of instrumentation resources posed problems.
Suggestions to improve supervision included training for supervisors and providing regular opportunities for them to interact with other Supervisors and Coordinator. Removing difficult and unnecessary calculations from the course material was suggested as well as an aptitude test to determine student's admission.

Collaboration:

The Coordinator felt that a DAT course website would help and is obviously uninformed as there is one with a Bulletin Board for students. Incentives for students were seen as being important
Supervisors indicated that they would benefit from a 'Train-the Trainer' support as well as extra manpower support from the Health Physics dept. and Radiopharmacy.
Students called for better collaboration in organizing practical demonstrations, regular workshops, time off to study and visits to departments with better resources, especially where there are SPECT facilities.

Capacity:
Student and Supervisor opinion regarding what aspects could be taught more effectively in a face-to-face situation is:

- Clinical topics
- Hot lab procedures
- PET and SPECT
- Computer processing
- New techniques
- Practical aspects of Gamma camera

Limited resources, limited time, studies not done and perceived level of course as being too difficult were all cited as the single most important factor why students could not meet course objectives.
Generally they benefited from an increase in knowledge, confidence and professionalism, which ultimately was of benefit to the patient.
Towards the end of the course the interest seems to have lagged, completing workbook practical tasks was difficult and the course took longer than expected.
Suggestions for course enhancements included:

- Basic Mathematics and Statistics
- Therapeutic Nuclear Medicine
- More frequent and regular workshops
- RIA
- On-line conference
- More emphasis on QA
- Course material on CD more widely available to Supervisors and libraries.

The general feeling was that the course had been a benefit to Nuclear Medicine practice in Pakistan and that student numbers should be increased. The ongoing support from the IAEA was needed to strengthen the expansion of the project.
The Course Developers' contribution was appreciated and their involvement needs to be continued.

Philippines: (Centres=11)
Student profile: N=9
Age: 33yrs+/- 3.3
Experience: 10.6yrs+/_2.1
Language: Tagalog
Qualification:
University qualification: 5

Supervisors profile: N=4
NM Physicians: 4
Mostly students were known to the Supervisors however one supervisor supervised students from a different hospital. Only one supervisor took the opportunity to comment in free form responses. This Supervisor admitted that they were not familiar with DAT course material at all. Supervising the DAT students required many more interactions outside of the home department.

Coordinator profile: 1
No. of Supervisors: 10
No. of Students: 29

Both Nuclear Medicine Residents and the Medical Technologist Organization helped with coordination and keeping students on course. The busy schedule of the Supervisors and availability of the students especially on examination dates made coordination difficult.

Customisation:
The students' experience in Nuclear Medicine, prior regulatory courses in handling radioisotopes, and motivation to learn the underpinning knowledge to their everyday practice prepared students best for learning. What made it difficult was that practical exercises could only be done in students' spare time. Lack of resources in the way of equipment and studies not done also made it difficult. One student moved out of Nuclear medicine and therefore found it difficult to fulfil course objectives.

Cost-Effectiveness:
The Students thought the course helped generally with knowledge gained, improved practical skills and dealing with patients and specifically with:

- Importance of gamma camera QC
- Data analysis
- Developing protocols
- Team building with other technologists
- Radiation Safety

The Supervisor considered the SPECT module to be most useful for those that had SPECT facilities and most confusing for those who did not.
Only two students responded to what was least helpful and that was the Medical literature review and Behavioural Sciences as well as some parts of computer module.
The workshops had been benefit to Nuclear Medicine in the Philippines according to the Coordinator.

Control:
There seems to have been no supervision at Capitol and Rizal Medical Centres. Students from other centres did not respond to the question regarding helpful supervision so it is not possible to map the type of supervision they received. Supervision is an important Human resource[2] and if supervisors were at other centres, planned meetings, arranging help with practical tasks and reviewing workbooks are all necessary aspects of supervision. For Students who did respond they found the encouragement, motivation and lectures on clinical aspects helpful.
This lack of uniformity in supervision was born out by a supervisor who reflected that although the number of students was manageable they were spread out at different centres and meeting them regularly was logistically not possible.
The Coordinator who conceded that students lacked enough supervision and gathering students together for examinations and lectures was a problem corroborated this. An improvement would be if all students had e-mail access and a better system of coordination with supervisors.

Collaboration:
The Coordinator experienced difficulties in coordinating the DAT course because of a busy schedule and felt that a teaching institute should be involved in coordinating such a course.
Students would have benefited from a better co-ordinated course especially with the organization of more workshops, lectures and support in finding resources needed for practical exercises e.g. laboratory materials.

Capacity:
Students felt that regular discussions and face-to-face interactions would have helped with:

- Computer modules
- Radiopharmaceutical preparation and QC
- Data analysis
- Experiments/practical tasks
- Gamma camera QC
- Non-imaging techniques

Factors making it difficult for students to meet the course objectives were:

- Lack of time/workload
- Instrumentation limitations
- Studies not done
- Performing exercises on paying patients
- Lack of discussions and sufficient workshops
- Student movement (out of Nuclear Medicine)

Generally completing the workbook was the activity, which provided the most help along with the SPECT module. The work activity where they had the most difficulty was the computer module.
Students insightfully suggested that supervisors should be trained for future enhancement of the course.
If the course is to be continued in the Philippines, the Coordinator suggests that it should be conducted by a Teaching Institution with the addition of traditional teaching methodologies such as lectures to reinforce learning and supervision should be on a one-to-one basis.

Sri Lanka: (Centres=2)
Student profile: N=41
Age: 41.5yrs+/- 4.3
Experience: 5yrs+/-.3
Language: Sinhala
Qualification: School leaving certificate: 1
Dip. in Radiography: 2
Training in RIA: 1

Supervisors profile: N=2
NM Technologists: 2

All students were known to Supervisors as they were co-workers.
Both supervisors had completed the course themselves and were thus well prepared to supervise the students.

Coordinator profile: N=1
The Coordinator was a Medical Physicist. The well-developed course material made coordination easy; however there was a lack of motivation on the part of the students with resultant drop out.

Customisation:
Two students cited their experience as Nuclear Medicine technologists as good preparation for the course. The other two students were Radiography Tutors wishing to establish a Nuclear Medicine course in Sri Lanka.
According to the coordinator, the students were not interested in enrolling for the course and lacked the motivation to see the course through. The regulatory authorities in Sri Lanka do not recognize the course and there are no incentives for personnel already doing the job to study the course.

Cost-Effectiveness:
Despite their lack of interest in doing the course, the students found that material helped them in developing knowledge and skills and encouraged them to improve their practice.
For the Tutor Radiographers the availability of already developed curriculum and materials paved the way to establish the training at the National Radiography School.
The supervisors thought that the distance training methodology had enhanced students' knowledge and skills. It made students appreciate the need for safety, and developed their patient communication skills. The assessment from external examiners was also seen as a benefit.

Control:
Students appreciated the regular discussions, practical tutorials, clinical exercises held with the supervisors and help with instrumentation. However they would have liked more help with Radiopharmaceutical QC exercises, as they had no access to materials for these exercises.

Supervisors had difficulty in coping with the lack of student motivation and had to coax students to meet deadlines. Students suffered from 'mid-course blues'[2] and dropped out. The Coordinator was sympathetic with the difficulties the Supervisors were experiencing in keeping the students on track, and saw national recognition of the course as a way of giving incentives by way of salary increases and promotion. However a lobbying for this is proving difficult as such a small group is involved.

Collaboration:
Students felt that collaboration could have been improved by having internet and e-mail access. Demonstrations on CD of studies or practical exercises in the course to which they had no access because of limited resources, would have given them added support.
Supervisors desired certification or recognition for their input.
The Coordinator felt that a collaborative effort was needed to solve the drop out problem.

Capacity:
Both students and supervisors alike felt that clinical exercises would be more effectively taught in a face-to-face situation. The greatest difficulties in meeting course objectives were the range of studies not done in their departments. The Coordinator, who pointed out that not being able to perform SPECT, Cardiac and Ventilation studies hindered the students in meeting course objectives, confirmed this.
Students felt that they had benefited from the self-directed learning[6] methodology used in the DAT programme and assessment from external examiners.
The work activities the supervisors and students perceived as being most helpful were:

- QC
- Instrumentation
- Radiation safety
- Bone, Renal, Thyroid studies
- Patient communication

The activity that posed the most difficulty as mentioned before was radiopharmaceutical QC because of lack of appropriate materials.

Thailand (Centres=7)
Student profile: N=10
Age: 30.3.5yrs+/- 4.3
Experience: 7.9yrs+/-3.6
Language: Thai
Qualification: University qualification: 4
Dip. in Radiography: 2

Supervisors profile: N=7
NM Physician: 5
Med. Physicist: 2
All students were known to Supervisors as they were employees or co-workers.
Supervisors seem to have understood the structure of the course before starting.

Coordinator profile: N=1
The Coordinator was the Chief Physicist and was afforded support from the various departments. Government offices, Atomic Energy, Course Coordinator (RCA?), Course Advisor (Advisory Board member?) and professional Societies

Customisation:
Students prepared themselves by improving their English usage and doing background reading. They had practical experience and overlapping basic knowledge from their qualifications. Language was undoubtedly a problem as was fulfilling practical exercises where there was a lack of resources.

Cost-Effectiveness:

The students felt that in general the course helped them to improve their knowledge and skills, problem solving abilities, understanding of underlying principles of Nuclear Medicine, and in particular helped them with; gamma camera QC, Radiopharmacy and SPECT.

They also felt that the structure and design of the material had aided learning.

Support from the project manager and departmental staff had helped.

However, students reported that the material was difficult to understand and it required a lot of time.

Supervisors indicated that the course had added value to their practice by increasing their knowledge, practical skills, attitude and organizational ability

More specifically it helped:

- Appreciate the value of Instrumentation QC
- Practice good Radiation Safety techniques
- Cardiology
- SPECT and computer analysis

One supervisor regarded the number of cases to be 'logged' in the workbook as insufficient.

Control:

Those students who did respond to questions regarding supervision reported that there were tutorials and monthly meetings and supervisors helped sort out problems. Specifically supervisors helped with QC and SPECT.

Supervisors reported that some of the exercises in the Physics section were too difficult even for them.

Workload of both the students and supervisors made supervision difficult. Supervisors would have liked extra manpower and more tutorials with students as well as regular meetings with other Supervisors and Coordinator was seen as necessary to establish a uniform standard and arrange for students to visit other departments.

The Coordinator reported that the students at outlying centres, notably Chiengmai and Khon Kaen could not attend tutorials and monthly meetings

Suggestions for improved coordination are that students should be committed to the course, pay tuition fees and have an entry requirement of a degree in Radiological Technology.

Collaboration:

Students would have liked more support by visiting hospitals with better facilities especially for SPECT imaging. Workshops increased their understanding of course material and arrangement of more of these and more tuition would have been welcome. Students would like the opportunity to log record case studies they have performed in their departments but which are not required in the workbooks e.g. CSF studies. Some Supervisors indicated good collaboration with Coordinator and senior staff. Funding students to travel to other institutions for workshops could be alleviated if supervisors had their own budget.

Capacity:

Both students and supervisors agreed that SPECT, QC and computer analysis could be more effectively taught in a face-to-face situation. One student would have liked the entire course to be taught using traditional teaching methodologies. Language, time constraints, equipment breakdowns as well as distance were seen as causing the most difficulty. Supervisors felt that student lack of motivation was also a problem.

The SPECT work activity, specifically SPECT filters, and Instrumentation QC was the areas that seemed to have posed the biggest problem for students. Behavioural Science was also mentioned.

Although the Coordinator is of the opinion that it is an excellent course, in order for the course to continue a budget needs to be provided and the course should be conducted at the University Hospital. The course should also be accepted by the Government (National accreditation).

There is a wish for a similar programme for the development of post graduate Medical Physicists in Thailand.

RECURRING THEMES

Customisation:

- Language difficulties: Pakistan, India, Sri Lanka and the Philippines have English as an Official (second language) or semi-official use[16] and therefore could cope. Whereas Bangladesh, Korea and Thailand do not, and students from these countries already struggling with language had greater difficulty with Behavioural Sciences, Medial Literature Review modules and to a lesser extent Human Biology.

- Concept of 'self-directed learning' was difficult for those used to traditional teaching methodologies.
- Prior experience in Nuclear Medicine added to success
- Desire for International standard was a motivating factor.
- Lack of National recognition/accreditation of course did not allow for incentives by way of salary notch increases and possible promotion.
- Distance between centres made it difficult to utilize resources efficiently.

Cost –effectiveness:

- Large input in terms of Coordinator's and Supervisor's time
- Range of Manpower input needed; Physicists, Physicians, experienced Nuclear Medicine Technologists, (Radiopharmacist?).
- Students need to use spare time to meet practical course objectives.
- Successful gain in KAP (knowledge, attitudes and practice) especially Radiation Safety and Quality Assurance.
- Development of problem solvers
- Development of critical thinkers
- Development of reflective practitioners
- Nuclear Medicine Service improvement
- Brought NM training to countries where none previously existed
- Availability of well conceptualized and designed course material

Control:

- Supervisor training is needed.
- Need to utilize the complete range of disciplines in the Nuclear Medicine team.
- Supervisor support is as important as student support.
- Supervisor recognition (for CME?) needed
- Additional workload for Supervisors and Coordinators without incentive.
- Logistical problems of arranging interactions between students at centres situated at a distance.
- Best model of Supervision is 'corridor' mentoring which works for those who meet often in their normal workplace.

Collaboration:

- Good communication essential
- Uniformity of supervision and pooling of resources required across various centres.
- Involvement of Professional Societies a bonus.
- More planned interactions needed.
- Volunteer Youth Ambassadors a definite bonus.
- Using resources effectively needs good planning.
- A measure of work relief for students and supervisors should be arranged.
- A budget is needed to successfully run the course.

Capacity:

- Studies not done in the various departments are a limitation.
- Lack of required instrumentation a limitation.
- Lack of additional resources e.g. Chinese language textbook, materials for laboratory exercises and software is a limitation
- Range of manpower resources needed.
- Curriculum should meet the needs of individual countries; consider making some modules optional.
- Lack of budget is a limitation.

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