Chapter 1 - Literature Review

An important part of any research project is being able to contextualise the research topic at the outset. Through an extensive review of the literature, the search strategy may be found in Appendix I, this chapter will review the need for non-medical healthcare practitioners to become involved in the reporting process, the need for training and to consider the nature of learning, learning behaviour, pertinent learning theories and how they may impact on the learning programme to be designed.

1.1 Reporting by non-medical healthcare practitioners

This section will focus on the role of non-medical healthcare practitioners issuing reports and in particular, reporting in the nuclear medicine setting. Every effort will be made to bring together the historical perspective through to the current day, whilst clarifying expectations and limitations of this area of practice.

1.1.1 The current and historical background

Shifting economic and healthcare climates have necessitated change amongst healthcare practitioners, where it is essential to develop new competencies as the role demands. Through this diversification, skills and practices can be enhanced, supporting flexibility and service improvement by responding to patient and service needs (Hardy, et al., 2008, p.15) in tandem with the notion of professional advancement.

It has long been a concern within nuclear medicine circles, over the lack of professional development, clear educational opportunities and training frameworks, which has limited the scope and diversity of the non-medical healthcare practitioners role. Invariably this has culminated in high staff turnover and dissatisfaction with career choice (Hogg, Williams & Norton, 1997, p.188; Griffiths, King, Stewart & Dawson, 2010, p.238).

The Department of Health report which looked at modernising scientific careers
(Great Britain. DoH, 2008, p.4; Great Britain. DoH, 2010a, p.6) offers guidance for technologists, and with precedents set by other areas of diagnostic imaging practice, for example ultrasound and appendicular reporting, there is a clear rationale to support the case for role advancement and reporting of diagnostic images by non-medical healthcare practitioners in nuclear medicine (RCP, 2008, p.244).

In diagnostic imaging, radiographer reporting can be traced back to the 1971, when Swinburne (as cited by Saxton, 1992, p.3) suggested that radiographers were capable of issuing a limited report. This was followed twenty years later by Leeds General Infirmary seeking to train radiographers to report on accident and emergency radiographs, having first undertaken specific training through an image interpretation module as part of a Masters course in Professional Studies. This went beyond the previously accepted, albeit limited, ‘red dot’ system, whereby radiographers could highlight potential abnormalities by the placement of a ‘red dot’ on the resulting images.

In terms of patient management, the benefits of radiographer reporting are clearly documented, making a positive contribution to the diagnostic decision making process (Kelly, Rainford, Gray & McEntee, 2012, p.94) including greater ‘ownership’ of the examinations by radiographers, who are able to impart an informed opinion of the patient directly under their care, rather than the more remote ‘cold’ reporting provided by radiologists. It has also been shown to improve cross disciplinary dialogue, provide greater job satisfaction and improve patient care (Griffiths et al., 2010, p.242). There is similarly some suggestion that the technical quality of images are improved, as radiographers appreciate the importance of optimum imaging outcomes.

Such is the success in general radiology, in 1997, the College of Radiographers expressed the opinion that reporting by radiographers is a requirement (College of Radiographers, 1997, p.4) where non-medical reporting is nationally accepted, certainly within accident and emergency and more recently, other areas, such as barium and computed tomography colonoscopy studies. Indeed, in 2007, a Healthcare Commission study, cited by the Society and College of Radiographers
(SCoR, 2010, p.7) found radiographers to be undertaking sixteen per cent (16%) of all reporting and, suggested that if carried out effectively by suitably trained individuals, it appears to be safe. (Although this latter point remains unproven at this time, in the absence of any detailed, published research, except in breast screening (RCR, 2010, p.2).

Yet its place within the healthcare setting remains a seemingly contentious issue with many professional barriers in place (RCR, 2010, p.2; RAD Magazine, 2010, p.3). Certainly within the field of nuclear medicine, published information regarding advancement and establishment of new skills and responsibilities seems limited and the contribution to the reporting process made by non-medical personnel, scarce. Even where it is recorded, it remains apparently localised, or limited to intermediate and higher grades of personnel (Hogg et al., 1997, p.181; Elliott, 2003, p.248).

1.1.2 The case for reporting by non-medical healthcare practitioners in nuclear medicine

Arguably, the case for reporting by non-medical healthcare practitioners, in the nuclear medicine context, can be supported by the working pattern of the departments. Many departments are experiencing a shortfall of specialist clinician cover, whilst other sites may lack a full time nuclear medicine physician, or radiologist at their disposal to fulfil the desired level of cover. As identified by a number of publications (Elliott, 2003, p.250) by the very nature of their role, radiographers and medical technical officers (MTO) are in direct contact with their patients before, during, and after the examination, and can provide a constant presence throughout the working day.

Standard imaging procedures require scanning staff to obtain additional clinical information, such as the physical presentation of the patient, any history of falls, localised sites of pain and previous treatment, or interventions, such as radiotherapy and surgery. Other information may be gleaned from access to other structural imaging modalities, including previous radiographic or cross sectional imaging, and where technical information associated with camera performance, or post processing issues, can be recorded.
Therefore, the utilisation of dedicated scanning personnel, responsible for the daily department schedule and imaging of the patients, means they are well placed to pass immediate comment on the images they produce. This would reduce patient anxiety, if images are found to be 'normal' and provide a timely referral of abnormal images for further assessment by the nuclear medicine specialist. One may surmise that this is a practice which occurs already, but not necessarily on a formalised or recognised basis, and is certainly an area of expertise which may be ‘tapped into’.

Previous authors, across nearly two decades, have indicated that non-medical healthcare professionals have a capability to report nuclear medicine images (Ware, Garside, Robinson & McWilliams, 1995, p. 228; Gulliver & Hogg, 2011, p.977). In some instances, this is without any formal training, suggesting that experience acquired during their work may have prepared them informally for a reporting role.

More recently, the British Nuclear Medicine Society (2005, p.1) supported the notion of reporting by non-medical personnel, publishing guidelines with the support of the BNMS Council, therein recognising the contribution these individuals could make. It is, however, important to acknowledge at this point, that there may be some resistance to role advancement. Yields and Davis (2009, p.345) suggest there is evidence amongst some non-medical healthcare professionals, namely radiographers, of a pervasive culture characterised by a low professional profile and perceived inertia, which in itself, may pre-empt a certain reluctance for roles to evolve or change. This is difficult to quantify but may be partly borne out of a lack of confidence in ability, perceived shortfalls in training, level of accountability or even a fear of litigation, yet clearly it has the potential to significantly stifle professional advancement and is an issue which needs to be recognised, challenged and thought through in terms of developing relevant expertise.

If non-medical healthcare professionals, working in nuclear medicine, wish to increase their sphere of practice by taking on the role of a ‘reporter’, more needs to be understood regarding the level and depth of knowledge required. To date,
little information has been available, although it might be reasonable to pursue the
guidance set out in the speciality training curriculum set out by the Joint Royal
Colleges of Physicians Training Board (JRCPTB, 2007, p.15). Here, it is
recognised that learning is both practical and theoretical, with much of the training
taking place within the workplace. It is clear that great emphasis may be derived
from experiential learning, but the inherent limitations are apparent.

Competence is a difficult area to assess. It relies on the individual having access
to a suitable range of patients in order to gain the necessary experience. It
similarly relies on the input of an on-site educator, or mentor, which is clearly not
always practicable. Also timing and achievement of competence may differ from
individual to individual, so it is not always possible to define how many patient
examinations a trainee may be required to see, do, or report before arriving at a
satisfactory level to suggest competence (JRCPTB, 2007, p.9).

1.1.3 What constitutes a report?
One of the many stumbling blocks, well documented by clinicians (NMC, 2004,
p.751; RCR, 2006, p.8; RCR, 2010, p.2) is the type of report that may be issued by
non-medical healthcare professionals, and it is important that all concerned
understand the difference.

Imparting a decision about findings from any diagnostic imaging examination, is,
by its very nature, a complicated task. A radiological, or medical image report
offered by a radiologist, or other medically qualified clinician, constitutes a clinical
opinion based on the patient’s clinical history, clinical signs and correlated with
information from other procedures. In other words, it is a synthesis of the different
strands of information combined with a wide, background medical knowledge, to
produce a clinically relevant report and possible prognosis (RCR, 2006, p.8; RCR,
2011a, p.6). It is not, as some may believe, an imaging diagnosis based on pattern
recognition alone.

The descriptive report is a more limited format, where image findings are related to
measurements and other factual observations (pattern recognition). It does not
constitute a medical opinion and is often regarded of limited value, although it can
provide useful information, such as confirming the presence or absence of disease, fracture and thereby if the appearances normal or abnormal? (RCR, 2010, p.2).

Unlike other structural imaging counterparts, interpretation of nuclear medicine data requires the individual to have a thorough understanding of physiological processes, bio-distribution and uptake of the appropriate radioisotope/radiopharmaceutical. Without this, it would be difficult to comment on normal (including normal variants) and abnormal uptake of the radioactive tracers, let alone to comment on the clinical significance of the findings.

All in all, the issue of what constitutes a report is a difficult area but it would seem there is a clear distinction between a report offering a medical opinion and a descriptive report. Table 1.1 demonstrates the six distinct components of a clinical report, as identified by the BNMS guidelines (2005, p.1) although these only offer a scant overview and are open to interpretation. (See Appendix II.a. for a full description).

Table 1.1 Components and levels contributing to a clinical report

| Level 1. | Appreciation of the indications for referral for investigation; |
| Level 2. | Description of image appearances; |
| Level 3. | Ability to differentiate between normal, abnormal and normal variants; |
| Level 4. | If indicated, the need to recommend further imaging/ or alternative investigations for the purposes of correlation; |
| Level 5. | If an abnormality is demonstrated, the ability to comment, or offer opinion on the most likely condition causing the abnormality; |
| Level 6. | Prognostic indication for the patient. |

These echo the chain of events and an evaluative hierarchy suggested by Brealey and Scally (2008, p.48) in describing the perceptual and cognitive processes that contribute to the interpretation of medical images (see Appendix II.b.).

The BNMS guidelines (2005) support the notion of non-medical healthcare professional providing descriptive report to Level 3, possibly to Level 4 ‘when
following a clear protocol' (Nuclear Medicine Communications, 2004, p.751).

However, they limit the scope of reporting to non-medical personnel with sufficient experience, whereby those with less than five years experience, were unlikely to be considered for a reporting role (although a draft version suggests a minimum of three years experience). It was also a consideration that reporting practice should be to those with sufficient seniority, such as medical technical officer - grade 3 or above, senior radiographer, or registered clinical scientist - grade B or above, perhaps further acknowledging that experience may influence performance.

Conversely, there are indications that reporting should be undertaken by non-medical healthcare practitioners, based on confirmation of individual ability and performance, rather than years of experience, or seniority. This in turn, could remove the limitation of levels to which such individuals could report, provided they could demonstrate the necessary degree of competence.

‘... in theory there is no limit to the level of reporting undertaken, provided that suitable levels of training have been reached' (Nuclear Medicine Communications, 2004, p.751)

This highlights the need for accredited education, where any non-medical healthcare professional seeking to report must ensure they have participated in formal, higher level of training, and attained the necessary expertise. In addition, further training can improve performance, sensitivity and specificity levels of the reporting practitioners (Loughran, 1994, p.945; Carter & Manning, 1999, p.78) indicating the need for ongoing, as well as initial training.

Whilst there are a number of educational programmes available for the general reporting radiographer (Paterson, Price, Thomas, & Nuttall, 2004, p.205), to date, only two universities, University of West England and Salford University, have provided training in nuclear medicine reporting for non-medical personnel. However, these in themselves are limited and certificates of completion do not constitute accredited medical qualifications which enable the individual “to interpret medical images independently” (RCR, 2010, p.3). In fact, competence and delegation of reporting duties can only be confirmed by input and support from the
learners’ clinician colleagues.

1.1.4 Issues of accountability and cost
This section would not be complete without considering accountability in reporting, which has always, and remains, a difficult issue (Lombard, Brown, Hall & Sturgess, 1997, p.1833). The case for the non-medical practitioner taking on tasks traditionally within the domain of medically qualified staff is contentious and remains very much the subject of debate (Lombard et al., 1997, p.1833). Although hospital trusts seem to have been willing to extend vicarious liability to indemnify individuals in their ‘altered’ roles, this has yet to be tested in a court of law.

Most non-medical personnel, with responsibility for issuing reports, do so only with the full backing and support of their clinical director. However, the recent report by the RCR (2010, p.2) reveals some further disquiet over image diagnosis by non-medical personnel, where the role and ultimate responsibility of the reporter can no longer be clearly defined, raising questions over patient consent and safety. This is particularly significant, given the context of the General Medical Council [GMC] guidance on best practice, which clearly implies that clinicians referring patients for imaging are seeking a medical opinion (GMC, 2006, p.54).

Key principles reiterate the need for training and clinical skill of the individual in their expanded role, plus a clear line of accountability between representative professions. As in the area of diagnostic imaging, it seems reasonable that any non-medical healthcare practitioner wishing to undertake a reporting role, must abide by the RCR guidelines – Standards for the Reporting and Interpretation of Imaging Investigations (RCR, 2006, p.6) and also by the guidelines for good medical practice (GMC, 2006, p.54).

Both documents clearly define the boundaries for reporting by non-medical healthcare professionals:

- Non-medical personnel may undertake image reporting where there is delegated authority by a named radiologist, or other doctor with responsibility for interpretation of medical images. Herein, the competence
of the individual reporter must be scrutinised to ensure they are capable. It infers a team approach to the work, yet, in law, team responsibility is not recognised, therefore responsibility is borne by the named individual. Generally, such delegation of duties is limited to suitable investigations such as suspected single organ pathology or a single organ investigation (with the exception of ultrasonography);

- Secondly - where a NHS trust, or other organisation responsible for providing medical services, formally and contractually empowers non-medical personnel to undertake image interpretation. Here, a named individual, such as the medical director, would hold legal responsibility for the safe provision of this service. If an adverse incident occurs, it would then be the responsibility of the chief executive of the organisation, or the medical director, to demonstrate that the individual issuing the report, had the relevant expertise, experience and qualification to do perform the identified task.

In returning to the RCR report (2010) whilst it confirms the presence of radiographer reporting, as

‘helpful in increasing the confidence of radiologists in the expertise of an individual radiographers to whom they are considering delegating medical image reporting.’

(Royal College of Radiologists, 2010. p.3)

supports the ability of radiologists, drawing on their specific professional expertise, understanding of clinical signs, results of laboratory tests and other investigations, to impart a full report, including any differential diagnoses.

Whilst the RCR would appear happy for non-medical personnel to fulfil a limited reporting role, in certain selected examinations, the resulting report is seen as limited, based on pattern recognition and a description of findings, as opposed to offering an informed medical opinion. As confirmed by the Society and College of Radiographers (2010, p.7) delegated authority is only given whereby the non-medical reporter is operating within a team, not independently. This is supported by the BNMS guidelines, which, whilst acknowledging the contribution made by non-medical staff in alleviating workloads, suggest that their contribution should
not be “considered as an alternative to the provision of suitably trained and experienced medical staff” (Gulliver & Hogg, 2011, p.977).

Given the boundaries of acceptable professional performance, any individual embarking on this path would be expected to achieve the same level of performance as “achieved by the majority of practitioners having similar experiences and responsibilities” (Dimond, B. as cited by Donovan & Manning, 2006, p.8) and indeed this appears to be the case in mainstream areas of diagnostic imaging, where the level of accuracy has been shown to be equivalent to that of the radiologists (Robinson, Culpan & Wiggins, 1999, p.550; Brealey, et al., 2003, p.61).

In nuclear medicine, Griffiths et al., (2010, p.242) suggest non-medical healthcare practitioners are capable of achieving similar levels of accuracy when compared to their medical counterparts, in line with the BNMS guidelines (2005, p.1).

Yet, despite support from various professional bodies, the case for reporting by non-medical personnel in nuclear medicine, is still largely unproven beyond a local level. Concerns remain over the comparatively small numbers, limited area of clinical input, and difficulties in accessing reporting, which may restrict activity.

In addition to this, it should emphasised that communication and dialogue with other clinicians, forms an important part of the reporting process. Although not stated, the RCR report (2010, p.2) conveys the impression that non-medical personnel are unsuited to this aspect of the reporting role, though with the advent of picture archiving and communication systems (PACS) the need for direct dialogue appears to have been challenged (Reiner & Siegel, 2004, p.1).

For those non-medical healthcare practitioners wishing to take on a more expansive role, they should be aware of the extent and limitation of their practice, working within their dedicated sphere of competence, as part of a multi-disciplinary team (Nightingale & Hogg, 2003, p.81) where all reporting personnel should be audited on a two yearly cycle. This is in accordance with guidance from the Society and College of Radiographers (2010, p.7) and yet there are potential
barriers which may prevent staff from achieving sufficient levels of expertise and experience, where the reporting radiographer may remain a “rare” exception (Donovan & Manning, 2006, p.11).

Lastly, the cost effectiveness of non-medical personnel fulfilling a “reporting” role, has been questioned by some professional groups (RCR, 2010.p.1). Such statements appear to be unfounded and may even be challenged by a recent press release, regarding the Spending Challenge (Great Britain. DoH, 2010b, p.1) which overtly encouraged the training of radiographers to report straightforward examinations, so as to release the medically qualified personnel to report on more complicated imaging. This was anticipated as saving the NHS approximately £7.9 million annually, although the impact and cost of non-medical practitioner reporting on society and whether this is acceptable, has yet to be determined.

1.1.5 Summary of reporting by non-medical healthcare professionals

Reporting by non-medical healthcare professionals is recognised in the wider healthcare context and can be viewed as making a significant contribution to patient management. Within the field of nuclear medicine, with dwindling clinician numbers and an ever increasing workload, there remains an opportunity for appropriate role advancement of non-medical healthcare professionals in the area of reporting. So, despite the apparent difficulty in reconciling current practice, especially in nuclear medicine, where reporting by non-medical personnel is still in its infancy and the ‘risk averse’ nature of the recent RCR (2010) report, it would appear that there is some support to extend the role in this area.

With suitable accredited training and competence, some non-medical healthcare practitioners could be capable of issuing a descriptive report, may be more. Not only would this alleviate some of the pressure on clinician workloads, but would also take advantage of the largely untapped resource of some highly experienced and knowledgeable staff, working within a multi-disciplinary team, so increasing patient benefit, with minimum risk, provided all co-operate and observe published and negotiated guidelines.

It does require sustainable, effective, nationally accredited, recognised training
schemes to be put in place, including the use of eLearning, as endorsed by the DoH press release (Great Britain. DoH, 2010b, p.1) although the impact of eLearning and the issue of competence remains largely untested (RCR, 2010, p.2) and where any non-medical reporting practitioner should be aware of the legal implications and level of accountability, in the event that a claim be made against them (Jones & Manning, 2008, p.205).

1.2 Learning and teaching in the modern world

The establishment of a rigorous and effective training programme could equip non-medical healthcare professionals with the necessary education, providing both knowledge and clinical skills to underpin and achieve the required level of competence for a reporting role. Yet healthcare education, which has traditionally taken the form of synchronous (face to face) teaching and learning, with learners attending centrally-based lectures, is not an option in nuclear medicine. This is a relatively small field of healthcare, where departments are dependent on relatively few members of staff to provide the daily service.

Distance learning overcomes this, offering a flexible and continuous learning alternative, which can easily be incorporated alongside full-time work (Bennett, Marsh & Killen, 2007, p.33) developing knowledge pertinent to professional practice, thus allowing the practitioner to remain in the clinical setting, potentially increasing patient care and management. However, conventional distance learning can be limited, whereas eLearning offers a viable solution.

With its rapid growth, supported by various recommendations, the advancement of electronic (‘e’) based resources has been shown to contribute to comprehensive web-based courses, enhancing and facilitating learning across a number of sectors (Sayce, 2001, p.2; Great Britain. DoH, 2002a, p.38; Great Britain. DoH, 2002b, p.2; Joint Information Systems Committee (JISC) 2005, p.11; RCR, 2008, p.2).

This is now a key focus in the development and delivery of higher education (HE) (University of Portsmouth, 2009, p.4) particularly in professional and adult
education, where the emphasis is increasingly on lifelong, life-wide learning and continuing professional development (Mullholland, 2003, p.97; RCR, 2008, p.3; Redecker, et al., 2011, p.13).

Effective and versatile, eLearning can offer a complete educational package away from the academic institution to a geographically diverse audience, supporting a continuous and effective educational process (McMahon, 2004. p.61). Engendering strong collaboration, compared with traditional didactic teaching (Salmon, 2000, p.90; McMahon, 2004, p.62) and with infinite access to information beyond conventional course material, eLearning has a clear advantage over conventional distance learning programmes. It lends itself to a modular style of delivery, an approach supported by the BNMS (NMC, 2004, p.751) as an acceptable means of educating professionals in organ specific reporting or other nuclear medicine examinations. However, in designing this programme of learning, it is important to appreciate learning theory, how individuals learn and what makes learning effective. This invariably informs the way in which information is presented to the learner and how learning outcomes may be realistically achieved.

1.2.1 Theories of learning
For centuries, knowledge has been passed down the generations through the use of didactic approaches, whereby the most prolific strategy has been lecturing, where knowledge and understanding is conveyed by the ‘expert’ to the student body.

Largely regarded as a passive act, the learner is seen as an empty ‘box’ for whom knowledge is delivered and received. The learning here, may be considered as a one-off, isolated, intellectual exercise, where memorised facts are regurgitated for the purposes of assessment, changing or reinforcing behaviour, by rewarding success with a ‘pass’ and punishing failure ‘by withholding certification’ (Elliott, 2009, p.1). This is associated with the behaviourist theory, conforming to a highly controlled environment, where a ‘drill and practice’ technique (Elliott, 2009, p.1) is pursued, caring little for the individual mental processes exhibited by the learner.

In contrast, cognitive learning theory regards learning as a process of
understanding concepts around us. It relies upon the educator to impart discrete and specific units of content, whilst the learner internalises and understands the facts presented. It acknowledges individual differences between learners and the way they learn, but the knowledge transferred is still essentially pre-determined by the educator and is therefore limited (Prensky, 2001, p.3; Elliott, 2009, p.2).

In order for teaching and learning to be effective, the two should be regarded as a ‘whole’ system, integrating the classroom, department and institution, to create a whole environment in which the desired learning outcomes are achieved, (Biggs, 2003, p.1). As such, key components of the teaching system, such as the curriculum, learning outcomes, teaching methods and assessment tasks are ‘aligned’, enabling effective learning to take place. Learners reach an understanding of the content through carefully designed activities, involving construction and reconstruction of ideas and experience (Britain & Liber, 1999, p.13). This is often referred to as ‘constructive alignment’ theory, or constructivism, which may, therefore, be defined as a philosophy of learning, based on the premise that through reflection of experiences, one can achieve and construct an understanding of the world around us and thereby accommodate new experiences as a result of past learning.

As an educational theory, learning is presented as a search for meaning, based on understanding of the whole context, as well as its component parts. It enables the learners to connect the component parts, encouraging development of analytical, interpretive and predictive skills. It eliminates standardised learning and testing, encouraging a problem-solving culture, rather than the memorisation of facts (as typified by more traditional behaviourist and cognitive educational approaches).

One needs to appreciate how and for whom this learning is aimed at and where conventional classroom approaches may not be appropriate. For any teaching and learning strategy to be effective, it should be targeted to meet the needs of its specified audience.

1.2.2 Modern educational theory

The traditional concept of learners as passive participants, whilst the lecturer
imparts an expert body of knowledge is no longer effective currency. Although good educationalists have always been able to ‘interpret’ the classroom atmospherics, interpreting verbal and non-verbal cues from learners, providing clarification and feedback with immediacy, plus promoting discussion, elaborating on content and offering guidance (Hirumi, 2002, p.19), simply talking to learners, without any active engagement does not achieve learning at a deep level.

In the contemporary world, educational theories have challenged the traditional approaches and led to the mindset of an ongoing evolution of knowledge and development of the individual through planned learning activities. Learners ideally, should be self-directed, critical thinkers and reflective engaged in an ‘active’ learning approach, where the learner has a stake in what they are learning and where educators seek to manage, direct and facilitate learning in an information-rich environment.

This leads to the theory of experiential learning, with active construction and reconstruction of ideas, where the concept of ‘experiential’ learning, or learning from experience needs to be addressed. This is an holistic process, involving emotions and motivations of the participant, their surroundings and social construct, not a “solely a cognitive endeavour” occurring in isolation (Stephenson, 2001, p.46) where learning is seen as an event which involves the ‘whole’ person, not something that may be pigeon-holed into discrete entities. It is inclusive, complex and individual, combining and integrating learning, as detailed below.

Complex learning is a relatively new term, as defined by Jochems, van Merriënboer & Koper (2004), where equipping the learner with 21st century skills, allows the

“coordination of constituent skills, integration of skills, knowledge and attitudes into professional competencies”

(Jochems, van Merriënboer & Koper, 2004, p.7)

through a problem or competency based approach. By incorporating flexible, dual and complex learning methods, it permits a degree of self-regulation, self-assessment, development of critical thinking, problem solving and allows for
experiential learning.

Current learners demand a flexible, relevant curriculum, which recognises their existing knowledge and experience. They require active learning rather than passive learning approaches; authentic learning experiences - relevant to real life, rather than contrived learning tasks; they tend to collaborate rather than compete; finding information rather than memorizing it. This has led to a fundamental change and a challenge to the way educators teach.

This model acknowledges the concept of the learner managing their own time and place of study, without making demands of single location based learning, it supports student-centred learning where instruction can be personalised and taken at the individuals own pace and level of competency. It incorporates the notion of the importance of realistic learning, learning in the workplace and promoting the coordination and integration of knowledge, skills and competencies (such as those found in the professional context) thereby minimising the gap between formalised education and professional practice. As a whole, it may be defined as 'integrated' learning, combining all elements of 'complex', 'flexible' and
‘dual’ learning into an integrated approach (Figure 1.1). (please refer to the Glossary for definitions of these terms).

1.2.3 eLearning – context and theory

New technologies such as eLearning, inevitably play a key role in helping to achieve these 21st century learning skills and employability goals. Balancing pedagogical and organisational drivers, reducing costs of conventional programmes, and improving efficiency, they are accepted as an integral, necessary part of developing education (Bates, 2009, p.1; Redecker et al., 2011, p.10). Certainly as an industry, eLearning is supported by the European Commission in the pursuit of a knowledge based society, mobilising educational and cultural communities (European Commission, 2000, p.3) warranting considerable investment, which is growing year on year (Clark, 2001a, p.1).

By definition, eLearning uses a number of forms of learning and teaching which are supported electronically and allow the construction of knowledge specific to the learner’s individual knowledge, experience and practice (eLearning Centre, University of Portsmouth, 2006, p.1). Within HE, the adoption of predicated policies on eLearning, increasing choice and location of study, have been actively pursued (JISC, 2009, p.6; University of Portsmouth, 2009, p.4). It is particularly noticeable in the area of ‘health informatics’, which has burgeoned in relation to the education of healthcare providers.

Therefore, with increasing learner diversity, learner perceptions and expectations, the use of open source materials makes the adoption of eLearning a more attractive choice for all learners of all ages and from a wide geographical spread (JISC, 2009, p.3; Bullen & Janes, 2007, p.762). Within the healthcare sector, it has been well documented that e-based information and learning is an important source for healthcare practitioners, with ever increasing usage, providing a welcome and immediate source of current medical information, which can be used to inform and update professional knowledge (Shanahan, Herrington & Herrington, 2008, p.233).

It does place e-delivery as a default, where there is an assumption that this is the
best and only way to reach such a diverse audience (Shephard, Wong & Phillips, 2007, p.161), whilst the impact of the technology, its effectiveness in teaching and subsequent changes to service operation within the healthcare sector, have yet to be fully evaluated (Lancaster & Hardy, 2012, p.106). It has also been suggested that its development and use within HE has been patchy, often with a ‘bottom-up’ approach derived from professional interest and individual staff input (JISC, 2009, p.3).

1.2.4 Designing eLearning

In order to design effective eLearning, there needs to be an appreciation of what, how and for whom the learning is aimed at. As highlighted by various authors, there are three fundamental questions which need to be addressed: How does eLearning differ from other modes of instruction? What are meaningful eLearning interactions? How do you design and sequence meaningful eLearning interactions in a health imaging related field? (Hirumi, 2002, p.19).

According to Mayes and de Freitas (2004, p.4) there are no “no models of e-learning per se” only enhancements, where, in order for the eLearning to be effective, the learner must be in a position where they have a favourable learning environment, provided by the technology, to learn in the same way as if they were campus based. Other authors contest this and two models of eLearning have been identified which are pertinent to this project.

The practice-based model is outcomes-based, whereby the designer adopts a constructivist approach to the planning and design of a course, module, or learning event. This approach is often preferred by practitioners, where there is a need for guidance and learning within a specified context. For the purposes of this project, this model seems appropriate - integrating learning, prescribing and directing practice in a specific way, to allow for reflection and evaluation after an event. There are some considerations which may detract from the learning generated, such as the difficulty in transferring learning, sharing of common terminology, comparison and evaluation across different contexts/scenarios represented.

The theoretical model tends to pursue a higher level of commitment towards the
cognitive aspects of learning rather than the application, gearing the learning towards structured, research type approaches. At first glance, this model does not appear appropriate, but clearly there are elements which are significant for the autonomous practitioner being able to deduce and implement concepts.

Clearly there is a philosophical distinction between the two models, but in reality one cannot use one exclusively without detriment to the learner, and therefore both can be used to shape and define the learning content. A common sentiment purports that any practice-based model should be ‘pedagogically sound’, inferring that theoretical models validated by research, are incorporated in the construction of any eLearning module (JISC, 2004, p.14). Therefore, elements where knowledge and cognition need to be achieved, are demonstrated by the theoretical model, yet to bring a clinical focus to the design, the problem-based approach should be adopted. Both encompass an ‘approach’ to learning and teaching, where exploring and explaining occurs within the learning context (JISC, 2004, p.12).

Therefore, in summary and in the context of this project, educational as well as instructional theories will be an important consideration, where the final design is likely to be a fusion of these ideas.

1.2.5 The learner professional
Technology has revolutionised the social and economic cultures, affecting how the population as a whole works, socialises and significantly, how we adapt to a constantly, fast paced changing world. The need to continuously update skills, knowledge and develop new areas of expertise, have become paramount, promoting the notion of lifelong learning wherein

"the ability to adapt and learn may never have been more urgently required"

(Mulholland, 2003. p.98)

In response to societal needs and governments’ ambitions of lifelong learning and a desire to prepare learners for the world of today and “networked society of tomorrow” (Jochems et al., 2004, p.10) significant changes have occurred within
Learning is now seen as a limitless process, a spiral, which should encompass the notion of opportunity, experience, shared learning as well as individual motivations and peer input, supported by feedback and time for reflection. Within this context, there are specific needs for professional learners, where web-based learning poses a number of suitable possibilities for actively managing and participating the need for continued learning and knowledge update (Trentin, 2002, p.55).

In addition, integrated learning fits well with professional development, where the opportunity to practise, integrate and coordinate knowledge and skills through a problem, or competency based approach, meets the needs of many professional learner groups. It allows a degree of transferability and flexibility to permit the application of knowledge and skills to new situations. It also fits well with the use of eLearning technology, which has the potential to change the nature of the “teaching and learning transaction” (Elliott, 2009, p.5) and the ongoing development of E-pedagogy.

With the rapid dissemination of information through technology, the educator can teach in parallel with the learner, keeping pace, rather than the traditional ‘step by step’ approaches of the past. Today’s learners themselves, having grown up with the technology, are usually regarded as ‘digital natives’ or ‘millenials’ (Prensky, 2001, p.1). With this project focussing on the experienced, learner professional, it is recognised the volunteer profile will be more likely to align with the ‘digital immigrant’ group who have learned and adapted to the new technologies, although, owing to professional background, they are likely to be au fait with technology, keen lifelong learners and used to web-based resources designed to impart learning (Tyler-Smith, 2006, p.74).

1.2.6 Quality of learning and teaching in the modern world
An eLearning presence is now commonplace within the majority of courses on offer, yet despite clear benefits and the proliferation of courses eLearning in HE circles, the issue of quality remains outstanding.
Chua and Lam (2007, p.133) suggest, quality and assurance of quality should be prominent factors within any effective eLearning forum, not only for the education provider in developing and preserving the integrity of the programme, but also for associated stakeholders, such as the learner, employer and any potential professional accreditation. To date, there remains a question mark and some apprehension over the experience, academic rigour and qualifications gained, compared to the recognition afforded by more conventional deliveries of education (Clark, 2001b, p.1; de Freitas & Jameson, 2006, p.818; Chua & Lam, 2007, p.134; Lancaster & Hardy, 2012, p.106).

It is imperative that these issues are not ignored and with this in mind, the following chapters will demonstrate how using a proven eLearning instructional design model (Clark, 2001a, p.1; Culatta, 2011, p.1; Littlejohn, 2004, p.2) an effective learning platform, was created, whilst appreciating the needs of the modern learner and its potential impact to a wider audience.

1.3 Research proposal

The proposal was formally submitted for approval from the University of Portsmouth Faculty Research Degrees Committee (Appendix III.a.) and also in accordance with research ethics guidelines from the School of Health Sciences and Social Work, University of Portsmouth (Appendix III.b.). Acceptance and approval for the project was gained from both and in addition, a letter of support was forthcoming from the Chair of the Research Ethic Committee for the Isle of Wight, Portsmouth and South East Hampshire (Appendix III.c.).

1.3.1 Research aim

To design, implement and evaluate the impact/effectiveness of a solely e-based learning module to prepare non-medical healthcare professionals to report nuclear medicine bone scans and to ascertain its application as an educational programme for a wider audience.
1.3.2 Research objectives

Objective 1: Design of an eLearning module using a Blackboard enabled product (Victory) and integrated, interactive packages;

Objective 2: Implement and evaluate the module design in terms of its impact and usability using online evaluation and feedback;

Objective 3: Establish the facilitation and effect on learning through objective and subjective measurement of the learning outcomes, using online assessments, tasks and design tools;

Objective 4: Assess the application of knowledge and skills learned to the clinical situation and organisational impact, by conducting an end of module survey.

1.4 Summary of chapter one

The rationale and drivers for the project from educational and professional perspectives have been reviewed. The case for the reporting within nuclear medicine, by non-medical practitioners, is still in its infancy and yet to be acknowledged as a widespread activity, let alone proven as a success. Furthermore, competence in nuclear medicine reporting by non-medical healthcare professionals and the impact of eLearning remains largely untested. Regardless of the medium of delivery, any educational programme purporting to educate individuals to specified levels of competency, particularly where patient management and issues of clinical governance may be at stake, high standards need to be achieved, assured and maintained.

The next chapter will explore the development of the module, its design, methodology and implementation.
Chapter 2 - Development of the eLearning module

Although the benefits of eLearning are evident for the modern learner, setting up eLearning opportunities, or standalone course modules, is not without problems. To this end, one needs to acknowledge the importance of the role of instructional design theory in supporting various learning theories, previously described, and how this helped to shape and define instructional material to build an effective learning programme.

Guided by an instructional design model, commonly known as the ADDIE model (Surtani, nd, p.1; Clark, 2010, p.2; Culatta, 2011, p.1) five key phases were identified in the design and development of the module, including its analysis, design, development, implementation and evaluation.

The analysis phase sought to clarify the ‘audience’, instructional problems, goals and outcomes. The design phase took into consideration the learning objectives, content, planning, media selection and assessment formats, which were assembled and integrated during the development phase. The implementation phase included the training and instruction of volunteers (learners) introducing them to software tools used. The evaluation phase would provide formative and summative evaluation, through the inclusion of tests, and giving an opportunity for feedback.

With regards to the analysis phase, the intended audience had already been identified, as broached in the last chapter, however, possible learning constraints and delivery options needed to be considered. eLearning lacked the spontaneity and contact of the classroom and if the educational value for the programme were to be ascertained, particularly in this instance where competency was being assessed, an insight into the e-pedagogy, careful planning and sequencing was required.

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2.1 Module design and development

The aim was to develop an eLearning module devoted to preparing non-medical healthcare practitioners to interpret bone scans in nuclear medicine, so the content was planned using a systematic approach.

It was recognised that cognitive (knowledge-based) and experiential learning strategies tend to dominate most health-related courses, yet for successful adoption of eLearning, one needed an appreciation of how practice, using technology, could enhance development of learning and how this could be integrated alongside established practice whereby learning could be regarded as an activity.

In considering this, one needed to appreciate the possible ‘digital divide’ and digital literacy of both learners and educators. For the educators – this meant having proficiency and technical ability to select and develop practice and skills through the use of technology, with careful reflection of approaches to teaching and learning, whilst maintaining a level of currency of materials used. For the learner – they needed to possess the appropriate skill levels and have an understanding of the technology deployed, so they could maximise, search, authenticate and evaluate a range of appropriate materials (JISC, 2009, p.34).

There was also a need to appreciate the changing demographic of the learner profile and the need to orchestrate a culture of student-centred learning, which, according to Downes (2005, p.1) is ‘thriving’.

Based on work by Beetham (as cited in JISC, 2004, p.15) Figure 2.1 shows how the learning framework was structured, using a number of theoretical and psychological assumptions, to align teaching methods and the learning environment and assessment procedures.

The volunteers (learners) as practising healthcare practitioners, bring with them their learning motivations, needs and expectations to the course. The learning environment, in this case a virtual one, allowed for the collation and collection of
facilities, tools and resources to match the volunteers’ (learners) needs, whilst the intended outcomes identified the purpose behind the learning activity. Most importantly, the learning activities represented the means through which volunteers’ learning was influenced and achieved. This approach not only accommodated prior knowledge and experience, but ensured volunteers could achieve ‘composite’ skills (Mayes & de Freitas, 2004, p.8) matched with individual performance, whilst allowing them to learn at their own pace and level.

**Key:** ‘Boxed’ areas show the various components;  
**Red** arrows show the relationship between the various components;  
**Black** arrows show the volunteers interaction with the learning environment, module components (outcomes and activities).

**Figure 2.1. Desired framework of learning activity design (JISC, 2004, p.15)**
2.1.1 Module learning outcomes

By referring to the BNMS guidelines, planned learning outcomes (Table 2.1) were identified.

Table 2.1 Module learning outcomes (Based on the Effective Practice Planner, JISC, 2004, p.52.; BNMS reporting guidelines, 2005, p.2)

- identify incoming level of knowledge and ability to report;
- identify the issues associated with nonmedical reporting;
- equip the learner with key knowledge of normal bone scan appearances;
- enable the learner to distinguish between normal and abnormal bone scan appearances;
- enable the learner to understand pathological processes and thereby;
- equip the learner with the necessary skills to separate appearances from normal/abnormal changes on a bone scan, identifying those which were clinically significant;
- allow engagement in on-line reporting assessment to assess level of sensitivity and accuracy of reporting skills.

These were aimed at helping volunteers learn, understand, test and retain key concepts within the relative safety of the programme and mapped throughout the programme to ascertain learning, theoretical understanding and thereby acquisition of skills necessary for success in the reporting.

2.1.2 Module content

It was imperative to align the course material with the clinical context and incorporate a problem based learning approach to maintain the interest of volunteers. With this in mind, the subject matter was organised through a series of integrated problem-based, simulated activities and other context specific material, which were embedded within the module.

Using various seminal nuclear medicine textbooks, such as ‘An Atlas of Clinical Nuclear Medicine’ by Fogelman, Maisey and Clarke, (1994) and ‘Nuclear Medicine in Clinical Diagnosis and Treatment’ by Ell and Gambhir, (2004) and other more recent resources and published papers, key topic areas were identified which
allowed for pertinent and practice-related content to be written and developed. Topics included:

- History of bone scanning – in order to ‘set the scene’, providing the context for this essential and widely used examination;
- Basics of bone scanning – to revise the technical issues involved in acquiring bone scan information and common technical pitfalls;
- Review of anatomy and associated pathological processes – based on common referral categories, such as for breast, prostate and arthritis;
- Introduction to bone scan interpretation to include normal versus abnormal findings and clinical significance;
- Basics of report writing and legal issues – to introduce the concept and issues surrounding image interpretation as offered by non-medical healthcare professionals;
- Assorted case studies based on referral category such as metastases, rheumatology, orthopaedic.

Inevitably there were drawbacks, the chief one being the underestimation of time to research each topic area, design, fully script, record audio tracks and synchronise animations to an acceptable standard for each presentation.

Whilst the compilation and authorship of content was largely undertaken by a single academic, in keeping with traditional higher education practices, it was accepted that content development need not be limited to one individual (Chua & Lam, 2007, p.135). Assistance was therefore sought from fellow academics within the School of Health Sciences and Social Work, University of Portsmouth for contributions from their own subject specific areas. In addition to this, parties external to the University were approached for permission to use various re-usable learning objects, such as those provided by Centre for Excellence in Teaching and Learning [CETL], University of Nottingham, through the use of hyperlinks. This enabled a rich diversity of content, adding to the perceived learning impact and credibility of the programme.
The content was then arranged in defined sequences, based on Beetham’s model (JISC, 2004, p.15) where activities could repeat learning, challenge thinking and allow ‘learning by doing’ activities (Knowles, 1990, p.102; Littlejohn, 2004, p.4). This was undertaken using advanced methods of delivery, visual layout and easy navigational features, which will be explored later in the chapter. (For a full overview of sections and subsections, please refer to Appendix IV).

2.2 Module delivery

Intended as a stand-alone web-based resource, there was no opportunity for any conventional didactic teaching, blended learning approach, or the use of other facilities, such as clinical departmental support, so learning was likely to be driven more by process than content. Consequently, it was acknowledged that volunteers were more likely to absorb information quickly, where a number of media were used, for example, visual aids such as images and graphics, audio and text, which were accessible through networked computers. Therefore within the framework adopted, careful consideration was given to the available technologies, supporting tools, clarity of information and usability of the system.

2.2.1 The learning management system (Victory)

From the outset, necessary consideration was given to the learning management system through which the module would be delivered and organised. This involved a web-based platform, which provided the ‘virtual learning environment’ (VLE). In the context of this project, a BlackBoard enabled product, licensed through the University of Portsmouth (locally known as Victory) was used. (Hereafter, this will be known as Victory).

This provided a sophisticated learning environment, which could support the entire module, allowing remote access, in line with the intended project aims. As suggested by other authors (Koper & Tattersall, 2004, p.689; Cosson & Willis, 2012, p.113) such platforms should be sufficiently flexible, to offer ubiquitous, seamless access to the learning facilities (whether from home, at work, or in a higher educational institution (HEI).
Victory had various key features which enabled the customisation and scaling of the module architecture increasing its interoperability. It also allowed for the integration with student information systems and authentication protocols which were critical in assigning temporary student accounts to volunteers, who, although, not registered students with the University, needed access to the University VLE.

Specific features pertinent to this project included:

- **Virtual course environment** – which included features such as Peoplelinks to link directly to a person such as within a Discussion Board;
- **Learning object manager** – giving access to different types of content (including word documents, Powerpoint presentations, pdf files, videos and podcasts). In addition, it allowed access to the institution-wide repository including access to University help pages;
- The **Powerlinks kit** enabled the system to encompass other software tools such as open source tools, which was useful to support the additional software used to promote the interactivity of the module, such as Captivate and Questionmark™ Perception™ (QMP);
- Whilst the **Powersight kit** provided access to quantitative data about volunteer activity as they engaged with the eLearning environment. Data from this was aggregated and analysed for reporting purposes and used in this project for quality review and programme planning.

  (based on Sayce, 2001; eLearning Centre, 2006, p.1)

It was important that all elements (academic resources and technologies) matched volunteer needs and expectations. These included issues such as accessibility, clarity and efficiency of the information presented, to meet with recognised quality standards and recommendations (Kheterpal, 2005, p.132; JISC, 2006, p.1) wherein the programme could be deemed to be compliant with Sharable Content Object Reference Model (SCORM) standards (2004) and Special Educational Needs and Disability Act (2001) (SENDA). (Definitions and explanations for these can be found in Appendix V).
2.2.2 Interactive features

In the context of this project, interactivity was regarded as one of the most important elements for the success of the module (Upton, 2004, p.15; Chua & Lam, 2007, p.136; Clark, 2010, p.2). Not only could it improve the learner experience, but would also help to promote the content focus on critical thinking skills, problem-solving and stimulated learning. Therefore in addition to the learning management system, additional software programmes were sourced, either to be used in their own right, or to create tasks and activities with perceived ‘added value’.

To this end, two key eLearning healthcare resources influenced this project, the first was eLearning for healthcare (e-LfH) which is a free, national eLearning programme developed by clinicians and educational providers, in conjunction with the Department of Health, to provide quality online training for healthcare professionals (www.elfh.org.uk). As an award winning programme, it has sought to support and enhance traditional teaching methods and to provide a “reference point which can be accessed anytime, anywhere” (e-LfH, 2010) embracing modern technology with professional needs and the concept for lifelong learning, through the assembly of various projects aimed at different healthcare professional groups.

With reference to this project, the author was interested by the recent addition of a resource concerned with image interpretation (June, 2010) developed in partnership with the College of Radiographers. This is an interactive programme, providing fifty sessions regarding the assessment and provision of reports for those involved in interpretation of plain film skeletal images. Specific attention was paid to the inclusion, layout and comprehensive coverage of anatomy, clinical presentation and pathology for each skeletal part. This gave insight into the quality and depth of information which was aimed, as with this project, at radiographers and other relevant staff working within this field.

The second resource of interest is the United Kingdom National External Quality Assessment Service (www.ukneqas.org.uk). Although primarily concerned with quality standards, it seeks to promote best practice and optimising patient care in laboratory medicine. Through an online package, clinical scientists can access
details and slides on a variety of cases ranging from the normal to the rare, with additional teaching information, quiz facilities and ability to self-test.

Using the above as benchmarks, and in order to enhance the learner experience and to promote interactivity, additional authoring software was purchased using a University of Portsmouth site licence. The software, Adobe® Captivate™ (Version 5) was chosen because it could be easily adopted, without the need for multimedia skills and knowledge of programming. This was sourced in preference to Xerte, from the Centre for Excellence in Teaching and Learning (CETL), University of Nottingham, which although a powerful authoring tool and available free of charge, was found to be difficult to master within the timeframe available.

Once purchased, the Adobe® Captivate™ was used to develop a number of simulated and ‘scenario-based training’ presentations which could then be published as professional quality Flash based (see Glossary for definition) tutorials, loaded and supported by the learning management system. It was recognised that volunteers may become frustrated by content that may be perceived as irrelevant to their own clinical learning, so by using the additional software, ‘situational’ (problem based) learning could be promoted to reflect the professional context. As Jowett (2008) states,

“learning in and from practice has always played a fundamental part in the preparation of health care professionals” Jowett, 2008, p.1.

2.2.3 Assessment and survey tools

In addition to Adobe® Captivate™, other eLearning software packages were considered for the creation of ‘media-rich’ items. This was aimed at broadening the scope and type of assessments required, encouraging and enhancing volunteer interaction and progression through module material, including self-tests, as well as mandatory elements for survey, formative and summative assessment purposes. It was anticipated this would influence and hopefully improve perceived module experience and satisfaction.

Different packages were reviewed, including Survey Monkey, the ‘in-house’
assessment facility provided through the Victory platform, Questionmark™ Perception™ and WebAiMS (the latter two are considered in more detail later).

Table 2.2 Summary of software considered for assessment purposes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Access</th>
<th>Interface with VLE</th>
<th>Question types</th>
<th>Self-test function</th>
<th>Grade mark function</th>
<th>Image inclusion</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victory</td>
<td>yes</td>
<td>yes</td>
<td>3</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>Limited functionality; No facility for image case display</td>
</tr>
<tr>
<td>QMP</td>
<td>Separate Login required</td>
<td>yes</td>
<td>22</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>Has the most useable &amp; interactive features + easy interface</td>
</tr>
<tr>
<td>Survey Monkey</td>
<td>Separate Login required</td>
<td>yes</td>
<td>15</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>Query of ownership Rights, UoP, or Survey Monkey? Held in an ‘open source’ bank - ?secure</td>
</tr>
<tr>
<td>WebAiMS</td>
<td>Separate Login required</td>
<td>yes</td>
<td>4</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>Ability to show images in DICOM format, interactive features + easy interface</td>
</tr>
</tbody>
</table>

From an authoring and assessment perspective, all had various positive features which were useful for the project (Table 2.2) but some software programmes, based on their limited functionality, or inability to display images were rejected. Ultimately WebAiMS and QMP were selected. These appeared to be the most flexible in terms of the range of question styles and interactivity for the volunteers and support for the image database, in spite of the need for the separate login in both cases. The merits of these are explored below. For a more in depth summary of the rejected software packages please see Appendix VI.

Questionmark™ Perception™ (QMP) is a browser-based Windows application, licensed to the University of Portsmouth, which was selected as a mainstay for use. Not only could it achieve a better user interface with the existing platform,
compared to other external providers, as an authoring tool, it could support the creation of twenty-two different question types, which allowed for questions to be assembled into question banks and applied in flexible formats depending upon the nature of the assessment. It is prudent to note at this point, the different question types can be used to test different cognitive levels as identified by Bloom’s taxonomy and reproduced for more current delivery methods as shown in Appendix VII.

For the purposes of this project, and bearing in mind the learning outcomes, the following question type formats were chosen:

- **Likert scales, survey and knowledge matrices** were used extensively in constructing the pre and end of module surveys, which were used to establish the demographic profile of the volunteers;

- **Multiple choice, multiple response and true/ false questions** were used to devise anatomy, physiology, pathophysiology and technologically related assessments. These were used to assess levels 3 to 4 within Bloom’s Taxonomy;

- **Adobe® Captivate™ Simulations.** This facility gave an additional dimension, allowing for the creation of assessments, using images from the Image Database, to enable volunteers to interact with the images by highlighting areas of clinical significance (‘hot spots’ exercise) on the image itself, which could then be scored for accuracy. This again addressed levels 3 and 4 as per Bloom’s Taxonomy;

- **Word response (text match)** was considered for the marking of the report writing assessments. By using the grading logic facility, it was anticipated that the presence/ absence of key words or phrases could be identified (allowing for typographical errors) and answers scored for those assessments felt to be highly significant in demonstrating the ability to accurately analyse and evaluate case images before drawing a conclusion.
based on their knowledge and experience. These were aimed at addressing Levels 5 and 6 of Synthesis and Evaluation according to Bloom’s Taxonomy. However, ultimately this facility was not utilised.

In addition to these, the development of the image database archive and WebAIIMS needed to be considered. It should be remembered that in the clinical setting, images and patient information are reviewed through the picture archive and communication systems (PACS), however, as Cosson and Willis (2012, p.113) identified, PACS is not available to those working beyond a specific hospital trust site, or to the wider NHS in general, let alone to learners attempting access through a university networked system. Therefore in the absence of being able to link directly with hospital networks, and with the intention of making the information available to learners from a wide geographical base, it was necessary to create a purpose-built digital teaching archive, with inclusive case studies, which would form an integral part of the programme, giving ‘situational’ based examples of actual cases, which could be hosted through Victory, whilst still maintaining a functional capability comparable with PACS and the clinical setting.

In order to establish and construct the archive, permission and consent was sought from two local nuclear medicine healthcare providers (Appendix VIII.a.) and their supporting NHS Research Governance departments (Appendix VIII.b.) to acquire diagnostic examination case information (including images and reports) for the purposes of education. Additional, consent was obtained from the patients themselves, through the use of appointment letters and patient information leaflets (Appendix VIII.c) which outlined the reason for the request and granted inferred consent, in the absence of a patient actively opting out. This was carried out in accordance with ethical approval from the School of Health Sciences and Social Work Research Ethics and Peer Review Committee, University of Portsmouth and the Chair of the Research Ethics Committee for Isle of Wight, Portsmouth and South East Hampshire (Appendices III.b. and III.c.). Attention, at this point, must be drawn to the fact that only outpatients were approached for consent and use of their examination information for the development of the database.
Confidential patient information, such as patient names, dates of birth, were removed in their entirety, with all cases being anonymised and coded prior to leaving the respective healthcare provider sites. Cases were, however, given a unique study identifier to allow a feedback mechanism to departments in the unlikely event of any overt discordance with original reports (which were regarded as the reference ‘gold’ standard).

In total, two hundred and fifty cases, with reports, were obtained from the two hospital trust sites and saved in a DICOM compatible format. DICOM enables the storage and handling of uncompressed data, thereby allowing images to be stored without any loss, or degradation to the quality.

The case information and images were uploaded to a secure server at the University of Portsmouth, but needed specific software to provide a relevant viewing platform, which was not immediately available through the existing VLE platform. Therefore, following several months of discussions and collaboration with Aimsability.com and using an existing license for WebAiMS (version 9), case information was uploaded and managed through this forum.

WebAiMS is an independent knowledge management and eLearning platform with inclusive teaching and assessment authoring tools. With its inherent functionality, and for the intended purpose of image interpretation, WebAiMS was able to offer a level of interactivity akin to PACS. Cases could be displayed in their true DICOM format, without loss and where the interactive interface allowed images to be, amongst others, multi-displayed, windowed, manipulated, magnified, inverted and spot zoomed. This level of functionality allowed the clinical setting to be reproduced, adding a sense of realism to the cases under review.

Although WebAiMS, through its search facility and use of Boolean logic, could have allowed for volunteer access to individual cases, it was decided to establish customised case collections. These were based according to referral history (such as metastases, rheumatology and orthopaedic) selected to reflect common workload patterns, avoiding pitfalls identified by Brealey and Scally (2008, p.49) who suggested purposive selection of image collections often contained a higher
prevalence of abnormality (typically 50%) than found in normal clinical practice. Although, it can allow a degree of control over prevalence of disease presenting within a ‘population’, it should be appreciated that many patients referred for nuclear medicine imaging frequently have pre-existing disease, so the presence of abnormality as seen on images was likely to be higher than for other diagnostic imaging modalities.

Regardless of this, the WebAiMS archive enabled the creation of tailored collections with supporting data, such as age group, gender and referral, providing a coherent and specific assessment (formative and summative) platform. It was hoped this would allow volunteers the possibility to review and comment on similar pathological patterns. An additional facility also allowed image cases to be exported to a Powerpoint ‘show’ format which could then be used for teaching purposes, with embedded hyperlinked function buttons, again adding an additional level of interactivity between the volunteer and programme.

**Note.** One point, which should be mentioned in relation to the images, was that any DICOM file should be regarded as multi-layered, containing various fields, allowing information to be attached to a single image, or set of images. This may include unique identifiers associated with the host hospital, the modality, even the specific equipment used to acquire and image (this is in addition to any patient information). In view of the educational nature of this project, with the permissions and consent in situ and the need to have a secure image database, all remaining information, except the unique study identifier for the project, was redacted on being uploaded to the University server. Only the module developers and volunteers with appropriate rights were able to access this specific database. A hyperlink was then added, to allow access directly from the Victory module, although volunteers did need to have accounts created for them, along with a separate login.

A number of limitations with the chosen software were encountered, the most significant being the expertise and learning required to understand the software authoring processes and facilities, which inevitably took time, requiring some assistance from eLearning technologists at the University of Portsmouth.
Both packages required volunteers to ‘log in’ to each assessment separately and on each occasion, which was not desirable. It may have been possible, with further investment, to establish a *Shibboleth* account (see Glossary) for the WebAiMS server, which would have offered a more seamless access, so reducing the need for the secondary login. However, in the interests of identification, the separate login did preserve the tracking of individual volunteers and their performance without confusion, and perhaps, as akin to the use of ‘student identity numbers’ during traditional examinations, this additional complication was regarded as acceptable in this instance.

Lastly, due to the nature of the DICOM cases secured from the two healthcare providers, it was not possible at the time of collection to save dynamic sequences, used in multiphase imaging, as an audio-visual interface (AVI). Consequently there was some loss of information associated with these particular examinations, which was accepted as an inherent limitation from the outset.

Regardless of the limitations, at the time of selection, WebAiMS and QMP offered the most reliable and comprehensive range of assessment authoring tools compatible with the module aims and also the eLearning platform. Of particular interest to this project, features such as the blind test and subsequent review of cases with the consensus report, were deemed to be a highly valuable reflective educational tool, which could be incorporated into this programme and taken forward. With the help of Aimsability.com and assistance from Technology Enhanced Learning (TEL) team at the University of Portsmouth, assorted assessments were created and incorporated at appropriate points within the module for formative and summative purposes.

### 2.3 Module interface and usability

When designing any course, the user interface has to be accessible, functional and easy to use (Saffer, 2007, as cited in Clarke, 2009, p.2) where usability is a key quality criterion pertinent to this (Littlejohn, 2004, p.3; Guralnick, 2006, p.1; Gilbert, Morton & Rowley, 2007, p.562). As one author states “usability is a
necessary condition for survival" where if a website is difficult to use, if users become ‘lost', or if the information and content is hard to read – “people leave” (Nielson, 2005, p.1).

Usability may be defined by five quality components:

- Learnability – which denotes how easy it is for volunteers to achieve the basic tasks the first time they come into contact with the design;
- Efficiency – where upon learning the design – how quickly volunteers can perform tasks;
- Memorability – on returning to the design, having not used it – how easily is proficiency re-established;
- Errors – if an error is made, how severe are the errors and how easy is it to recover from them;
- Satisfaction – how pleasant is the design to use.

(based on Neilson, 2005, p.1)

Although other quality attributes, including ‘utility’ (which refers to the functionality) are intrinsically linked with the learning management system, the ‘visible course’ architecture, from the users (volunteers) viewpoint, should support ease-of-use. In other words, how pleasant was the design to use, i.e. user satisfaction.

To promote this, a simple, structured format was devised, as shown in Figure 2.2. Content was arranged in five, colour coded sections. Each section contained three to four subsections of learning content, presented in a variety of formats, which ranged from presentations through to assessment packages, self-tests and hyperlinks to other web sites. This was achieved by using the different software packages and features therein, addressing different sensory stimuli, to accentuate interactivity (Littlejohn, 2004, p.5) depending upon the nature and type of learning required.
Figure 2.2
Anticipated layout of module home page

University Links:
- Victory – A How to guide
- Setting up a web cache
- University Help Pages
- Academic Skills

Useful Links:
- British Nuclear Medicine Society (BNMS)
- European Association of Nuclear Medicine (EANM)
- WebAIMs

Section 0
This section contains introductory material to help get you started with the module. It also has a consent form, Pre-module survey and two baselines tests for you to complete.

Section 1
Introductory section containing information about the module, learning styles, preliminary quizzes and questionnaires, + presentations and information about bone scans.

Section 2
Assorted presentations, quizzes/assessments and information on Prostate, Breast and normal bone scan appearances.

Section 3
Assorted presentations, quizzes/assessments and information on Paget’s Disease, Arthrides, Primary Bone Tumours and report writing in Nuclear Medicine.

Section 4
Final assessments including report writing, quizzes and short answer questions. Section also includes the Post-module survey.
2.4 Implementation and release of the module

Ultimately, the module was released through a web browser, which could be accessed from any web-accessible location to all volunteers who were registered over the trial period.

Engagement with the module could have been achieved by a combination of ‘synchronous’ and ‘asynchronous’ activities. Synchronous learning would have to have taken place in real-time, which was logistically difficult to deliver given the prospective cohort profile, who as working professionals, would find it awkward to be online at a mutually convenient time. Therefore, it was anticipated that the majority of the learning would take place asynchronously, based around ‘learner to content’ engagement, enabling volunteers to access course material in their own time and desired location, so providing better flexibility.

To promote accessibility and efficiency, volunteers were able to exercise a degree of free choice in accessing the content within each section in a sequential or non-sequential pattern. However, to aid systematic learning and so as not to saturate information delivery, release and access to each section was based on individual progression through ‘gateway’ assessments, as tracked by the learning management system. Not only did it demonstrate the flexibility of eLearning in terms of staggering course content, but also showed how information could be selectively released and monitored on a weekly basis by the programme facilitator. This allowed for the differing levels of expertise to be accommodated, including the possible influence of previous experience and showed how the module could be tailored to specific individual needs, varying skill levels and pace.

There was also the opportunity for the provision for ‘learner to learner’ interaction through the ‘Discussion Board’ within Victory. Not only did it provide a learning and reinforcement opportunity, but also support for various learning needs and styles and from a social learning perspective, it was felt it would reduce the possibility of learner isolation.
2.5 Evaluating the module

According to Culatta (2011, p.1-3) measuring and evaluating the effectiveness of any training programme, is key to any individual or organisation, not only in terms of outcome and performance, but also in terms of invested time and resources. eLearning itself (Tyler-Smith, 2006, p.75) has been heralded as a better, more effective and cost efficient way of maximizing assessment (Mayes & de Freitas, 2004, p.8) and therefore it was important to understand how the module design aided effective learning, its depth and the establishment of a new skill base. This was aimed at addressing the lack of research in this area for assessing the effectiveness of resources/ tools used for eLearning (Littlejohn, 2004, p.4; Wutoh, Boren & Balas, 2004, p.21), especially stand alone models.

To measure the effectiveness of the module as a whole, including volunteer interaction, the Kirkpatrick model (KM) was applied. This is a well known model used in the assessment of training programmes, (Business Performance Pty Ltd, nd, p.1; Kirkpatrick Partners, 2011, p.2).

The Kirkpatrick model identifies four levels, reaction, learning, behaviour, results, each one providing a diagnostic check of the training programme:

**KM Level 1 – Reaction** seeking to establish how the volunteers reacted with the module;

**KM Level 2 – Learning** demonstrating knowledge and skill gain as a result of the assessments;

**KM Level 3 – Behaviour** seeking information on how the volunteers changed their behaviour once back in the workplace following training;

**KM Level 4 – Results** looking at organisational benefits of training.

*Note:* Although the notation of levels implies a hierarchy, no one level is more important, or significant, than another, however, they are inter-related, with each one being progressively dependent on the outcome of the previous level.

Owing to logistical constraints, only Levels 1 and 2 were applied in full, Level 3
could only be partially covered whereby any behavioural change and the influence of experiential learning, as evidenced by changes in workplace, could not be fully gauged given the time constraints of the research. Likewise any lasting organisational benefit (Level 4) could not be covered within the remit of this project.

2.5.1 KM level 1 - reaction (volunteer experience)

Within the context of Kirkpatrick’s model and as a newly designed module (taking account of its remote nature as a learning environment) comments and contributions made by volunteers during the course of the module, were used to change and shape content where appropriate, allowing for successive iteration as required.

Various other sources were utilised to gauge volunteer reaction. These included use of the student tracking facilities available in Victory, QMP and WebAiMS, to demonstrate the contact time with the module and also the preference shown by volunteers in the order in which they accessed different subsections and assessments.

More importantly, the post-module feedback survey was developed, based on University of Portsmouth unit feedback proformas and Upton (2004, p.67-68) to gain formal and qualitative comments from volunteers as to their experiences. This included those characteristics which were regarded as having a positive impact on the e-experience, such as linkage with the systems, peer recommendation, learner engagement and other elements e.g. navigation and clarity of information presented (Littlejohn, 2004, p.4). Data from this was also used to establish the usability of the module in delivering its content and learning.

2.5.2 KM level 2 - learning

To measure the effectiveness of the learning and impact of the instructional design, both formative and summative assessments were used at each stage of the module. These offered a variety of different style assessments ranging from simple multiple choice questions, through to case reports, however, only data from the summative assessments – before, during and at the end of the module could
be used to demonstrate, test and reflect the development of knowledge, understanding, interpretative skills and competence over a period of time.

Mapping volunteer achievement of learning outcomes did go some way to providing quantitative evidence of academic rigour, however, there was a need for learners to have knowledge of their results, so they could gauge success and transfer learning to their daily practice (Speck, 1996, p.41; Higgins, 2000, p.6). This was achieved through the provision of feedback.

Various authors (Rolfe & McPherson, 1995, p.838; Higgins, 2000, p.1; Northwest Regional Educational Laboratory, 2005, p.2; Learning and Teaching Centre, Macquarie University, 2008, p.1-2) have identified feedback, knowledge of results and performance, as essential and central to learning and development. Not only can it benefit the learner by directing, or redirecting their learning, it can also help refocus and improve content, methods of instruction and delivery, which in the context of this research is paramount. So, providing the right kind of feedback in a timely fashion where it is useful and usable is significant. A variety of mechanisms were considered, including the assessment feedback facilities incorporated within the integrated software, which could given near instantaneous scores, to written feedback generated by the facilitator, which could be generic or individualised, both of which were deployed.

Similarly, with regards to the interpreting decision outcomes, bearing in mind design issues for diagnostic performance studies (Appendix II.c.) identified by Brealey and Scally (2008, p.49) it was the intention to demonstrate the clinical competence to a minimum of Level 4 (BNMS, 2005) so verifying diagnostic ability and accuracy of performance.

Competent staff should be able to report “to level 3 (possibly level 4 when following a protocol) with appropriate training.” (BNMS, 2005, p.1) with achievement of Knowledge Levels 1-5 considered a minimum requirement for reporting to Level 4 competency (Appendix II.a.).
This was ascertained through the initial baseline and protocol driven reports, which were regarded as giving the volunteers sufficient scope to report to BNMS Level 4. Normally an individual wishing to report to this level would have their work double reported by a more experienced clinical colleague, but in the context of this project, the image database, and corresponding reports provided the point of reference and thereby a ‘double reporting’ facility, against which volunteer competency and learning could be assessed. Findings from these assessments were also used to provide an insight into the practicalities of reporting.

As volunteers progressed through the module, the number of cases in the report writing assessments was raised (twenty QMP case reports in QMP and forty cases in WebAiMS). This was seen a way of assessing the volunteer’s increasing efficiency in diagnostic performance and ability to interpret. Also, the caseload was more representative of a typical reporting session, thereby providing a degree of authenticity to the task (Littlejohn, 2004, p.3). It was anticipated volunteers would be able to competently report nuclear medicine skeletal images to Level 5. In this, they would achieve Knowledge Levels 1-6 (Appendix II.a.) demonstrating the transition between ‘novice to competent reporter’ and achieving a level equivalent to that of an established, experienced, independent medical reporter.

For diagnostic accuracy, all volunteer case reports were correlated with the reference reports. (All cases having been previously reported by a consultant physician/radiologist to obtain a ‘gold standard’ report (reference report) and for randomly selected cases, separate assessment by an independent reporting radiographer, were used to check for concordance). Cases were deemed to be of comparable difficulty, wherein an expected level of 95% agreement between volunteers and reference reports was hoped to be achieved (Nuclear Medicine Communications, 2004, p.751). This would confirm accuracy of performance, although recognition was given to the ability to acknowledge any differential diagnosis and the possibility of inter-observer variability was also acknowledged, so a feedback mechanism was available, if required.
Using identified parameters, volunteers were asked to make an interpretative decision (opinion of findings) as to the image appearances in each image set, using the following categories:

- Normal – no abnormalities were identified;
- Probably/possibly normal – where no abnormality was suspected, but further diagnostic examination was required;
- Equivocal/unsure – no firm decision could be made, for example, poor technical outcome;
- Probably/ possibly abnormal - where abnormality was suspected, but further diagnostic examination was required;
- Abnormal – abnormalities identified.

The descriptive content of the volunteers’ reports were compared to the reference standard reports, through the use of key words and phrases (text matching). These were marked on various criteria which included the ability to locate, define and describe the image appearances in a systematic way such as identifying an area of uptake with specific detail as to its precise location and shape, plus any incidental findings for example soft tissue appearances, or artefacts. This provided an insight, not only into the visual acuity and decision making by the volunteer group, but also their ability to transcribe their findings in a succinct and clinically efficacious manner.

Volunteers were also asked to decide whether the appearances were clinically significant. This was to allow for areas such as degenerative changes to be noted, yet contextualised, depending upon the referral and also for any unexpected, yet clinically significant findings to be noted. This latter point is in line with recent report by the Royal College of Radiologists (2011b, p.9) which suggested that unexpected or incidental abnormal findings often arise (30% in ‘body imaging’) where if these go unreported or unrecognised, may have a profound implication on the future health of a patient.

The results were compared to the reference standard reports for agreement and
parity, regarding the clinical significance of their findings, These were determined using the following parameters.

- True positive (TP) – findings were correctly identified as clinically significant;
- True negative (TN) – findings were correctly identified as not clinically significant;
- False positive (FP) – findings were incorrectly identified as clinically significant;
- False negative (FN) – findings were incorrectly identified as not clinically significant.

It was anticipated that this measure of performance would emphasise the third level of Kirkpatrick’s model – giving an indication of volume changes in ‘behaviour’ in a simulated workplace setting.

It is important at this juncture, to acknowledge the development of expertise and how this may influence performance. Developing expertise is where expert clinical knowledge becomes “*embedded in perception rather than precepts*” (Benner, 1984, p.43). A learner will progress through a series of stages in the transition from novice to expert. This begins initially by establishing causal relationships between elements contained within a knowledge base, where novices rely on a structural, or process driven format, in order to reach a decision (Schmidt & Rikers, 2007, p.1133-4).

As they progress, encountering, and acquiring more experience, they will begin to perceive the relevance of new knowledge, becoming more able to contextualise it in the light of prior knowledge/experience (Gunderman, Williamson, Frank, Heitkamp & Kipfer, 2003, p.15-17; Verkoeijen, Rikers, Schmidt, Van de Wiel & Kooman, 2004, p.618).

Through this mechanism, original knowledge is not lost, but condensed. With experience, skills are transformed from the initial slow, sequential pattern of events, used in establishing a skill set, to a more rapid and effective approach, where
relative importance of outcomes are based on interpreting the context and allows for ‘free recall’ without the reliance on original learning (Verkoeijen et al., 2004, p.618; Woods, Howey, Brooks & Norman, 2006, p.975). This ‘re-structuring’ is a phenomenon often referred to as ‘encapsulation’, which can be defined as:

“the subsuming or packaging of lower level, detailed concepts and their inter-relations, under a smaller number of higher level concepts with the same explanatory power” (Schmidt & Rikers, 2007, p.1134-1135).

This is also known as ‘clinical knowledge’ or ‘practical knowledge’ where the acquisition and exposure to learning over time, evolves into a ‘hybrid’ of knowledge and experience. It summarises the effects of experience, where experts utilise “more encapsulating concepts than those of sub-experts” (Schmidt & Rikers, 2007, p.1136) although, if necessary, experts can revert non-automated processing of information and call upon their original causal knowledge foundation in preference to ‘clinical knowledge’, should the situation demand.

In developing expertise in image interpretation, Nodine and Mello-Thoms (2010, p.139) describe the “hallmark of an expert in radiology” as one who is consistently and reliably accurate in their diagnostic performance. They suggest this requires talent and motivation as well as proof of performance based on specialist training.

According to Reeves (2004, p.213) pattern recognition is the foundation of radiographic reporting, where a diagnostic opinion may be derived from a sequential approach based on the assimilation of knowledge of anatomical and pathological appearances of images.

Various authors (Robinson, 1997, p.1087; Kundel, Nodine, Conant & Weinstein, 2007, p.397; Schmidt & Rikers, 2007, p.1136; Nodine & Mello-Thoms, 2010, p.142) suggest such experts have highly developed perceptual and cognitive skills. These skills are honed after many hours studying normal and patho-physiological presentations, establishing an innate knowledge base through re-structuring, applying image appearances to biomedical concepts and vice versa.

Search strategies adopted by novices are less efficient. Their approach tends to be
incremental, often resulting in over simplification of appearances which may lead to early vital, or salient information being lost, overlooked, or where the increased time (often referred to as ‘dwell time’) spent searching for abnormality may be counterproductive to the diagnostic accuracy. In contrast, the expert, with their encapsulated knowledge and ability to use ‘free recall’ (Verkoeijen, et al., 2004, p.619) can deploy a fast and simple ‘at a glance’ search strategy, to collate and differentiate between normal and abnormal appearances. This enables a more holistic approach to accurately assess an image, fixating and contextualising on abnormal patterns in a time efficient manner (Haller & Radue, 2005, p.983; Kundel et al., 2007, p.402; Nodine & Mello-Thoms, 2010, p.143).

Expertise can be further enhanced by limiting knowledge to specific domains/sub-domains to improve cognitive and perceptual knowledge. Although expertise may not then be easily transferred to other domains, for example chest radiograph interpretation to mammography (Nodine & Mello-Thoms, 2010, p.139).

Yet, even within a specific area of expertise, image interpretation may be regarded as subjective (Robinson, 1997, p.1086) open to variation between observers, where differences in agreement between the severity/importance of findings may be identified. Clearly there is a continuum upon which findings may be placed, ranging from the near certainty of findings through to those which are inconclusive, resulting in genuine differences of opinion. However, it should be accepted that degrees of error do exist. If discovered, they may be of little or no consequence to the patient, whilst others are more significant and usually highlighted through negligence and malpractice suits (Robinson, 1997, p.1087) although any ‘miss’ is undesirable.

According to Berlin (1996b, p.1028) errors in interpretation usually fall into three categories: lack of knowledge (including lack of depth of knowledge, lack of knowledge of normal variants, or lapses in knowledge) perceptual errors and those due to inadequate diagnostic quality of images (Berlin, 1996a, p.771). In addition, Robinson (1997, p.1087) suggest other ‘misses’ include those due to a phenomenon known as ‘satisfaction of search’ whereby subtle abnormalities are overlooked in the presence of more significant abnormality.
In acknowledging, the potential for inter-observer variation and possible ambiguity in reporting the less obvious ‘abnormal’ cases, perceptual errors are cited as the most common problem. However errors of judgment may also feature resulting in a propensity to ‘over report’ (Robinson, 1997, p.1087) culminating in a higher number of false positive findings, which may be more detrimental than omitting information (Reeves, 2004, p.215). This highlights the importance of measuring outcomes in image interpretation training, and establishing how often errors, or differences of opinion, may occur.

As demonstrated by various studies in this area (Nodine, et al., 1999, p.576; Hardy & Culpan, 2007, p.65; Kundel et al., 2007, p.397; Kelly et al., 2012, p.91) it is possible to measure performance by using a test bank of images, as carried out in this research. According to Metz (1978, p.283) this allows the comparison between the decision making process made by the ‘observers’ and the ‘truth’ (actual outcomes as detailed in the reference reports). This can be assessed by counting the number of times ‘observers’ correctly identified the outcome and may be referred to as the diagnostic accuracy. Although, as identified by Metz (1978, p.284) this approach is simplistic and often of limited usefulness, particularly where the likely prevalence of disease within a population sample is unknown. Therefore, by using paired indices of the proportion of ‘true positives’ (sensitivity) and ‘true negatives’ (specificity) correctly called across a whole sample, diagnostic accuracy can be improved, providing an indication of how efficient the observer is overall (Moran & Warren-Forward, 2011, p.129).

However, this approach, forces decisions based on the presence/absence of disease. It does not take account of more ambiguous cases, where image presentations may be ‘possibly normal/possibly abnormal’. In addition, merely counting correctly identified cases, does not give any indication of the severity of individual case errors, or the number of falsely identified cases (both false positive (false alarms) and false negative (missed) calls.

Therefore, if the purpose of the diagnostic test is to arrive at a diagnosis, it is prudent to consider the probability that the test will give the correct answer. Sensitivity and specificity rates, as described to above, will not give that information,
so to complement these, positive and negative predictive values were used (Altman & Bland, 1994a, p.102).

Predictive values describe the "power of the diagnostic procedure in terms of its probability of giving a correct positive or correct negative outcome from a sample of tests" (Carter & Manning, 1999, p.73) where the probability relates to the likelihood of the test increasing the certainty of a positive or negative diagnosis. In the context of this research, the positive and negative predictive values relate to the likelihood of the volunteers arriving at the right decision of image findings in relation to the reference reports.

With regards to confirming the diagnostic accuracy, a number of authors (Metz, 1978, p.288; Altman and Bland, 1994b, p.188; Obuchowski N, 2003, p.4; Zou, O’Malley & Mauri, 2007, p.654) suggest the use of receiver operator characteristic curves (ROC). It is suggested that this is a more "resilient and reproducible indicator of accuracy" than merely using sensitivity and specificity (Robinson, 1997, p.1088). However, it requires the comparison of the test method to a reference standard. Due to the isolated nature of the module, no comparisons could be made with more traditional methods of image interpretation education, such as with face to face teaching. In addition, the veracity of the reference reports against which the volunteers were to be judged, could not be independently verified. Therefore, the Kappa statistic, as a measure of reproducibility of performance, was used to indicate the observed level of agreement, between the cohort observations to the reference reports and the level of agreement attributable by chance (Robinson, 1997, p.1088).

Ultimately, the following formulae were used to elicit quantitative information and to verify the results (Altman, 1991, p.406; Carter & Manning, 1999, p.73) based on the accumulated results of the QMP report writing assessments (three in total: initial, interim and final tests). These were used primarily to ascertain if the programme contributed to the development of expertise in image interpretation as the module progressed, thereby confirming the influence of the eLearning programme, although some statistical analysis was applied to see if discipline specific knowledge and length of experience contributed to module success.
**False positive rate (FP%)**
These may be defined as the number of cases falsely identified as being abnormal.

\[
\frac{FP \times 100}{TN + FP} = FP\%
\]

**False negative rate (FN%)**
These may be defined as the number of cases falsely identified as being normal.

\[
\frac{FN \times 100}{TP + FN} = FN\%
\]

**Sensitivity rates**
This measures the proportion of actual positives correctly identified, which may, in the context of this research, be defined as the ‘true-positive’ (TP) percentage of patients presenting with an abnormality. This can be calculated by:

\[
\frac{TP \times 100}{TP + FN} = Sensitivity
\]

**Specificity rates**
Conversely, this measures the proportion of actual negatives correctly identified. This can be defined as the true-negative (TN) percentage where, in the context of this research, the findings are negative. This can be calculated by the following formula:

\[
\frac{TN \times 100}{TN + FP} = Specificity
\]

**Error percentage rates**
These were used to demonstrate where volunteer decisions did not agree with the reference reports:

\[
Error = \frac{FP + FN \text{ (total false decisions)}}{TP + TN + FP + FN} \times 100
\]

(total cases reported)
**Accuracy percentage rates**

These were used to establish agreement between volunteers and the reference reports:

\[
\text{Accuracy} = \frac{TP + TN \text{ (total correct decisions)}}{TP + TN + FP + FN} \times 100
\]

In addition to the statistics above, positive and negative predictive values (PVP and PVN) were calculated to determine how likely each volunteer was, to arrive at the correct decision. That is, they are summary statistics used to describe the performance of a diagnostic test, to determine the prevalence of correct decision making within the sample of image data sets.

**Negative predictive value formula**

This may be defined as likelihood of the test to determine 'normality', so increasing confidence that the result is a truly negative test result.

\[
\frac{TN \times 100}{TN + FN} = \text{Predictive Value Negative (PVN)}
\]

**Positive predictive value formula**

This indicates the likelihood of a positive test result from the diagnostic test, so increasing the confidence that the results reflect a truly positive for an abnormal finding.

\[
\frac{TP \times 100}{TP + FP} = \text{Predictive Value Positive (PVP)}
\]

By the same token, the level of agreement, or precision, between the observed ‘opinion of findings' and reference reports, and agreement expected by chance, was tested using both weighted and non-weighted Kappa statistics. This was considered appropriate in the light of the data obtained, by assigning, in the case of the former, less weight to agreement as categories were regarded as being further apart (Viera & Garrett, 2005, p.362) than if a non-weighted Kappa had
been used. This was then calculated for overall cohort agreement levels, test by test.

Kappa can be calculated as shown below:

\[
K = \frac{\text{observed proportion minus expected proportion}}{\text{one minus expected proportion}}
\]

Where the 'observed proportion' is:

\[
\text{Observed proportion} = \frac{\text{TP} + \text{TN}}{\text{Total number of cases}}
\]

And the 'expected proportion' is:

\[
\text{Expected proportion} = \frac{(\text{prevalence} \times \text{TP} + \text{FP}) + (100 - \text{prevalence} \times \text{TN} + \text{FN})}{\text{Total number of cases}}
\]

Although Kappa can be manually calculated, a statistical package was used to reduce the possibility of human error. There are a number of software packages freely available, such as the 'Online Kappa Calculator' (Randolph, 2008, [http://justus.randolph.name/kappa](http://justus.randolph.name/kappa)), however for the purposes of this project, following advice and assistance from the University statistician, a software package, known as ‘Statta’, was used to calculate the Kappa scores. It is useful at this juncture to acknowledge that the Cohen’s kappa calculation is not without limitations especially where it measures agreement between two raters only (in this instance the original reference report and the volunteer report). Fleiss’ kappa could have been used where there are more than two rates, but as this study wanted to assess individual volunteer performance, using Cohen’s kappa was regarded as the most appropriate.

In terms of interpreting the significance of the ‘k’ values gained by undertaking Kappa, Landis & Koch (1977, p.65) offered a table as shown in Table 2.3. It is included here to offer some context by which to attribute ‘k’ value, but it would
seem this was based on personal opinion, so not considered appropriate by other authors, and therefore should be treated with a degree of caution (Viera and Garrett, 2005, p.363).

Table 2.3 Interpretation of ‘k’ values

<table>
<thead>
<tr>
<th>k</th>
<th>Interpretation</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0</td>
<td>No agreement</td>
<td>Poor</td>
</tr>
<tr>
<td>0.0 – 0.20</td>
<td>Slight agreement</td>
<td></td>
</tr>
<tr>
<td>0.21 – 0.40</td>
<td>Fair agreement</td>
<td></td>
</tr>
<tr>
<td>0.41 – 0.60</td>
<td>Moderate agreement</td>
<td>Fair</td>
</tr>
<tr>
<td>0.61 – 0.80</td>
<td>Substantial agreement</td>
<td></td>
</tr>
<tr>
<td>0.81 – 1.00</td>
<td>Near perfect agreement</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Based on Landis & Koch (1977)

Lastly, Mann-Whitney U tests were used to look for correlation/comparison between professional background and volunteer performance across the module, and also performance across the various aspects of the report writing assessment criteria. These were carried out using a free statistical online package from www.holah.karoo.net.

2.5.3 KM level 3 – changes in behaviour
In order to establish whether volunteers may have changed their behaviour as a result of the module experience, qualitative and quantitative information was acquired through specific questioning posed in the final part post-module survey. Questions were based upon perceived relevance of the module to their current, or future professional role, learning gained, advancement of understanding of topic area and whether participation in the module had caused them to their professional practice.

2.6 Summary of chapter two
This was a complex methodology with multiple parts, achieving the first research objective, which was aimed at the creation and design of the module from its
accessibility and layout, organisation and development of content within each module section, through to the assessment and evaluation of performance and analysis of the data gained. Collectively these elements were used to inform and assess the programme, as a whole and the findings are explored later.
Chapter 3 - Pilot Study

As a newly developed module and owing to its remote nature, it was important to consider the likely impact of the eLearning environment. The module design demanded a certain level of technological proficiency by the volunteer in terms of their ‘digital literacy. It also needed to test the linkage with software used, memorability, navigation and clarity of information presented.

In terms of professional impact, there was little point releasing a module unless the contents were likely to meet with and maybe exceed, professional expectations.

Data regarding these aspects were considered essential and to this end, a pilot study was conducted to assess and establish the usability of the module in delivering its content and learning, with seven pilot volunteers taking part.

3.1 Release of pilot module

The prototype module was released in its entirety for a four week duration between April and May 2011. Pilot volunteers were emailed with details of their unique usernames and passwords for accessing the VLE (Victory) and module contents, including accounts created for access to Questionmark™ Perception™ (QMP) and WebAiMS. In addition, a step by step guide on how to locate and remote access the VLE was sent in the form of an illustrated Microsoft Word document.

The pilot volunteers were encouraged to ‘peruse’ the module content, undertake various assessments and to assess the layout and navigational features. At the end of the pilot – semi-structured interviews were carried out either in person, or over the telephone in order to gain and gauge feedback. A collective overview of questions is given in Appendix IX.
3.2 Profile of pilot volunteers

Seven volunteers were purposively recruited, in part due to their age profile, which placed them in the ‘digital immigrant’ category and therefore likely to reflect the anticipated age profile of the trial volunteers. All were known to the facilitator in either a personal, or professional capacity and were approached with details of the module and the overall research remit, requesting their consent and assistance with this project. All agreed without hesitation.

Table 3.1 Profile of pilot volunteers

<table>
<thead>
<tr>
<th>Pilot No.</th>
<th>Discipline</th>
<th>Gender</th>
<th>Age (Years)</th>
<th>Qualifications (*)</th>
<th>Experience in Nuclear Medicine</th>
<th>Hours spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NM Pilot1</td>
<td>Lay person</td>
<td>M</td>
<td>41-50</td>
<td>MBA</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>NM Pilot2</td>
<td>Lay person</td>
<td>M</td>
<td>&gt;50</td>
<td>MSc Eng</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>NM Pilot3</td>
<td>Diagnostic Radiographer</td>
<td>F</td>
<td>&gt;50</td>
<td>DCR(R) DRI MA</td>
<td>20-30</td>
<td>2</td>
</tr>
<tr>
<td>NM Pilot4</td>
<td>Diagnostic Radiographer</td>
<td>F</td>
<td>&gt;50</td>
<td>DCR(R) DRI MA</td>
<td>20-30</td>
<td>4</td>
</tr>
<tr>
<td>NM Pilot5</td>
<td>Diagnostic Radiographer</td>
<td>M</td>
<td>&gt;50</td>
<td>DCR(R) MA</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>NM Pilot6</td>
<td>Diagnostic Radiographer</td>
<td>F</td>
<td>41-50</td>
<td>DCR(R) PgD (Interp)</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>NM Pilot7</td>
<td>Diagnostic Radiographer</td>
<td>M</td>
<td>41-50</td>
<td>DCR(R) MSc PhD</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

(*See list of abbreviations. p.xiii)

As indicated in Table 3.1, two were established nuclear medicine specialists, with significant experience within the clinical field and with known expertise in reporting in nuclear medicine. Three pilot volunteers came from higher education, with known expertise in module design, eLearning and skeletal image interpretation in diagnostic imaging. The last two came from non-healthcare professional backgrounds with no knowledge of nuclear medicine, yet were known to have basic computing skills. (Note: One pilotee (NM Pilot5) only gave their demographic profile, but did not access the module at any point).
Gender: Allowing for the small sample size, it is anticipated that the slight preponderance of male participants will be reversed in the main trial, owing to most diagnostic imaging professions being more heavily dominated by women.

Age Profile: With the purposive selection of individuals who held senior positions in their representative professions fields, the age profile was not unexpected.

Range of Qualifications: All, except the two non-healthcare pilot volunteers, held professional qualifications in Diagnostic Imaging ranging from the basic Diploma of the College of Radiographers, through to Bachelor of Science awards (which reflects the current award status). All had further postgraduate qualifications ranging from professional accreditation in nuclear medicine, to teaching awards and awards in clinical image interpretation. Of the two non-healthcare pilotees – one held a Masters degree in Business and Administration, the other, a Masters degree in Engineering.

Number of years in nuclear medicine: This was a slightly superfluous question, at this stage, given the profile of the pilot volunteers, however, it was hoped in the main trial to have a wider variation in terms of the number of years spent in the field of nuclear medicine. This in turn, was expected to reveal the possible influence of experience on progression and ability. Therefore the question was retained.

Engagement data (number of hours spent on reviewing the module): Allowing for busy work schedules and also taking into account the initial problems with access, the mean review time was 5.6 hours.

3.3 Findings from pilot study

In the main, the pilot module was well received, with some highly constructive comment relating to design and layout being raised. There were only minor negative criticisms which were easily resolved. These are discussed in the following paragraphs.
3.3.1 Accessibility of pilot module

Almost from the outset, it became apparent that those individuals, external to the University, encountered difficulties with accessibility. This was found to be a hitherto unappreciated maintenance change to the University server during the Easter vacation, which prevented pilot volunteers from accessing the separate assessment software packages. This was associated with the level of access originally allocated to the pilot group. Although they could access the module within Victory, review the various presentations and content, they were initially unable to access QMP and WebAiMS, which clearly was a necessary part of assessing learning, performance and progression.

Discussions with the University Security Architect revealed there was an issue with the internal security firewall. The solution involved giving the pilot volunteers a temporary, yet full registrant (LDAP) account with the University of Portsmouth, despite not being fully registered ‘students’, for the duration of the pilot study. Once this was identified, pilot volunteers were re-assigned new usernames and passwords, which then gave them full access to the module. This information was also carried over for the main trial to ensure this issue did not occur again, (with the added caveat that all volunteers were then to abide by University regulations regarding use of eLearning facilities).

An additional issue was raised over the accessibility of WebAiMS when using hospital based computers. It would seem that their internal computing security prevented WebAiMS from being shown. Therefore, advice was given that if this did occur, such individuals may seek to gain access from their home computers.

3.3.2 Navigation and layout of pilot module

This generated a number of comments which are outlined below. Where appropriate, responses given, acting as an indication of where modifications were made to the final module prior to release.

All pilotees commented on the perception of being ‘overwhelmed’ by the sheer amount of information contained on the Home Page which showed all four sections, which was thought to be confounding. However, once it was confirmed
that sections would be released section by section, the release being based on an individual progression and gateway assessments, the pilot group were satisfied.

With regards to the general loading of material:

Comment

“Front page took a while to set up because of the animated images” (NMPilot7).

Response On discussion with this pilot volunteer, it seemed they were referring to a small video clip on the Home page. It also transpired that they were using Internet Explorer (Version 9). The impact of this on the stability of the learning management platform had not been explored by the University eLearning team, by the release of the main trial in June 2011. Therefore, trial volunteers were advised in their initial instructions, which were updated and clarified, to use browsers such as Internet Explorer (Version 8) or Firefox, avoiding the use of Internet Explorer (Version 9) and Google Chrome, the latter being problematic with the use of Questionmark™ Perception™.

The actual layout, in clear sections, with designated colour coding was thought to be ‘good’, offering clarity and a sense of accomplishment. Directional features and signposting, so individuals could navigate away and easily back to the Home Page, was also felt to be simple, yet effective.

However, some criticism was made regarding the presentation of the Adobe® Captivate™ files.

Comment

“I did not like the fact that when you run the Captivate presentations you have no idea how long they are.” (NMPilot7).

Response This was a valid point and easily remedied, so duration times (in minutes) were added to the title file of each presentation, so students studying a
section could exercise some self-direction in terms of the order in which they viewed the content.

Collective comments about function buttons within Adobe ® Captivate™ presentations, resulting in the need “to ‘toggle’ between slides” (NMPilot1, 2 and 7)

**Response**  This in fact was apparent if the pilot volunteers reduced the computer window settings from 100% to 95%.

With regards to sequencing and organisation of material, it was suggested that some of the content, especially at the beginning of the module, would be better placed in an additional section, such as the consent/ disclaimer form, baseline tests etc. It was also suggested that some instructional ‘videos’ on how to use QMP and WebAiMS would be of benefit, because none of the pilot volunteers had ever encountered these pieces of software before. For this reason, Section 0 was added to the main trial module (therefore five sections in total) with additional Captivate presentations detailing how to access and identifying the various functional features of both QMP and WebAiMS being created to enhance usability.

All pilot volunteers felt, once access and initial skills had been mastered, that the design features were easy to use and memorable between sessions.

### 3.3.3 Assessment of pilot module content

Owing to busy schedules and also given the remit of the Pilot group to establish usability, rather than undertaking the module for learning and assessment purposes, it was appreciated that not all the content was covered by the pilot group. However, quantitative and qualitative feedback was gained on the areas which were reviewed, based on individual preference through the semi-structured interview and emailed comments. Generally this was perceived as appropriate and comprehensive

Of particular interest were the assessments created in QMP and WebAiMS. Although these were not marked per se, those who undertook various assessments made the following comments (again responses are given, and
where appropriate).

In respect of the Questionmark™ Perception™ assessments, the following comments were made:

Comment

“Had a go at a couple of assessments, quite pleased with myself as I scored over 50% even though this isn't my field”  (NMPilot2).

Response  Based on this remark, it was decided to set the ‘pass mark’ at 50% for all QMP multiple choice tests

Comment

“I seemed to be able to have several attempts at some of the assessments – is this right?”  (NMPilot1)

Response  For all QMP assessments, it was decided to limit volunteers to two attempts, with the second attempt only being made available if they scored less than 50%. Surveys required just the one attempt.

Comment

“I struggled a little to get into the initial Perception tests… I only completed one quiz – it was fairly easy to do although had some pretty hard questions (but I suppose I should expect that) and it was nice to get my results immediately”  (NMPilot3)

Response  This feature was felt to be highly positive for the multiple choice styled assessments and therefore retained, so all those ‘passing’ an assessment, would gain immediate feedback of their percentage (%) mark. If answers were ‘incorrect’ even after repeating the assessment, feedback would be given for those incorrectly answered questions, so learning and reflection could be maximised. However, it would not be possible for the ‘report writing’ or short answer questions which may yield more complex answers. It was anticipated these would be better marked separately.
Comment

“I felt the images displayed quite well...... when starting to report it is important to be able to establish between normal and abnormal”

(NMPilot4)

Response  Owing to time limitations and hospital access issues, this pilot volunteer only accessed the “final exam” (the Final Report Writing Assessment) had they been able to access earlier assessments – the progression in terms of difficulty level would have been more apparent.

Comment

“Liked the interactive ‘hot spots’ self assessment – made me think”

(NMPilot6)

Response  This showed the importance of self-assessment and the need for interactive engagement between the learner (volunteer) and the module content. This feature was retained.

With regards to the WebAiMS assessments, the usability of this software was difficult to assess given the initial delay and access problems, however, for those who tried and did obtain access, some valuable feedback was given.

Comment

“Reminded me of interpretation self-assessment packages already online in general imaging”

(NMPilot6)

Response  This was a valued comment given the individual’s background clinical experience and expertise.

Clearly there were some issues and reluctance over the need to set up a proxy web cache:

Comment

“I was reluctant to set this up first off, however, once I had the web cache sorted – I was able to see this. Looked quite good, but took some time to work out what I was supposed to be looking at and
how to ‘manipulate the images. Perhaps some instructions are needed....”

(NMPilot2)

Response  
Further to this, separate instructions were devised and clarified.

Comment

“Found it annoying that after setting up the Web Cache – every time I turned my computer on for other things – this kept coming up!”

(NMPilot1)

Response  
In the absence of a Shibbolith® account being established – it was necessary to use a proxy web cache in order to access WebAiMS, so there was no simple solution to this, other than to advise volunteers that the proxy web cache could be easily removed by following the University instructions in reverse. Volunteers were advised to leave it in situ for the duration of the module, primarily to save time on each session.

Despite this advice, the additional issue of security blocking by hospital trust site computers became evident.

Comment

“my internet kept blocking me from the [other] assessments and unfortunately I was time limited, so could only look at the final [QMP] exam”

(NMPilot4)

Response  
This was a potential issue which could not be easily remedied, hence the advice as already detailed in the Accessibility section.

NMPilot4 also raised several valid points with regards to the case collections and report writing assessments, which are detailed below

Comment

“All our clinicians work differently, some will comment on degenerative changes ...others won’t. Some will comment on ... activity in the kidneys, other won’t. For the sake of you teaching database – I assume you would expect students to comment on everything”

(NMPilot4)

Response  
This point was acknowledged and addressed during the creation of
the formative and summative case assessments, where volunteers would be expected to comment not only on the presence of abnormality (whether in bone or soft tissue appearances) as supported by module presentations on reporting abnormalities, but also on whether the findings were ‘clinically significant’.

**Comment**

“For many abnormal scans, I would have expected additional views as this enables the reporter to be more definitive about the nature of a specific lesion …. I have found it difficult to come to a definitive decision on many of the scans, but that may be because I am trying to go beyond what is expected of the student” (NMPilot4)

**Response**  This comment revealed the possibility of differences in professional approaches from the source trust hospitals and individual professionals therein. The comment given by NMPilot4 is entirely appropriate and this limitation of the database is acknowledged.

**Comment**

“Very often radiographs are available for comparison and although I can see gross abnormalities, I am not trained to interpret them so I cannot let them influence my report and I am pleased to see that this wasn’t expected though I think it is useful to have a relevant radiograph report if available” (NMPilot4)

**Response**  Consent allowing the sourcing of the cases for the image database only extended to the nuclear medicine departments in each of the two trusts approached. No permission was sought from their respective radiology departments for relevant diagnostic images, which, with hindsight, may have ‘added value’ to the reporting process in spite of NMPilot4’s reservations.

### 3.3.4 General feedback on pilot module

This included some highly positive comments, which seemed to confirm not only the usability of the module, but also its professional content and the level of learning offered.
Comments
“...completely snowed under and didn’t really complete much of the module [but] what I did do seemed very good. ....On the whole, what I saw looked good and I would have got further if I had had time”
(NMPilot3)

“What I have seen is excellent and I am sure will be an excellent teaching tool.”
(NMPilot4)

“it is looking good. Has a professional feel about it”
(NMPilot7)

“it was interactive enough and held interest – yes – I liked it”
(NMPilot6)

“Thought it was excellent, very professional and informative”
(NMPilot2)

“Although I know nothing about nuclear medicine, the module site certainly compares with previous experiences of eLearning”
(NMPilot1)

Note: No feedback was given by NMPilot5 following lack of engagement due to work constraints.

3.4 Pilot study conclusions

In conclusion, the pilot module was well received. No major amendments were made in terms of content, satisfaction, or professional level, although valuable feedback was given regarding the layout and navigation of content, allowing for modifications, additions to individual sections and for minor corrections to be made to some of the presentations. It must be highlighted that the Pilot group looked mainly at usability, rather than being assessed for knowledge and progression in respect of the assessments.

One significant finding did manifest itself over the accessibility. Had the issues concerning the changes to the University firewall not been highlighted, LDAP connections and temporary registrant status would not have been given to the incoming trial volunteers. This may well have impacted upon their subsequent willingness to engage and experience with the module.

Other modifications included a change in the way in which qualitative feedback could be used. Generally, there are several criticisms/ weaknesses which could be
levied at the ADDIE model of instructional design, one of these being the assumption that a linear approach would be followed, based on pre-existing knowledge of content and how learners will engage (Allen Interactions, 2007).

As this was a new module, with no history, or certainty as to how it would work, it became apparent that there needed to be flexibility to change and shape the design, and its contents, following any immediate queries, experiences and observations contributed by volunteers, as and if necessary. This allowed for improvements to be made in an iterative way, section by section, rather than waiting until the module was completed, providing a powerful tool in honing and refining with near immediate effect.

### 3.5 Summary of chapter three

As demonstrated through the pilot, eLearning has numerous advantages. Internet access and basic IT skills were a requirement, yet the convenience and flexibility, especially where learning sessions could be self-paced, twenty-four hours a day without the physical constraints of attending in one place at a specified time, were of clear benefit to all involved. Certainly the application of the instructional model, used in designing the programme, met with some success and it was hoped that its effectiveness, as defined by the achievement of the learning outcomes, would be demonstrated in the subsequent trial, which will be explored in the next chapter.
Chapter 4 - Trial Implementation and Results

In accordance with the instructional design process, this chapter will explore the implementation of the module to the wider audience of trial volunteers and subsequent results.

It is worth commenting that the rich seam of data produced, was overwhelming and presented one of the greatest challenges in the research process so far, giving rise to careful consideration of how to best to present the results generated.

After many versions, the final product is an assimilation and synthesis of the various results, using quantitative data from the management systems within Victory (Powersight kit); WebAiMS teaching administration records and Questionmark™ Perception™ (QMP) as well as qualitative data obtained through the pre and post module surveys.

These are represented under the key themes, as identified within Kirkpatrick’s model (KM) establishing the implementation and participation with the module, volunteer profile and expectations, volunteer experiences (including usage patterns) (KM level 1), perceived and actual performance based on the statistical analysis of the summative assessments (KM level 2), culminating in reflections and professional perspectives on how the module may have influenced behaviour (KM level 3).

4.1 Implementation of trial module

4.1.1 Recruitment of volunteers

From the outset, the module was directed at practising, non-medical healthcare professionals working within the field of nuclear medicine. Ethical approval was gained from the School of Health Sciences and Social Work, University of Portsmouth, in accordance with the Isle of Wight, Portsmouth ad South East Hampshire Research Ethics Committee (Appendix III.b. and III.c.).
Regarding professional support for the trial, initially approaches were made to the Chair of the British Nuclear Medicine Society Technologists group. This enabled permission, sought from the Secretary of the British Nuclear Medicine Society, to place a web advertisement in professional area of the BNMS website, which was displayed for a period of six weeks between April and May 2011.

In addition, with support of the professional group, a presentation was given at the Spring Conference of the British Nuclear Medicine Society, 2011, outlining the aims and objectives of the trial, and flyers were distributed inviting non-medical practitioners to take part (Appendix X).

It was anticipated this would provide a cohort of volunteers from a range of non-medical professions (such as radiographers (diagnostic/therapeutic) and medical technical officers with possible background education in physics, anatomy etc). Ideally, they would be from a wide geographical area, therefore able to demonstrate the flexibility of solely e-based module, without relying on teaching from within the clinical departments. In respect of the latter point, it was important that trial volunteers were recruited independently, so interested individuals were asked to contact the programme facilitator for further details and selection.

It was thought that this approach would yield useful information as to the appropriateness and effectiveness of the module for specific disciplines and the reveal the possible impact of prior learning, or professional level. Age was not considered a barrier to participation, but volunteers were expected to have a minimum of one year’s experience working in, or allied to a nuclear medicine department.

On contacting the programme facilitator, further information about the module was released to volunteers via email, including details such as the aims and objectives of the trial expected time commitment, duration of the module. (Appendix XI).

Forty-seven people contacted the programme facilitator expressing an interest in the trial, with thirty-three volunteers finally recruited to the programme (numbers were restricted due to the availability of funding, given the offer of high street
vouchers for those who completed all the summative assessments).

Selection of volunteers was primarily based on location (to assess the flexibility of eLearning in a multi-centred approach) and professional experience. Two potential volunteers were rejected based on length of experience, in one instance, the name of a third year radiography student was put forward, but in line with the BNMS guidelines (2005), only qualified practitioners, with more than a year’s experience in nuclear medicine, were accepted to the module. In addition, as a number of potential enquiries came for individuals working at the same hospital trust sites, it was decided to limit participating volunteers to two per site, to prevent collaboration and possible bias on individual performance.

4.1.2 Trial module release

The module was released on June 13th 2011, whereupon volunteers were given three months to complete. Due to early technical difficulties experienced and the announcement of vital maintenance work in late August/early September, which was likely to disrupt access to the Victory platform, the deadline was extended to September 30th 2011.

All accepted volunteers were notified by email beforehand with details of their unique usernames and passwords, including an updated Microsoft Word document (following the pilot study) giving detailed instructions with the use of screenshots, to show, step by step, how to log on to Victory and access to the module (Appendix XII). This, as detailed previously, was achieved through a standard web browser, although it was recommended that Internet Explorer (Version 8) or Firefox, should be used. Examples of screenshots used in the instruction document, are shown in Figure 4.1.
4.2 Module participation

4.2.1 Access patterns to trial module

Using quantitative data obtained from the Powersight kit embedded within the eLearning platform (Victory) access patterns to the module were established.

Of the thirty-three recruited, one failed to confirm their ultimate intention to participate and another volunteer asked to withdraw prior to the start date, therefore the module was released to thirty-one volunteers.

Unfortunately, these figures did not remain static, with some volunteers either withdrawing from the programme, or not progressing through. By the closure date, sixteen (n = 16) volunteers had finished the module, including the required summative assessments, giving a completion rate of 48.5%. A summary of engagement with the module is shown in Figure 4.2.
With regards to online activity over the trial period, this was anticipated to be variable owing to the flexible nature of delivery and onus on volunteers to be self-regulated and motivated in managing the workload. Figure 4.3 shows the peaks and troughs as volunteers engaged with the module.
Despite a slow start, activity picked up in week 3 – 4, although there is a significant reduction in week 5. This corresponds with completion of module section 0 and the release of module section 1, during which time a number of volunteers discontinued with the module. Another significant trough in weeks 11 – 13, related to August when most people are likely to take a holiday. It also coincided with the period in which the eLearning platform was unavailable due to maintenance work. Apart from this, and the reduction in volunteer numbers, activity levels remained relatively constant throughout.

It had been anticipated that each volunteer would spend approximately twenty to thirty hours across the whole module. Table 4.1 shows the total time spent by all accepted volunteers over the trial period. It was interesting to note that amongst the early withdrawals and non-completers, many gave the programme less than 1 hour before deciding not to proceed. However, the data only records the time spent ‘logged on’ to the module, but does not reveal how active volunteers may have been during this time.
Table 4.1 Time spent by volunteers engaged with module

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>Time Spent in hours/minutes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Por505</td>
<td>40 mins</td>
<td>Accessed Section 0 but no further activity</td>
</tr>
<tr>
<td>Por506</td>
<td>16 h 11 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por507</td>
<td>29 h 43 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por508</td>
<td>1 h</td>
<td>Part completed Section 0 then withdrew</td>
</tr>
<tr>
<td>Por509</td>
<td>35 h 10 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por510</td>
<td>17 h 50 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por511</td>
<td>16 h 19 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por512</td>
<td>12 h 18 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por513</td>
<td>13 mins</td>
<td>Accessed Section 0 but no further activity</td>
</tr>
<tr>
<td>Por514</td>
<td>0</td>
<td>Never accessed module</td>
</tr>
<tr>
<td>Por515</td>
<td>18 mins</td>
<td>Accessed Section 0 but no further activity</td>
</tr>
<tr>
<td>Por516</td>
<td>0</td>
<td>Never accessed module</td>
</tr>
<tr>
<td>Por517</td>
<td>9 h 12 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por518</td>
<td>4 h 26 mins</td>
<td>Completed Sections 0 +1 only</td>
</tr>
<tr>
<td>Por519</td>
<td>20 h 54 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por520</td>
<td>21 h 10 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por521</td>
<td>30 h 10 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por522</td>
<td>27 mins</td>
<td>Accessed Section 0 but no further activity</td>
</tr>
<tr>
<td>Por523</td>
<td>0</td>
<td>Never accessed module</td>
</tr>
<tr>
<td>Por524</td>
<td>1 h 27 mins</td>
<td>Completed Sections 0 only</td>
</tr>
<tr>
<td>Por525</td>
<td>8 h 50 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por526</td>
<td>15 h 19 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por527</td>
<td>0</td>
<td>Did not confirm so module not released</td>
</tr>
<tr>
<td>Por528</td>
<td>0</td>
<td>Withdrew prior to start of module</td>
</tr>
<tr>
<td>Por529</td>
<td>1 h 9 mins</td>
<td>Partial completion of Section 0 then withdrew</td>
</tr>
<tr>
<td>Por530</td>
<td>6 h 5 mins</td>
<td>Completed Sections 0 +1 only</td>
</tr>
<tr>
<td>Por531</td>
<td>2 h 5 mins</td>
<td>Completed Section 0 only</td>
</tr>
<tr>
<td>Por532</td>
<td>5 mins</td>
<td>Accessed Section 0 - then withdrew</td>
</tr>
<tr>
<td>Por533</td>
<td>30 h 6 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por534</td>
<td>1 h 43 mins</td>
<td>Completed Section 0 only</td>
</tr>
<tr>
<td>Por535</td>
<td>21 h 4 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por536</td>
<td>29 h 2 mins</td>
<td>Completed whole module</td>
</tr>
<tr>
<td>Por537</td>
<td>13 h 45 mins</td>
<td>Completed whole module</td>
</tr>
</tbody>
</table>

Once the consent/disclaimer form (examples of these may be found in Appendix XIII) and the baseline tests were completed, subsequent module sections were
selectively released based on individual progress through each of the assessments. Through the series of ‘gateway’ assessments, levels of knowledge level and ability were ascertained at the end of each module section (Upton, 2004) prior to the release and progression to subsequent sections. The module was finally ‘closed’ on September 30th 2011, with sixteen volunteers having completed all five module sections.

4.2.2 Volunteer profile of trial module

Establishing the demographic profile and expectations of volunteers was considered important in identifying the appeal of the module to a defined population and their likely expectations of the programme. This information was obtained using data from the pre-module survey (module section 0).

Twenty-five volunteers undertook and completed the pre-module survey, which obtained a demographic and professional profile of the volunteer cohort and also their attitudes towards computers and eLearning, which may have had a bearing on usability or completion of the course.

The gender profile of male to female volunteers revealed, nine males and sixteen females reflecting the dominance in healthcare related fields by this gender.

![Figure 4.4 Volunteer age range](image)

Although the module sparked interest from a wide age range of volunteers, the majority were found to be 26 – 40 years (Figure 4.4) which perhaps reflects those
at a certain career stage where they wished to promote their level of professional expertise further.

Further to the initial enquiries, the selection of volunteers from across England (Figure 4.5) demonstrated the appeal and flexibility of eLearning in being able to target a wide geographical audience. It was interesting to note that there were no volunteers from Scotland, Northern Ireland or Wales, which may have reflected the delegate profile from the BNMS conference where the majority of interest in the
project seemed to be generated, and in spite of the advertisement on the official BNMS website.

Figure 4.6 shows a considerable number of volunteers held higher educational and professional qualifications, in addition to their basic professional qualifications, showing their intent to further their academic credentials, as well as professional selves.

This profile reflects the multi-disciplinary and diverse nature of nuclear medicine practice. Yet, it was surprising that there were relatively few numbers from traditional radiography backgrounds, with only three holding the Diploma of the College of Radiographers and three with a BSc in Diagnostic Radiography. (There were no volunteers from a therapeutic radiography route). Twelve volunteers came from physics backgrounds (six with BSc, or Higher National Certificates (HNC) in physics and physiological measurement, five had Masters degrees in Medical Physics), whilst two further volunteers came from Clinical Physiology and one volunteer held a qualification in Advanced Practice in Nuclear Medicine.

All volunteers were currently employed working with nuclear medicine providers. Level of experience as anticipated by the number of years spent in nuclear medicine practice ranged from thirteen months to over twenty-one years of experience (Figure 4.7).
It was noted that the majority of volunteers had less than five years experience (36%), perhaps belying their intention to commit to the advancement of their own professional skills. The remainder were reasonably distributed, with the exception of those in the 16 - 20 year category.

4.2.3 Volunteer attitudes to computers
As the research focussed around eLearning, it was important to establish a baseline of volunteers’ perceptions regarding their ability and confidence in the use of computers. This was to see if there was any correlation between this and successful usage of the module software.

Ninety-six per cent (96%) of the volunteers had computers at home, with 77% suggesting they used them regularly. Eighty-eight and a half per cent (88.5%) agreed that they regularly ‘surfed’ the internet and fifty-seven point seven (57.7%) declaring involvement in social networking sites. Fifty-four per cent (54%) (fourteen volunteers) had used online educational packages before – however no detail was given as to whether these were through local hospital intranet sites for staff training, or wider accredited courses. It was also not elicited as to whether these were solely e-based packages or part of a blended learning programme.
Table 4.2 shows a spectrum of perceived confidence and competence levels amongst volunteer attitudes. Looking at the age profile it was not surprising that half the cohort could be regarded as ‘digital natives’ and therefore comfortable and at ease with using computers.

### 4.2.4 Volunteer expectations

There were many reasons and motivators for undertaking module, as shown in Figure 4.8. Although volunteers were allowed to give more than one answer, the most common reason was the desire to acquire knowledge.

Additional qualitative comments were offered in response to anything else which volunteers wish to gain by undertaking the module:

- “Feasibility of online learning”

- “More experience at looking at other reasons for referral for bone scans from specialities that may not be available at my hospital”

- “This course sounds like an excellent way to fulfil CPD requirements”

- “We are not allowed to report bone scans, but this will be a great help in explaining scans to junior doctors and radiography students”

- “I have recently started to issue reports, however they are always checked and verified by a second person before being made available to the referrer.”
In summary, the volunteer profile reflected an anticipated cohort of mainly female, mid-career individuals seeking further knowledge, rather than new skills, and to improve their understanding and confidence. What was slightly surprising was the high proportion presenting from physics backgrounds and also the potential professional registration and continuing professional development influences.

4.3 Volunteer experience (KM level 1)

Information and comments regarding volunteer experience of their Victory experience was elicited mainly from quantitative and qualitative responses from the post-module survey and information from the management systems. This was used to evaluate the reaction to the module as a learning resource (Level 1 of Kirkpatrick’s model). Further evaluation of the module as a whole is considered later).

Only those completing the module had access to the post-module survey, so additional, informal feedback derived from email communications, has been used to illustrate some areas.
For ease of representation, the data and responses have been arranged into categories:

1. Experiences of the eLearning platform: technical features;
2. Evaluation of the module design;
3. Evaluation of the module content.

### 4.3.1 Comments and evaluation of eLearning platform (Victory)

Feedback was used to establish the reaction by volunteers to the accessibility and technical features of the programme and thereby aspects of ‘usability’ associated with the system.

The results indicate that the majority of volunteers found the module relatively easy to access, responsive and flexible to their needs. A selection of comments as written by the volunteers, are shown below.

> “The ability to access the module at a time and a pace to suit myself.” (por507)

> “I loved the way I could access and work from home (I never attempted to do so from work).” (por510)

> “ability to work at own pace and revisit content for reinforcement. …. I would like to think that this would be an affordable resource as well that could be completed flexibly as some people are not released from work to participate in such opportunities” (por525)

> the ease of access, anytime and virtually anywhere made it very convenient to use. This flexibility is very useful and could potentially enable many more students to participate. (por533)

> “I am a complete computer hater but did find this very easy to use and did not have to ask my computer geek husband to help other than initial setting up.” (por535)

Figure 4.9 shows the quantitative data generated in response to questions evaluating the eLearning platform (Victory) showing a high level of agreement regarding the connectivity, convenience, ease of use and interactivity.
Some volunteers did appear to be using the trial as a continuing professional development opportunity in their workplace. Although this had been anticipated (as per the pilot study) and forewarned against, nevertheless these volunteers struggled in accessing some of the software, as borne out in their comments.

“The main point was that it was too difficult to connect to the module - Had trouble getting flash player installed, had trouble connecting to web cache.” (por509)

“Being able to access at work. its much easier to stay on an extra hour or so than find an hour or so at home” (por512)

“...unfortunately due to difficulties with firewalls at work I struggled to use the software. I also had problems at home with my internet (NOT related though with victory I hasten to add!). So, when I eventually got it all working at home, I did have to complete the modules very quickly which I am disappointed about.” (por519)

“I don't think there's an issue with my computer skills but the various web elements of this were clunky and annoying to access and use and detracted from the experience.” (por520)

“I didn't like not being able to access it at work (too many fire walls etc)” (por536)

“All the logins!” (por537)
In two instances, the access difficulties did appear to cause volunteers to withdraw from the programme, as shown in the two email communications detailed below.

“I am going to have to withdraw from the online NM module, unfortunately I can’t access any of the e learning from my work computer as our trust seems to block the site as it is not secure and I can’t set up a proxy server either. Unfortunately this was the location I had planned to do most of the work from – sorry this is a shame as I have completed some online MSc modules with Newcastle University previously and not encountered any problems...” (por529. personal communication, June 26, 2011)

“Unfortunately I have not been able to start the webaims cases. We have just started a research project here at [xxx] and I don’t feel I am able to give as much effort to both as I would like to. Therefore I am unable to continue in your reporting study” (por508. personal communication, July 11, 2011)

Inevitably, the withdrawal by some volunteers was unfortunate and a reflection of how the vagaries and limitations of software interface can be ‘off putting’. It is also interesting that NHS sites blocked external access, although at least one of the volunteers had clearly had direct experience from other online educational providers, possibly through the Pathways to Open Resource Sharing through the Convergence of Healthcare Education (PORSCHE), or the Accredited Clinical Teaching Online Resources (ACTOR) programmes, which had not resulted in the same access issues from a work environment. Compatibility and software issues will be explored further in subsequent chapters, sections 5.1, 5.2, 6.2.

4.3.2 Volunteer evaluation of module design
This focussed on usability issues experienced by volunteers and their interaction and rating of the module design. This demonstrated that the structure and design was organised, well arranged and interactive (shown in Figure 4.10). Clearly the design layout and use of colour coded sections made navigation easier and the selective release of subsequent sections through the use of gateway assessments had made the module more manageable, with qualitative comments supporting this perception.

“The interactive element was very useful.” (por506)

“The lay out was easy to follow.” (por510)
Similarly the range of resources was clearly appreciated and the sequencing of information had allowed for the content to be delivered at the right pace, which appeared to suggest that careful consideration of the design features had contributed to the usability of the module.

![Volunteer rating of module design](image)

**Figure 4.10 Volunteer rating of module design**

**4.3.3 Volunteer evaluation of module content**

It is useful, at this point, to consider the individual elements within the module content. This was an important element of feedback with regards to gauging the receptiveness of volunteers to the level and standard of the content, much of which had been specifically created for the module. Again using quantitative data obtained from the Powersights kit, individual elements could be reviewed to ascertain the number of times each one had been accessed. Superficially, the
notion that the module and its content were well received is supported, as shown in Table 4.3.

Table 4.3 Use of presentation and teaching elements

<table>
<thead>
<tr>
<th>Module Section</th>
<th>Times accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 0</strong></td>
<td></td>
</tr>
<tr>
<td>Welcome</td>
<td>53</td>
</tr>
<tr>
<td>Module Overview</td>
<td>84</td>
</tr>
<tr>
<td>Instruction for QMP (Audio presentation)</td>
<td>77</td>
</tr>
<tr>
<td>Instructions for WebAiMS (Audio presentation)</td>
<td>56</td>
</tr>
<tr>
<td><strong>Section 1</strong></td>
<td></td>
</tr>
<tr>
<td>Learning cycle (CETL presentation)</td>
<td>29</td>
</tr>
<tr>
<td>Learning styles (CETL presentation)</td>
<td>21</td>
</tr>
<tr>
<td>Approaches to effective learning (CETL presentation)</td>
<td>22</td>
</tr>
<tr>
<td>About bone scans (Audio presentation)</td>
<td>55</td>
</tr>
<tr>
<td><strong>Section 2</strong></td>
<td></td>
</tr>
<tr>
<td>Breast anatomy, physiology and pathology (Audio presentation)</td>
<td>22</td>
</tr>
<tr>
<td>Prostate anatomy, physiology and pathology (Audio presentation)</td>
<td>51</td>
</tr>
<tr>
<td>Significance of Metastases (Video clip)</td>
<td>31</td>
</tr>
<tr>
<td>Bone metastases management</td>
<td>31</td>
</tr>
<tr>
<td>Normal bone scan appearances (Audio presentation)</td>
<td>23</td>
</tr>
<tr>
<td>Interpreting bone scans for abnormality (Audio presentation)</td>
<td>33</td>
</tr>
<tr>
<td>Sensitivity vs specificity of Diagnostic tests (Audio CETL presentation)</td>
<td>23</td>
</tr>
<tr>
<td>Standardised reporting grid</td>
<td>32</td>
</tr>
<tr>
<td>Hyperlinked presentation to identify normal vs abnormal images (Formative interactive presentation)</td>
<td>46</td>
</tr>
<tr>
<td><strong>Section 3</strong></td>
<td></td>
</tr>
<tr>
<td>Arthritis (Audio presentation)</td>
<td>23</td>
</tr>
<tr>
<td>Primary bone tumours (Audio presentation)</td>
<td>34</td>
</tr>
<tr>
<td>Paget’s Disease (Audio presentation)</td>
<td>30</td>
</tr>
<tr>
<td>Report writing</td>
<td>25</td>
</tr>
<tr>
<td>Hot spot analysis (Formative interactive presentation)</td>
<td>32</td>
</tr>
<tr>
<td>Positive and negative predictive values with Diagnostic tests (Audio CETL presentation)</td>
<td>27</td>
</tr>
</tbody>
</table>

It seems apparent that certain elements were visited on numerous occasions, not only demonstrating a level of acceptance, but also demonstrating the flexibility re-
usability and repeatability of this style of delivery. In particular, learning and teaching presentations were well utilised, with interactive elements clearly the most popular. One must note that the apparent reduction in access over the course of the module was clearly related to the dwindling volunteer numbers.

Figure 4.11 Volunteer engagement with module content

This is supported by data from the post-module survey demonstrating that
volunteers liked the range and extent of the content and topics covered. Figure 4.11 shows volunteers found the module content interesting and engaging, easy to follow and gained in knowledge. Less popular were the additional web-based resources which, including self-assessment quizzes and additional reading resources, had been linked to the site (Table 4.4).

Table 4.4 Use of additional web-based resources

<table>
<thead>
<tr>
<th>Module Section</th>
<th>Times accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td></td>
</tr>
<tr>
<td>McGraw &amp; Hill Bone anatomy quiz</td>
<td>16</td>
</tr>
<tr>
<td>Section 2</td>
<td></td>
</tr>
<tr>
<td>Breast cancer quiz</td>
<td>11</td>
</tr>
<tr>
<td>RCN Guide to Breast cancer and bone health</td>
<td>8</td>
</tr>
<tr>
<td>RCN Guide to Prostate Neoplasm</td>
<td>6</td>
</tr>
<tr>
<td>Section 3</td>
<td></td>
</tr>
<tr>
<td>ICRP_84_Pregnancy Guidelines for the use of radionuclides</td>
<td>19</td>
</tr>
</tbody>
</table>

Volunteers also engaged with various assessment elements presented throughout the module. Supporting the findings in terms of what was liked ‘best’ about the delivery, interactivity and presentation of content, clearly a number of design considerations proved their worth. As always, the qualitative comments, written by the volunteers were revealing.

“The interactive element was very useful, in particular was the addition of audio to the teaching presentations.” (por506)

“…… the variety of presentations, quizzes and assessments kept the module interesting and valuable.” (por510)

“There was a good range of images.” (por517)

“I liked multiple choice tests. I liked the structure of the report writing form, rather than having to fill in something blank. I liked seeing clearly what tasks were in each module.” (por520)

“the chance to assess my own knowledge and improve on it!” (por526)

“I appreciate the new knowledge & experience gained” (por536)

“Some of the background information i.e. bone pathology and bone scans were very interesting and useful” (por537)
Table 4.5 shows the data from the Powersights kit within the VLE management system detailing the number of times the various assessments were accessed.

Table 4.5  Access to formal assessments

<table>
<thead>
<tr>
<th>Module Section</th>
<th>Times accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 0</td>
<td></td>
</tr>
<tr>
<td>WebAiMS baseline test *</td>
<td>22</td>
</tr>
<tr>
<td>Initial Report Writing assessment (QMP)</td>
<td>23</td>
</tr>
<tr>
<td>Section 1</td>
<td></td>
</tr>
<tr>
<td>Principles of bone scans. Short answer assessment (QMP)</td>
<td>37</td>
</tr>
<tr>
<td>Section 2</td>
<td></td>
</tr>
<tr>
<td>Breast and Prostate MCQ (QMP)</td>
<td>23</td>
</tr>
<tr>
<td>WebAiMS Metastatic case collection*</td>
<td>11</td>
</tr>
<tr>
<td>Section 3</td>
<td></td>
</tr>
<tr>
<td>Bone Issues MCQ (QMP)</td>
<td>41</td>
</tr>
<tr>
<td>Interim Report Writing assessment (QMP)</td>
<td>66</td>
</tr>
<tr>
<td>WebAiMS Rheumatology case collection*</td>
<td>11</td>
</tr>
<tr>
<td>WebAiMS General and orthopaedic case collection*</td>
<td>16</td>
</tr>
<tr>
<td>Section 4</td>
<td></td>
</tr>
<tr>
<td>Bone Scan MCQ (QMP)</td>
<td>16</td>
</tr>
<tr>
<td>Final Report Writing assessment (QMP)</td>
<td>16</td>
</tr>
<tr>
<td>WebAiMS Final case collection*</td>
<td>0</td>
</tr>
</tbody>
</table>

It is prudent to note, the number of access times is not necessarily a true reflection of a full attempt, or even completion of an assessment. In fact, the number of attempts may have increased due to system errors and software limitations encountered resulting in problems with connectivity and the user interface. These are explored next.

Early experiences with the pilot study had highlighted access issues with WebAiMS from the various trust site computers, due to hospital site permission issues and firewalls. As a result, explicit instructions were included in the initial set up pages, but in spite of this, problems were encountered shortly after the module went 'live' by those trying to access the module from work computers.
Further comments were generated relating to interactive nature of the WebAiMS display, and the use of DICOM images within the associated assessments, which were not fully appreciated. This is illustrated by the comments below.

“The WebAims software couldn’t be accessed at work. The images on WebAims were not, in my opinion, the easiest to interpret. The use of brightness/contrast would have been replaced by a windowing/level option as on a PACS system. Also, the sole use of greyscale was slightly distracting, a choice of colourmaps would have been better.” (por506)

“WebAIMS I found the image quality (and the limited ways in which the operator could adjust the image quality) limited my visualisation of the images, and therefore was detrimental to my confidence in writing the report. Conversely, the image quality in the QuestionMark Perception formal assessments was much better.” (por510)

“....images could not be manipulated” (por533)

Originally, when designing the module, WebAiMS had been used to create various interactive case collections. However, an issue with the WebAiMS image display emerged, where cases could only initially be viewed in a JPEG format, which detracted from the quality and interactivity of this piece of software.

Although this was eventually overcome with repeat instructions and assistance from the company Aimsability.com resolving the image display issue, a decision was taken to reassign all the WebAiMS assessments, across the module, to a formative rather than summative status. In spite of this, the WebAiMS components appeared to remain unpopular and not particularly user friendly. It is possible that the low level of usage was due to a reluctance to set up a proxy web cache, but there was a suggestion that only those who were more computer literate were able to circumvent the problem, as demonstrated by one volunteer:

“I have tried the link from a non-domain machine in the department and it has allowed me to set up the web-proxy – all seems to be OK”

(por537. personal communication, July 4, 2011)

In addition to WebAiMS, access issues were also encountered with the QMP assessments. It became evident that the restriction of two log in attempts per assessment was insufficient. (It is thought that volunteers may have been reviewing questions first before attempting to answer them). Following a number of
emails where access had been denied or there was only partial completion of the whole assessment, this restriction was lifted. This was extended to all QMP assessments to avoid undue delay, or a potential barrier to completion. One volunteer did email stating technical difficulties with accessing the QMP assessment. Although this was reset on three occasions and access gained, the volunteer then did not participate, or submit any further information).

Apart from access issues identified, clearly a number of volunteers found the level of content to be more extensive than required.

“I found some of the presentations to be more complex than is needed for non medical reporting in the early stages.”  (por507)

“Some of the anatomy covered was too detailed & not relevant to interpreting bone scans in my opinion”  (por517)

“It was more clinic based than I expected - I expected a lot more explanation about bone scanning and discussion of bone scans.”  (por519)

“Content of slideshow style presentations was too detailed without covering the basics clearly and fully enough...... I didn’t think any of the RLOs were particularly informative.”  (por520)

“I found the breast and prostate presentations very long”  (por521)

“....images could not be manipulated images not labelled and often of poor quality poorly positioned, frequent tissue injections)”  (por533)

Clearly it was felt by a couple of volunteers that there were some omissions in content, as shown by the qualitative comments overleaf.

“I found the technical and clinical information about the images a little sparse, clinically I would expect much more information, specifically with access to other modality results and any technical issues in the acquisition”.  (por506)

“..... lack of access to supporting imaging occasional test questions on material not covered in lectures/learning material no SPECT+CT”  (por533)

This is a very valid observation and relates to volunteers only having access to the nuclear medicine images, which is not reminiscent of the normal clinical setting where access to patient files, previous nuclear medicine scans, and or other
diagnostic test, would usually be readily available.

In addition, there were a number of concerns pertaining to technical issues associated with the delivery of the content.

“Poor quality of audio and visual, ie audio was pages ahead of slides”. (por512)

“I was unable to take notes as once the power point began there was no way of pausing it...... I had to sit through the whole power point again, I couldn't just pin point certain parts of it.” (por536)

“Slideshow speaking pace was too slow and made some of the content seem dull even when it wasn't. Skipping back to review slides required listening to that section again as slides did not contain a useful summary of the spoken facts, often just bullet point titles.” (por520)

“...... I would have particularly liked to have been able to download the teaching material and get a written transcript of the various lectures as trying to listen to a lecture and remember what was said to be able to answer a question was very hard” (por537)

It also became evident that some of the instructions and also the interactive tools needed to be refined

“the hot spot exercise was way too sensitive ... placing of hotspots had to be exact to gain marks even if the spot covered the abnormality in question” (por525)

4.3.4 Suggestions for improvement

Comments were invited to suggest possible improvements to the content, resulting in a constructive list. These focussed on report writing concepts and feedback. Extracts are shown below.

“The images for interpretation should be sent separately to the users, so they can be viewed in a clinical environment, using software where report would take place, for example as DICOM images so that the appearance could be optimised for the students traditional environment. Maybe the addition of worksheets etc. to help consolidate the information delivered in slides. Even other research tasks, to help understand”. (por506)

“It would be more appropriate to concentrate more on the format of reports and interpretation of findings in the assessments rather than just listing the uptake seen on the scans. There was not any actual report writing within the module.” (por507)
“I think more images demonstrating certain pathologies and appearances, within the powerpoint style presentations would have been useful.”

“Inclusion of more pattern recognition exercises, not necessarily related to bone scans directly”

“More discussion about bone scanning, and less clinic based information.”

“Cover the basic appearances of different pathologies more fully with more example images. Match difficulty of presentations to difficulty of subsequent questions and cover all tested material clearly in presentations.”

“more regular and in-depth personalised feedback better image manipulation capabilities (windowing etc) far better clinical information/history with the images transcripts/notes for the lectures not sure if our reports were compared to an 'ideal' report using the same criteria as us, or whether to a NM Consultant's medical report? SPECT/CT a widespread and established technique but not covered”

“I found it difficult to write reports not knowing what criteria the marker was using although recommendations exist for report writing each clinician and institution have varying styles and standards i do accept that this would be an extremely difficult thing to account for”

“Give more instant feedback on progression. Produce a set of aims and objectives and how you will achieve these outcomes. See the Open University distance learning software!”

4.3.5 Summary of volunteer experience

Whilst the quantitative results revealed a generally high level of acceptance of the delivery, design and content of the module, there were inherent difficulties, in particular with some aspects of the software used. Whilst a number of these could be addressed during the trial period, clearly they detracted from the volunteer experience.

Likewise, the content of some of the presentations needed to be re-focussed, with clear constructive criticism raised in relation to be more transparent with the parameters and criteria required for the report writing and use of feedback. These points will be further explored in the next chapter.
4.4 Learning and verification of diagnostic performance, accuracy and progression (KM level 2)

One of the main thrusts of the research was to establish whether the module could influence and effect learning and competence in the area of reporting nuclear medicine bone scans. The following section explores and elucidates the quantitative results generated by the volunteers as they progressed through the various summative assessments. This was in line with level 2 of Kirkpatrick’s model, pertaining to performance and progression.

Initially the cohort performance will be demonstrated across all assessments, then the results from the individual multiple choice and short answer assessments, followed by the combined results from the three report writing assessments. Thereafter the influence of professional background for overall module performance and report writing skills will be considered.

Note. Unless stated otherwise, only those volunteers who completed the module are included.

4.4.1 Cohort progression

Figure 4.12 shows the performance of the cohort in terms of their average marks across the various module assessments (summative only), where the minimum mark awarded was 44% and the maximum 73%, the average mark was 60%, with a standard deviation of 9.

It is interesting to note that a number of volunteer percentages seemed to fall below of the average score, which may be explained by some volunteers not completing some of the multiple choice assessments. It may also be related to time spent engaged with the module, so Figure 4.13 reflects the module performance in respect of the average time spent.
Lastly, it was felt prudent to consider the number of years of experience tabulated against the average module scores, the results from this are shown in Figure 4.14.
It is apparent from this figure that there is no overt relationship between achievement in the module, and years of experience.

4.4.2 Performance in short answer and multiple choice assessments
These were positioned at the end of each module section and formed part of the ‘gateway’ assessments which required completion before the next section was released. In addition to quantitative results obtained through QMP Result Manager facility, qualitative feedback, derived from the post-module survey has been included where appropriate.

Results from the short answer bone assessment (module section 1.2) were marked and collated. The results were as expected. Of the eighteen volunteers who attempted the assessment, seventeen submitted answers. One volunteer failed to submit due to technical issues, despite three attempts, so their results were excluded. The majority scored exceedingly well, demonstrating their professional knowledge base. Percentage scores are shown in Figure 4.15 of all those attempting and completing this assessment.
As expected, volunteers achieved high scores on this element. Given the healthy recruitment of physicists, providing definitions of technical aspects of nuclear medicine equipment proved easy, yet all volunteers performed well, as borne out by the high average score of 81%.

In terms of the summative elements, the scores from the QMP multiple choice breast and prostate quiz (module section 2.3) are shown in Figure 4.16.

Some volunteers clearly struggled with this assessment, perhaps due to the depth of knowledge required (which was raised in the post module survey qualitative
comments). It is interesting to note that those who repeated the assessment did improve their scores, suggesting evidence of learning and knowledge gain.

Results of bone issues multiple choice assessment (module section 3.3) are shown in Figure 4.17. Again, some volunteers clearly experienced difficulties with this assessment showing a wide range of marks. From the management system, it was interesting to note that four volunteers repeated the assessment, whilst three clearly reviewed the assessment before attempting it.

This test looked at more subtle and less common bone pathologies as seen in nuclear medicine image (for example, arthritides, primary bone tumours) which could account for the reviewing of content prior to attempt by some volunteers. It may also account for the lower scores, although the average marks remained similar to the previous assessment

![Figure 4.17 Percentage scores bone issues MCQ](image)

Results of bone scans multiple choice assessment (module section 4.1), this assessment was in the final section of the module, using the same straightforward multiple choice format. Looking for general knowledge about bone scans, it was anticipated that volunteers would score well and results from these are shown in Figure 4.18.
Figure 4.18 Percentage scores from bone scans MCQ

It was interesting to note that there were only three, second attempts by volunteers to improve scores and no individuals reviewing the assessment first. Either this was because they were more confident in their ability, or with the system. Alternatively, it could be that interest was beginning to wane as the module deadline approached.

Qualitative comments were raised relating to these assessments. Although not widespread, it was worth considering, especially where they related to the structure, complexity of the assessments and availability of feedback:

".... The questions asked … were too complex, ….. When there were multiple answers it was not always clear." (por520)

Most comments, however, concentrated on the omission of feedback.

"....Correct answers to tests were not always given so it was not possible to learn from these. ……." (por520)

“lack of personalised feedback” (por533)

"Being given feedback/answers to the quizzes" (por536)

“…..Really should be some feed-back showing how well you have performed in the assessments, just saying that you have got 8 out of 20 correct you have 24 hours to try again does not tell you where you have gone wrong! The structure of the wrong answers to a MCQ should be used to identify areas of missing knowledge or mis-understanding and be used to give hints or suggestions where to re-read the module” (por537).
Although scores were readily available, lack of feedback indicating where volunteers had made incorrect answers, did detract. Feedback, allowing adequate time for reflection, discussion and mentoring with peers/experts to integrate/contextualise knowledge from various sources, is fundamental in the development of knowledge and expertise (Carter & Manning, 1999, p.76; Schmidt & Rikers, 2007, p.1138). A simple feedback facility, particularly in the self-assessment multiple choice tests, would have been easy to establish thereby enabling further learning and certainly increasing satisfaction. The oversight to incorporate this, by its omission, was a significant design limitation.

4.4.3 Performance in report writing

Report writing was assessed initially, with the placement of two assessments in module section 0 and module section 4, with ten and then twenty cases a piece, with all volunteers, presented with the same case series, limiting exposure to the trial period only, so as to avoid the possibility of a ‘learning effect’ (Brealey & Scally, 2008, p.47) which may have biased the results.

The addition, the interim report writing assessment, with an additional twenty cases, was introduced part way (module section 3) following the problems with WebAiMS, to offset the perceived shortfall in the number of cases available. It was felt this assessment would not only help show the growth in report writing skills between the initial baseline test and the final assessment, but also give greater exposure and experience of report writing and use of the reporting grid. This in turn, might therefore reduce any bias which may have resulted from early usability issues.

Scoring for these assessments and thereby assessment of performance, was based on three key criteria to reflect the evaluative hierarchy (Brealey & Scally, 2008, p.48 (Appendix II.b.)) and levels of competence (BNMS guidelines, 2005, p.1 (Appendix II.a.)):

- written content of the individual reports - to assess the volunteers ability to translate their visual perceptions onto the written word, including the location, distribution and shape of uptake seen;
• ‘opinion of findings’ - to assess the perceptive ability of volunteers to identify patterns of image appearances, whether they be normal, abnormal, normal variants or incidental findings;
• ‘clinical significance’ decisions - where volunteers had the opportunity to contextualise their knowledge in the light of the referral, giving an indication as to the diagnostic and therapeutic outcome.

In total, seven hundred and eighty reports were generated by the sixteen volunteers, which was less than half the original expected number. As results were limited, findings are shown mainly by means of descriptive results, with statistical analysis used where appropriate. (Individual results for each report writing assessment can be found in Appendix XIV).

The collective scores based on the descriptive content of the reports (compared to the reference reports) show a reduction in average scores across the three report writing assessments (Table 4.6).

<table>
<thead>
<tr>
<th>Volunteer No.</th>
<th>% Score for report content of Initial Test</th>
<th>% Score for report content of Interim Test</th>
<th>% Score for report content of Final Test</th>
<th>Improved 1st/3rd +/- 1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>por506</td>
<td>58</td>
<td>60</td>
<td>60.1</td>
<td>Y</td>
</tr>
<tr>
<td>por507</td>
<td>85</td>
<td>72.9</td>
<td>64.3</td>
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<td>50</td>
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<td>73</td>
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<td>56.9</td>
<td>57.9</td>
<td>N</td>
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<tr>
<td>por525</td>
<td>67</td>
<td>0</td>
<td>58.6</td>
<td>N</td>
</tr>
<tr>
<td>por526</td>
<td>57</td>
<td>48.9</td>
<td>42.7</td>
<td>N</td>
</tr>
<tr>
<td>por533</td>
<td>81</td>
<td>74.6</td>
<td>63.6</td>
<td>N</td>
</tr>
<tr>
<td>por535</td>
<td>70</td>
<td>73.3</td>
<td>69</td>
<td>S</td>
</tr>
<tr>
<td>por536</td>
<td>30</td>
<td>44.2</td>
<td>53.4</td>
<td>Y</td>
</tr>
<tr>
<td>por537</td>
<td>69</td>
<td>54.4</td>
<td>47</td>
<td>N</td>
</tr>
<tr>
<td>Total Improvement</td>
<td>Average % = 63</td>
<td>Average % = 58</td>
<td>Average % = 59</td>
<td>5 improved (31.25%)</td>
</tr>
</tbody>
</table>

Improvement Average % = 63 Average % = 58 Average % = 59
Only five volunteers improved their average percentage scores between the initial and final tests, although results may have been skewed by the difference in the number of cases presented to the volunteers, with the first test, consisting of ten cases, and the interim and final assessments containing twenty cases each.

To ascertain whether there was any statistical improvement in report writing skills, and therefore establish any change cohort performance, and to rule out the influence of any ‘usability’ issues with volunteers getting used to the software, or those occurring by chance, two one-tailed, non-parametric statistical tests (Mann-Whitney U) were carried out. These assessed average performance in the writing of the descriptive content of initial and final assessments and also between the initial and interim assessments. Statistically, there was no significant improvement in performance (U value = 95.5) between the first and final report writing tests, nor between the initial and interim tests (U value = 101.1). So clearly the descriptive content did not significantly improve over the course of the module.

Table 4.7 Progress in decisions based on agreement of ‘opinion of findings’

<table>
<thead>
<tr>
<th>Volunteer No.</th>
<th>% Agreement for Initial Assessment</th>
<th>% Agreement for Interim Assessment</th>
<th>% Agreement for Final Assessment</th>
<th>Improvement between 1st &amp; 3rd Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>por506</td>
<td>20</td>
<td>50</td>
<td>50</td>
<td>Y</td>
</tr>
<tr>
<td>por507</td>
<td>20</td>
<td>65</td>
<td>65</td>
<td>Y</td>
</tr>
<tr>
<td>por509</td>
<td>60</td>
<td>55</td>
<td>30</td>
<td>N</td>
</tr>
<tr>
<td>por510</td>
<td>50</td>
<td>70</td>
<td>40</td>
<td>N</td>
</tr>
<tr>
<td>por511</td>
<td>60</td>
<td>55</td>
<td>45</td>
<td>N</td>
</tr>
<tr>
<td>por512</td>
<td>30</td>
<td>75</td>
<td>55</td>
<td>Y</td>
</tr>
<tr>
<td>por517</td>
<td>30</td>
<td>65</td>
<td>55</td>
<td>Y</td>
</tr>
<tr>
<td>por519</td>
<td>40</td>
<td>55</td>
<td>60</td>
<td>Y</td>
</tr>
<tr>
<td>por520</td>
<td>20</td>
<td>60</td>
<td>30</td>
<td>Y</td>
</tr>
<tr>
<td>por521</td>
<td>40</td>
<td>50</td>
<td>30</td>
<td>N</td>
</tr>
<tr>
<td>por525</td>
<td>60</td>
<td>0</td>
<td>50</td>
<td>N</td>
</tr>
<tr>
<td>por526</td>
<td>30</td>
<td>55</td>
<td>35</td>
<td>Y</td>
</tr>
<tr>
<td>por533</td>
<td>40</td>
<td>65</td>
<td>35</td>
<td>N</td>
</tr>
<tr>
<td>por535</td>
<td>60</td>
<td>60</td>
<td>55</td>
<td>N</td>
</tr>
<tr>
<td>por536</td>
<td>40</td>
<td>50</td>
<td>30</td>
<td>N</td>
</tr>
<tr>
<td>por537</td>
<td>50</td>
<td>55</td>
<td>55</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Total Improvement</strong></td>
<td><strong>Average %</strong></td>
<td><strong>Average %</strong></td>
<td><strong>Average %</strong></td>
<td><strong>8 (50%)</strong></td>
</tr>
</tbody>
</table>

Average % = 41
Average % = 55
Average % = 45
Table 4.7 shows the volunteers ability to interpret image findings as to their ability to assign normal, possibly normal, equivocal, possibly abnormal, abnormal categorisations to their findings. These were correlated with the original reference reports, wherein eight volunteers improved between the initial and final test, the remainder appeared to reduce their scores by 5% of more.

Calculating the scores using the initial and interim results only, twelve volunteers showed improvement, with an overall increase in the average percentage rising from 41% to 55%.

Using Kappa statistics, a summary of the weighted and no-weighted Kappa scores regarding the progress of volunteers as a cohort across all three assessments are shown below (Table 4.8). The significance of these ‘k’ values are assessed against the interpretation table as identified by Landis & Koch (1977) as detailed in the methodology.

**Table 4.8 ‘k’ values based on cohort performance for each assessment**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>‘k’ value (non-weighted)</th>
<th>‘k’ value (weighted)</th>
<th>Agreement Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial report writing assessment</td>
<td>0.2149 (Fair)</td>
<td>0.3288 (Fair)</td>
<td>Poor Agreement</td>
</tr>
<tr>
<td>Interim report writing assessment</td>
<td>0.4023 (Moderate)</td>
<td>0.5560 (Moderate)</td>
<td>Fair Agreement</td>
</tr>
<tr>
<td>Final report writing assessment</td>
<td>0.2797 (Fair)</td>
<td>0.4227 (Moderate)</td>
<td>Fair Agreement</td>
</tr>
</tbody>
</table>

Although not outstanding, there was a statistically significant improvement (using the weighted ‘k’ values) in the volunteer performance between the Initial baseline test, the interim and final report writing assessments, clearly demonstrating that the module had influenced cohort behaviour and their ability/ performance in this task, compared to those expected by chance. Again, the comparison between the initial and interim tests, show the most marked improvement.

Finally, the data were collated to ascertain if there was any progress by the
volunteers in arriving at a decision based on their opinion of the ‘clinical significance’ of the findings compared to the reference reports. This was considered appropriate given the nature of some of the referrals and to determine the ability of volunteers to distinguish between clinically important abnormal findings and those patterns of abnormality attributed to less significant changes, such as degenerative change, thereby potentially influencing the diagnostic and therapeutic outcome (BNMS Level 6).

Table 4.9 Progress in decisions based on agreed ‘clinical significance’ of findings

<table>
<thead>
<tr>
<th>Volunteer No.</th>
<th>% Agreement for Initial Assessment</th>
<th>% Agreement for Interim Assessment</th>
<th>% Agreement for Final Assessment</th>
<th>Improvement between 1&lt;sup&gt;st&lt;/sup&gt; &amp; 3&lt;sup&gt;rd&lt;/sup&gt; Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>por506</td>
<td>50</td>
<td>74</td>
<td>53</td>
<td>Y</td>
</tr>
<tr>
<td>por507</td>
<td>80</td>
<td>79</td>
<td>63</td>
<td>N</td>
</tr>
<tr>
<td>por509</td>
<td>40</td>
<td>68</td>
<td>74</td>
<td>Y</td>
</tr>
<tr>
<td>por510</td>
<td>60</td>
<td>68</td>
<td>63</td>
<td>Y</td>
</tr>
<tr>
<td>por511</td>
<td>60</td>
<td>74</td>
<td>68</td>
<td>Y</td>
</tr>
<tr>
<td>por512</td>
<td>50</td>
<td>58</td>
<td>42</td>
<td>N</td>
</tr>
<tr>
<td>por517</td>
<td>40</td>
<td>79</td>
<td>63</td>
<td>Y</td>
</tr>
<tr>
<td>por519</td>
<td>50</td>
<td>53</td>
<td>58</td>
<td>Y</td>
</tr>
<tr>
<td>por520</td>
<td>10</td>
<td>63</td>
<td>42</td>
<td>Y</td>
</tr>
<tr>
<td>por521</td>
<td>60</td>
<td>58</td>
<td>53</td>
<td>N</td>
</tr>
<tr>
<td>por525</td>
<td>50</td>
<td>0</td>
<td>63</td>
<td>Y</td>
</tr>
<tr>
<td>por526</td>
<td>40</td>
<td>58</td>
<td>37</td>
<td>N</td>
</tr>
<tr>
<td>por533</td>
<td>60</td>
<td>74</td>
<td>63</td>
<td>Y</td>
</tr>
<tr>
<td>por535</td>
<td>70</td>
<td>42</td>
<td>53</td>
<td>N</td>
</tr>
<tr>
<td>por536</td>
<td>30</td>
<td>42</td>
<td>37</td>
<td>Y</td>
</tr>
<tr>
<td>por537</td>
<td>60</td>
<td>53</td>
<td>42</td>
<td>N</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Average %</strong></td>
<td><strong>Average %</strong></td>
<td><strong>Average %</strong></td>
<td><strong>10 (62.5%)</strong></td>
</tr>
<tr>
<td><strong>Improvement</strong></td>
<td><strong>= 51</strong></td>
<td><strong>= 59</strong></td>
<td><strong>= 55</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.9 shows the progress of and demonstrates a marked improvement by ten volunteers between the first and final tests, with improvement in the average marks clearly indicated, albeit minimal.

Finally, calculations were carried out across all three tests (Table 4.10). These show that both the number of false positive, sensitivity and error rates were reduced, whilst false negative rates increased. Specificity and accuracy rates improved, particularly in relation to the interim report writing test.
Table 4.10 Calculations for ‘clinical significance’ decisions across all tests

<table>
<thead>
<tr>
<th></th>
<th>Initial QMP *</th>
<th>Interim QMP</th>
<th>Final QMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Rate (FP%)</td>
<td>59%</td>
<td>49%</td>
<td>48%</td>
</tr>
<tr>
<td>False Negative Rate (FN%)</td>
<td>33%</td>
<td>34%</td>
<td>42%</td>
</tr>
<tr>
<td>Sensitivity Rate</td>
<td>67%</td>
<td>66%</td>
<td>58%</td>
</tr>
<tr>
<td>Specificity Rate</td>
<td>41%</td>
<td>51%</td>
<td>52%</td>
</tr>
<tr>
<td>Error Rate</td>
<td>52%</td>
<td>39%</td>
<td>45%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>48%</td>
<td>61%</td>
<td>55%</td>
</tr>
<tr>
<td>Predictive Negative Value</td>
<td>74%</td>
<td>40%</td>
<td>58%</td>
</tr>
<tr>
<td>Predictive Positive Value</td>
<td>33%</td>
<td>75%</td>
<td>52%</td>
</tr>
</tbody>
</table>

(* these calculations were based on performance from 20 volunteers)

To statistically verify the results, a non-parametric one-tailed test was used to see if there was any significant difference in ability between the initial and final report writing assessments. With a U value of 102, there was again no significant statistical improvement regarding the ability of volunteers to determine the clinical significance between the first and final tests.

Based on the assumption that volunteers may have been rushing to complete the module within the given timeframe, the same test was applied to the interim report writing clinical decision results, in comparison to the initial test.

(Note: One volunteer failed to complete the Interim test, so results are based on 15 volunteers only). Statistics calculated using MWU package from [www.holah.karoo.net](http://www.holah.karoo.net)

Figure 4.19 MWU for clinical significance decisions between Initial & Interim report writing tests

104
As shown in Figure 4.19, a statistical significance was found at a 5% level (U value = 66). This suggests that with less time pressures and sense of urgency, the cohort were apparently more able to decipher the clinical importance of the image appearances. This trend in performance may, however, be attributed to other factors (K. Piper, personal communication, March 15, 2012) which will be explored in the discussion chapter, section 5.3.2.

It was also important to establish whether, given the fairly young cohort profile, the number of years of experience in nuclear medicine had influenced report writing ability.

Table 4.11 Report writing assessment outcomes compared to years experience

<table>
<thead>
<tr>
<th>Volunteer No.</th>
<th>Years of experience</th>
<th>Report writing average (%) (all tests)</th>
<th>Improvement in descriptive reports (1st/3rd tests)</th>
<th>Improvement in Opinion of Findings (1st/3rd tests)</th>
<th>Improvement in determining clinical significance (1st/3rd tests)</th>
<th>Improvement in descriptive content (1st/3rd tests)</th>
</tr>
</thead>
<tbody>
<tr>
<td>por506</td>
<td>&lt;5</td>
<td>59</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>por507</td>
<td>&gt;21</td>
<td>74</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>por509</td>
<td>&lt;5</td>
<td>56</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>por510</td>
<td>&lt;5</td>
<td>74</td>
<td>S</td>
<td>N</td>
<td>Y</td>
<td>S</td>
</tr>
<tr>
<td>por511</td>
<td>11-15</td>
<td>62</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>por512</td>
<td>&gt;21</td>
<td>61</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>por517</td>
<td>11-15</td>
<td>51</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>por519</td>
<td>6-10</td>
<td>78</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>por520</td>
<td>&lt;5</td>
<td>49</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>por521</td>
<td>16-20</td>
<td>64</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>por525</td>
<td>11-15</td>
<td>63*</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>por526</td>
<td>6-10</td>
<td>50</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>por533</td>
<td>6-10</td>
<td>73</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>por535</td>
<td>11-15</td>
<td>71</td>
<td>S</td>
<td>N</td>
<td>N</td>
<td>S</td>
</tr>
<tr>
<td>por536</td>
<td>6-10</td>
<td>43</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>por537</td>
<td>&gt;21</td>
<td>57</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>

Y = improved performance; N = performance fell; S = maintained similar level. (* = average based on 2 report writing assessments only)

Although there was no overt link found between experience and report writing ability, Table 4.11 demonstrates that between the initial and final report writing assessments, the module appeared to have benefitted those with less experience.
As with the previous section, concerns were raised, albeit minimal, which identified difficulties with structure, length, and again, feedback:

“....Reporting tests were too long. 20 cases in one go takes a really long time (especially if you’re having to do it from home rather than during work time) and the case number did not appear so it was not possible to keep track of progress through the 20 cases without counting” (por520)

“Being given feedback/answers to .... report writing” (por536)

As one volunteer pointed out:

“...... knowing the actual report of the scan after you have attempted it would help to learn if you were making systematic errors and improve future progress”. (por506)

Again the lack of available feedback was an oversight, but in respect of the latter comment, the turnaround time for marking the report writing assessments had been underestimated.

4.4.4 Influence of professional background
To discover whether professional background may have influenced progress and achievement, demographic details from the pre-module survey were used to compile an overview of the final sixteen volunteer professional backgrounds. Professional areas were divided into three categories: those with radiography qualifications, those with physics qualifications and a third group where the background profession was not stated.

Initially, average marks for each summative assessment were recorded according to each professional groups as described above. These were tabulated and a graph produced to demonstrate overall performance, as shown in Figure 4.20.
As demonstrated, the radiographer category scored marginally, yet consistently better across all the summative tests than those from a non-radiographer backgrounds. There were fewer numbers represented in the radiographer category (n = 4) compared to those from either physics or professional background unknown (n = 12) which may have affected the average.

To establish and verify whether there was a statistical difference in the report writing ability between either of the professional groups (radiographer or non-radiographer) for the initial and final tests, another Mann-Whitney U, this time a two tailed test was carried out, as shown in Figure 4.21.

Results from this concluded that there was no statistically significant difference associated with professional background in terms of influencing report writing ability, however, it can be conceded that there was insufficient data for the outcome from this test to be wholly reliable.
4.5 Changes in behaviour (KM level 3)

To see whether volunteers may have changed their behaviour as a result of the module experience, quantitative and qualitative data was gathered through the post-module survey.

4.5.1 Volunteers evaluation of learning achieved

This was a key area, which helped to elucidate, by means of a series of questions, volunteer thoughts on the learning and skills they may have achieved by undertaking the module.

Figure 4.22 shows volunteers appeared to agree that they had widened their knowledge base in various aspects of bone scanning, the components and writing of a report and legal issues. It is probably prudent to highlight at this juncture, that some of the volunteers were either already reporting bone scans, or in the process of learning to report, therefore their knowledge gain may not have been as great as those embarking on this for the first time. (This information only came to light through personal communications proffered by some volunteers once they had completed the module, as detailed in the next chapter, section 5.4).
Figure 4.22 Areas where knowledge was gained

Figure 4.23 shows the volunteers' perceptions of skills gained. As with the previous comment, prior knowledge and experience may have affected the perceived acquisition, although on balance, it would appear gains had been achieved in report writing and interpretation.

Figure 4.23 Volunteers' perceptions of skills gained

In terms of confidence and competence gained, clearly volunteers felt more confident, but competence was not perceived to be overt. (See Figure 4.24)
In asking volunteers to judge what scores they should have, if they were to competently interpret bone scans. This generated a wide range of opinions, with some suggesting that a percentage accuracy score of between 56-65% was adequate, however, sensibly, the majority seemed more aware of BNMS guidance, suggesting scores should be in excess of 86%. (Figure 4.25).

4.5.2 Volunteer evaluation of eLearning
In terms of the evaluation of eLearning, some highly positive and encouraging feedback was received. The volunteers’ perceptions of eLearning, per se, were largely unchanged, with this medium for learning still being highly acceptable. It showed volunteers enjoyed the flexibility of the programme, learning at their own pace which is a key benefit, although many clearly would have preferred to have
had some face-to-face teaching (Figure 4.26). This may have been a reflection of the age profile of the cohort and which may have influenced some of the perceptions.

![Volunteer perceptions of eLearning]

Figure 4.26 Volunteer perceptions of eLearning

This was elaborated upon through feedback given as to whether such a module would be feasible and effective for learning a new skill (i.e. interpreting bone scans). It should be noted here that at the time of completing the post-module survey, volunteers did not know their results from the report writing assessments or their overall module score, which may have introduced some bias. Results are shown in Figure 4.27.

![Volunteer perceptions of the feasibility and effectiveness of the module to acquire a new skill]

Figure 4.27 Volunteer perceptions of the feasibility and effectiveness of the module to acquire a new skill
Generally, the module was seen as effective, but there was a clear suggestion that the module may be better as a supporting resource, than a sole medium for teaching a new skill. There was also some hesitance over how confident or competent volunteers perceived their ability in reporting following their completion of the module.

The final questions revealed the perception by volunteers of the appropriateness of the module to their current and future professional roles, with the majority strongly agreeing or agreeing that the module content and experience was highly relevant (Figure 4.28).

It had also been a catalyst in causing some volunteers to reflect and review their own professional practice and advancing their understanding of bone scan interpretation. This was supported by some of qualitative comments generated, extracts are shown below:

“I don’t have a medical background but I’m being trained to report nuclear medicine images. I currently sit in on reporting sessions and will soon start writing provisional reports - It will probably take a few years at least before I feel I have enough experience to report these images alone - I don’t feel the skill of reporting bone scans is something that can be taught in an e-learning format - It will be a slow process involving discussions with radiologists/physicist/technologists.” (por509)

“Although I do not feel this module alone would be sufficient for me personally to undertake bone scan reporting, it has taken me a lot closer to it for the future. In the here and now, it has served to: 1. improve my ability to spot abnormalities when undertaking bone scanning. 2. improve my ability to consider the need for
additional views when viewing the whole body scan. 3. enhance my enjoyment of undertaking bone scanning!" (por510)

4.6 Overall evaluation of module

With regards to the overall satisfaction expressed by the volunteers (see Figure 4.29) the module was well received, being both enjoyable, interesting with some learning gained.

Although it did not promote further knowledge and understanding of computers and was perceived as being quite difficult to pursue, it did not detract from the idea of using of an eLearning medium for future continuing professional development.

![Bar Chart](chart.png)

**Figure 4.29 Overall evaluation of module**

Indeed, the qualitative comments further supported the necessity of programmes such as this:

- “I enjoyed the opportunity to learn a bit more about reporting images” (por512)
- “Commenting on images was interesting....” (por517)
- “I liked the idea of e-learning” (por519)
“I would also like to praise the sheer effort and time that has gone into producing this resource and would like to see it expanded into an easily accessible accredited course to train non-clinicians to report.” (por525)

“Well thought out module which thoroughly enjoyed. I don’t do any reporting nor am I expecting to do so in the future but wanted a greater understanding of what I acquire on a daily basis. This course has given me that knowledge.” (por526)

“It’s very difficult to get the time off and travelling expenses to enrol in a residential course given the current financial climate; but distance learning is not only cheaper but also allows students to learn during quiet periods at work (or at least be available to on-demand whilst learning at work)” (por533)

“The course was very enjoyable, however as a physics graduate with no biology background at all (did not study it at school past 13 years of age) I did find the bony, breast and prostate pathology difficult to understand and did have to do a lot of extra reading to complete the assessments on those.” (por535)

“With the decline in being able to attend courses through work due to lack of funding & staff, I wish there was more online opportunities like this that would encourage me & give me renewed interest in what is becoming quite stale in my job.” (por536)

Other comments were submitted in the informal feedback received by email once the module was completed, but these will be included in the discussion chapter.

Only one volunteer expressed outright dissatisfaction with the module as shown below:

“Overall I was disappointed with the course. I am interested in learning more about bone scans and am an intelligent person who generally finds it easy to learn new and complex things. This course left me feeling demoralised that I had not made much progress given the time that I put into it.” (por520)

4.7 Summary of findings

This was a complex chapter presenting initial challenges owing to the wealth of data generated. Through the completion of the post-module survey and alongside quantitative data obtained from Victory records and the additional software management programmes, it has provided some highly supportive, positive and constructive feedback for the module, generated.
Inevitably there was some attrition and although this was higher than the anticipated, it fell broadly within the range expected for an eLearning module of 20-50% (Tyler-Smith, 2006, p.73). Overall the module achieved and met, with some success, the second research objective to evaluate the module design in terms of its impact and usability using online evaluation/feedback. One aspect which should not go unnoticed was the considerable commitment by volunteers, which, in the absence of any academic credit, was much appreciated.

From the data, experiences and reflections of the volunteers, it has demonstrated the need for an educational programme such as this. The benefits were overt, both in terms of the content and delivery to a wide geographical and professionally diverse audience.

Not only was the content tested for its robustness, but volunteer performance and progression analysed, where a positive change in average scores, false positive/false negative rates, specificity and accuracy rates in reporting ability as the cohort progressed through the module, was noted.

With regards to the latter, two areas proved to be statistically significant, as revealed by the agreement regarding the ‘opinion of findings’ demonstrated by the weighted Kappa statistics and the Mann-Whitney U one tailed test looking for improvement in the decisions based on clinical significance between the initial and interim report writing assessments.

No other verifiable improvement in report writing ability was found including the influence of professional background. Time spent did appear to influence results, with poorer scores noted amongst those who had spent the least amount of time.

In conclusion, the second and third research objectives have been met where module experience has proved usable and positive. Programme content clearly influenced performance, however, owing to low volunteer numbers and therefore limited statistical analysis, the ability to demonstrate whether the programme was effective for learning, or achieving competence in report writing, can only be cautiously optimistic at this point.
Chapter 5 – Discussion

This chapter will discuss the findings from the trial module, including key areas relating to the original aim and objectives of the project. It is therefore useful, at this point, to revisit and re-iterate these, as shown below.

**Aim:** To design, implement and evaluate the impact/effectiveness of a solely e-based learning module to prepare non-medical healthcare professionals to report nuclear medicine bone scans and to ascertain its application as an educational programme for a wider audience.

**Objective 1:** Design of an eLearning module using a Blackboard enabled product (Victory) and integrated, interactive packages;

**Objective 2:** Implement and evaluate the module design in terms of its impact and usability using online evaluation and feedback;

**Objective 3:** Establish the facilitation and effect on learning through objective and subjective measurement of the learning outcomes, using online assessments, tasks and design tools;

**Objective 4:** Assess the application of knowledge and skills learned to the clinical situation and organisational impact, by conducting a post module survey.

(It should be appreciated that Objective 1 has already been met and discussed in the previous chapter).

Findings will be aligned with the parameters outlined in Chapter 4, using the Kirkpatrick model as a point of reference, and in doing so, will seek to confirm the intended outcomes: (1) whether eLearning is a viable stand alone resource in the provision of nuclear medicine postgraduate education; (2) establish the effectiveness of the programme in developing new skills which may then be used to the benefit of the individual, employing organisation and profession; (3) help support further investment and opportunity for development from an higher education perspective. These will be addressed through the following areas, which
include:

- Volunteer profile;
- Volunteer reaction and experience (to accessibility, design and usability, content and feedback);
- Volunteer learning (including verification of diagnostic ability and accuracy of performance);
- Volunteer behaviour (including discussion of overall module experience).

5.1 Volunteer profile

Following the project ‘launch’ at the 2011 Spring British Nuclear Medicine Society (BNMS) conference, there was clear and considerable interest, with enquiries received from a wide geographical spread across England. The interest confirmed the appeal and flexibility of this type of educational delivery, including its potential catchment for volunteers/learners, who otherwise may have been constrained by physical limitations of delivery by a single university campus based approach.

Equally, interest did not appear to falter, despite the restriction in volunteer numbers and the overt statement that participation in the trial did not carry any formal, recognised professional, or academic accreditation. The offer of high street vouchers had been made from the start as an incentive, however the amount was not revealed until the end of the module, therefore it was felt that any initial bias, which may have been introduced, would not be sustained for the duration of the trial period. Therefore, the interest generated was perceived as genuine and a positive indication that a module such as this, had highlighted an omission in current educational provision for qualified personnel, a factor which will be explored later.

It is prudent to take a moment to consider those volunteers who did not access or complete the module. Of interest were those, who despite confirming their intentions to take part in the trial, failed to log on. In such instances, whilst some attrition was expected, it is reasonable to assume that regardless of any initial
enthusiasm, these individuals were unable to commit for reasons beyond the facilitator’s control, as supported by Tyler-Smith’s article (2006, p.77).

Data acquired through the pre-module survey, revealed a largely anticipated demographic profile, with a predominantly female gender distribution (64%) entirely in keeping with the national demographics for the healthcare sector. However, in terms of module completion, equal numbers of males (n = 8) and females (n = 8) completed, suggesting that male volunteers were evidently more likely to persevere than their female counterparts, although the reasons behind this cannot be established.

The age profile was more surprising, with numbers skewed towards the younger generations, where 80% were aged 40 years or less. In reviewing the post-module data, this trend remained, with eleven (69%) of those completing the module being under 40 years of age.

Similarly, the majority of those wishing to take part, had been in their chosen discipline/ practice for less than fifteen years, with a significant proportion with less than five years experience. Again this trend was echoed amongst those completing the module with twelve volunteers (75%) qualified for fifteen years or less.

This could reflect the culture and growing emphasis on the importance of continuing education and professional development past a first qualification and the desire amongst younger healthcare professionals to be more proactive in maintaining interest and increasing their knowledge base and being more deliberate in seeking progression in their careers. As one potential volunteer expressed in their email:

"please keep my details on file.... we are going stagnant in our department & with no funding for us to do any courses, this would [be] a great opportunity."
(por536, personal communication, June 13, 2011)

Certainly within the healthcare sector, the need to actively maintain competence, advance learning and understanding in an ever changing environment has
become more overt, as roles and responsibilities are re-defined and where the need to maintain professional registration is paramount. Educational provision remains relatively sparse, or inaccessible to most, given the time needed for completion and geographical and financial constraints. E-Learning clearly provides some resolution to these difficulties.

The range of the professional backgrounds of volunteers was unexpected given the launch at the Clinical Technologist BNMS forum. The majority were first degree graduates (54%), yet only a few radiographers volunteered to take part (20%). The remainder were either medical technical officers (MTO’s) from non-radiographic backgrounds, such as clinical physiology, or physicists. Eighty-four per cent held postgraduate qualifications, ranging from postgraduate certificates through to full Masters level (although none held doctoral level qualifications, but this may be explained by the age profile). It reflects the diversity of professionals and the specialist expertise seen in the delivery of a nuclear medicine service.

The low radiographer numbers was surprising given the growing expectation and support for those from radiography backgrounds to further their skills/competence in areas such as reporting to improve service delivery, as highlighted by the Royal College of Radiologists and Society and College of Radiographers (2007, p.7). Whether this apparent disinterest was due to lack of publicity of the trial in radiography circles, or limited radiographers numbers working within nuclear medicine practice, is hard to tell.

This was a free trial, non-judgemental in format, anonymous and available beyond the confines of any political or professional constraints found within the working environment. So, to have so few radiographers, was surprising. It could be reminiscent of Yielder and Davis’s paper (2009, p.346) which demonstrated an apparent and pervasive culture amongst radiographers concerning low expectations and perceptions of their own professionalism. This may manifest itself through a possible reluctance to accept new roles, or, in this instance, a lack of confidence, low self-esteem, or simple apathy, to take up the offer of training. Equally, it may be that this particular professional group were more reticent about devoting their time to a trial product, with no proven worth. As suggested by
previous authors (Chua & Lam, 2007, p.136; Lancaster & Hardy, 2012, p.108) there can be a certain degree of apprehension regarding the value of eLearning in an area of professional advancement, particularly where the quality of the learning experience and recognition of outcomes may not have been proven.

Another possible explanation could be that the physicists had more opportunity than their radiographer, or MTO counterparts, to embark on reporting endeavours, where possibly their likely involvement in the manipulation and processing of images, places them away from the immediacy of image acquisition and the camera face. (It should be noted that this is an assumption, and therefore cannot be verified).

Ultimately, given the data obtained, the reasons behind the lack of uptake, can only be speculated upon. However, there was clear evidence to suggest that most volunteers seemed more focussed on acquiring knowledge and understanding, rather than a competence in reporting, which again was surprising given the overt nature of the module in establishing a programme to teach reporting skills.

In summary, the volunteers who took part and subsequently completed the module appeared to reflect a fairly young profile, still relatively early on in their career pathways, with a strong physicist presence, which may echo the distribution of the workload and availability, or even the willingness of certain professional groups to extend their roles.

5.2 Volunteer reaction and experience

With reference to Kirkpatrick (KM level 1), it was important to evaluate the volunteers’ reaction and experience to the module. Using feedback obtained from the formal management systems and post-module survey, as well as informal email communications, key information was ascertained.

5.2.1 Accessibility of trial module

As expected, the majority of volunteers found the module convenient and easy to
access, with speed of access and the ability to log in from anywhere seemingly appreciated. As previous authors have pointed out (Neilson, 2005, p.1; Clark, 2001a, p.1; JISC, 2009, p.4) the flexibility and availability of eLearning is not in doubt and the benefits of being able to reach a wide and diverse geographical audience, undisputed. Certainly, from an HEI perspective, the investment and use of eLearning and perceived economies of scale in terms of delivery of material, seem undeniable. However, delivery should be seamless and uncomplicated to the end-user and as with any new venture, several issues did emerge during the trial period which caused concern.

Following the pilot study, it had been recognised that accessing the virtual learning environment (VLE) may be restricted from hospital trust site computers, so, for this reason all volunteers were given temporary Lightweight Directory Access Protocol (LDAP) logins. Some volunteers did not progress beyond the early stages (module section 0 and module section 1). This invariably raised the question as to what may have happened to hamper their continued support. Such reasons could not be elicited through the recognised feedback routes (clearly these volunteers would not have progressed to that point) therefore informal feedback from email communications was used to illustrate the issues. These were mainly associated with accessibility and compatibility with incorporated software at the user interface, rather than the VLE platform itself.

The inclusion of the LDAP logins, enabled straightforward access to Victory with relatively few emails suggesting any difficulty beyond initial login issues as volunteers familiarised themselves with the system requirements. For most queries, the programme facilitator could direct volunteers to specific instructions, downloaded as a Microsoft Word document, giving step by step instructions on how to use the various aspects of the module, in keeping with the instructional design methodology. Where more overt technical assistance was required, volunteers were re-directed to the learning technology support staff, who responded within a twenty-four hour period.

Three volunteers, who accessed the initial section of the module, did not complete any elements, therefore progressing no further with the trial. In two cases, no
communication was received, the third cited technical difficulties. However, in all cases, the VLE system record showed these individuals spent less than one hour logged on, one being for less than five minutes. Such limited time could only give a cursory overview of the module and gave the impression that these volunteers perhaps had a change of heart regarding their commitment to the project, rather than technical issues as cited. Although one needs to be mindful of issues regarding quality and usability. One further volunteer withdrew due to pressures of work and an unanticipated work project, although they had completed all the necessary precursors in module section 0.

Other technical difficulties were less straightforward, being attributed to access to the WebAiMS and Questionmark™ Perception™ (QMP) software. Most of these related to the absence of a Shibbolith® account, which as an industry standard, open source software package, allows for a single web sign-on across, or within organizational boundaries. In the absence of this, accessing the additional software was not as straightforward, or as easy as one would have liked, with volunteers needing secondary login details each time this software was used.

In addition, WebAiMS was ‘blocked’ by some computer firewalls. This particular problem had been highlighted by the pilot study, but by establishing a proxy web cache, which was relatively simple, and with additional instructions added to Section 0, content could be delivered. In spite of this, it transpired from various email exchanges, that many volunteers were accessing the module through their respective hospital trust site computers. It had not been appreciated that a number of volunteers, and their managers, had decided to utilise the trial as part of their continuing professional development, and therein, be given time to complete it during working hours. In the absence of agreements and permissions between the University and each of the respective hospital trust site security architects, the restricted access did not allow for the establishment of the proxy web cache, so none of the WebAiMS content could be accessed, which was a significant, unanticipated limitation. This adds credence to Cosson and Willis’s (2012) statement where they suggested that

“relying on external services that have no contractual obligation ....
puts the teaching and learning resources at risk” (Cosson & Willis, 2012, p.112).

So despite the extra instructions added following the pilot study, only one volunteer (por537) with self-professed experience in computers and web design, actively sought to resolve the issue by seeking out a ‘non-domain controlled’ computer in their work environment, highlighting the issue and need for digital literacy.

If the programme were to become commercially viable, access to any external, yet integral software products, such as WebA1IMS could and should be resolved prior to module release through the establishment of Shibboleth accounts.

In the immediacy of a limited trial period, the WebAiMS software remained a ‘stumbling block’ for various reasons (including with the visualisation of images covered later), which raised a concern over the sustainability of volunteer numbers to the programme and the possibility that if people cannot access a site ‘they leave’ (Neilson, 2005, p.2). Once it became clear problems were likely to persist and may cause other volunteers to withdraw, changes were reluctantly made to the status of the WebAiMS assessments. These were re-assigned as formative, rather than summative, so no longer mandatory for the achievement of the learning outcomes. Volunteers were notified of this change by email and no further queries were raised.

In executing this change, the quantitative summative assessment information was inevitably reduced thereby limiting the performance data generated, so an additional report writing assessment (Interim Report Writing) was introduced in module section 3. This in itself emphasises the advantage of eLearning where successive iterations can be made in the light of user experience.

In summary, whilst eLearning can usually be regarded as a flexible and beneficial means of delivery, seamless accessibility is crucial and has significant implications on development. As this research has indicated, ‘on-the-job’ training and education, is clearly an option, particularly for the busy professional ‘learner’. If, Botkin and Davis are correct in their assumption that ……
“employee education is not growing 100 per cent faster than academia, but 1000 times or 10,000 per cent faster…” (as cited in Clark, 2001b. p.1).

careful consideration should be given to how and where the product is likely to be used. Certainly from an HE and eLearning development perspective, such fundamental issues, which may ultimately impact on attrition and experience, need to be taken into account at the outset.

5.2.2 Design and usability of trial module
In addition to accessibility, design and usability were paramount. As illustrated in the results elicited through the post-module survey, the majority of volunteers reported a positive experience, finding the organisation of structure and content to be highly useable (n = 10), interactive (n = 10) and easy to navigate (n = 9). Specifically the ‘look’ of the module with its colour coded sections was clearly appreciated (n = 14), although only tentative appreciation was shown for the gateway assessments (n = 8) and selective release (n = 8).

Usability, as previously discussed, is a key quality criterion for eLearning. It incorporates learnability, efficiency, memorability, errors and satisfaction associated with module design and is, again, crucial to the ‘survival’ of an eLearning programme (Neilson, n.d, p.1). Clearly the module design and inherent features met this with some success, although, paradoxically, the navigation was only thought to be memorable by less than half of the completing volunteers (n = 7).

Despite claims of digital literacy (please refer to Glossary) regarding the volunteers’ knowledge, use of computers and related technology, there was evidence of a lack of skill beyond basic functionality and navigation. For instance, optimising the visual display of presentations and images, was evidently an issue for some volunteers and did detract from the usability of the programme. Yet this unfamiliarity was not recorded in data obtained from the post module evaluation where more than half the volunteers (n = 12) felt their IT skills had not improved, which suggested they were unaware of any shortcomings.
This lack of understanding could be a generational issue, especially where the age profile would have placed some of the volunteers in the ‘digital immigrant’ category, or they may have lacked the confidence to find a solution, or to seek clarification. It could also be, that owing to the normal working environment, use of picture archiving and communication systems (PACS) and other work related software, volunteers were likely to overestimate their ability and “underestimate the broader range of skills required by an eLearner” (Tyler-Smith, 2006, p.79).

This echoes some of the findings from Shanahan, et al., (2008, p.234) who found low level information technology skills amongst medical radiation science practitioners, confirming the need for individuals to be ‘techno savvy’ when using e-based material. Therefore, as a development point, the notion to embed more purposeful learning activities to promote digital literacy skills, without detracting from the discipline specific content, was regarded as a positive consideration which could be taken forward.

With regards to the flexibility of delivery, volunteers evidently appreciated being able to repeatedly replay presentations (one of the positive points of creating media rich, re-usable learning objects) thereby being able to revisit content on numerous occasions as shown by the quantitative data regarding the number of ‘hits’ against each element . With such a discerning audience, a number of areas for improvement were identified, relating to the technical display, delivery and quality of various content elements.

Some expressed difficulty with some of the slide transitions within the presentations:

“I was unable to take notes as once the power point began there was no way of pausing it. ....... I had to sit through the whole power point again, I couldn't just pin point certain parts of it.” (por536)

Adobe® Captivate™ presentations had been scaled to fill the whole screen to facilitate viewing, with navigational buttons present which should have enabled the slide shows to be ‘paused’, or for specific slides to be re-visited. By adjusting the screen display, it should have been possible to see these and an inability to do this
may be again attributed to lack of technical familiarity, or prowess on behalf of some volunteers. Alternatively, although the format of the navigational buttons was considered to be generic in appearance and reminiscent of other online programmes, the absence of any explicit instructions on how to set up the screen viewing facilities may have hampered usability, which is a factor which could be taken forward in any further development of the module.

Valid comments relating to the delivery were also highlighted, such as length of presentations. Clearly some of the presentations were too long and would have benefited from being shorter in order to keep the viewer engaged. The presentations relating to the breast and prostate were about thirty minutes duration and perhaps a key development point here, would be to curtail presentations to a maximum of twenty minutes.

Incorporating and clarifying summary points and the need for more useful summary slides was also suggested. This would be relatively simple to address and is another development point which may be taken forward.

In addition to summary slides, some volunteers clearly felt the need for tangible handouts and supporting texts to accompany the presentations, or to be able to download the teaching material, such as presentation transcripts. This brings to the forefront features acknowledged in Beetham’s model (Chapter 2, Figure 2.1) where postgraduate learners will often hold expectations based on prior experiences. Given the likelihood that most volunteers would have been used to more didactic teaching approaches, where substantial handouts and course material would have been available, this request does not seem unreasonable. Yet, owing to nature of delivery and paperless eLearning environment, this could possibly be indicative of the generational gap. So, although the comments made were valid and the inclusion of edited summary highlights, would admittedly have added value, the inclusion of transcripts could be onerous and lengthy and careful thought would need to be given to the format and focus of such material.

The use of the audio tracks to explain and expand the content of the presentations also came under some scrutiny. For the majority of volunteers, the integration of
synchronised audio tracks to expand and elucidate the presentation content was regarded as highly beneficial, generating overt and positive appreciation, so it would seem that failure of slides to progress with the audio track, as reported by one volunteer, was more likely related to the processing speed of the individual’s computer, rather than being a more perennial problem.

It was also accepted that the standard and quality of delivery was not as fluid as anticipated and clearly fell short of some volunteers expectations. The presentations had been simplistically developed by preparing a script and recording the oral explanations through a headset and microphone, using the authoring software available. In the absence of a professional recording setup, it was accepted early on that the audio tracks would contain a degree of ‘white noise’. In an age where we are bombarded by high quality audio visual content through the various media channels, this lack of finesse was noted.

With technical assistance from a sound engineer, it would be possible to improve and ‘clean up’ the audio tracks to a higher standard and perceptibly make them more acceptable to the listener. Although this would take time and some financial investment to develop more fully, it would be a worthwhile and an appealing option if considering the module for release to the commercial market.

It is also worth commenting that even for experienced lecturers, the change in medium and indirect contact with one’s audience, unlike a conventional lecture, can constrain delivery. Along with the use of a script, it was quite an isolating exercise and regardless of expertise, or soundness of knowledge, the lack of spontaneity may have led to some of the commentary sounding quite pedestrian. Perhaps with more experience with using this medium, or the use of trained media presenters, a more acceptable ‘on-screen’ presence could be developed.

One of the research objectives had been to identify the effectiveness of the eLearning tools used. Of particular interest were the various interactive features which had been specifically created and developed as self-assessment tools. These included items such as the hyperlinked powerpoint presentation, module section 2, and the ‘hot spot’ analysis exercise, module section 3. Both were
designed to allow volunteers to informally self-test their ability of pattern recognition and determination of the clinical significance of image appearances. They were created using different software, one with a simplistic powerpoint show, with embedded hyperlinks, the other, using QMP to create the ‘hot spot’ exercise in the later section. Both exercises clearly achieved some degree of success, being accessed on several occasions (46 and 32 times respectively), but it was useful to gauge approval from the critique and feedback given.

The hyperlinked presentation seemed to be widely accepted in its presented form with no overt comments made. This was quite satisfying, as this type of interactive resource did not require detailed technological expertise to produce, yet clearly was effective, with a positive impact.

Certainly the ‘hot spot’ exercise, required more expert development, was clearly not sufficiently fine tuned in its current form.

“the hot spot exercise was way too sensitive ... placing of hotspots had to be exact to gain marks even if the spot covered the abnormality in question”
(por525)

This type of commentary was useful in gauging the usability and acceptability of integrated learning objects, either by confirming their place as worthy contenders for inclusion in an eLearning programme, or by highlighting the need for refinement and further development.

Finally, it became evident from the volunteer experience that the academic structure needed to be more overt, with particular reference to the pathways through the module sections. Aims and objectives for the whole module had been included in section 0 and available to download (module section 0.1), but were apparently missed by some volunteers. Certainly, the inclusion of separate aims and objectives for each section would have aided clarity, assisting the learner through each discrete entity and could be made more transparent for each learning activity. This would not only add purpose, direction and a sense of accomplishment on completion of each stage, which are key to the more mature learner, but also would have given an added psychological ‘lift’ for learners as they
progressed through. One needs to remember, that with any eLearning resource, the learner is often in isolation, separated from their peers, and at best, has only limited access to the programme facilitator. Therefore clarity of the structure, direction and easy transfer between one module section to the next, should be paramount. Such modifications could, and should be made, with relatively little effort, if the product is to become commercialised.

5.2.3 Module content
One should remember that designing an eLearning resource, which is easy to use, should not be the sole focus, and one, particularly with professional ‘learners’ should take into account how and what motivates that individual to learn.

Feedback from the post-module survey about the module as a teaching resource, was highly positive. The majority of volunteers suggested the content had been enjoyable (n = 9), interesting (n = 14) and had contributed to their learning (n = 10). The range and quality of resources had been appreciated and it was also gratifying to note that many regarded the content as relevant, useful and informative to their practice (n = 11).

Despite this, a number of volunteers did remark upon the level and depth of information included in some presentations being too involved and detailed, with comments querying the relevance of some of the information presented. The strong physics presence may have accounted for some of the comments, which could be attributed to lack of background knowledge, as highlighted by one volunteer,

“.....as a physics graduate with no biology background at all (did not study it at school past 13 years of age) I did find the bony, breast and prostate pathology difficult to understand.”

This does possibly echo concerns raised by the Royal College of Radiologists (2010, p.3) where there is a suggestion that those not medically qualified, may misunderstand the full nature of diagnosing images, mistaking it for a pattern recognition exercise which can be learnt, where, in fact, this is only part of the process. As suggested, content should reflect the “academic rigour benefitting the
level for which the subject is intended” (Chua & Lam, 2007, p.137) and from an educational perspective, it is desirable for ‘learners’ to acquire a body of knowledge, so an appreciation of the subject matter is understood in its entirety. Focussing on one aspect could marginalise cognition, leading to fundamental misunderstandings, where, in this context, concentrating purely on image appearances, without any background information regarding, for instance, pathological processes and disease progression could culminate in possible misdiagnosis.

On reflection, it was apparent that rather than authorship contributions made largely by one academic, albeit with some assistance from fellow academics and in spite of the extensive research involved and time taken to develop each topic area, more could have been done to invite contributions from other experienced academics and healthcare professionals of some standing. Quality of content contributes significantly to the learners’ experience as well as the learning outcomes and programme development. Use of external contributions by ‘expert’ authors may have raised the perceived profile of content and perhaps dispelled some of the less generous remarks.

It should be acknowledged that whilst some found the depth of information and thereby the module, ‘difficult’, as shown in the post-module survey, some turned this to their advantage by self-motivating and reading around subject areas to improve their assessment performance:

“[I] … did have to do a lot of extra reading to complete the assessments.”

(port535)

This raises a potentially contentious issue as to how much information should be incorporated within an eLearning resource. Without the conventional access to the academic resources, or tangible learning support structures, should everything be made available so the module is entirely self-contained, as with the Open University (although this would require considerable investment)? The likely answer is inevitably – yes.

In addition to the quality and extent of information provided, a number of
volunteers mentioned the issue of limited clinical information, particularly with reference to the report writing assessments. In the normal healthcare setting, clinical information from other investigations and diagnostic test results would normally be accessible when reporting images, contributing to the diagnostic process. Such information was not available during the course of this research, in part, due to the arrangement with the two hospital trust sites providing the case information used in the compilation of the image database.

Agreements and permissions were exclusively with the nuclear medicine departments for cases acquired between September and January 2007/08. The permissions did not include access to information regarding the same patients from other sources, such as Radiology, patient records, histology results, or even previous nuclear medicine examinations acquired prior to the database collection period. This meant the cases presented, were supported by referral information alone, which is often limited, and any additional information recorded by the operator during that particular examination. Hence, the omission of any additional clinical details and diagnostic results, may have detracted from the volunteers’ ability to contextualise their findings and this was a clear and accepted limitation of the study.

If the intention is to design acceptable and effective eLearning scenarios, which can mimic real life clinical situations, then an omission such as this needs to be addressed. Again, should the product become commercial, the establishment of ‘streamed’ information from a healthcare provider, with all the necessary facets to maximise the effectiveness, would resolve this issue, (a factor identified by Cosson and Willis, 2012, p.113).

Similarly, a number of other issues relating the case collections were identified by some volunteers. These seemed to be twofold, regarding the presentation and technical quality, as explored below.

Firstly, the quality and standard of the images was questioned. Volunteers were able to assess the image quality as part of the report writing process in an attempt to ensure that they understood and appreciated the technical limitations of the
examination. Despite some initial filtering of cases, where those cases considered inadequate for educational purposes were removed from the database, volunteers identified various technical shortcomings in other instances. These included the misplacement, or lack of anatomical markers, poor symmetry, absence of additional views or further imaging, such as single photon emission computed tomography (SPECT) which would have provided additional and necessary information. Whilst it is accepted that it is not always possible to produce technically perfect images with each examination, this was an evidential and salutary reminder of the importance of professionalism and technical expertise in acquiring definitive, high quality images in the pursuit of diagnostic excellence, as with any diagnostic imaging modality.

It also demonstrates the apparent transition between a technician accepting an image that 'will do', compared to the needs of the reporter, who, in the absence of direct patient contact, is reliant on sufficient high quality diagnostic information in order to formulate an absolute report. This reiterates findings from research, mentioned previously, where with increasing autonomy, the non-medical practitioner, assuming a reporting role, is more likely to critique and improve their standards of practice in the pursuit of technical excellence. This, in turn, through their unique interaction with the patient and added responsibility, can promote and ensure a continuous high quality service, which matches individual patient needs and subsequent management.

The second issue to be raised was associated with image display. There was a known inherent limitation to show dynamic image sequences in connection with multiphase bone scans, which will be explored later, but in addition, there was an emerging problem in displaying images in the appropriate format.

Originally when designing the module, WebAiMS had been deliberately chosen, owing to its ability to show images in series, allowing a degree of interactivity through the display functions, such as magnification and zoom etc. However, it was chiefly selected due its capability to display images in their true DICOM format, without loss or degradation, as found in the clinical setting. However, the reality was somewhat different due to an incompatibility issue between the JAVA
script used in WebAiMS and the version required by the VLE (JAVA 1.6.0-20) which resulted in images being displayed in a JPEG format, causing some inherent loss. It also meant that the viewing software, and hence the report writing assessment facilities, did not reflect actual clinical situation, so the objective of using resources to contextualise learning, could not be fulfilled.

This incompatibility had not been realised during the pilot study and although raised with Aimsability.com as soon as it became evident (Week 4) it could not be resolved in a timely fashion. This added credence to the decision to reassign the WebAiMS assessments to a formative status. However, although an extra report writing assessment was introduced using QMP, this could only display images in a JPEG format and therefore image viewing facilities remained suboptimal. Both factors may have influenced the effectiveness of the report writing assessments.

Incidentally, one volunteer did suggest image cases could be sent on a CD to be viewed with the appropriate DICOM viewer. If the above issue had remained insurmountable, this indeed would have been an option, although ultimately, such a solution would have detracted from the concept of eLearning and the pursuit of an entirely web-based teaching resource.

5.2.4 Release of scores and feedback issues
Release of scores and feedback appeared to be a contentious issue, raising comments from a large number of volunteers, including those who were generally less inclined to comment.

It was understood from the pilot study, and previously published research, that results and feedback are important to learners, maintaining interest and supporting a sense of achievement within any educational programme. To maximise its benefit and significance for the learner, it needs to be timely, useful and usable. This means taking into consideration, the release, format of feedback (whether informal, or formal) and its placement within the course structure (Rolfe & McPherson, 1995, p.838; Higgins, 2000, p.1; Learning and Teaching Centre, Macquarie University, 2008, p.2).

Timing and release of result scores, through the integrated software was
straightforward and through the establishment of question banks with answers, allowed for a quick turnaround of assessments. For example, scores for summative multiple choice assessments were instantaneously available as the test was completed, which was clearly appreciated by volunteers, who on several occasions would repeat tests to improve their scores.

Along with the electronic scoring, the question bank facility should have also enabled automatic feedback to be given on incorrect answers to multiple choice questions, a factor identified in the pilot study. Unfortunately, this facility was overlooked on the release of the main trial and had this feature been visible, it may have aided learning, reducing the number of concerns and level of assessment difficulties as perceived by some volunteers.

It is interesting to note that in the absence of this provision, a number of volunteers clearly stated in their informal exchanges, that it had made them seek out additional and relevant information from other sources such as the text books. This demonstrated ingenuity and motivation, and should be regarded as highly positive. Sadly, however, others appeared less willing to do this, with the expectation that all information should be provided, but this is another academic debate.

With regards to the provision of scores and feedback for the report writing and short answer assessments, these required an individual marking process to be adopted, thereby incurring some delay. Answers, as with traditional essay style exams, were more complex than anticipated, particularly with the report writing assessments, where volunteers, despite the guidance given, expressed themselves in different ways, often with use of colloquial language.

QMP does allow for marking of long question formats through the use of text matching, but as this was the first time the software had been used in this context, the facility was not used. In preference, and so as to identify any subjective variation within the report writing process and to establish level and depth of answers, it was considered appropriate to carry out the marking process 'by hand'.

Although time consuming, it enabled marks to be awarded for all anomalies
contributing to the overall image appearance, including degenerative change, renal activity, or artefact (for example – pacemakers). Although not necessarily pertinent to the referral, or likely to be of clinical significance, and therefore not mentioned in the reference reports, these incidental findings demonstrated the perceptive ability of the volunteers. In acknowledging them, this was regarded as a necessary step in the learning process and part of developing a systematic approach in image analysis, which was accommodated within the marking scheme. It was also acknowledged that such information could then be used to develop and inform any text matching facility for use in the future.

In addition to slow marker turn-around times, further delays became inevitable as a direct consequence of module flexibility. Volunteers were able to complete assessments at their own pace, inadvertently leading to staggered marking. To avoid potential discussion or sharing of marks (some volunteers were known to each other) it was not possible to release generic comments (Appendix XV) until all volunteers had completed each of the assessments.

With hindsight, deadlines should have been set for each section and summative assessments therein. Although this would have detracted from some of the flexibility of programme delivery, it would have prevented delays, made the marking load more manageable and from the volunteer’s perspective, possibly made the feedback more usable/effective for subsequent assessments.

Lastly, Victory did allow for discussion or chat room areas, which would have allowed ‘learner to learner’ interaction thereby providing a vehicle for informal feedback. Ultimately, due to logistical reasons, and to prevent bias of performance through information sharing, this facility was not used. Again with hindsight, had the opportunity been provided, it may have encouraged participation and mutual support within the social learning context, and greater insight into the ‘learner’ experience beyond the limitations of summative performance and the surveys.

5.2.5 Summary of volunteer reaction and experience
As a ‘trial’, there were elements which could clearly be improved relating mainly to accessibility, but as discussed, could be remedied. Other expressions of concern
related to quality of delivery, but again these could be easily addressed.

Clearly there were issues associated with the compatibility of some software used, although, one advantage of the eLearning design process was that successive iterations to amend, could be made in the light of problems encountered, thereby allowing a retrieval mechanism so adequate and meaningful data could still be acquired during the trial period.

The final point regards feedback and the release of marks. Feedback by its very nature usually provides comment on submitted work. Yet it also ‘feeds forward’ to the next assessment and should aid the learning process by offering reflection and constructive criticism from which the ‘learner’ can gain in knowledge, progress and improve. The format of the feedback was clearly insufficient and the inclusion of reported case study examples, opportunity for provisional reporting with individual feedback and also informal discussion regarding cases, perhaps through a ‘live’ forum, would have aided confidence and addressed this issue. Even, however, with the feedback format used, delays in its release meant it could not be used effectively to inform volunteers before they attempted the next assessment. It is possible that performance, particularly for the report writing elements, may have improved, had the feedback been more readily available. It would also have positively influenced the acquisition of expertise by establishing the clinical connection between a knowledge base and the visual perturbations seen.

In designing the eLearning interface, it was clear that access, usability and quality of features were not individually the sole focus and as Saffer (2007) points out:

“interface design is the experienced representation of the interaction design, not the interaction design itself” (Saffer, D. 2007, as cited in Clarke, 2009. p.2).

It was how these elements interacted with each other, and how they were perceived, which collectively created an appropriate setting in which the volunteers could learn and be supported. Overall, the module was extremely well received.
5.3 Volunteer learning - verification of diagnostic ability and accuracy of performance

5.3.1 Volunteer engagement
One of the research objectives was to assess the facilitation and effect on learning and performance, where results from assorted summative assessments, and engagement with the module, were key indicators to success and achievement.

As detailed in Chapter 4, the minimum engagement time of those completing the module, ranged from 8 hours 50 minutes, to a maximum of 35 hours 10 minutes, with an average time of 22.8 hours spent. This was within the anticipated range of 20–30 hours expected although some did fall short of this expected level of engagement. For those whose time commitment to the module was less than the average time expected (fifteen hours or less), performance across all assessments tended to be poorer than those spending more time. This supports the widely accepted correlation between engagement by ‘learners’ and the achievement of academic success. There was also some indication that those repeating assessment improved their performance scores.

5.3.2 Verification of diagnostic ability and accuracy of volunteers’ report writing performance
One of the main foci of the research was to ascertain whether the module, as a sole eLearning resource, could prepare and influence non-medical healthcare practitioners to acquire report writing skills, to a level of acceptable accuracy, so effecting a change in behaviour and acquisition of skill. Quite clearly, despite the reduced numbers of volunteers completing the module, the software problems encountered, and limited data, the statistical results verified a change in behaviour and ability. Though, the impact of diagnostic and therapeutic outcomes could not be conclusively ascertained within the remit of this research (Brealey and Scally, 2008, p.48)

Reflecting upon the British Nuclear Medicine Society criteria for reporting by non-medical practitioners (Appendix II.a.) it is clearly accepted that some non-medical practitioners are capable of offering a descriptive report possibly to Level 4, when
following a clear protocol. This entails the ability of the ‘reporter’ to justify the referral based on the contextual history of the patient, offer a description of appearances seen and to comment upon whether the said appearances are normal or abnormal. (It also implies, at Level 4, the ability to correlate findings with other investigations, which, as already stated, is an inherent limitation of this research due to the lack of access to other imaging modalities and patient case notes).

It was evident that the majority of volunteers improved in their ability to describe the image appearances (BNMS Level 2), and through the use of the Kappa statistics, volunteers clearly improved regarding their opinion of findings, from a ‘poor’ to ‘fair’ level of agreement with the original reference reports, albeit marginal (BNMS Level 3).

As noted in the methodology, Kappa is limited and does not make distinctions between various types and sources of disagreement. This may well have led to some inappropriate conclusions being drawn, especially where the clinical relevance of findings may be questioned, for example, degenerative findings. In such instances, given certain referrals, these may not have been considered significant by the original reporter, and so not recorded. Likewise, some incidental findings, unless clinically significant, were not included in the final reference report. Although many of the reference reports showed evidence of audit activity, where there was doubt, second opinions were sought.

The lack of veracity of the reference reports is noted and accepted as an oversight/shortcoming in the process and it is acknowledged that all cases should have been reported by independent observers. The use of triple reporting, using the same reporting schemes and parameters, would have reduced the potential for inter-observer variability, or scoring bias, and allowed for a more consistent and verifiable approach.

In seeking to establish whether it was possible to improve the skill base and competence beyond BNMS Level 4 to Level 6, volunteers were asked to record whether the findings were clinically significant. The Mann Whitney U tests, showed
the cohort statistically improved their performance (particularly between the initial and interim tests) in determining the significance of the findings and offering an opinion of the pathologies responsible.

Performance improved significantly between the initial and interim assessments, the pace of improvement slowed by the final assessment. Overall, between the initial and final assessments, specificity (+11%) and accuracy rates (+7%) improved, error rates were reduced (-7%) and there was notable drop in the number of false positive reports rates (-11%), although false negative rates increased (+9%) implying that the volunteers were ‘missing’ a number of abnormalities.

With regards to the predictive values and the likelihood of volunteers arriving at the correct decision regarding the outcome of the tests (whether they were truly positive, or truly negative) in relation to the reference reports, the positive predictive value increased by 19%. This was a successful result, demonstrating that beyond the more simplistic measures of assessing diagnostic accuracy, volunteers were better able to determine a positive test outcome, in the light of abnormal cases presented to them. However, their ability to determine truly negative cases as negative, did reduce to by 16% suggesting that they became more cautious, or non-committal in declaring a negative diagnostic outcome for those cases where disease was not present.

Whilst such results might be expected, the change in diagnostic accuracy may have been due to a number of reasons. Certainly the figures echo the phenomenon identified by Hardy and Culpan (2007, p.69) and Piper (2012, personal communication, March 15, 2012), where early marked improvement by those learning to interpret, is often followed by a reduction in performance, as the complexities of interpreting, and providing a report, in conjunction with relevant pathologies, are realised. This latter point was noted in generic feedback comments distributed to volunteers, where the pertinence of referral details were perhaps overlooked (BNMS Level 1) with volunteers concentrating on the major visual abnormalities, rather than more subtle or incidental anomalies, or failing to contextualise findings in the light of the referral.
It may have been useful to compare the intra-observer variability amongst the volunteers to ascertain their individual reporting ability and diagnostic performance. This could have been achieved through the use of receiver operator characteristic curves (ROC’s) as suggested by a number of previous authors. Although initially dismissed in the methodology chapter in preference to the use of Kappa and descriptive statistics, with hindsight, such statistical analysis may have brought greater coherence to the relatively limited data set and taken account of image presentations seen in nuclear medicine practice. It would also have allowed for greater distinction along the continuum of what may be considered ‘normal’ or ‘abnormal’, allowing for differences amongst the case population represented, and subjective nature of decision making in arriving at a diagnosis, rather than a single point of measurement. Again, this is another consideration to be taken forward, if the module were available to a wider pool of practitioners for training purposes.

With this in mind, it should be acknowledged that the research was somewhat isolated in nature, restricted solely to the performance of non-medical staff passing comment of nuclear medicine images only. Other research published in the area of the development of expertise, have considered comparative performance between expert reporters and either, junior medical staff and/or non-medical healthcare practitioners (Nodine et al, 1999, p.575; Hardy & Cuplan, 2007, p.68; Kundel et al., 2007, p.40 ; Kelly et al., 2012, p.90) in domain specific areas, such as mammography and trauma reporting. It would therefore have been interesting, and may be significant, to have widened the scope of the volunteer group to include other medical personnel to ascertain the influence of prior knowledge/experience.

In addition, it may have been beneficial to consider the impact of the eLearning module on performance, compared to more traditional methods of medical education. A number of those studies previously mentioned, have demonstrated the importance of mentorship, traditional face to face education or shared commenting schemes, which facilitate the development of ‘clinical knowledge’ and thereby expertise. Within the timeframe of this research, this aspect was largely overlooked, although the modest gains in performance reflect a potential change in ability and behaviour, and, given the profile of volunteers where the greatest gains were seen, are likely to be attributable to the module influence and learning.
achieved.

The most marked improvement was shown between the initial (baseline) and the interim reporting exercises, yet performance fell on the final assessment. Bearing in mind the phenomenon identified by Piper (personal communication, March 15, 2012), this may have been associated with the developing expertise, but at the time was connected with a number of more mechanistic issues. These included the timing of the module, by which volunteers nearing completion had to maintain their interest and motivation over the summer vacation period. This may have caused some volunteers to rush completion of the final assessment prior to the September module deadline, thus spending less time than was needed to adequately report findings, as borne out in feedback comments given to volunteers. It should also be remembered that external influences may have prevailed, including the loss of Victory due to vital maintenance work during the latter part of the trial, which may have had an impact.

Additionally, workload may have been an issue. As identified in the post-module survey, reporting twenty cases at any one time may have been too onerous, particularly for those volunteers trying to attempt the module during working hours, where other demands on their time or interruptions may have affected their ability to concentrate on the task in hand (a factor which had not been appreciated at the outset).

To this end, it should be remembered that any learning exercise should be realistically achievable, so perhaps the number of cases per reporting exercise should have been limited and remained consistent, with report writing tests within each section. In doing so, it may have been possible to show a more consistent improvement in performance across the entire cohort, with exposure to a greater number of cases, which would have contributed to the performance data generated.

With regards to the process and construction of reports and report writing, further development was needed. As Guralnick (2006, p.1) recognised, by understanding how the volunteers learn, using the set tasks, the effectiveness of the eLearning
design and interface could be gauged. Certainly, more explicit and gradual stages were desirable in order to develop and identify the learning process required in the development of interpretation skills. From the data generated, less experienced volunteers appreciated the use of the reporting grid and guidance, which helped provide a structured and systematic approach. For those volunteers who were already reporting, or learning to report, the reporting grid was perhaps too rigid and the need to develop a more freestyle reporting assessment was identified.

Similarly there was a need for greater linkage between the demonstration of various pathophysioologies, as shown by radionuclide imaging, and the reporting process, as mooted by several volunteers. Should the commercialisation of the module be realised, then the use of ‘expert’ contributors to develop specific case presentations of relevant pathologies, would clearly embrace a more discursive element, lending perceived added value and credibility.

As these were mature learners, the influence of experience should be taken into consideration. There was no direct link between years in practice and module completion or overall module performance. With an average cohort score of 62% for report writing assessments, there was no direct link shown. However, there was some suggestion that those, although not all, with less experience in nuclear medicine practice (5 - 15 years) benefitted from the module the most. These individuals demonstrated consistent improvement in two or more areas of report writing, between the initial and final tests suggesting that participation had influenced performance ability.

Clearly some volunteers were more adept at reporting than others, although those from known radiography backgrounds scored marginally better across the module as a whole. This perhaps challenges the parameters set by the BNMS that reporting by non-medical practitioners should be limited to those with greater experience, or certain levels of seniority and demonstrates that a reporting role should be based on the confirmation of individual ability.

It is prudent to add at this juncture, that a number of volunteers did reveal, following the close of the trial, that they were either already, or learning to report
bone scan images. Clearly for those with experience, more highly developed perceptual skills, and who were more proficient in decision making and reporting (Kundel et al., 2007, p.402; Nodine & Mello-Thoms, 2010, p.142) the influence of this prior experience would have increased their aptitude, placing them at a distinct advantage with pattern recognition and formatting of reports, which may have impacted on the results. Equally, however, they may have been constrained by the limitations of the reporting grid.

As one volunteer, a reporting radiographer, highlighted in an informal email:

“The report is interpretation (I know the BNMS guidelines are staged) not just a list of what can be seen. There needs to be a build up to a useful report by the end of the module.” (por507)

The reporting grid and prompts used in the report writing assessments, did establish an early proforma (based on BNMS guidelines for competence and knowledge levels) which for the uninitiated, gave a systematic introduction to the reporting process. Based on the performance results, it gave some credibility and suitability of the module in creating a learning environment and some suggestion that as an initial educational forum, it could be used to implement training for an informal comment system. However, for those seeking to expand, or test their existing performance levels for interpretation, the systematic approach may have been limiting factor and reducing commitment.

Indeed, reflecting upon an earlier review (Brealey & Scally, 2008, p.48), the research has not been able to verify, or validate performance and progression to higher levels of the evaluative hierarchy (Appendix II.b.). This is a key area requiring further research, looking into the process of learning to report and how best to develop this skill, not only in the initial stages, but also for more seasoned reporters, where the opportunity for a more discursive format would be of benefit.

One area which has not yet been fully discussed, is the level of complexity of the cases presented to the volunteers. Most of the cases held on the image data base were for suspected, or existing, metastatic disease. Quite rightly, it can be
assumed that the majority of referrals for bone scanning will be from this category, but clinical practice does give rise to cases from other referral sources, such as those with orthopaedic issues (including metabolic disease), rheumatology and degenerative changes. The presentation of cases from less common sources, in which volunteers may have had scant experience, may have negatively impacted on their ability to report in these instances. However, these accounted for less than 10% of the test bank of cases presented, and therefore any negative influence was likely to have minimal impact.

The way in which the images were acquired and saved, may have been hampered by visual display difficulties, such as dynamic sequences from multi-phase bone scans, which could only be shown in a composite images format, rather than frame by frame. (As previously discussed, this was due to difficulties encountered during the establishment of the image database). All these factors may have culminated in these cases being more complicated to report upon, although, the proportion of cases from less common referral sources were minimal, therefore unlikely to have influenced outcome.

In terms of perceived performance as judged against the level felt necessary to competently interpret bone scans, it was clear that the volunteers were realistic. The majority felt a level of 86%, or above, should be achieved. From their own self-assessed scores, volunteers were apt to be slightly ambitious with regards to their individual performance. In fact, no one achieved the desired level (although por519 scored consistently well), with the cohort average for each of the reporting assessments falling well below the expected level, which was disappointing. Again one must acknowledge there were some limitations with the module design and content which may have impeded performance.

5.3.3 Conclusions on reporting ability as verified by the results
In conclusion, evidence from the results of the report writing assessments suggest that the module had clearly influenced learning and acquisition of skills for some volunteers, although this would seem to be most overt amongst those with less experience.
Overall cohort performance indicated a statistically significant improvement regarding opinions of findings and determining clinical significance. The most marked improvement appeared to be between the initial baseline and interim tests, however, as suggested, this phenomenon may not be as unusual as first thought, where exposure to a wider range of cases, over a longer period of time may have led to more sustainable levels of performance.

With hindsight, it would have been beneficial to statistically verify individual scores and to ascertain intra-observer variability and performance, but with only limited cases reviewed by a relatively small number of volunteers, the use of the weighted Kappa statistics was not feasible. However, a performance index could have been derived by using the individual sensitivity and specificity results, yet within the timeframe of the project and the sheer volume of data, this was overlooked and is a point of learning which should be taken forward.

Volunteers needed to achieve a level of concordance of 95% (Nuclear Medicine Communications, 2004, p.751) in the descriptive content and overall accuracy compared to the reference reports, if they were to be considered equal to their medical counterparts, and a minimal risk to patients. Ultimately, despite volunteers clearly indicating increased confidence in reviewing images (n = 10) and reporting issues, the performance level was not sufficient to meet this criterion.

This may have been due to usability issues and time pressures, but it is more likely that it indicates an insufficiency in expertise amongst some volunteers at this point. As suggested in Section 4.4.4 (Figure 4.20) those volunteers from diagnostic imaging backgrounds scored better than their peers. This highlights the complexities in the development of expertise and the potential influence of prior and ongoing experience. It is likely the radiographers', because of their imaging background, possessed more highly developed perceptual skills and experience of pattern recognition, which, given this encapsulated and innate knowledge, were able to apply these strategies to the clinical cases presented. This placed them at an advantage compared to the non-radiographer volunteers who had not had access to the same professional influences. (Similar findings are echoed by various authors such as Kundel et al., 2007, p.402, and Nodine and Mello-Thoms,
One should also acknowledge that, regardless of professional background, those with reporting experience in nuclear medicine, including those already in training, were more likely to have been exposed to a significant caseload and possible input from nuclear medicine experts, which clearly would have benefitted their performance. However, all the volunteers, regardless of background would have benefitted from more constructive feedback and the use of a mentorship scheme to help guide and elucidate image findings (Gundeman et al., 2003, p.16).

In view of the limited data, one would be reluctant, at this stage, to accept the module and report writing assessments as a solely rigorous and reliable educational resource to teach the expertise required of a reporter. There is, however, evidence to suggest that as a supporting tool for initial training purposes, perhaps through a blended learning approach, there is some potential. Equally with the indication of improving performance by some volunteers, the possibility of further research to develop and hone a more effective resource, perhaps for self-audit purposes, should not be dismissed.

5.4 Volunteer behaviour

Within the time constraints of this research, changes regarding volunteer behaviour in their workplace/organisation, following the module experience, could not be formally gauged, although data regarding relevance to professional practice and immediate application could be ascertained.

By and large, most volunteers appeared to feel their professional learning and understanding of bone scan interpretation had been advanced \( n = 10 \), with clear relevance to both their current \( n = 11 \) and future role \( n = 11 \).

Evidently, the module had attracted a range of non-medical healthcare professionals, many of whom either were already or learning to report, so these comments and feedback were regarded as highly positive and supportive. In view of the range of experience amongst the cohort, it is possible that the
module did not reach the level of expectation which some desired. Having said that the volunteers gave favourable comment regarding their perceptions of the module contribution towards elements involved in report writing, such as legal issues where a majority (n = 12) felt they had gained, with ten suggesting they had acquired knowledge and understanding of bone scans and components associated with a report. In terms of report writing, eleven felt they had improved their skills, although less than half (n = 7) felt they had gained skill in interpretation, a factor raised earlier and a recognised shortcoming, again indicating the need to align design and learner activity.

Therefore, whilst the module may not have met all expectations, it appeared to have had a positive impact on current and future practice, causing some individuals to re-evaluate and reflect on their professional role, as indicated by one volunteers who suggested that:

“I did learn something about some disease processes and it made me look at my reporting style (although I have not changed it)” (por507)

Given this person’s role as a consultant technologist, this was positive praise indeed.

Further to this, once the closure/completion date for the module had been reached, the receipt of various unsolicited email exchanges demonstrated and repeated the impact this module brought. In many ways the content of these exchanges was more revealing than some of the formal feedback, as shown below:

“Thank you for allowing me to be participate in the trial, I found it very informative and rewarding”  
(por506, personal communication. October 26, 2011)

“I think the whole module is very workable and the trial has been a good thing. Hope it goes forward”  
(por507, personal communication. September 28, 2011)

“...I’ve thoroughly enjoyed completing the module, so thank you for the opportunity and for your timely communications”  
(por510, personal communication. September 15, 2011)

“It was good to be involved with the module”  
(por511, personal communication. October 14, 2011)
“I hope that it is a success ...I am currently learning to report.....I would be very interested in any other e-learning opportunities that you may organise”  
(por519, personal communication. October 14, 2011)

“I really enjoyed the course, it has helped to –re-energise me with reading up, and taking more of an in-depth look when I’m imaging”  
(por521, personal communication. October 16, 2011)

“Thanks again for your patience and effort in designing this fantastic resource”  
(por525, personal communication. October 02, 2011)

“I am pleased I managed to finish it and I certainly found it worthwhile doing”  
(por526, personal communication. October 18, 2011)

“I really enjoyed the course and look forward to hearing from you with my results”  
(por535, personal communication. August 25, 2011)

“I enjoyed being part of the trial.. it relieved the boredom a little and certainly gave me more insight into reporting”  
(por536, personal communication. October 18, 2011)

“Many thanks and good luck with the study”  
(por537, personal communication. October 17, 2011)

Not only were these remarks spontaneous and therefore quite gratifying in nature, they also confirmed the need for this type of learning opportunity amongst practising healthcare professionals and were constructive with regards to the perceptions of the module overall.

Of the sixteen completing volunteers, only one volunteer seemed to feel quite negative about the whole experience, as shown by their final email:

“.... the module wasn’t that useful to me. I knew it was only a trial when I chose to take part and hopefully the comments I have made will be useful. Sorry they are mostly negative”  
(por520, personal communication. October 14, 2011)

To have only one overtly dissatisfied individual is quite an achievement and it does demonstrate that as with any programme of learning, one cannot fulfil everyone’s expectations. Perversely, this volunteer appeared to be one of those who had made significant gains in the report writing exercises and had they been aware of this at the time of the email, may not have commented in such a negative light.
5.5 Summary of chapter five

During the course of this chapter, the volunteer profile, the ‘learner’ experiences through their interaction with the module and academic performance have been discussed and the research objectives, met.

A significant number of strong and positive findings, along with some highly constructive feedback were generated regarding eLearning design and interaction, although various inherent flaws and limitations, both in the design interface, content and implementation of the programme, were identified. These were not considered to be insurmountable and it is accepted that many of these could have been pre-empted with greater forethought and appreciation for the design interaction process.

The research has contributed to greater understanding of volunteers’ expectations, both as ‘learners’ and as practising healthcare professionals, which was useful, insightful and constructive and whilst no educational programme can ever be successful and complete at first iteration, the process has highlighted some key opportunities for further development.

From a professional and reporting perspective, whilst performance did not reach expected levels, there is some indication and cautious optimism to be realised, particularly in developing a programme to promote reporting skills, or for use as a simple self audit educational resource. With regards to the latter, audit is a valuable tool in confirming the efficacy and level in standards of practice, particularly in gauging inter-observer variability and accuracy. Whilst the majority of clinical reporting audits are carried out amongst colleagues, the use of a simple educational resource would help prepare individuals for such a task.

Finally, the research evidenced the lack of post-qualifying educational opportunities available to those within the sphere of nuclear medicine, emphasising the need for development. eLearning is clearly an effective and time efficient medium for education for all concerned and with further development, could be a significant contender in a highly competitive niche market for nuclear
medicine.

In considering a more holistic viewpoint, success of a programme such as this, could impact positively on improvement and retention of a discipline specific knowledge base, improved professional credibility, as well as the possibility of improving service delivery and ultimately more timely management of patients.
Chapter 6 – Conclusion

The concept for the module dates back nearly a decade, so much has occurred within the development of eLearning technology during this time. Its use within education and near ubiquitous access of the internet, has sustained interest, not just in supporting distance learning ventures, but also in integrating and embedding of the technology as part of the normal educational experience (which is now a common expectation amongst learners).

As the evolution and application of educational technologies has continued to expand, delays to the research have inadvertently benefitted the programme, allowing for the latest interactive technologies to be used in the creation of some effective and stimulating educational resources, which have clearly met with some success.

The acquisition of quantitative and qualitative data, confirmed the concept of the module itself, demonstrating a significant impact, good levels of satisfaction and cognitive gain, as well as influencing the achievement of skills and competence, providing an insight into issues that could be used to enhance and shape both current and future educational and professional practice.

It has confirmed the advantages of eLearning, its appeal and flexibility of use, which remain unchallenged, and even though this was a small scale study, the acknowledged geographical diversity of those taking part, has evidenced the national applicability and capability for this type of programme and the possibility of extending this to the international stage.

The following sections will consider the impact of the module at a local level, then look at the potential national/international implications and the future.
6.1 Application to practice

The research has identified a niche within the eLearning market for nuclear medicine educational provision. By integrating educational theory, analysing performance and feedback, it has shown that flexible learning, constructively aligned with the practice based model, often regarded as essential within healthcare education, has been highly constructive, positive and informative both from a technological, educational and professional perspective.

Various issues were highlighted that could be taken forward as development points, such as adaptations which would need to be made before considering releasing the product to a wider market. Many of these were related to the quality of content and delivery, such as the need for better instructions, supporting text, clearer aims and objectives within each section, as well as the use of summary slides and downloadable supporting material. Further refinement of some of the learning objects is also needed, such as with the ‘hot spot’ exercise, quality and synchronisation of audio tracks. Additionally, use of ‘live’ forums to encourage debate might address the need for more discursive elements with immediate, clinical colleagues. All of these could be easily remedied with relatively little investment.

Looking forward, forging partnerships with external providers, such as nuclear medicine clinicians and NHS hospital trusts, to incorporate specific ‘expert’ teaching elements and to construct a more coherent, inclusive case database, with permissions for access and use of material from all relevant parties, as per the clinical setting, would be an advantage. Not only would this help raise the quality of the cases used, but also help to contextualise them through the availability of additional information. It is accepted that this would take time to establish, but acknowledged this would add credibility to the programme.

What cannot be wholly explained were the drivers and expectations of those who failed to persevere or withdrew from the module. In addition to extraneous factors, this was possibly due to lack of initiative, or self-motivation, which fell short of expectations, but may have impacted upon the findings. Therefore, it should be
conceded that perhaps with a formally accredited course, such factors may not have been an issue, although this would need further research.

Regardless, for those completing the module, the content evidently achieved some considerable degree of resonance and relevance with participating volunteers, pertaining to professional learning and increased confidence in looking at bone scan images. From the formal and informal qualitative data, evidence showed volunteers recording a positive module experience with regards to their own clinical practice, which was clearly significant. Previous research had suggested that eLearning may be effective at imparting knowledge, but there is very little information available as to whether this new knowledge, or skills have been translated into changes in practice, optimising, or improving performance. This is a familiar shortcoming in teaching healthcare practice, so the overt commentary revealing a transition of theory to practice, was a bonus.

Indeed, from the survey data, many expressed an interest in undertaking a solely e-based module again, as a useful adjunct to support conventional learning, for the purposes of continuing professional development (CPD). Its use as a standalone module to teach a new skill such as interpretation was not considered an option, although this may have been attributed to the age profile of the volunteers being mainly digital immigrants and one variable which may change with more digitally literate generations,

In terms of reporting ability and module success in helping to develop competence, it undoubtedly influenced many of those taking part. The most marked improvement in performance was amongst the less experienced and whilst one can be optimistic that the educational resources had a positive influence, there was insufficient data to confirm the effectiveness of the module to enable achievement of competence to an acceptable level at this stage.

In summary, whilst it may not, in its current form, apparently be a suitable, sole vehicle for teaching a new skill or competence, it could be market ready as a supporting resource, or even a simple audit tool for CPD purposes, from which clear benefits, with appropriate validation and academic accreditation, could be
6.2 National/ international implications and the future

As shown by this research, there is growing and continued interest in the use of an eLearning model to support healthcare education and the wider healthcare community, supporting learners to achieve knowledge and skills in a safe, risk-free environment.

Higher educational institutions, supported and funded by nationally recognised organisations such as JISC and the Higher Education Academy, continue to raise the profile of eLearning within local and regional contexts, yet also beyond, to national and potentially international forums.

eLearning resources can, without question, offer a flexible and efficient way of delivering engaging and stimulating learning, although the use of web-based technology is fraught with problems, where financial, technological and cultural issues can create constraints, some of which were encountered within this research. With many resources developed at local level, often resting on the expertise and enthusiasm of a few individuals, quality can be an issue. Software design and compatibility issues often require further input and it is worth noting from industry, that evaluation of the instructional design, is often ignored, or overlooked (yet this is one of the most reliable tools for the continuous improvement and quality within any training system). Collaboration with software design teams and dedicated technological assistance can help to overcome this. In the current economic climate, this may not always be viable, and often necessitates a clear business model to be developed in order to facilitate collaboration between educators and possible private sector investment to show how eLearning may benefit both, which can be costly and time consuming.

Hence, much time is being invested in developing joint collaborative programmes and initiatives between various education providers, promoting the use of shared repositories, such as CETL University of Nottingham used in this research, where
learning resources can be optimised, shared, re-used, re-purposed, or adapted, as re-usable learning objects (RLOs) either for subject specific requirements, or for the creation of more generic content, as seen within many healthcare education provisions. Not only does this help optimise the output but also increases the opportunity for academics to develop and exploit their own eLearning presence. In addition to this, many educational and professional providers are seeking support from the private sector, such as with e-LfH.

This appears to allow infinite possibilities for creating innovative resources, but for healthcare educators creating provisions for healthcare workers, this may be curtailed due to internet access blocks from within the NHS, hampering the development and progress of collaborative schemes and remains a significant obstacle in spite of shared repositories and RLOs.

Owing to recognised constraints, many providers are sensibly moving away from institutional based learning platforms (VLE) with their inherent problems, to more open sourced software and the promotion of open educational resources (OERs). In some instances, recent initiatives, such as the Accredited Clinical Teaching Online Resources (ACTOR) programme, a consortium of five HEIs in the UK delivering postgraduate clinical education in human and animal healthcare, and the Pathways to Open Resource Sharing through Convergence of Healthcare Education (PORSCHE) project, have overcome the problem by sharing an infrastructure across the NHS and HE to provide seamless access to relevant resources, a factor clearly alluded to by one of the volunteers withdrawing from this research (p.78).

The key focus currently is on sustainable development of learning and teaching resources and where the findings from this research compliments this profile as the University of Portsmouth moves towards the provision of its intranet resources through open sourced software (Moodle) is clearly the future focus. This is a potential route for development, and one which compliments widespread internet usage. It also highlights the possibility to access a wider international forum.

Thus said, one caveat remains, which has not been broached within the remit of
this thesis. This regards copyright and intellectual property rights and also consent issues in the use of clinical information for teaching purposes, as per the image database established as part of this research. Ultimately, however, these should not be barriers to stifle progress. As shown by this research, practice-based education is essential to all healthcare practitioners, both at undergraduate and postgraduate level, and if the use of open source technology can provide access to a sustainable and relevant resource, then every effort should be made to disseminate and share the findings, not to work in isolation.

6.3 Recommendations and future work

At the time of writing, two articles are currently underway, one to an educational technology journal, the British Journal of Educational Technology, another to a professional journal, Radiography, to disseminate the findings from this research, namely regarding the experiences of establishing a stand alone eLearning module and its potential professional impact.

The research process has identified various development points, on which to base recommendations for further research:

- Extend the module to a six month time duration, to allow realistic completion of whole module, albeit with intervening section completion deadlines;
- Ensure any additional software used is compatible with the VLE and DICOM formatted image display, so as to provide a ‘true-to-life’ context for situational learning;
- Improve the efficiency of assessment marking and provide timely feedback;
- Further explore methods to improve the quality and delivery of content;
- Develop and widen the scope of the content to enhance relevance to reporting, with presentations from expert reporters;
Further research and develop the educational resources needed to teach the skills required in the reporting process, progressing from ‘novice to expert’ status;

Seek to identify the latest technologies which would enhance interactive learning and make it more responsive to individual learner needs (adaptive learning);

Explore the adoption of and conversion to sustainable open source resources;

Explore the possibility of accreditation with HEI and support from the professional bodies.

6.4 Conclusion summary

The overarching aim of the research was to design, create, and implement an eLearning module to assess its effectiveness in creating a credible teaching resource to prepare non-medical healthcare practitioners to report nuclear medicine bone scans, has been met. In doing so, this project has gone some way to re-dress the imbalance of research in this area, particularly with regard to the use of stand alone eLearning models. Although a relatively small scale trial, the findings are relevant and in keeping with providing and preparing for new working practices and professional advancement. Not only does it demonstrate how eLearning can address some of the current shortfall in the development of resources, but it has also demonstrated how specifically designed material can allow learners a safe, yet stimulating environment in which to exercise and practise their skills.

From professional and educational perspectives, it has provided an insight into the type of elements appropriate for the development of report writing skills and the possibility for technological advancement of eLearning resources and assessment. Above all, it has highlighted a gap in nuclear medicine educational provision and a body of non-medical healthcare professionals, who are capable, eager to learn and committed to developing their skills and competencies in the interests of improved service delivery, enhanced professional and discipline specific profiles,
and career advancement.

New technology and research continually informing and updating the educational process and eLearning will continue to evolve as new, effective and interactive innovations become available. In a world where access to education can be global, eLearning is a multi billion euro industry open to many different providers, there is clearly an opportunity to be at the forefront of sound educational investment, where positive transition of learning into action through eLearning provision, would be a competitive advantage.

One sobering reminder would be for all HEIs need to collaborate more inclusively and effectively with each other, and with external providers, whether they are NHS, or private companies. It is entirely possible, if the higher educational institutions move too slowly, they may find themselves eclipsed by the private sector, with many products already coming to market, and it is a salutary reminder for professional groups and educators, not to be complacent.
References


Donovan, T., Manning, D.J. (2006). Successful reporting by non-medical practitioners such as radiographers will always be task-specific and limited in scope. *Radiography, 12*(1), 7-12.


Appendix I –
Search strategy for review of relevant literature
In order to inform and optimise the research process, it was important to identify and search literature previously published on this topic area. The subject area encompassed key, yet different foci, so three overarching themes were identified, which needed to be separately searched and reviewed. These were: learning theories (including andragogy/ professional learning); eLearning; and reporting of diagnostic images by non-medical practitioners.

As each of these topics have been previously, and extensively researched, both from academic and professional perspectives, the search was restricted mainly to peer reviewed, published articles/journals in English language, to enhance/ ensure credibility and validity of source information used.

Search dates inclusions/exclusions were varied depending upon the topic, for instance, learning theories and andragogy were given a wide latitude so as to encompass seminal works by, for example, Bloom and Biggs, whilst eLearning and Reporting by non-medical healthcare practitioners were restricted to 2000-2011 and 1990-2011, respectively.

These were accessed through use of search engines and database searches, using Boolean logic to frame and define search sequences, such as ‘radiographer’ AND ‘reporting’ OR ‘image interpretation’.

Search engines such as PubMed/Medline; Scopus and the University of Portsmouth electronic journals resource. These gave access to peer reviewed journals including Radiography, British Journal of Radiology, Radiology, Synergy (although the latter is not peer reviewed, it provided useful source material) and educational journals, such as the British Journal of Educational Technology.

Other sources included the world wide web, which although not peer reviewed, making it difficult to validate some material found, was none-the-less an invaluable resource. Searches were limited to specific professional sites and special interest groups, such as the Higher Education Academy (http://www.hea.ac.uk); Joint Information Services Committee (http://jisc.ac.uk); British Nuclear Medicine Society (http://www.bnms.org.uk); Royal College of Radiologists (http://www.rcr.org.uk); Royal College of Physicians (http://www.rcp.org.uk);
Society and College of Radiographers (http://www.scor.org.uk) and other academic institutions, such as CETL, University of Nottingham.

An assumption was made early on the in development process, that owing to the technological emphasis of the research and rapid recent advancements within this field, books were likely to be of limited value to the research. This was largely correct, however, use of the catalogue and hand searching through the University of Portsmouth library, revealed some credible books (educational and statistical) which were used at various stages during the research process.

As anticipated the search revealed a broad and extensive collection of relevant texts and articles, which were then reviewed, revised in terms of relevance then collated according to the three main foci and used to inform and contextualise the module development and its findings.
Appendix II –
Competence, knowledge levels, hierarchy & design parameters for assessing diagnostic performance
Appendix II.a. Knowledge & Competence Levels as per BNMS Guidelines (2005, p.1)

Table 1: Levels of Competence

1. Appreciation of the indications for referral for investigation;
2. Description of image appearances;
3. Ability to differentiate between normal, abnormal or normal variants;
4. If indicated, the need to recommend further imaging/ or alternative investigations for the purposes of correlation;
5. If an abnormality is demonstrated, the ability to comment or offer opinion on the most likely condition causing the abnormality;
6. Prognostic indication for the patient.

(based on BNMS guidance, 2005. P.1)

- **Level 1. Indication for the investigation** - This infers the reporter’s ability to assimilate the justification for the examination, demonstrating an ability to contextualise the likely findings given the patient history;
- **Level 2. Description of the appearances seen** – This allows the reporter to comment on the radiopharmaceutical used and its dose; the technical quality of the scan; images acquired; whether these are appropriate given the indication for the investigation;
- **Level 3. Visual opinion** – This allows the reporter to pass comment on visual findings, that is, whether the scan is normal or abnormal (including any normal variants/ artefacts),
- **Level 4. Correlation** – This includes correlating and comparing findings with other investigations, such as plain film, MRI;
- **Level 5. Clinical comment** – This part of the report allows the reporter to comment on the significance of abnormal findings, giving an opinion of the most likely condition and possibly indicating, or recommending further imaging/ investigations;
- **Level 6. Prognostic Value** – This is where a prognostic opinion for the patient may be given.
The modular content should include the following knowledge elements, which are considered important (BNMS, 2005):

**Table 2: Key Knowledge Elements**

1. Basic principles of anatomy and physiology associated with the skeletal system;
2. Choice and localisation of appropriate radiopharmaceuticals;
3. Equipment functions, limitations and artefacts;
4. Alternative imaging techniques, role and contribution
5. Factors affecting radiopharmaceutical distribution (such as pathology, drug interference)
6. Image interpretation, common and rarer appearance, correlation with alternative imaging, likelihood of patterns of pathology given clinical information);
7. Prognosis and management of relevant conditions

*(based on BNMS guidance, 2005, p.2)*
Appendix II.b. Evaluative Hierarchy used to assess the effects of radiographer reporting (as reproduced from Brealey and Scally, 2008. p.48)

**Technical Competence:** Do radiographers use visual search patterns comparable with that of an expert?

**Diagnostic Performance:** Do radiographers accurately interpret films in comparison with a reference standard? Do radiographers consistently agree with the expert observers in clinical practice?

**Diagnostic outcome:** Does radiographer reporting improve clinicians’ diagnostic confidence and understanding?

**Therapeutic outcome:** Does radiographer reporting contribute to the planning and delivery of therapy?

**Patient outcome:** Does radiographer reporting result in the improved health of the patient?

**Societal level:** Is the cost (borne by society as a whole) of radiographer reporting acceptable?
Appendix II.c. Key design parameters to consider in diagnostic performance studies (adapted from Brealey and Scally, 2008. p.e49)

- Was an appropriate selection of cases (e.g. images) included that comprise the caseload to be used in the evaluation?
  
  Yes – as indicated in Chapter 2, cases were randomly selected from the image database based on referral rather than presence of abnormality as indicated by the reference reports.

- Was an appropriate group of observers (non-medical practitioners) selected for the evaluation?

  Yes – as the trial was directed at non-medical practitioners invited to participate through the distribution of flyers at the BNMS conference 2011 and a web-based advert, selection was appropriate yet random in nature resulting in participants from multiple hospital trust sites taking part.

- Were the conditions under which the reporting is undertaken adequately described?

  Through the VLE platform, with generic guidance on how to use the QMP and WebAiMS software, plus with additional instructions offered at the beginning of each assessment and the use of a structured reporting grid, conditions were consistent and controlled

- How was the reference standard defined and applied?

  Reference reports were issued by consultant physicians and radiologists working within the two hospital sites from which image cases were obtained. Many of these indicated evidence of internal audit activity

- Was the reference standard report made blind to the knowledge of the observer’s report and vice versa?

  All volunteer observations were ‘blind’ to the original reference reports.

- Was an appropriate arbiter selected and did they compare the report blind to whether they were made by an observer or reference standard?
Only informal arbitration was applied to reference reports where there was no overt clinical outcome. These were in the minority.

- Were there explicit criteria for determining agreement between reports? Using a standardised reporting grid, attributed to specified criteria applied across each of the report writing assessments, allowed for consistent allocation of marks.

- Was an appropriate control group selected if the effectiveness of an intervention (for example, a training programme) is to be evaluated? No, although in essence, volunteers participating in the trial could be used as a control group against which to assess any future programme.
Appendix III -
Research & ethical approvals
21 January 2008

Mrs Penelope J Delf
Glenthorne
Maurys Lane
West Wellow
Romsey
Hampshire SO51 6DB

Dear Mrs Delf

Re: Application for Progression to Professional Doctorate Stage 11, Part 11

I apologise for the delay in sending you this formal notification but I was away from the University for some weeks before Christmas and I am only now in the process of catching up with outstanding work.

Thank you for submitting our application for Progression to Professional Doctorate Stage II, Part II. I am pleased to inform you that the Faculty Research Degrees Committee has approved your application, and your registration has been upgraded.

I enclose copies of the reports for information and advice with the project and final thesis. Also returned are two copies of your submission as returned by the assessors.

Best wishes.

Yours sincerely,

Hilary Gillians
Research Degrees Officer

Cc: Dr Alan Castle
Dr Graham Mills
Charlotte Roberts
Appendix III.b Approval from the School of Health Sciences and Social Work Research Ethics Committee.

Dr Jeannette Bartholomew BSc PhD PGCE ILTM
Head of School

Penny Delf
School of Health Sciences and Social Work
University of Portsmouth

14 July 2010

Dear Penny

Application to SHSSW Research Ethics Committee: To develop and evaluate the efficacy of an online learning module to train non-medical staff in reporting Nuclear Medicine bone scans

Thank you for your response to the School of Health Sciences and Social Work (SHSSW) Research Ethics and Peer Review Committee.

Committee members would now like to give a favourable opinion.

Best wishes and good luck with the project,

Dr Rebecca Stores
Chair of SHSSW Research Ethics and Peer Review Committee
Appendix III.c  Letter of support from the Chair of the Research Ethics Committee for the Isle of Wight, Portsmouth and South East Hampshire (COREC)

DC/sta

5 December 2008

Ms Penny Delf
Centre for Radiography Education
University of Portsmouth
Portsmouth
Hants

Dear Penny

Thank you for your enquiry regarding the status of your proposed research as discussed at our recent meeting and outlined in your email to me. I am of the opinion that your project would not be considered as NHS research and therefore does not have to be reviewed by a NHS REC

Most significantly I agree that the proposed study does not constitute research as defined in key documents including the Research Governance Framework and Governance Arrangements for Research Ethics Committees. It would appear to be a clear example of service evaluation – you are intending to evaluate the efficacy of a teaching package.

In summary

1. The projects are not NHS research insofar as there is no intention to derive generalisable new knowledge
2. As the activities proposed are not research, the criteria stated in GAIREC 3.1 do not apply
3. Notwithstanding 2 (above) it might be observed that the data you intend to access is patient data; however, in itself, it is not the subject of research. In brief, neither patients nor their data are subject to research.
4. There are, of course, legal and ethical concerns with regard to you accessing the data you require. These should be addressed via normal data protection measures. As I understand matters, the data can be provided as long as it is in anonymous form
5. Your research participants will be University students so you will still need to submit your proposal for review by the appropriate departmental / faculty research ethics committee

Yours sincerely

David Carpenter
Chair – Isle of Wight, Portsmouth and SE Hants NHS Research Ethics Committee

An advisory committee to South Central Strategic Health Authority
Appendix IV-
Overview of module sections & subsections.
Appendix IV. Overview of sections and subsections

Module Section 0.0

Module Section 0.1 included initial information about the module concept, module aims and objectives;

Module Section 0.2 contained two Captivate presentations with audio, detailing the functional features of WebAiMS and Questionmark Perception;

Module Section 0.3 Every care was taken to emphasise that this was an evaluation of eLearning, looking at the efficacy of a sole eLearning module to teach a new skill/competence and that participation would not lead to an accredited award by the University of Portsmouth. To this end, accepted volunteers were asked to complete the e-based Consent/Disclaimer form set up in QMP survey format (Appendix XII) prior to accessing the module. This was also used to indicate consent for the programme facilitator to use their anonymised data for research purposes (in accordance with research ethics guidelines from the School of Health Sciences and Social Work, University of Portsmouth);

Module Section 0.4 It was important to collect demographic and professional data of all participating volunteers through the Pre-module survey. This allowed for the volunteer profile to be established, including details of their professional backgrounds and years of experience.

In addition, two baseline tests were included, using real cases from the image database, with associated details patient referral details. These initial assessments were used to establish the incoming level of knowledge and ability, which would then be used to gauge subsequent assessment and progression performance. These were designed using WebAiMS and QMP.
Module Section 1.0

Module Section 1.1 included interactive and presentations with audio, on the principles and history of bone scans and three interactive presentations from CETL, University of Nottingham to prompt volunteers about their learning styles, needs and approaches to learning;

Module Section 1.2 Formed an assessment and quiz section, including an online self-test element from the publishers McGraw and Hill about bone anatomy, and a summative, short answer QMP test about bone scans to test the depth and accuracy of volunteers’ knowledge about this area.
Module Section 2.0

Module Section 2.1 contained interactive presentations, with audio reviewing breast and prostate anatomy, significance of metastases and management of bone metastases;
Module Section 2.2 covered basic skills associated with interpreting/reporting bone scans in nuclear medicine (including normal bone scan appearances and interpreting for abnormality). Presentations on sensitivity and specificity of diagnostic tests from CETL, University of Nottingham were also included, plus a standardized reporting grid;

Module Section 2.3 involved a selection of formative and summative assessments to test existing and knowledge gained about topic areas. These were created using WebAIMS and QMP software, with multiple-choice questions and cases to support learning and assessment. A simple, interactive, hyperlinked presentation to self test visual acuity and knowledge was also included.
Module Section 2.4 gave hyper-links to web-based materials relevant to the topics covered such as breast cancer and prostate cancer networked sites.
Module Section 3.0

Module Section 3.1 covered further anatomy and pathophysiology relevant to common referrals in nuclear medicine, such as arthrides, primary bone tumours and metabolic disease processes, such as Paget’s Disease;
Module Section 3.2 sought to build on previous sections, introducing the concept of report writing and issues associated with this activity;

Module Section 3.3 (as in Module Section 2.3) incorporated assessments relevant to the section subject matter, created with QMP and WebAIMS (again including some formative assessments);

Module Section 3.4 gave hyperlinks to further web-based material pertinent to the subjects covered.
Module Section 4.0

This final section brought together knowledge and experience acquired throughout the module.

Module Section 4.1 was composed of various assessment elements, each created and used to gauge progression and performance between the initial baseline tests and completion of the module. It was anticipated this would demonstrate the impact of learning, knowledge acquired and progression in terms of performance and possible competence in interpreting nuclear medicine bone scans.

Module Section 4.2 gave access to the post-module survey which formed a significant role in evaluating the module as a whole. Using QMP to create it, with the inclusion of questions designed to elicit both qualitative and quantitative information, it was divided into four key parts: Part 1 – looked for feedback on technical issues; Part 2 considered the volunteer experience/interaction with the content; Part 3 sought to evaluate the learning; Part 4 look at the overall module experience.
Appendix V –
SCORM & SENDA definitions
Appendix V. SCORM and SENDA definitions

**SCORM.**
SCORM compliance refers to Sharable Content Object Reference Model (SCORM) which is a compilation of technical specifications and standards specifically aimed at web-based eLearning, governed by the Advanced Distributed Learning Initiative (ADL). One of its primary purposes is to ensure the accessibility, interoperability of the learning management system, its content and its reusability. In order to ensure the eLearning content was SCORM compliant – it was designed to meet the following requirements: delivered via a web browser; self-contained e.g. in a ZIP file; not dependent on server-side script languages; or dependent on external URLs of external files; or reliant on downloadable components installed by an administrator. (SCORM, nd).

**SENDA**
Compliance with the Special Educational Needs and Disability Act 2001 (SENDA) ensures every effort was made so that the rights of any disabled volunteers would not be discriminated against. The Act protects the rights of disabled volunteers to access ‘education, training and services which are provided wholly or mainly for students ..... enrolled on courses provided by responsible bodies’ which includes higher education providers (http://www.accessibility101.org.uk/sendap.1). This means that reasonable adjustments were made to make sure such volunteers were not disadvantaged or treated less favourably compared to other volunteers. Therefore, in the context of this project, ‘reasonable adjustments’ ensured, where appropriate, that the website design was relevant and observant of the W3C standards and recommendations from the outset. In addition, the physical features of the web utilities enabled any such volunteer to access, with ease, the course materials by means of their format, combination and variety.
Appendix VI – Overview of rejected software packages
Appendix VI. Overview of rejected software packages.

**Survey Monkey™** - Initially Survey Monkey™ was considered for use in this project. With no software to install and basic tools being freely available, it appeared to be a suitable vehicle for the assessments proffered for this module. Certainly in terms of questions types, it offered easy access to survey type tools which could be utilised for the Pre and end of module surveys. It also offered a comprehensive selection of different question types (15 in total) which were readily configured such as Multiple Choice, Rating scales and the ability of text box/comment responses. It also allows for the inclusion of images or diagrams, for assessment purposes. However, as an assessment authoring tool for this project, despite evident advantages in terms of ease of use, it was quickly ruled out, as it did not offer the facility for self-assessment by volunteers and therefore would not enable formative assessments, which were considered a necessary part of this module, to take place.

**Victory** - As Victory (Blackboard™ enabled product) formed the overall management platform for this module, it was well placed to provide the assessment tools needed for both formative and summative assessments, with ease of access without the use of separate logins.

It does allow for various different question type formats and the creation of question banks (including multiple choice, short answer questions and self-assessment facilities) although the variation of type was limited. There is also a Grademark facility whereby volunteers can receive grades and feedback.

However, it was found that it would not easily support the use of images for inclusion within the questions, or provide the inter-activeness afforded by Questionmark™ Perception™. It was also limited in its ability to provide means for survey type questions, including Likert scales to be used.

For this reason was rejected for use as an assessment or survey tool for this project based on its lack flexibility.
Appendix VII –
Bloom’s taxonomy related to Questionmark™ Perception™ question types
Diagram of Bloom’s Taxonomy related to Questionmark™ question types

Evaluation (Level 6)
- Report writing

Synthesis (Level 5)
- Creation of responses based on information previously taught and own experiences (e.g. short answer)

Analysis (Level 4)
- Questions capable of assessing at analysis level such as multiple choice & multiple response questions

Application (Level 3)
- Such as the hot spot assessment

Comprehension (Level 2)
- Covered within multiple choice and short answer questions

Knowledge (Level 1)
- Covered within multiple choice and short answer questions
Appendix VIII – Permissions from hospital trust sites to use images.
20\textsuperscript{th} March 2007

Mrs Penny Delf,
Senior Lecturer,
Centre for Radiography Information,
School of Health Sciences and Social Work,
University of Portsmouth.

Dear Penny,

The Nuclear Medicine Department of Poole Hospital would be happy to assist in the development of an experimental web based teaching course at the University of Portsmouth. Once patient consent has been established the Department will provide anonymous bone scan images and clinical reports. This project has the support of the Head of Department and the lead Radiologist.

Yours sincerely,

Dr Kat Dixon
Senior Clinical Scientist
Nuclear Medicine Department
Tel: 01202 442185
Appendix VIII.a. Permission to use images granted by Southampton University Hospitals Trust

Novell WebAccess

Mail Message

Wed, 11 Apr 2007 15:01:35 +0100

From: "Nick Bryant" <Nick.Bryant@suht.swest.nhs.uk>
To: <Penny.Delf@port.ac.uk>
Subject: Reporting Course - Doctorate project
Attachments: Mime.822 (4029 bytes)

Dear Penny,

Thank you for the details of your project and our discussions.

Please inform me as soon as we can be of assistance regarding images and any recruits onto the course.

Please accept this email as confirmation of my full support.

If in the meantime I can be of any further assistance, please contact me.

Regards,

Nick Bryant
Department Manager
Nuclear Medicine
Southampton General Hospital
Tel. 023 80 796211
e-mail. Nick.Bryant@suht.swest.nhs.uk

Nick Bryant
Department Manager
Nuclear Medicine

http://dundee.iso.port.ac.uk/gw/webacc?action=ItemRead&context=er7oo7Uk3... 20/05/2007
Appendix VIII.b. Permission granted by Poole Hospital NHS Trust, Research Governance Department.

Re: On-line training programme for Nuclear Medicine

Following our recent telephone conversation, the Study you are undertaking is evaluation of the education programme rather than research. Therefore you do not require the project to be reviewed against the Research Governance Framework for Health and Social Care (2nd Edition 2005).

As you are collecting patient images please can you liaise with the Information Governance Manager (Richard Hatton Telephone No: 01202 442866) to ensure that the Data Protection Act 1998 and Caldicott Principles are met.

Regards,

Yours sincerely

Mary Burrows
Research Governance Manager

cc: Richard Hatton
Appendix VIII.b. Permission granted by Poole Hospital NHS Trust, Research Governance Department.

Further to our telephone conversation last week I can confirm that we agree in principal for this to go ahead.

If you have any queries please do not hesitate to contact me.

Regards,

Lyn Griffiths
Information Governance Management Assistant
Poole Hospital NHS Trust
Tel: (01202) 442866

DISCLAIMER: This e-mail and any files transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed. If you are not the intended recipient, any reading, printing, storage, disclosure, copying or any other action taken in respect of this e-mail is prohibited and may be unlawful. If you are not the intended recipient, please notify the sender immediately by using the reply function and then permanently delete what you have received. Any views or opinions expressed are those of the author and do not represent the views of Poole Hospital NHS Trust unless otherwise explicitly stated. The information contained in this e-mail may be subject to public disclosure under the Freedom of Information Act 2000. Unless the Information is legally exempt from disclosure, the confidentiality of this e-mail and your reply cannot be guaranteed.

Please check for viruses before accessing attachments. Although we endeavour to keep files clean we can take no responsibility for any damage caused by contagion.
Appendix VIII.c.  Patient recruitment, consent & disclaimer form.

Name of Investigator: Mrs P Delf, Senior Lecturer, University of Portsmouth
Contact details: Centre for Radiography Education. University of Portsmouth
Tel. 023 9284 5397

Information regarding Patient Consent for the Prospective Use of Nuclear Medicine Examination Data to Establish a Data Archive for Teaching Purposes

You are being asked to volunteer consent for the use of the data from your Nuclear Medicine examination, to establish a comprehensive digital data archive for teaching purposes. All information, will be coded and anonymised.

What is the purpose of the teaching archive database?
The database is being established as part of a Doctoral project, which aims, using the data archive system, to establish the effectiveness of an e-learning course, to train medical and paramedical Nuclear Medicine personnel in reporting Nuclear Medicine bone scans. The project has two overall aims: 1) to set up and implement an on-line course; 2) to assess the credibility and effectiveness of learning by the study participants. The archive database will be used to illustrate course content and for assessment purposes only.

Why have you been asked to take part?
We are inviting all patients referred for a Nuclear Medicine bone scan, to take part in the study. Taking part is entirely up to each individual. If you do decide to take part, you will be given this information sheet and asked to sign a consent form. You are free to withdraw at any time, without giving a reason and your data will be removed from the database immediately. A decision to withdraw from the study will not affect the standard of care you receive.

What will happen if you do take part?
If you decide to take part in this study, you will not be required to do anything over and above that required of a patient undergoing a standard bone imaging study. There will be no intrusion on your care, or to your subsequent management. We purely wish to gain your consent to use your examination data for teaching purposes.

Once your scan is completed, and if considered to be of educational value, it will be added to the database.

Only the following information will be contained on the database:
• Age at time of scan
• Gender
• Brief clinical history pertinent to the scan
• Images form the bone scan
• Report written by fully trained clinical team.

In order to anonymise data, Information such as name, address or date of birth will not be included. However, to collect all relevant information to your history, it may sometimes be necessary for the researcher to have access to your clinical records.

Please note: the images sought are being used as an educational tool and are not the focus of the study itself.
Appendix VIII.c.  Patient recruitment, consent & disclaimer form

Confidentiality
All information about your participation in this study will be kept strictly confidential. All information which is collected about you during the study will be kept strictly confidential. As the training database will be completely anonymous, it will not be possible to identify you from the information contained within it.

Contact details
If you require further information about this study please contact Mrs Penny Delf, Senior Lecturer) on 023 9284 5397 (Tuesdays – Fridays) or by email at penny.delf@port.ac.uk

Thank you for taking time to read this information sheet.
Appendix VIII.c. Patient recruitment, consent & disclaimer form

CONSENT FORM

WORKING TITLE OF PROJECT:
The Development of an E-based Postgraduate Reporting Course on Skeletal Imaging in Nuclear Medicine

NAME OF RESEARCHER: Mrs P Delf, Senior Lecturer

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<td>1. I confirm that I have read and understood the information sheet dated (version 2.0 March 2007) for the above study and have had the opportunity to ask questions.</td>
</tr>
<tr>
<td>2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, and without my medical care or legal rights being affected.</td>
</tr>
<tr>
<td>3. I agree to volunteer consent my examination data for establishment of the teaching archive.</td>
</tr>
</tbody>
</table>

Centre Number:
Patient Number:
Patient Identification Number for Archive Purposes:

___________________________  __________________________  __________________________
Name of Patient                Date                        Signature

___________________________  __________________________  __________________________
Researcher/Department Staff Member Date                        Signature
Information about you will only be given to your relatives and carers with your consent

Updating information

We have a duty to keep your records up to date. Please inform us of any changes that occur or any errors of fact you are aware of.

If you want to know more

If you would like to know more about how we record or use your information, please contact the

Health Records Manager or
Data Protection Officer

at the following address:

Corporate Information Services
Mailpoint 79
Old Nurses Home
Southampton General Hospital
Tremona Road
Southampton SO16 6YD

Confidentiality and use of patient information

Information for patients

At Southampton University Hospitals NHS Trust, we collect and hold information about you to enable us to give you the correct care and treatment.

The information will be kept on a computer or paper record (or both). It forms part of your Health Record and will be kept in case we need to see you again.

This leaflet tells you more about the information we hold and how it is used.

Everyone working for or on behalf of the hospital has a legal duty to keep any information held about you confidential.
Example of patient information leaflet from a participating Trust

Appendix VIII.c.
Appendix IX – Example of Pilot semi-structured interview feedback questions
Appendix IX. Example of Pilot semi-structured interview feedback questions

<table>
<thead>
<tr>
<th>Review of nuclear medicine - interpretation module</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please tick the most appropriate answer)</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
<tr>
<td>Found the initial instruction to access the module easy to follow</td>
</tr>
<tr>
<td>The layout of the module was easy to navigate</td>
</tr>
<tr>
<td>The colour scheme used in the module context was easy to see</td>
</tr>
<tr>
<td>Instructions for assessments were easy to follow</td>
</tr>
<tr>
<td>Presentations were engaging</td>
</tr>
<tr>
<td>Presentations were &quot;better&quot; with audio</td>
</tr>
<tr>
<td>Assessments were varied</td>
</tr>
<tr>
<td>Found the interactive presentations useful</td>
</tr>
<tr>
<td>Found the use of the MCQ assessments helpful</td>
</tr>
<tr>
<td>Found no difficulty in accessing WebAIMs</td>
</tr>
<tr>
<td>Found no difficulty in accessing the &quot;Questionmark Perception” assessments</td>
</tr>
<tr>
<td>Found WebAIMs assessments useful</td>
</tr>
<tr>
<td>Felt confident in the level of information presented to me</td>
</tr>
<tr>
<td>Didn't feel comfortable in using a computer as a learning resource</td>
</tr>
<tr>
<td>The assessments allowed me to test the full extent of my knowledge</td>
</tr>
<tr>
<td>The elements covered in the module encouraged me to think for myself</td>
</tr>
<tr>
<td>Can access information in my own time</td>
</tr>
<tr>
<td>Prefer face-to-face teaching</td>
</tr>
<tr>
<td>pilot distance learning with computers ideal for my lifestyle</td>
</tr>
</tbody>
</table>

Based on Upton, 2004
# Pilot Volunteer Feedback - Semi Structured Interview

Please score how useful or interesting you found the following 1-5 (1 being the lowest score you would wish to give, 5 being the highest). Please give any additional comments as appropriate.

<table>
<thead>
<tr>
<th>Did you feel adequate contact was made prior to the start of the module?</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were the instructions to access the module easy to follow?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were the instructions regarding usernames and passwords self-explanatory? (including how to access WebAIMs and QMP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you note/ have to access the 'help' pages?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you note/ have to access the 'useful' websites?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How would you rate the layout (in colour coded sections)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Section 1 - how would you score the following elements?

- Welcome message & module overview
- Surveys: Initial demographics survey and WebAIMs quiz
- Presentations - Bone scans and learning styles
- Assessments (Bone MCQs and a self test on bone scans)
- Are there any general comments/ improvements/additions you would make to this section?

## Section 2 - how would you score the following elements?

- 2.1 Anatomy presentations with audio
- 2.2 Image Interpretation - basic elements (incl RLO's from CETL)
- 2.3 Assessments - Hyperlinked ppt, Breast / Prostate QMP,
### Pilot Volunteer Feedback - Semi Structured Interview

<table>
<thead>
<tr>
<th>Section 3 - how would you score the following elements?</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Arthritis, Pagets, Metastases presentations</td>
</tr>
<tr>
<td>3.2 Writing Report in Nuclear Medicine presentation with audio, ROI from CETL on positive &amp; negative predictive values</td>
</tr>
<tr>
<td>3.3 General MCCs, WebAims and Hot Spots</td>
</tr>
<tr>
<td>3.4 Additional web links</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 4 - how would you score the following elements?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Final Assessments in QMP and WebAIVIs</td>
</tr>
<tr>
<td>4.2 Post module survey</td>
</tr>
</tbody>
</table>

#### Additional Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think an online module such as this is an effective way in which to teach a new skill?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you think this could be an effective way to teach a new competence?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you think this module could help radiographers and MTC's to interpret bone scans?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are there any additional comments/observations you would like to make about the module?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
Appendix X –
Flyer to advertise trial
Appendix X. Flyer advertising trial

VOLUNTEERS WANTED
FOR A TRIAL BONE INTERPRETATION MODULE
IN NUCLEAR MEDICINE

We are currently seeking non-medically qualified volunteers (Radiographers and Medical Technical Officers) working in Nuclear Medicine, to take part in a doctoral study, evaluating the efficacy of an eLearning programme to train non-medical personnel to interpret bone scans.

The study will involve online lectures, quizzes and assessments, to see if a dedicated eLearning environment is suitable for training individuals to interpret bone scan images to a level compatible with BNMS guidelines (2005). Volunteers will also be required to complete pre and post module questionnaires. The study will open over a 12 week period (June – August 2011).

Although there is no academic accreditation associated with the trial, volunteers who participate fully in the module (including successful completion of assessments and questionnaires) will be given a high street voucher in gratitude of their contribution.

If you are interested in finding out more, and to see if you are eligible to take part, please contact the Mrs PJ Dell, Programme Facilitator, at the University of Portsmouth (email: penny.dell@port.ac.uk, or telephone: 023 9284 5397)
Appendix XI –
Example of project details email for enquirees
Appendix XI. Example of project details email for enquirees

Dear XXXX

Thank you for your interest in the module, I have put further details below, which you may wish to consider.

This is trial educational module, to engage volunteers with presentations, formative assessments and various summative assessments to assess the efficacy of a solely e-based programme to teach/train nuclear medicine technologists/radiographers to interpret bone scans.

The hope is that volunteers will do this in their own time, so demonstrating the flexibility of eLearning and its accessibility (plus so as not to impact upon the working day).

The module is still under 'pilot', but initial feedback suggests a commitment of 4-5 hours per section with four learning sections in total (so approx. 20hrs in total) although this figure may vary between individuals.

The module will be available over a three month period, starting in early June through to early September, although volunteers will progress through the learning sections at their own pace within this time frame, so it is conceivable one could finish earlier.

As this is a trial module, there is no academic accreditation associated with it, but in gratitude to volunteers who engage fully with the module (incl. assessments) and have generously given their time, the offer of high street vouchers will be made.

The research also has full ethical approval from the University of Portsmouth.

Please can you confirm if you wish to proceed.

With kind regards
Mrs P. Delf  MSc, BSc (Hons), PgC RNI, DCR (R), FHEA.
Programme Facilitator, Radiography, SHSSW,
University of Portsmouth
Appendix XII –
Instructions for accessing the module
Appendix XII. Login in details email

Dear XXXX

Thank you for agreeing to take part in the above trial, please find an initial 'instructions' Microsoft word document (attached).

Your Username is: porXXX

Your password is: XXXXXXXX

Please do not alter these as we have set up accounts using these details.

The first section of the module will be released on Monday 13th June 2011.

Thank you in advance for taking part.

With kind regards
Mrs P. Delf  MSc, BSc (Hons), PgC RNI, DCR (R), FHEA.
Programme Facilitator, Radiography, SHSSW,
University of Portsmouth
Instructions for Volunteers for Trial Module in ‘Nuclear Medicine – Interpreting Bone Scans’

Thank you for agreeing to take part in this trial. The email accompanying these instructions will have given details of your unique username and password. (Please do NOT alter these).

1) Accessing the module:
   a) Using Internet Explorer - Version 8 or Firefox as your web browser (avoid using Google Chrome or Internet Explorer - Version 9), go to the University of Portsmouth website and virtual learning environment ‘Victory’
   https://victory.port.ac.uk

   b) Log in using your unique allocated User name (e.g porxxx) and Password (e.g. xf0xf)
c) This will bring up the courses/modules assigned to you – select ‘Nuclear Medicine – Interpreting Bone Scans’.

![Image of course selection](image)

**Please Note:** There are useful hints and tips under the University Links section, including how to set up Web Cache which you will need for accessing WebAiMS, as well as links to useful websites.

d) Now you have access to the module **Home Page**.

![Image of module home page](image)
2) Select Section 0 (the red button)

3) What to do now:
   Go through each subsection to ensure you:
   a) Read through the **Course Aims and Objectives** and the **Welcome**
   b) Complete the **Consent/Disclaimer** form
   c) Two presentations (with audio) to explain some of the features of **QuestionMark Perception** and **WebAiMS**.
   
   d) Complete the **Pre-module Survey** – ‘About You’
   e) Complete the **two** baseline tests in WebAiMS and also in QuestionMark Perception
   f) Once this section has been completed, other sections will be made available to you.
4) When you finish a module session - Please remember to log out of Victory.

Please Note: If you have any queries or difficulties – please contact either the Programme Facilitator (penny.delf@port.ac.uk) or the eLearning team (sarah1.cooper@port.ac.uk).
Appendix XIII - Volunteer disclaimer and consent form
Appendix XIII. Volunteer disclaimer and consent form

Name of Principal Investigator: Mrs P Delf, Senior Lecturer, University of Portsmouth
Contact details: Radiography, School of Health Sciences and Social Work, University of Portsmouth  Tel. 023 9284 5397

Information regarding Volunteer Participation in the Development of an eLearning Module for Reporting of Nuclear Medicine Bone Scans

You are being asked to volunteer and consent to take part in an experimental eLearning Module to train non-medical Nuclear Medicine personnel to report Nuclear Medicine bone scans. All information, provided by the volunteer will be coded and anonymised.

What is the purpose of the trial module?
The module has been established as part of a Professional Doctoral project, which aims to establish the effectiveness of an eLearning module, to train healthcare professionals working in Nuclear Medicine in reporting Nuclear Medicine bone scans. The project has three overall aims: 1) to set up and implement an on-line course; 2) to assess the effectiveness of the eLearning environment as a teaching medium for this subject; 3) to assess the effectiveness of learning by participating volunteers.

Please Note: This is a trial module to assess the efficacy of using an eLearning environment to teach this subject area and does not lead to any accredited academic award offered by the University of Portsmouth.

Why have you been asked to take part?
We are inviting non-medical healthcare professionals working in Nuclear Medicine, to take part in the study. Taking part is entirely up to each individual. If you do decide to take part, you will be given this information sheet and asked to sign a consent form. You are free to withdraw from the module at any time, without giving a reason. A decision to withdraw from the study will not adversely affect you.

What will happen if you do take part?
If you decide to take part in this project, once you have signed the consent form to volunteer, you will be given complete access the module Nuclear Medicine – Interpreting Bone Scans.

You will be required to undertake a Pre-module survey and two baseline tests prior to the main content of the module. This will then be followed by further sections covering a range of topics, which you will study. Within each section, there will be formal online assessments to complete (either using QuestionMark Perception or WebAISMs) and at the end of the module you will be asked to complete a Post-Module survey.

A period of three months is allowed, although you can complete at any time.
Important: It is emphasised that this is purely a trial module to assess the efficacy of using an eLearning medium to teach this subject area and does not lead to any accredited academic award offered by the University of Portsmouth. We wish to gain your consent to use evidence of your learning and volunteer experience to assess the suitability of the module for curriculum development purposes. The project meets with criteria set and is approved by the University of Portsmouth Research Ethics Committee, School of Health Sciences and Social Work).

Confidentiality
All information about your individual participation in this study will be kept strictly confidential. All information which is collected about you during the study will be anonymised and destroyed following completion of the project.

Contact details
If you require further information about this study please contact Mrs Penny Delf, Senior Lecturer on 023 9284 5397 or by email at penny.delf@port.ac.uk

Thank you for taking time to read this information sheet.
VOLUNTEER CONSENT AND DISCLAIMER FORM

WORKING TITLE OF PROJECT:
The development and evaluation of the efficacy of an eLearning module to train non-medical personnel to report Nuclear Medicine bone scans

NAME OF PRINCIPAL INVESTIGATOR:
Mrs P Delf, MSc, PgC (RNI), BSc (Hons), DCR (R) FHEA. Senior Lecturer, Radiography, School of Health Sciences and Social Work

<table>
<thead>
<tr>
<th></th>
<th>Please initial box</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I confirm that I have read and understood the information sheet dated June 2011 (version 3) for the above study and have had the opportunity to make contact with the principal investigator in order to ask for further information.</td>
</tr>
<tr>
<td>2.</td>
<td>I understand that my participation is voluntary and for curriculum development purposes only and that I am free to withdraw at any time, without giving any reason, and without any adverse effect.</td>
</tr>
<tr>
<td>3.</td>
<td>I understand that by undertaking this module in the capacity as a volunteer, it will not lead to any accredited academic award made by the University of Portsmouth.</td>
</tr>
<tr>
<td>4.</td>
<td>I understand that the offer of high street vouchers will only be made on completion of the module (including all assessments).</td>
</tr>
<tr>
<td>5.</td>
<td>I agree to volunteer and consent to participate in this trial module.</td>
</tr>
</tbody>
</table>

________________________  ____________________  ____________________
Name of Volunteer        Date                      Signature
Appendix XIV - Results from the report writing assessments
Appendix XIV. Results from the report writing assessments

Initial report writing (QMP) results

Of the twenty five volunteers active at this stage, only twenty volunteers fully completed the assessment. Figures and calculations are therefore based on 200 cases. Two volunteers attempted the assessment, but did not complete all ten cases therefore their results have been excluded from the statistical analysis. Statistical evaluations of the results were carried out using the formulae outlined in the methodology. These were based on the overall accumulated results for the whole cohort as well as individual scores.

The reference reports showed 70% of the ten cases were not clinically significant, 30% were. Figure XIII.1 shows the cohort decisions of clinical significance (twenty volunteers answering ten cases).

![Cohort decisions of clinical significance (Initial QMP)](image)

**Figure XIV.1 Cohort decisions of clinical significance (Initial QMP)**

Sensitivity, specificity, error rate percentages, accuracy rates and positive and negative predictive values were then calculated, based on responses given in line with the clinical significance. These are shown in Table XIII.2.
### Table XIV.2. Calculations ‘clinical significance’ decisions (Initial QMP)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Rate (FP%)</td>
<td>59%</td>
</tr>
<tr>
<td>False Negative Rate (FN%)</td>
<td>33%</td>
</tr>
<tr>
<td>Sensitivity Rate</td>
<td>67%</td>
</tr>
<tr>
<td>Specificity Rate</td>
<td>41%</td>
</tr>
<tr>
<td>Error Rate</td>
<td>52%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>48%</td>
</tr>
<tr>
<td>Predictive Negative Value</td>
<td>74%</td>
</tr>
<tr>
<td>Predictive Positive Value</td>
<td>33%</td>
</tr>
</tbody>
</table>

### Inter-rater agreement (Kappa) - Initial
Kappa statistics were then used to look for the level of agreement between the volunteers and original reference reports. The use of the inter-rater agreement statistic established the level of agreement regarding the ‘opinion of findings’ between the volunteers compared to the reference reports (KAPPA) and those expected by chance. These are shown in Table XIII.3.

### Table XIV.3 Inter-rater agreement based on cohort performance (Initial QMP)

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>Reference</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>23</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>12</td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>4</td>
<td>26</td>
<td>48</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>79</strong></td>
<td><strong>59</strong></td>
<td><strong>0</strong></td>
<td><strong>21</strong></td>
<td><strong>40</strong></td>
<td><strong>199</strong></td>
</tr>
</tbody>
</table>

Key: Numbers in red denote agreement between reference and volunteer reports

This gave an agreement of 37.19%, where the expected agreement was 19.99% with a standard error of 0.0332. The overall Kappa score was 0.2149, which demonstrated a borderline ‘slight’ to ‘fair’ agreement. Using a weighted Kappa these percentages could be improved to an agreement of 70.1%, expected agreement of 55.45%, with a standard error of 0.0464. The Kappa was improved to 0.3288, putting the performance firmly into the ‘fair’ category.

The Initial QMP test consisted of ten cases, therefore there were too few to establish
individual Kappa scores for each volunteer, therefore these are shown by means of descriptive statistics in the form of a percentage, as shown in Table XIII.4. This also shows the percentage scores from the descriptive element of the volunteer reports, which were marked using a standardised reporting grid, enabling analysis of content regarding location, shape and description of image appearances (in conjunction with the reference reports).

Table XIV.4. Volunteer Percentage Scores for Initial QMP Report Writing Assessment

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>Descriptive Score (%)</th>
<th>Percentage of Agreed ‘Opinion of Findings’</th>
<th>Percentage Agreed ‘Clinical Significance’ Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Por506</td>
<td>(68) 58%</td>
<td>20%</td>
<td>50%</td>
</tr>
<tr>
<td>Por507</td>
<td>(83) 85%</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>Por509</td>
<td>(52) 50%</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>Por510</td>
<td>(74) 73%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Por511</td>
<td>(68) 66%</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Por512</td>
<td>(65) 62%</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>Por517</td>
<td>(63) 53%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Por519</td>
<td>(80) 75%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Por520</td>
<td>(45) 39%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Por521</td>
<td>(78) 78%</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>Por524</td>
<td>(60) 50%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Por525</td>
<td>(74) 67%</td>
<td>60%</td>
<td>50%</td>
</tr>
<tr>
<td>Por526</td>
<td>(63) 57%</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Por530</td>
<td>(48) 38%</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>Por531</td>
<td>(23) 13%</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Por533</td>
<td>(83) 81%</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>Por534</td>
<td>(26) 23%</td>
<td>10%</td>
<td>40%</td>
</tr>
<tr>
<td>Por535</td>
<td>(72) 70%</td>
<td>60%</td>
<td>70%</td>
</tr>
<tr>
<td>Por536</td>
<td>(33) 30%</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>Por537</td>
<td>(75) 69%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Percentage scores in brackets (..) indicate scores prior to moderation.

This showed an ability by volunteers to describe the image appearances, although feedback demonstrated a paucity of specific detail (size, shape, specific location) for which marks were deducted (Appendix XII.a).

Note: Following a consultation with a reporting radiographer, marks were adjusted regarding the categorisation of the ‘opinion of findings’, that is whether the appearances, in the light of the referral were: normal, possibly normal, equivocal, possibly abnormal or
abnormal. Negative marking was applied dependant on the agreed outcome category. In this assessment, full agreement was upheld regarding the categorisations with the exception of one case (SG76) where the following discussion, the decision was amended.

Results of Interim QMP Report Writing Assessment Module Section 3.3

Based on twenty cases, fifteen volunteers fully completed this assessment. Figures/calculations are therefore based on three hundred submitted reports (although the results show four instances where a decision regarding an ‘opinion of findings’ was not recorded.

Interim Report Writing Statistics

As with the Initial QMP report writing exercise, a statistical evaluation of the results was carried out, using the formulae described in the methodology, to look for the level of agreement between the volunteers and original reference reports. These were calculated on the overall accumulated results for the whole cohort. Individual scores are recorded separately.

Sensitivity, specificity, error rate percentages, accuracy rates and positive and negative predictive values were calculated, based on responses given in line with the clinical significance of findings for each case. One case (Case PG 3.55) according to the reference report, was equivocal, this has therefore been omitted from the calculations along with the volunteer responses. Therefore calculations are based on decisions in nineteen cases (285 in total) by the fifteen volunteers who took part. Reference reports suggested 68% clinically significant findings, 32% were not. Figure XIII.5 and Table XIII.6 show these calculations.
Table XIV.6. Calculations of Clinical Significance Decisions (Interim QMP)

<table>
<thead>
<tr>
<th>Calculations</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Rate (FP%)</td>
<td>49%</td>
</tr>
<tr>
<td>False Negative Rate (FN%)</td>
<td>34%</td>
</tr>
<tr>
<td>Sensitivity Rate</td>
<td>66%</td>
</tr>
<tr>
<td>Specificity Rate</td>
<td>51%</td>
</tr>
<tr>
<td>Error Rate</td>
<td>39%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>61%</td>
</tr>
<tr>
<td>Predictive Negative Value</td>
<td>40%</td>
</tr>
<tr>
<td>Predictive Positive Value</td>
<td>75%</td>
</tr>
</tbody>
</table>

Based on 15 volunteers for 19 cases

Inter-rater agreement (Kappa) - Interim

The use of the inter-rater agreement statistic was then used to establish the level of agreement regarding the 'opinion of findings' between the volunteers compared to the reference reports (KAPPA) and agreement expected by chance. These are shown in Table XIII.7.
Table XIV. Inter-rater agreement based on cohort performance (Interim QMP)

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
<td>4</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>41</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>14</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>132</td>
<td>145</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>15</td>
<td>0</td>
<td>44</td>
<td>165</td>
<td>296</td>
</tr>
</tbody>
</table>

Key: **Numbers in red** denote agreement between reference and volunteer reports

This gave an agreement of 59.8%, where the expected agreement was 32.74% with a standard error of 0.0313. The overall Kappa score was 0.4023, which demonstrated ‘moderate’ agreement.

Using a weighted Kappa these percentages was significantly improved to an agreement of 81.42%, expected agreement of 58.15%, with a standard error of 0.0451. The Kappa was improved to 0.5560, putting the performance firmly into the upper ‘moderate’ category.

Once again, it was felt that the numbers were too small to perform individual Kappa statistics and that individual performance could be indicated by percentage as shown in the next section.

**Interim Report Writing - Interpretive Comment**

Using the same standardised reporting grid, in conjunction with the reference reports, a content analysis was used to assess and score volunteer reports for location and description of image appearances. A summary of the percentage scores are shown in Table XIII.8.

**Note:** As before, and following consultation with a reporting radiographer, the marks were adjusted regarding the grading of the ‘opinion of findings’, as to whether the appearances, in the light of the referral were: normal, possibly normal, equivocal, possibly abnormal or abnormal. Negative marking was applied dependant on the agreed outcome.
Table XIV.8. Volunteer Percentage Scores for Interim QMP Report Writing Assessment

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>Descriptive score (%)</th>
<th>Percentage of Agreed ‘Opinion of Findings’</th>
<th>Percentage Agreed ‘Clinical Significance’ Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Por506</td>
<td>(63.3) 60%</td>
<td>50%</td>
<td>74%</td>
</tr>
<tr>
<td>Por507</td>
<td>(72.9) 72.9%</td>
<td>65%</td>
<td>79%</td>
</tr>
<tr>
<td>Por509</td>
<td>(59) 53.5%</td>
<td>55%</td>
<td>68%</td>
</tr>
<tr>
<td>Por510</td>
<td>(75.4) 75.8%</td>
<td>70%</td>
<td>68%</td>
</tr>
<tr>
<td>Por511</td>
<td>(63.8) 61.7%</td>
<td>55%</td>
<td>74%</td>
</tr>
<tr>
<td>Por512</td>
<td>(64.6) 62.9%</td>
<td>75%</td>
<td>58%</td>
</tr>
<tr>
<td>Por517</td>
<td>(55) 53.3%</td>
<td>65%</td>
<td>79%</td>
</tr>
<tr>
<td>Por519</td>
<td>(81.3) 77.1%</td>
<td>55%</td>
<td>53%</td>
</tr>
<tr>
<td>Por520</td>
<td>(61) 59.8%</td>
<td>60%</td>
<td>63%</td>
</tr>
<tr>
<td>Por521</td>
<td>(60.6) 56.9%</td>
<td>50%</td>
<td>58%</td>
</tr>
<tr>
<td>Por525</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Por526</td>
<td>(55.9) 48.9%</td>
<td>55%</td>
<td>58%</td>
</tr>
<tr>
<td>Por533</td>
<td>(74.6) 74.6%</td>
<td>65%</td>
<td>74%</td>
</tr>
<tr>
<td>Por535</td>
<td>(80.8) 73.3%</td>
<td>60%</td>
<td>42%</td>
</tr>
<tr>
<td>Por536</td>
<td>(48.3) 44.2%</td>
<td>50%</td>
<td>42%</td>
</tr>
<tr>
<td>Por537</td>
<td>(57.7) 54.4%</td>
<td>55%</td>
<td>53%</td>
</tr>
</tbody>
</table>

Percentage scores in brackets (..) indicate scores prior to moderation.

In some instances, the opinion of findings were adjusted to reflect differing opinion between the original categorisation and the opinion of the reporting radiographer based on image appearances and clinician report summaries. This was mainly applied to those cases where original opinion categories related to possibly normal, equivocal or possibly abnormal. In total, amended decisions were reached and amended in six out of the twenty cases.

**Summary of Interim Report Writing Results**

From both the statistical and descriptive analyses, there would appear to be an improvement in performance across the cohort.
Final QMP Report Writing Assessment. (module section 4.1)

The final summative assessment was a third report writing exercise consisting of twenty cases, of which all sixteen volunteers fully completed.

Final Report Writing Statistics
As with the two previous report writing exercises, a statistical evaluation of the results was carried out using the same formulae as before, to look for the levels of agreement between the volunteers and original reference reports. These were calculated on the overall accumulated results for the whole cohort. Individual scores are reported separately. Reference reports found 47% of cases to be clinically significant. Figure XIII.9 shows the cohort decisions.

![Figure XIV.9 Cohort Clinical Significance Decisions (Final QMP)](image)

Sensitivity, specificity, error rate percentages, accuracy rates and positive and negative predictive values were calculated, based on responses given in line with the clinical significance of findings for each case. Owing to the error in referral details, Case 49 was omitted from the calculations along with the volunteer responses. Therefore calculations are based on decisions by the sixteen volunteers in nineteen cases (304 cases in total) are shown below (Table XIII.10)
Table XIV.10. Calculations of Clinical Significance Decisions (Final QMP)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>False Positive Rate (FP%)</td>
<td>48%</td>
</tr>
<tr>
<td>False Negative Rate (FN%)</td>
<td>42%</td>
</tr>
<tr>
<td>Sensitivity Rate</td>
<td>58%</td>
</tr>
<tr>
<td>Specificity Rate</td>
<td>52%</td>
</tr>
<tr>
<td>Error Rate</td>
<td>45%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>55%</td>
</tr>
<tr>
<td>Predictive Negative Value</td>
<td>58%</td>
</tr>
<tr>
<td>Predictive Positive Value</td>
<td>52%</td>
</tr>
</tbody>
</table>

Based on 16 volunteers for 19 cases

Inter-rater agreement (Kappa) – Final Test

Once again the inter-rater agreement statistic was used to establish the level of agreement regarding the ‘opinion of findings’ between the volunteers compared to the reference reports (KAPPA) and that expected by chance. In theory this should have yielded results for 320 cases regarding the ‘opinion of findings’, however ultimately in four cases, no opinion was given. These are shown in Table XIII.11.

Table XIV.11. Inter-rater agreement based on cohort performance (Final QMP)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>57</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>77</td>
</tr>
<tr>
<td>2</td>
<td>33</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>6</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>11</td>
<td>68</td>
<td>103</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>32</td>
<td>16</td>
<td>32</td>
<td>93</td>
<td>316</td>
</tr>
</tbody>
</table>

Key: Numbers in red denote agreement between reference and volunteer reports

This gave an agreement of 45.57%, where the expected agreement was 24.43% with a standard error of 0.0296. The overall Kappa score was 0.2797, which demonstrated only ‘fair’ agreement. Using a weighted Kappa these percentages were improved to an agreement of 72.47%, expected agreement of 52.31%, with a standard error of 0.0427. The Kappa was improved to 0.4227, putting the performance firmly in the ‘moderate’ range. Once again, it was felt that the numbers were too small to perform individual Kappa statistics and that individual performance could be indicated by percentage as shown below.
Final Report Writing - Interpretive Comment
Using the same standardised reporting grid as before, a content analysis was used to assess and score volunteer reports for location and description of image appearances. A summary of the percentage scores are shown in Table XIII.12

Table XIV.12 Volunteer Percentage Scores for Final Report Writing Assessment

<table>
<thead>
<tr>
<th>Volunteer</th>
<th>% score (excluding Case 49)</th>
<th>Percentage of Agreed 'Opinion of Findings'</th>
<th>Percentage Agreed 'Clinical Significance' Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Por506</td>
<td>(65.4) 60.1%</td>
<td>50%</td>
<td>53%</td>
</tr>
<tr>
<td>Por507</td>
<td>(65.6) 64.4%</td>
<td>65%</td>
<td>63%</td>
</tr>
<tr>
<td>Por509</td>
<td>(69.7) 64.5%</td>
<td>30%</td>
<td>74%</td>
</tr>
<tr>
<td>Por510</td>
<td>(76.1) 72.4%</td>
<td>40%</td>
<td>63%</td>
</tr>
<tr>
<td>Por511</td>
<td>(59.4) 58.6%</td>
<td>45%</td>
<td>68%</td>
</tr>
<tr>
<td>Por512</td>
<td>(62.3) 56.6%</td>
<td>55%</td>
<td>42%</td>
</tr>
<tr>
<td>Por517</td>
<td>(52.7) 47%</td>
<td>55%</td>
<td>63%</td>
</tr>
<tr>
<td>Por519</td>
<td>(85.3) 82.2%</td>
<td>60%</td>
<td>58%</td>
</tr>
<tr>
<td>Por520</td>
<td>(52) 48.9%</td>
<td>30%</td>
<td>42%</td>
</tr>
<tr>
<td>Por521</td>
<td>(62.7) 57.9%</td>
<td>30%</td>
<td>53%</td>
</tr>
<tr>
<td>Por525</td>
<td>(61.6) 58.6%</td>
<td>50%</td>
<td>63%</td>
</tr>
<tr>
<td>Por526</td>
<td>(49.2) 42.7%</td>
<td>35%</td>
<td>37%</td>
</tr>
<tr>
<td>Por533</td>
<td>(67.5) 63.6%</td>
<td>35%</td>
<td>63%</td>
</tr>
<tr>
<td>Por535</td>
<td>(74.7) 69%</td>
<td>55%</td>
<td>53%</td>
</tr>
<tr>
<td>Por536</td>
<td>(61.3) 53.4%</td>
<td>30%</td>
<td>37%</td>
</tr>
<tr>
<td>Por537</td>
<td>(51.4) 47%</td>
<td>55%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Percentage scores in brackets (..) indicate scores prior to moderation.

Note: Marks were again moderated, following consultation with a reporting radiographer, regarding the categorisation of the ‘opinion of findings’, and negative marking was applied dependant on the agreed outcome. Again, some of the ‘opinion of findings’ were adjusted to reflect differing opinion between the original categorisation and the opinion of the reporting radiographer based on image appearances and clinician report summaries. Three cases decisions were amended. Also, one of the referral details (Case 49) was found to have been duplicated from the previous study, so descriptive reports relating to this case and decisions regarding the clinical significance of the findings, were omitted from the final results, so only descriptive reports for nineteen cases were scored for content and percentages based on this figure.

Summary of Final Report Writing Results
From both the statistical and descriptive analyses, the performance appears to have
regressed from the previous similar assessment. However, the results are still better than the findings of the Initial report writing assessment.
Appendix XV – Generic feedback given on the report writing assessments
### Appendix XV.a. Generic feedback for Initial Report Writing Assessment

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Initial QMP Report Writing Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructions to Volunteers</td>
<td>Ten cases to write preliminary reports, using prompt questions. Cases presented within Questionmark™ Perception™</td>
</tr>
<tr>
<td>No of Volunteers</td>
<td>33 (21 volunteers attempted assessment)</td>
</tr>
</tbody>
</table>

**Generic Comments**

- On the whole, a good baseline test, with a range of marks produced (6-83%).
- Volunteers reviewed with ten cases.
- Generally there was an accurate correlation between volunteer findings and original reports.
- Marks were deducted for:
  - Insufficient detail – regarding specific location and shape of increased areas of uptake;
  - Incorrect details given shape and location of uptake
  - Insufficient comment regarding soft tissue findings;
  - Lack of correlation between comments and ‘clinical significance’ placed upon findings;
  - Incorrect assessment of findings (normal, abnormal etc..);

- It was noted and accepted that degenerative or other changes were often commented upon, which had not been included within the original reports due to perceived lack of clinical significance. However, for the purpose of this module, inclusion of such detail was considered important part of developing a systematic approach, therefore marks were awarded accordingly.

**Summary**

This was a first test, used to establish baseline knowledge. Performance was ‘good’ considering the requirement for volunteers to familiarise themselves with new software, question formats and answer expectations. Simple measures such as adding more precise detail, as suggested above, or where a scan was ‘normal’ adding a phrase such as ‘skeletal appearances are within normal limits’ would have demonstrated evidence of a systematic approach and offering greater concordance with original reports.

It is hoped that subsequent assessments of a similar nature, placed later within the module, will provide an opportunity to improve performance based on feedback given, content covered and software experience.
## Appendix XV.b. Generic feedback for Interim and Final Report Writing Assessments

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Comments from Interim and Final QMP Report Writing Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volunteer Number</strong></td>
<td>xxxx</td>
</tr>
<tr>
<td><strong>Score for Interim QMP</strong></td>
<td>xxxx</td>
</tr>
<tr>
<td><strong>Score for Final QMP</strong></td>
<td>xxxx</td>
</tr>
<tr>
<td><strong>Instructions to Volunteers</strong></td>
<td>Total of forty cases to write preliminary reports, using prompt questions. Cases presented within Questionmark™ Perception™</td>
</tr>
<tr>
<td><strong>No of Volunteers</strong></td>
<td>16 volunteers attempted assessment</td>
</tr>
<tr>
<td><strong>Mark range across cohort</strong></td>
<td>Interim QMP: 0 – 83% (one volunteer did not complete this assessment) Final QMP: 44 – 84%</td>
</tr>
<tr>
<td><strong>Generic Comments</strong></td>
<td>The percentages are awarded based on the descriptive content of the report and correlation with reference reports as produced by nuclear medicine physicians. Additional marks were available for details recorded by volunteers, but not overtly stated in original reports. Negative marking was applied and statistical analysis using a weighted Kappa was used to assess inter-rater agreement (although these figures are not included here)</td>
</tr>
<tr>
<td></td>
<td>• On the whole, a good range of marks were produced</td>
</tr>
<tr>
<td></td>
<td>• Higher marks were awarded where greater detail regarding actual site, shape etc. were given</td>
</tr>
<tr>
<td></td>
<td>• Some reports scored less well regarding clinical significance of findings/ opinion of findings where there was little/ no correlation with the referral</td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>These two final assessments demonstrated that the majority of volunteers improved their scores between the initial and the final QMP assessments, indicating greater familiarity with software as well as improved performance in terms of descriptive ability.</td>
</tr>
</tbody>
</table>