Delivering World Class Radiotherapy NHS

Virtual Environment for Radiotherapy Training (VERT)

Final Project Report

A Project funded by the Department of Health for England and the Cancer Action Team; and Managed by the Society and College of Radiographers

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1.0 Purpose of the Report

The purpose of this Report is to inform the key stakeholders, radiographers and the wider radiotherapy community about the progress and outcome of evaluation of the Virtual Environment for Radiotherapy Training (VERT) Project. The Report highlights good practice and identifies some of the issues that hindered effective use of the technology during the course of the Project.

The Report is not intended to be a handbook to guide users of VERT. However, it does contain examples of effective use of VERT by both clinical departments and educational institutions around the country and will be of use to those considering purchasing a VERT system or as a reference source for those who have VERT installed currently.

2.0 Introduction

2.1 Background

2.1.1 The National Radiotherapy Advisory Group (NRAG) Report to the UK Government in 2007[1] identified a potential crisis in England in relation to radiotherapy education and training and an urgent need to reduce the attrition rate of student therapy radiographers. The Report included a recommendation to introduce Hybrid Virtual Environment skills training facilities across the 10 education providers and 51 associated radiotherapy and oncology sites providing clinical training and experience. The aim would be to improve retention by enhancing the student learning experience through provision of the opportunity to develop knowledge and skills in a 'safe' environment while limiting the impact on already stretched clinical resources.

2.1.2 A suitable virtual reality platform was readily available – the Virtual Environment for Radiotherapy Training (VERT) system – utilising immersive visualisation technology and software developed by Vertual Ltd[2]. The VERT system provides a life-sized virtual radiotherapy treatment room and allows the user to interact with the virtual room, control the equipment and set up radiation treatments as if in the real world.

2.1.3 In response to the NRAG recommendation, the Department of Health and Cancer Action Team made £5 million available to fund:

- purchase of the VERT software and required hardware;
- refurbishment costs; and
- an 18-month project, led by the Society and College of Radiographers, to manage the implementation of the VERT technology and begin evaluating its impact.

2.1.4 Educational institutions providing pre-registration radiotherapy education and training in England and radiotherapy and oncology departments providing the associated student placements were invited to submit expressions of interest in participating in this supported VERT Project which ran from April 2008 to October 2009.

2.2 Project Aim and Outcomes

The aim of the 18-month VERT Project was to assess the potential use of the VERT technology – the projectors, screens, immersive and seminar auditoria and the software. It was designed to achieve the following specific outcomes through an integrated approach to the introduction of VERT into educational institutions and clinical radiotherapy and oncology departments:

- To assess the potential impact of VERT on student recruitment and retention, especially in year one;
- To investigate how students learn in virtual environments;
- To assess the impact of VERT on student confidence;
- To assess the impact of VERT on student enjoyment of their courses;
- To assess the extent to which VERT enhances students' knowledge and understanding of relevant radiotherapy concepts;
- To determine the extent to which students' psychomotor and practical skills can be developed using VERT;
- To share the learning outcomes associated with the use of VERT across all the universities and departments; and
- To appraise the long term potential of VERT, making recommendations regarding its impact on future curriculum design and teaching, learning and assessment strategies.

2.3 The VERT Technology

2.3.1 The VERT system and its functionality have been fully described elsewhere[2, 3, 4]. Basically, however, high resolution stereoscopic projection on to a large screen produces a realistic, virtual environment of a radiotherapy treatment room. It provides a life-size model of a linear accelerator with full functionality except for the production of radiation. Users wear either liquid crystal display (LCD) shutter glasses or light polarising glasses (depending on the type of system being used) so that they are immersed in a three dimensional (3-D) image projected in the space around them. The environment is a hybrid one in that a *virtual* linear accelerator is controlled using an *actual* hand-pendant.

2.3.2 It is possible to import images and radiotherapy treatment plans in DICOM format, thereby allowing a vast range of simple and complex treatment plans as well as the related anatomical data to be visualised in 3-D.

2.3.3 Different systems are provided in educational institutions and clinical areas. Educational institutions use a system called 'Immersive VERT'. These systems are housed in a purpose-built, bespoke auditorium and employ rear projection using active stereoscopy requiring the user to wear LCD shutter glasses. A tracking system is provided that enables the image to be projected according to the user's position relative to the projection screen thus further enhancing the degree of 'immersion'. Radiotherapy and oncology departments use a system called 'Seminar VERT'. These systems can be situated in seminar or meeting rooms and require no significant refurbishment to support installation. Seminar VERT features front projection using passive stereoscopy requiring the use of polarising glasses. User tracking is not provided. At the time of the Project, the cost of

Seminar VERT was approximately one quarter that of Immersive VERT, excluding room modification costs.

2.3.4 The large screen stereoscopic projection, faithful representation of the treatment room and linear accelerators, use of an actual hand pendant and, in educational institutions, use of a tracking system, all contribute to a high degree of physical and psychological 'presence' – the phenomenon whereby users are convinced they are part of a 'real' environment.

2.3.5 The VERT technology claims to offer a number of potential advantages:

- A cost effective alternative to training in clinical environments;
- Unlimited practice opportunities without risking harm to patient or equipment;
- Radiotherapy treatment rooms become more efficient as training demands are reduced;
- A realistic insight into the experience of using the equipment, but without the stress of being in a clinical setting;
- Enhance the understanding of those radiotherapy concepts that are often difficult to teach in a classroom and/or placement setting;
- Student attrition is reduced as the learning experience is enhanced.

2.4 Project Design

The Project had two distinct elements, each led by a Project Co-ordinator.

2.4.1 Implementation and Education

The implementation and education phase included:

- planning for installation of Immersive VERT systems within educational institutions and the installation of Seminar VERT systems in radiotherapy and oncology departments;
- training in use of the systems;
- incorporation of VERT experience within academic and clinical components of pre-registration radiotherapy programmes; and
- gathering information for dissemination and continued development based on user experience.

2.4.2 Evaluation and Research

The impact of VERT was assessed from the perspective of students, academic staff and clinical radiographers to address the Project outcomes. Review of associated literature and informal data gathered through communication during the Project informed and enhanced the overall evaluation strategy which comprised both quantitative and qualitative elements including:

- questionnaires and tests to assess the impact of VERT on the development of student skills, confidence and performance;
- collection and interpretation of data in relation to the impact of VERT on recruitment and retention;
- reports compiled by educational institutions and clinical departments; and
- a final evaluation survey distributed at the end of the Project.

3.0 Project Management

3.1 Steering Group

The Project was overseen by a Steering Group which determined the direction of the Project and ensured objectives were met.

3.1.1 The role of the group included:

- Overseeing the establishment of the Project User Group;
- Receiving and approving the interim and end of Project reports;
- Commenting on the evaluation and research elements of the Project;
- Ensuring that the Project considered and made recommendations on the wider use of the tool across other professions;
- Receiving regular progress reports from the Project Co-ordinators;
- Overseeing the financial probity of the Project.

3.1.2 Membership of the group consisted of the two VERT Co-ordinators and representatives from:

- The College of Radiographers;
- The Department of Health;
- The Cancer Action Team;
- The Royal College of Radiologists;
- The Institute of Physics and Engineering in Medicine;
- Higher Education Institutions; and
- Radiotherapy and Oncology departments.

The Steering Group met 4 times during the course of the Project.

3.2 National User Group

A National User Group, reporting directly to the Steering Group, was established early in the Project to provide a forum for discussing the VERT Project, its evaluation and the technology involved.

3.2.1 The role of the User Group included:

- facilitating a wide-reaching communication network regarding the use of the VERT technology;
- ensuring that the Project met the desired outcomes of the stakeholders;
- generating, sharing and disseminating ideas and best practice regarding the use of the VERT technology;
- providing the foundation for continued development after the initial supported 18 months;
- feeding information back to the VERT Co-ordinators as required; and
- reporting on the discussions to the Project Steering Group.

3.2.2 The VERT Project funded the technology for institutions in England only. However, it was considered that participation in the National User Group by colleagues in Scotland, Wales and

Northern Ireland would be beneficial and, consequently, a representative from each of these countries was invited to attend.

3.2.3 The National User Group consisted of:

- The Society and College of Radiographers;
- VERT Co-ordinator – Implementation and Education;
- VERT Co-ordinator - Evaluation and Research;
- One representative from each of the 10 English educational institutions;
- One representative from each group of radiotherapy and oncology departments (see 3.2.4 below);
- One representative from either Glasgow Caledonian University or Queen Margaret University, Scotland;
- One representative from Cardiff University, Wales;
- One representative from the University of Ulster, Northern Ireland; and
- Vertual Ltd.

There were 4 National User Group Meetings during the course of the project.

3.2.4 Representatives from educational institutions and clinical departments were expected to cascade information about the VERT technology and generate interest in its use by both students and staff. However, because of the number of participating radiotherapy and oncology departments in England, it was impractical to include a representative from each department on the User Group. A 'Group Representative' system was established, therefore. Departments were allocated to one of 10 groups, based on the educational institution from which they received their main cohort of students. This was considered to be the most appropriate arrangement for the following reasons:

- Geographical location – the majority of the radiotherapy and oncology departments in each group were within a reasonable travelling distance from each other and the educational institution, making it easier to set up Regional User Groups;
- Most had already established links with each other and the educational institution, although not necessarily with the representatives who attended the National VERT User Group; and
- Grouping the departments with their associated educational institution was one way of encouraging communication and partnership working between them – essential for meeting the Project objective of sharing learning outcomes associated with the use of VERT across universities and departments.

3.3 Regional User Groups

3.3.1 One element of the National User Group departmental Group Representatives' role was to report back to their regional centres. Some educational institutions and associated departments took the initiative and set up their own Regional User Groups at an early stage to facilitate information exchange and, in particular, to discuss the ways in which VERT could be used with both students and qualified staff. These groups consisted of the VERT Leads from the educational institution and each associated clinical placement site.

3.3.2 The potential benefits of Regional User Groups were identified as:

- promoting a co-ordinated approach to using VERT in meeting the Project objectives;
- preventing inappropriate repetition of material for the students; and
- generating a shared understanding of student learning outcomes so that clinical teaching in the radiotherapy and oncology department could be more readily related to learning outcomes.

4.0 Installation of VERT Systems

4.1 Installation of VERT in England

4.1.1 Funding for software (Version 2.5), hardware and some refurbishment was originally provided to 10 educational institutions and 42 NHS trusts within England. Subsequently, one additional trust, which had a new radiotherapy service, was granted funding for a Seminar VERT system.

4.1.2 Installations in trusts and educational institutions commenced in early 2008 and continued throughout the course of the 18 month Project. All 10 Immersive VERT systems were installed within educational institutions by July 2008. Seminar VERT systems were installed in radiotherapy and oncology departments of 31 NHS trusts by the end of September 2009 with a further 4 anticipating completion within the four months following completion of the Project. Installation in another 7 trusts is planned for later in 2010 or early 2011. One Trust which received funding had not planned or commenced preparation for installation by the end of the Project.

Table 1 below summarises the position at the end of September 2009.

Immersive VERT systems installed in educational institutions	10
Seminar VERT systems installed in radiotherapy and oncology departments	31
Departmental installation expected by February 2010	4
Future installations within departments planned for 2010/2011	7
Funding approved but installation not planned	1
No application for funding made and VERT not installed	8

Table 1: VERT Installations in England

4.1.3 Systems in institutions with readily available rooms, requiring minimal building work, were the first to be installed. Although sufficient funding was originally identified for Seminar VERT systems in 51 radiotherapy and oncology departments, 8 departments did not apply for funding. These trusts elected to delay installation until completion of work associated with a new build or extension to an existing department. While this has delayed the introduction of VERT and means these departments have missed out on the available support, there may be longer term benefit because of the possibility of securing a purpose-built room, closer to the department. (See 6.4.4 Location of VERT' on p.32)

4.2 VERT in Northern Ireland, Scotland and Wales

Representatives from the educational institutions in Northern Ireland, Scotland and Wales attended the National User Group, contributing their different experiences with VERT over the course of the Project.

4.2.1 Northern Ireland

The University of Ulster purchased and installed an Immersive VERT system before funding was made available to the English institutions and had started using it, therefore, with students prior to the other countries. There were no Seminar VERT systems installed in the Northern Ireland radiotherapy and oncology departments.

4.2.2 Scotland

There were no installations in Scotland during the period of the Project. However, the two educational institutions in Scotland had both sought private sector funding for VERT.

4.2.3 Wales

Cardiff University purchased and installed a custom version of VERT during the course of the Project. Vertual Ltd. supplied the software but the University negotiated with different companies for supply of the computer hardware and projectors. There was no plan, at that time, to install Seminar VERT systems in any of the Welsh radiotherapy and oncology departments.

5.0 Implementation and Education

5.1 Approach to Implementation and Education

5.1.1 VERT contacts in each radiotherapy and oncology department and educational institution in England were identified at the start of the Project. These institutional Leads provided information which, with the monthly installation and training information provided by Vertual Ltd., enabled the Co-ordinator for Implementation and Education to monitor installation and training progress in the 41 institutions which completed installation during the 18 months of the Project. The Steering Group was also kept appraised of the situation in relation to those Trusts unable to install VERT during this period.

5.1.2 Visits by the Implementation and Education Co-ordinator commenced in mid-April 2008 and continued regularly until mid July 2009. All educational institutions and 30 of the 31 departments were visited at least once - the remaining department did not have VERT installed until August 2009. However, departments and educational institutions visited early in the Project were offered a further visit in the latter stages both to:

- share the ideas and suggestions for VERT use gained by the Co-ordinator through discussion with a wider group of users during the Project; and to
- capture insights and evolving ideas for using VERT in these institutions which, by then, had had the most experience.

5.1.3 During visits the Co-ordinator provided support, help and advice on the use of the VERT software and hardware, recording details of any associated problems or issues. These were fed back to Vertual Ltd. after each visit.

5.1.4 The Project outcomes were discussed during visits to clinical departments and educational institutions. VERT Leads were asked about the ways in which they were using, or planning to use VERT to meet the objectives and, where necessary, were given advice on planning relevant tutorials and teaching sessions. In addition they were asked to compile a report at the end of the Project indicating how they had addressed, or would address, the Project outcomes.

5.2 Procurement and Installation Issues

5.2.1 The procurement process was identified as challenging by the majority of institutions, primarily due to the extremely tight deadlines imposed by the funding process. Perhaps unsurprisingly, the major problem encountered by both educational institutions and Trusts was identification of suitable physical space for the VERT installations. However, the timescale for the Project also pushed the boundaries for educational institutions in terms of the time required to meet institutional tendering requirements and for internal administrative processes. Similarly internal procurement processes led to delay with building work for some radiotherapy and oncology departments housed in Private Finance Initiative (PFI)-funded buildings.

5.2.2 The majority of installations were straightforward with few issues arising. However, several problems were identified in some centres including:

- room refurbishment error (for example, incorrect calculation of aperture size for screen);
- hand pendants not working (generally identified as a training issue rather than malfunction);
- unreliable PCs (for example, a graphics card problem in one or two educational institutions); and
- projector alignment and image blending issues (primarily a training/familiarisation issue rather than technical problem).

Where problems were identified they were usually resolved quickly through contact with Vertual Ltd.

5.3 Training

5.3.1 Vertual Ltd. provided a 2-hour training session for staff as soon as possible after installation although it was noted that some centres experienced a little delay during the period when installations were at their peak. Some departments were unable to release all relevant staff to attend these sessions because of service commitments but key personnel attended and subsequently cascaded training to others.

5.3.2 A number of centres developed their own training packages for delivery to different groups of students and staff. This was considered to be good practice by the User Group and thus it is strongly **recommended** that:

- centres develop suitable training packages to supplement training offered by Vertual Ltd. and cascade training to various user groups at a frequency appropriate to local needs.

5.4 Outcomes from Implementation of User Groups

5.4.1 National User Group and Grouping of Departments

5.4.1.1 Attendance at the National VERT User Group evolved during the course of the Project. The majority of departmental representatives at the first meeting were Heads of Department, Department Managers or Superintendent Radiographers. However, representation at subsequent meetings included a higher proportion of VERT Leads, departmental educators and other staff, reflecting the way implementation of VERT moved into the hands of those more directly involved in training students and colleagues within the departments.

5.4.1.2 One consequence of limiting departmental membership on the National User Group and establishing the Group Representative system instead was that staff in some departments felt remote from the Project. For example, several departmental managers contacted the Co-ordinator asking to send their own individual representative for this reason.

5.4.1.3 The VERT Lead for each of the clinical departments was expected to communicate with other members of the Representative Group. This worked well generally, particularly where the groups were smaller but proved more problematic in some, but not all, of the larger ones.

5.4.1.4 A major benefit of establishing the Group Representative system was the way in which communication between radiotherapy and oncology departments was encouraged. Good communication between department, departmental groups and educational institutions was essential in ensuring that the Project aims and objectives were achieved and to ensure that VERT became embedded in curricula. The VERT Project Co-ordinator facilitated this process where necessary.

5.4.2 Regional User Groups

5.4.2.1 Although in most cases the educational institutions led formation of the Groups, a number of departments set up their own Regional User Group and involved the associated educational

institution. The Groups functioned in a similar way in either case with most Groups, once established, meeting on a regular (typically 2-3 monthly) basis.

5.4.2.2 The primary purpose of meetings of these Groups was to discuss the ways in which VERT could be used with students and qualified staff. However, they also facilitated significant collaboration in the acquisition of patient data to be used with VERT systems both in clinical departments and educational institutions. Acquisition and transfer of suitable treatment planning data was identified as an issue throughout user group discussions (see 6.4.5 Access to Treatment Planning Data on p.32).

5.4.2.3 Staff involved in discussions about the use of VERT in radiotherapy programmes during the early stages of the Project tended to be those traditionally involved in course discussions between clinical departments and educational institutions - i.e. Managers from clinical departments and Course/Programme Directors from the educational institution. However, many VERT Leads were not Managers or Course Directors and thus the Regional User Groups provided a forum for discussion between groups of staff who might not otherwise usually meet. The consequent discussion of new ideas on a range of other relevant subjects was considered to be of benefit in improving the student experience more generally.

5.4.3 Local User Groups

5.4.3.1 Small, local User Groups evolved within the radiotherapy and oncology departments. These commonly included the institutional VERT Lead, other interested radiographers, dosimetrists, physicists and medical staff.

5.4.3.2 The potential advantages of a multidisciplinary user group were identified as:

- facilitating the acquisition of suitable treatment plans;
- inclusion of different professional perspectives in planning the use of VERT;
- fostering inclusive ownership of VERT across the whole radiotherapy team;
- encouraging different groups of staff to use VERT with students;
- promotion of wider dissemination of VERT initiatives, research and resources; and
- enhancement of communication between professional groups.

The multidisciplinary nature of local User Groups was considered, therefore, to be beneficial as a foundation for further development of high quality, more diverse VERT resources, enriched by different professional perspectives.

5.4.3.3 A strategy that incorporates local VERT leads, local user groups, regional user groups and a national user group was considered essential for the continued development of the most effective use of VERT. Such a strategy: promotes sharing of ideas and approaches to problems or issues; provides mutual support: and facilitates the sharing of data. It also has wider benefits for students, staff and departments involved as it promotes collaboration between the educational institutions and departments more generally. Accordingly, it is strongly **recommended** that:

- Local, regional and national user groups are established with a multidisciplinary membership wherever possible.

5.4.4 Department and Educational Institution VERT Leads

Identification of an institutional VERT Lead was crucial to the development of VERT use within clinical departments and educational institutions. Adequate support and, in particular, allocation of sufficient time to undertake the role was found to be essential. Where the VERT lead was allocated time within their workload VERT use was well-developed and maintained. However, from feedback during Co-ordinator visits, it was clear that erosion of this time by departmental or other pressures had a detrimental effect on the implementation, development and evaluation of VERT and a possible consequential decrease in enthusiasm for VERT use. Inadequate allocation of time resulted in some VERT installations being used well below their full potential. (See 6.4.2 Staffing and Time' on p. 30)

6.0 Evaluation

The evaluation strategy comprised both quantitative and qualitative elements and encompassed the following complementary components.

- Impact on the Student with studies focused on assessment of:
  - students' first impressions of VERT;
  - the impact of VERT on the development of practical skills and confidence; and
  - the impact of VERT characteristics on students' knowledge and understanding, performance and application of skills.
- Recruitment and Retention: collection and interpretation of data collected by educational institutions, supplemented by questionnaires/interviews about the impact of VERT.
- Staff and Student Experience: final reports compiled by educational institutions and clinical departments and an evaluation survey distributed at the end of the VERT Project.

6.1 Impact on the Student

6.1.1 First Impressions

A questionnaire (see Appendix 1) distributed to all pre-registration students during the first semester of the 2008/9 academic year explored initial perceptions of the impact of VERT on learning and skills development. Students were also asked to indicate:

- any difficulties experienced;
- the amount of time and for what purpose they had been using VERT; and
- what they had liked/disliked about its use.

Findings following analysis of the 184 questionnaires returned from students in 7 educational institutions are outlined below.

6.1.1.1 Students had used VERT for 3 hours and 40 minutes on average by the time they had completed the questionnaires. However, considerable variation in exposure to VERT was noted with a range of 30 minutes to 20 hours reported.

6.1.1.2 The students' first impressions were generally very positive. There was a perception that use of VERT had a positive impact on: development of their understanding of radiotherapy concepts (82% agreed or agreed strongly); enhancement of practical skills (72% agreed or strongly agreed); and motivation (70%). It was reassuring to find that 90% of respondents agreed or strongly agreed that VERT had contributed to their enjoyment of the learning and teaching scenarios. Very few students identified problems during the early use of VERT with 81% indicating either no, or very few, problems.

6.1.1.3 Table 2 below lists comments students included about features of their early VERT experience they particularly liked or disliked.

Liked	***Disliked***
Most frequently identified: • Familiarisation with handset and preparation for practice • Less pressure (ability to learn at own pace) • Feel more confident • OK to learn from mistakes • Very interactive • Relating the CT data to other tasks • Feeling immersed in scene • Complex concepts easier to understand through visualisation	**Most frequently identified:** • Not having enough time to use it (40% of respondents reported they would like much more individual time) • Headaches and/or eye strain (24% of respondents) especially where wearing 3D glasses for over 30 minutes • Not enough plans, CT datasets to view • 3D glasses heavy/uncomfortable/difficult to wear over spectacles (15% of respondents)
Less frequently identified: • Tracking • 3D relational anatomy • Practising electron set-ups • Potential to reduce errors in real set-ups	**Less frequently identified:** • Disorientation (particularly when other users manipulate the view) • Nausea (less than 3% of respondents)

Table 2: Early VERT experience - summary of student likes and dislikes

Summary of main findings and recommendations

- Early experiences of using VERT were largely very positive.
- The majority of students indicated that VERT had enhanced their knowledge, understanding and skills.
- The majority of students indicated that they had enjoyed using VERT and found the experience motivating.
- Limited individual hands-on time was identified as the most common problem experienced.
- Headaches and/or eye-strain were reported by one quarter of students with increased incidence when 3D glasses were worn for over 30 minutes.

Accordingly it is **recommended** that educators:

- integrate VERT into learning and teaching scenarios as early as possible in pre-registration programmes; and
- limit session length where 3D stereoscopy is enabled, and consider disabling 3D stereoscopy where depth perception is not essential.

6.1.2 Skills and Confidence

6.1.2.1 Traditionally during the initial clinical placement students have been unfamiliar with equipment controls; lacked confidence in operating a linear accelerator handset; and simultaneously tried to focus on developing important clinical/patient-oriented skills. All educational institutions planned to use VERT to provide students with an opportunity to develop some confidence in operating the equipment prior to the first clinical placement.

6.1.2.2 Quantitative and qualitative data were collected from students via pre- and post-experience questionnaires (see Appendix 2), supplemented with qualitative data generated through focus groups following the initial clinical placement. The impact of pre-placement VERT experience on the skills and confidence demonstrated by students from the perspective of clinical staff was ascertained using an online questionnaire (copy included as Appendix 3) which was completed by 44 staff from 23 radiotherapy and oncology departments

6.1.2.3 The following key findings emerged from analysis of questionnaires which were returned by 98 students from 5 educational institutions.

- 83% of these students described themselves as ‘confident’ or ‘very confident’ in their use of computer technology. (This was considered to be a potentially important factor in predicting confidence in operating a linear accelerator in both virtual and real environments.)
- Statistically significant positive correlations were identified between confidence in the use of computer technology and both confidence in operating a linear accelerator *before* pre-placement VERT experience and improvement in confidence *after* that experience.
- 77% of students had 20 minutes or less *individual* hands-on experience of operating the virtual machine and only 7% had more than 40 minutes.
- 88% of respondents indicated that they felt the pre-placement VERT experience was both enjoyable and had enhanced their practical skills. The remaining 12% neither agreed nor disagreed.

- Student confidence in using a linear accelerator improved after VERT experience as illustrated in Figures 1 and 2 below.

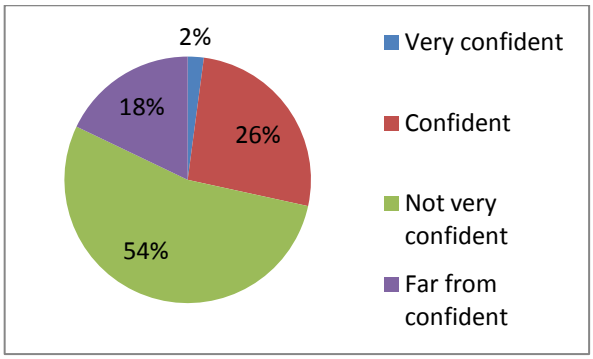

Figure 1: Confidence before VERT experience

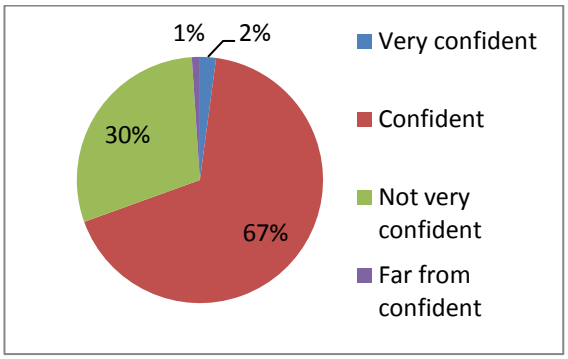

Figure 2: Confidence after VERT experience

6.1.2.4 Staff perceptions of student skills and confidence in operating the equipment (hand pendant) on commencing clinical placement following pre-placement VERT experience are illustrated in figures 3 and 4 respectively.

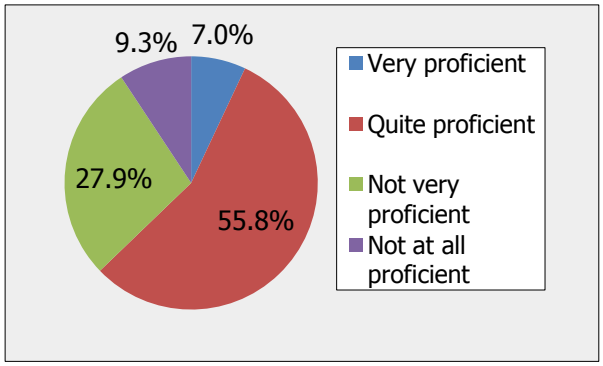

Figure 3: Staff perception of students' *skills*

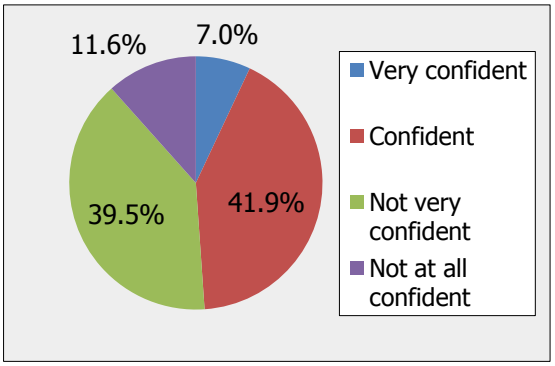

Figure 4: Staff perception of students' *confidence*

Levels of skills and confidence were perceived to be lower by staff than by students. 62.8% agreed that the student's initial skills and confidence were either 'better' or 'somewhat better' when compared with those of previous students without pre-placement VERT experience. 48.9% were 'confident' or 'very confident' that the student was able to operate the equipment safely and confidently following VERT experience. The view of the majority of clinical staff is captured by the following comment from one respondent:

> *"After repeated sessions on VERT in the department I think the skills, confidence and capability increased more rapidly than perhaps previous students."*

However, increased student confidence can be un-settling:

> *"Students felt they could get involved more quickly on their first placement as they already knew how to dim the lights, rotate the gantry etc. This sometimes led to frustration however as the staff were less comfortable with this, still relying on their own explanation/observation before letting the students take part."*

6.1.3 Staff and Student Experience

Seven major themes emerged from analysis of the qualitative data derived from student and staff questionnaires and the student focus groups.

6.1.3.1 Focus on familiarisation with use of the hand-pendant

All students recognised that their VERT skills development centred on familiarisation with use of the hand-pendant and *did not* prepare them for interaction with a patient or for the way '*teams*' were involved in the set-up of patients. The lack of practice with couch controls; the importance of patient positioning; and knowing 'who was doing what' were all issues raised during focus groups and highlighted by this student comment.

> *"When [the radiographer] passed me the handset for the first time I more or less knew what I was doing (with it) but when they started moving the bed I got thrown a bit. It took me a while to work out what bits I was doing with the handset. But, I'm fairly sure that this ... knowing what buttons to press ... meant I could concentrate on the patients and what was going on around me rather than only looking at the thing in my hand. The student I was working with told me they spent ages getting to grips with the handset."*

Similarly, some staff noted that the focus on the hand-pendant may have been to the detriment of other skills development.

> *"Some of the first yr students have concentrated on being the first to get hold of the hand pendant - they have … been reluctant to do the patient side of setting treatments up. … They usually can move the bed / gantry and do the auto set-up, but forget about the why they are doing what they are doing. … Some 1st yrs have had to be 'weaned off' the hand pendant and then given objectives regarding set up, patient care and communication."*

6.1.3.2 Reduction in anxiety

A frequent comment by students was that, although still very anxious about their first clinical placement, VERT experience had reduced this considerably. This was not universal, however, and students with a relatively low level of confidence in using computer technology tended to feel the most anxious. Some were reluctant to actively engage in the pre-placement VERT sessions although, arguably, they were the most likely to benefit.

Staff identified similar issues to those highlighted by students as illustrated by the following comments:

> *"1st year students lack confidence so they may have some basic skills but they are wary of using them."*

> *"Confidence is difficult to quantify as the first placement is still daunting no matter what level of training."*

> *"Their anxiety remained high - but was focused on inter personal areas such as talking/touching patients and fitting in with staff."*

Most frequently noted, however, was the perception that more time for individual practice in VERT would have further reduced anxiety.

6.1.3.3 Insufficient time for practice

It was disappointing to find that only a limited number of the students said that they had been able to take advantage of practice sessions using departmental Seminar VERT systems, although most commented that it would have been useful to have had such VERT sessions integrated into early placements.

A majority of students considered that they had insufficient time in VERT prior to their first placement. Most clarified that this related to *individual*, *interactive* engagement with the handset.

> *"VERT definitely helped me to grasp some of the basics of different techniques. I wish I could have had more time using it myself though rather than just watching the lecturer demonstrate things. I didn't get enough hands-on experience myself and I think this would help a lot."*
>
> and:
>
> *"Visualising stuff was helpful but I got less than 15 minutes using the handset and I needed much more time. Maybe we could have had drop-in sessions that we could have booked ourselves after the ones already in our timetable."*

Some students commented that they had benefited from a mentoring/'buddying' system where more experienced students had assisted and/or facilitated sessions. Other suggestions included: start using VERT earlier in the course (consistent with findings of the 'early impressions' survey); and have regular sessions right up to commencing the first clinical placement.

A number of staff also commented on the lack of VERT time as the following examples suggest:

> *"The students remarked that they had only had one session on VERT and it was quite a long time before moving into the clinical environment."*
>
> *"The students at [University] said the VERT experience was in groups, not all used the system and their clinical ability to use the handset one year on is very poor due to high numbers of students on each machine and lack of use on VERT at the hospital or the university. VERT is a good idea which is under utilised."*
>
> *"More time pre-clinical VERT experience needed (our students only had very little time on it*)."

6.1.3.4 Realism

Students commented that, although VERT was realistic and helped them prepare for exposure to a real linear accelerator, there were still differences between the virtual and real worlds. Some of these were relatively minor, such as small variations in gantry/couch speed or the previously-highlighted lack of couch controls, but others, especially the lack of a realistic patient, were of greater significance. However, probing during focus groups confirmed that students did appreciate

that the VERT experience was not intended to replace the real environment and that focussing on development of psychomotor and simple practical skills prior to placement would allow more time to develop important 'clinical' skills in the real environment.

> *"I remember during the VERT sessions before placement that I made a comment [on the questionnaire] about not having an actual patient seriously limited how useful it would be but a discussion with my mentor kind of opened my eyes. ... She made me realise that I'd been able to spend my first 2 weeks on a linac doing more than learning how to operate the machine."*

This comment also highlights the importance of awareness by clinical staff of not only the benefits but also limitations of VERT in preparing students for clinical practice and the consequent necessity for some adjustment to student training during early placements.

6.1.3.5 Active learning in a safe environment

A key benefit of the use of a virtual environment for skills development is that it allows learners to make errors, from which they can learn important lessons, but which would not be tolerated in practice. Many students did identify as beneficial the ability to develop knowledge and skills through active participation in sessions and to learn through their mistakes. However it was interesting to note that some students were more cautious about the application of pre-placement VERT experience to the initial placement, identifying, as this student did, a different cause for anxiety.

> *"It was actually really different when I got on to placement. I wasn't so much anxious about not knowing what I was doing because of VERT, but I was really worried that I would make a mistake. It didn't matter in VERT but I was terrified of crashing the machine or even pressing the wrong button. It didn't help that it felt like everyone was watching me."*

6.1.3.6 Developing strategies for clinically relevant tasks

Students were asked to identify any other ways in which pre-placement VERT sessions had contributed to their preparation for clinical practice. Responses included:

- developing a better understanding of basic concepts such as the isocentre;
- understanding couch shifts and developing a strategy for accurately undertaking them;
- building knowledge and understanding of simple techniques; and
- improving knowledge of anatomy and, in particular, the ability to relate radiographic to surface anatomy.

6.1.3.7 Adverse effects

Incidence and frequency of adverse effects noted by students was consistent with the outcome of the 'first impressions' survey. Approximately one quarter of students reported dizziness, headache, eye strain or disorientation and 2% reported nausea. Most students commented that the adverse effects were minor or, at most, moderate. However, a very small minority reported that headache and/or visual strain and/or disorientation was so severe that they had to stop participating (see section 6.4.1 Adverse Effects' on page 30).

Summary of main findings and recommendations

This study reflects the performance of only one cohort and further evaluation is recommended but the general trend is positive.

- Pre-placement VERT experience enhanced basic practical skills and confidence.
- Students' confidence in operating a linear accelerator using a hand-pendant was significantly improved after pre-placement VERT experience.
- Skills developed during pre-placement VERT experience, in general, transferred well to the clinical environment.
- Confidence with computer technology correlated positively with confidence in operating a linear accelerator before and after pre-placement VERT experience.
- Pre-placement VERT experience that focuses solely on learning how to operate a linear accelerator with a hand-pendant is insufficient.
- A lack of individual hands-on time was identified as a substantial shortcoming both by students and radiographers.
- Seminar VERT facilities were relatively under-utilised.
- The incidence of adverse effects was consistent with that noted in the 'first impressions' survey.

Thus it is **recommended** that educational institutions:

- continue to use VERT for the development of basic psychomotor/practical skills and to enhance confidence prior to initial clinical placements;
- ensure sessions are interactive and increase the time available for all students to engage individually, where possible;
- include within pre-placement VERT sessions: an introduction to fundamental concepts underpinning clinical practice; essential practical aspects; a focus on anatomy; and practice with simple techniques that facilitate the confident development of psychomotor skills;

and that

- pre-placement VERT sessions in educational institutions are supplemented by seminar VERT sessions during initial clinical placements to further enhance knowledge and skills; and
- following use of VERT for pre-placement preparation, the aims of the initial placement are reviewed and consideration given to a change in emphasis from development of simpler psychomotor/practical skills to clinical and team working skills.

6.1.4 VERT and Skills Development in Skin Apposition Techniques

Skin apposition techniques demand good spatial awareness, psychomotor skills and, ultimately, a large amount of experience. However, students have limited opportunity to practice, or even

develop, the requisite skills for clinically acceptable positioning accuracy of the electron treatment technique. The VERT technology enables this to be addressed by providing the opportunity for practice in a safe environment.

6.1.4.1 A stratified randomised controlled trial in which 103 students participated was undertaken to assess the influence of both VERT tracking technology and 3D stereoscopy on performance of skin apposition techniques. Student performance was determined using an objective measures schedule and an accuracy tool integral to the VERT software. Performance was also correlated with students' spatial ability, measured using a Mental Rotation Test[5]. A post-experience questionnaire (included as Appendix 4) was used to determine: students' experiences of using VERT; the extent to which they considered it had enhanced their clinical practice; and any adverse effects. Follow-up interviews after relevant placement experience explored the extent to which practice in VERT was transferrable to the clinical environment.

6.1.4.2 Participating students completed a guided self-directed practical enabling them to practice electron technique set-ups after randomisation into 1 of 3 arms:

- 3D stereoscopy ON, Tracking ON
- 3D stereoscopy ON, Tracking OFF
- 3D stereoscopy OFF (tracking therefore unavailable)

6.1.4.3 A subsequent objective assessment of ability to accurately and efficiently complete a specified pre-determined skin apposition set-up provided within the VERT software was the main outcome measure. Accuracy and efficiency were determined using the following factors based on the work of Srinivasan et al[6] and Park et al[7]:

- Error score:
    - collisions between equipment and patient;
    - incorrect beam alignment to skin marks.
- Degree of skin apposition - defined as the standard deviation of the distance measured at all four corners of the applicator to the 'skin' surface. This measurement was available via the VERT software. Related to this measurement is an assessment of the degree of proximity of the applicator to the skin surface (the mean distance of all four corners of the applicator to the skin surface).
- Time taken to achieve an 'acceptable' set-up (established by an experienced radiographer whose score was used as a benchmark against which student performance was normalised).
- Economy of movement - defined as the number of gantry/couch/collimator movements to achieve what the student deemed to be an acceptable set up.

The method of calculating the resultant performance score is detailed in Appendix 5. The findings below are based on the results included in Appendix 6.

6.1.4.4 Qualitative analysis indicated that students in the 'Tracking ON' group found completion of electron set-ups more challenging although there was no statistically significant difference in set-up scores between the three arms of the trial.

6.1.4.5 It was noted that, for those students with tracking turned OFF, the view had to be manipulated by an experienced radiographer. Although no verbal guidance was offered by the person manipulating the view, inevitably they used their own experience to intuitively adjust the view for the student. This *guided* the student as to where they should be looking and provided clues regarding action required.

6.1.4.6 Follow-up interviews explored the extent to which the type of VERT experience influenced the transfer of skills to real world set-ups. Students from the 'Tracking ON' arm were more positive about the speed with which they felt able to put their VERT experience into practice. However, the key theme from the interviews was the concern, expressed by most students, that the experience had not fully prepared them for the real set-ups.

6.1.4.7 All students enjoyed the VERT experience and recognised that it helped them to achieve acceptable electron set-ups but the majority felt that the situation in the real clinical environment was very different. They highlighted daily variations in position and patient breathing as examples of where VERT had not adequately prepared them for the need to adapt. While confidence increased as a result of VERT experience, anxiety in real world situations only lessened through real world practice.

6.1.4.8 Students found the objective assessment of their performance particularly useful. It helped to improve their skills substantially whether or not they had experience of clinical electron set-ups. Many students, but particularly those with some clinical experience of electron techniques, suggested that practice in either Immersive or Seminar VERT facilities before and during relevant placements would be very beneficial.

6.1.4.9 Comments from students with poorer spatial ability about the possible benefit of VERT in developing strategies for electron techniques were pertinent in light of the moderately positive correlation found between spatial ability and set-up score (see Appendix 6). The following comment was typical:

> *"My spatial awareness is terrible and that probably explains why I've shied away from getting more actively involved with electron set-ups. I just can't see how gantry and couch need to be moved. Spending time in VERT has really helped. I wish it had been there when I was in year 1."*

Summary of main findings and recommendations

- Strategies for achieving good skin-apposition can be effectively learnt in VERT.
- Objective assessment of set-up in VERT can lead to improved students skills.
- 3D stereoscopy and user tracking do not appear to influence student performance or experience.
- Tracking appears to more accurately reflect the actual clinical scenario but may detract from students' ability to accurately visualise alignment of light beam with skin marks.
- Inherent spatial ability correlates positively with set-up score.

It is **recommended**, therefore, that:

- VERT use is considered for the development of strategies in spatially complex set-ups at an early stage, particularly for those students with relatively poor spatial ability;
- user tracking and 3D stereoscopy are used with caution, particularly where students are prone to vection-induced simulator sickness, headaches or visual disturbance;
- further research which eliminates the influence of intuitive view manipulation by experienced personnel is undertaken to determine the influence of user tracking on student performance in VERT scenarios; and
- inherent spatial ability of students is assessed to assist identification of individuals who are likely to benefit most from VERT experience.

6.2 The Impact of VERT on Recruitment, Retention and Attrition

Reliably assessing the impact of VERT on attrition in pre-registration programmes was clearly unachievable given the duration of the VERT Project. However, data from the annual monitoring survey submitted by educational institutions to the Society and College of Radiographers[8]; a supplementary survey; site visits; and 'end of Project reports' were analysed. The outcomes are outlined below.

6.2.1 Recruitment

6.2.1.1 Centres appeared to be using VERT effectively by integrating demonstrations and interactive sessions into prospective student visits, interview days, recruitment fairs and sixth-form events. At least two educational institutions had purchased/developed a 'portable VERT' system with dedicated hand-pendants for recruitment use. Evaluation forms completed by prospective students in some institutions indicated that the VERT experience was the most enjoyable element of their visit. However, it is too early to determine the impact on application rates.

6.2.1.2 The introduction of VERT was too late to have influenced recruitment in 2008 when more educational institutions met target commissions than in previous years. However, the continuing upward trend for therapeutic radiography programmes to be undersubscribed is of concern. Applications data for the 2009 intake were incomplete at the time of this Report. However, anecdotal evidence from a supplementary survey distributed to educational institutions seemed to indicate relatively limited impact of VERT on applications to date with some institutions noting an increase in applications from younger prospective students while others had seen little or no difference.

6.2.2 Attrition

Overall attrition in radiotherapy programmes decreased by 5.4% between 2007/8 (42.7%) and 2008/2009 (37.3%)[8]. Although still high, the continuing downward trend (attrition was 48.7% in

2006/7) was reassuring. The impact of VERT on this reduction is unknown but it was interesting to note that, in the annual report to the Society and College of Radiographers[8], no educational institution explicitly identified use of VERT as contributing to a strategy for reducing attrition.

6.2.3 Retention

Although the attrition data were equivocal, VERT may have a role to play in retention.

6.2.3.1. A small number of informal interviews were held with 'at-risk' students with whom VERT had been used to support specific weaknesses in an effort to improve retention. VERT had been used on an individual tutorial basis to help explain concepts and/or facilitate guided practice with these students who had been struggling with either academic content or clinical assessments. The students were very positive that using VERT had been a successful approach while acknowledging that alternative approaches may have achieved a similar outcome.

6.2.3.2 Responses from educational institutions in 'end of Project reports' also identified ways in which VERT was being used to address retention issues. For example, in one institution a 'peer-assisted learning scheme', in which final-year students provided support and guidance within VERT for 1st-year students, was piloted and positively evaluated.

It is **recommended** that:

- staff consider using VERT to support 'at-risk' students where appropriate.

6.3 Overall Evaluation of the Implementation and Impact of VERT

At the end of the Project 9 educational institutions and 25 clinical departments completed an 'end of Project report' and 108 individuals responded to an online evaluation survey (copy as Appendix 7). Responses in the final evaluation survey reflected comments in the institutional Project reports and were distributed as follows:

- students - 64%
- academic staff - 14%
- clinical staff - 22%

The survey results, including additional comments made by staff and students, are included for information in Appendix 8 and the findings from both outlined below.

6.3.1 Use of VERT

6.3.1.1 VERT facilities were used almost exclusively by pre-registration radiotherapy students although it was noted that other groups did use the facility. The majority of respondents (83%) considered that 1st year students benefitted most from VERT.

However, many centres were beginning to realise the potential of the technology for:

- postgraduate students;
- those re-entering the profession;
- training new staff in local techniques;
- staff development;

- evaluation of new or unusual techniques; and
- use with other staff groups.

6.3.1.2 A number of departments indicated that dosimetrists made substantial use of Seminar VERT to augment treatment plan evaluation and, in some centres, integrated student learning within the process.
Many radiotherapy departments used VERT to demonstrate principles of radiotherapy to other health care professionals including medical staff, nurses and other visitors.

6.3.1.3 Some educational institutions had begun to develop applications employing stereoscopic visualisation to run on the available hardware for other student groups. Examples included:

- an interactive 3D house for use with Occupational Therapy students;
- stereoscopic photos and videos for illustration where depth perception is critical; and
- interactive 3D anatomy materials for use with various health care students.

At least one institution had employed a technical officer to be responsible for stereoscopic software development and to assist the local VERT Lead with management and development of the VERT facility.

6.3.1.4 While widening access to other professional and student groups maximises use of VERT facilities, careful management to minimise the impact on pre-registration radiotherapy students is required.

It is **recommended**, therefore, that local VERT Leads encourage:

- student engagement in the process where other groups of staff such as dosimetrists utilise Seminar VERT facilities; and
- wider use of the facility while ensuring its availability to radiotherapy staff and students.

6.3.2 Enhancement of Knowledge and Understanding

The general perception was that VERT, currently, had the greatest impact on students' knowledge and understanding of fundamental concepts, simple techniques and anatomy as illustrated by the following student comment:

"The anatomy sessions were brilliant and really helped to gain an in depth understanding of how organs overlapped and sat next to each other."

while this staff member considered that the first year students:

"… seemed to pick up the basics much more quickly (isocentre etc) and the calculating bed shifts was much less of a struggle than in previous years."

However, the following student comments indicate the value in other areas such as plan evaluation where use may increase as institutions improve their access to DICOM data.

"Very useful for looking at the plans … seeing where we were treating and what the dose distribution was like. Helps put the theory into practice in a safe way."

and

"Using VERT to evaluate plans … has helped me to understand the importance of accurate contouring and what the dose distribution looks like in 3-dimensions. It has made me realise that I have to think in 3D when I'm planning."

6.3.3 Impact on Clinical Competence

6.3.3.1 The results of the end of Project survey and Reports (Appendix 8) generally reflected those from the pre-and post experience questionnaires (see 6.1.2 Skills and Confidence' p. 18) in that confidence was perceived to be either 'much better' or 'a little better' by more than 80% of respondents.

6.3.3.2 VERT was considered to have improved the development of general psychomotor skills, performance with simple set-ups (single fields and parallel opposed) and electron set-ups by over 60% of respondents but by fewer (approximately 45%) in relation to complex set-ups.

6.3.3.3 Filtering responses by user group (student, academic staff and clinical staff) indicated that students regarded VERT to be more effective at enhancing aspects of clinical competence - particularly confidence - than either academic or clinical staff.

6.3.4 VERT Influence on Enjoyment of the Course

VERT influenced student enjoyment of the course considerably more in the educational institution than it did during clinical placement. This may reflect the fact that VERT is relatively under-used in clinical departments but, that in addition, there is no substitute for real clinical experience where it is safe and available as the following comment illustrates:

"There may be limited use on clinical placements as this is the only time that students will have real experience of dealing with patients which is highly valued by them."

6.3.5 Curriculum Enhancement

Respondents provided additional comments regarding the use of VERT and ways in which integration into radiotherapy curricula could be enhanced. These included references to

1. technical developments such as:
    - linking treatment planning systems directly to VERT;
    - developments to support knowledge and understanding of 3D CT anatomy; and
    - improved dosimetric visualisation and the effect of set up errors on dose volume histograms;

as well as

2. specific educational uses including:
    - teaching more complex techniques;
    - using VERT for assessment;
    - incorporation into more post-registration and CPD programmes;

- ensuring links between VERT use in the academic and clinical settings; and
- integration of VERT into multidisciplinary training within the clinical department.

However, as one respondent noted, meeting the challenge of a *"packed curriculum … requires radical thinking"* and for several institutions review and revalidation of their programmes provided the opportunity to build in more fundamental use of VERT across the curriculum.

6.4 Barriers to Effective Use

Potential barriers to the effective use of VERT identified during the Project, along with possible solutions, are outlined below.

6.4.1 Adverse Effects

6.4.1.1 Side-effects such as vection-induced simulator sickness, visual disturbances and headaches are associated with the use of virtual environments. The prevalence and severity of such symptoms can be affected by a number of factors including: the degree of immersion (presence); susceptibility to travel sickness; image flicker; misaligned projected images; and concomitant illness[9].

6.4.1.2 The incidence of adverse effects reported in the studies undertaken was relatively low (see pages 17 and 22). The most commonly reported symptoms were minor and detracted little from user experience. However, minimising the possibility of occurrence by avoiding excessive manipulation of the scene during user interaction and keeping sessions relatively short seems prudent.

6.4.1.3 Adverse effects were less severe when the stereoscopic 3D feature was turned off and users viewed 2D images without the 3D glasses. The consequent reduced 'immersion' in the virtual environment could be considered an acceptable trade-off where appreciation of depth cues is not vital to students' understanding or skills development. Similarly, for those individuals susceptible to motion sickness or who experience disorientation when the view is manipulated by another person, user tracking is a useful alternative.

Consequently it is **recommended** that:

- educators inform all users of the likelihood of symptoms prior to use; and minimise manipulation of the scene when a user is interacting with it.

6.4.2 Staffing and Time

Staffing levels and access to VERT facilities, while variable across sites, were identified as barriers to use, particularly in clinical departments.

6.4.2.1 The implementation of VERT and expectation that it would be widely integrated into the curriculum placed substantial pressure on staff in both educational institutions and radiotherapy and oncology departments. The rapid introduction of the technology complicated timetabling and added to workloads for academic staff who had to reconsider curriculum design and prepare VERT sessions. Clinical staffing levels in many departments limited opportunities for radiographers to use VERT in student teaching.

6.4.2.2 VERT use in both clinical departments and educational institutions was most effective where a VERT Lead had been appointed. It was vital, particularly in clinical departments, for this member of the team to have protected time to: plan the way VERT would be used; learn how to use the system; train colleagues; gather the necessary resources; and then to plan and deliver training sessions. There is a risk that VERT facilities will be significantly under-utilised, particularly at busy times, without time allocated to support the role. As in the educational institution, VERT needs to be integrated within, rather than 'bolted on' to, departmental activity.

6.4.2.3 Nominating a clinical VERT Lead who may be primarily available for student teaching in VERT is of advantage but can lead to infrequent use by other clinical staff trained in VERT and consequent de-skilling. Students may also become reliant on one style of teaching and not benefit from exposure to a wider breadth of skill, opinion and knowledge.

6.4.2.4 Problem-based learning sessions that require relatively limited direct supervision by clinical and/or academic staff require significant initial preparation and support but provide students with a valuable learning experience and may reduce radiographer input.

6.4.2.5 Some centres evaluated the use of final-year students to facilitate VERT sessions. Students were taught to use VERT and then had the opportunity to develop their own mentorship and supervision skills. This may be a cost-effective way of addressing the issue of limited clinical staff time. However, care needs to be taken to ensure that it does contribute to the development of the students and is not exploitative, over-burdening students at a stage when they need to focus on honing their own clinical skills and experience.

Consequently it is **recommended** that:

- centres appoint VERT Leads and offer an appropriate level of protected time/workload allocation to ensure successful implementation and management of VERT;
- in the medium term, more radiographers are trained to use VERT and afforded opportunities to facilitate teaching and learning sessions;
- centres consider the use of problem-based learning in VERT; and
- educational institutions consider adopting a mentoring/'buddying' scheme whereby pre-placement VERT sessions are facilitated by experienced students.

6.4.3 Management of VERT Resources

6.4.3.1 Implementation of the VERT technology was funded to support the education and training of therapy radiographers but has the potential for wider use (see p. 27, 6.3.1 Use of VERT') in both educational institutions and radiotherapy and oncology departments.

6.4.3.2 Care needs to be taken to ensure that under-utilisation, which provides the opportunity for links and further developments of VERT use within an educational institution or Trust, does not lead to encroachment on the time available for students. Academic and clinical VERT Leads need to maximise use to ensure the access required for radiotherapy education and training purposes is protected and maintained.

6.4.3.3 This may take the form of 'block-bookings' used for individually negotiated drop-in sessions in addition to those timetabled. Such an approach also allows educators to tailor the use of VERT to individual needs and, if appropriate, make more effective use of user tracking. Including students in work within the clinical department where VERT is used by others such as dosimetrists provides additional learning opportunities for students as well as developing VERT use.

6.4.3.4 The necessity for educational institutions and their associated placement centres to work together in maximising effective use of VERT cannot be overemphasised.

6.4.3.5 The ongoing costs, including those of hardware and software maintenance/support contracts and projector bulbs, need to be considered. The total cost of replacing both bulbs (approximate life-span 1500 hours) together for the Immersive VERT system is close to £3000 for example and thus wider use of the Immersive VERT facility needs to be appropriate. For example, it would be unwise to use it for simple projection of, say, PowerPoint presentations. Some centres have addressed this by installing a separate projector, and a document is now available to assist users to maximise bulb life. Seminar VERT systems can expect a bulb lifespan of 2000 hours, with bulb replacement costs approximately £400.

6.4.4 Location of VERT

6.4.4.1 VERT has been sited some distance from the main department in many clinical departments and in some educational institutions away from the faculty area. The time taken to get to VERT from the main work area has meant that: using VERT can be seen as a chore; and the staff member involved in the teaching session is not readily available if required urgently in the department.

6.4.4.2 The majority of Seminar VERT installations are in busy shared teaching or seminar rooms and, although advance room-booking is possible in many centres, priority is often given to other staff groups and meetings. Consequently, opportunities for spontaneous learning with VERT are often lost because of rigorous timetabling and/or block-booking.

Therefore, it is **recommended** that:

- VERT installations are located as close as possible to the main work area; and
- VERT facilities are booked on a regular basis and the time utilised in a meaningful way.

6.4.5 Access to Treatment Planning Data

Access to DICOM data and integration with treatment planning systems were identified as significant issues during the Project although, during the Project, sample DICOM data was made available by Vertual Ltd to provide a start for system users.

6.4.5.1 Obtaining data to import into VERT for subsequent use in learning and teaching scenarios was a major problem in many centres. Ensuring the necessary patient consent for use of CT and treatment planning data for teaching purposes was an issue initially, although generally resolved at local level. Some users suggested establishing a repository of shared DICOM plan files but this is unlikely in the immediate future because of similar consent issues. Production of example plans

based on the visible human female CT dataset has been explored but there are limitations to the usefulness of this approach.

6.4.5.2 Those educational institutions with in-house treatment planning systems (TPS) and associated CT data appear to be at a significant advantage, particularly in relation to the use of VERT for demonstrating techniques and enhancing plan evaluation (see 6.3.2 Enhancement of Knowledge and Understanding' on p.28).

6.4.5.3 Centres with TPS networked to VERT identified several issues with data transfer to VERT in the required DICOM format. Some users reported that the process was excessively time-consuming, taking up to 5 minutes where data were exported to a folder on the TPS server. In addition, the risk of students accessing and inadvertently corrupting other vital data on the TPS server when exporting and importing data themselves needed to be considered. These are not insurmountable problems and using a portable USB drive for export and import of data provides a simple solution which addresses both issues.

It is **strongly recommended** that:

- educational institutions seek funding for treatment planning systems for integration with the VERT technology.

7.0 Summary of Recommendations

Recommendations regarding the implementation, management, current and future use of VERT have been made throughout this Report. They are grouped below according to their primary focus.

General Recommendations

It is recommended that:

1. local, regional and national user groups are established with a multidisciplinary membership wherever possible;
2. further research which eliminates the influence of intuitive view manipulation by experienced personnel is undertaken to determine the influence of user tracking on student performance in VERT scenarios.

It is recommended that Educators:

3. integrate VERT into learning and teaching scenarios as early as possible in pre-registration programmes;
4. ensure sessions are interactive and allow sufficient time for all students to engage individually where possible;
5. limit session length where 3D stereoscopy is enabled, and consider disabling 3D stereoscopy where depth perception is not essential;
6. use 3D stereoscopy and user tracking with caution, particularly where students are prone to vection-induced simulator sickness, headaches or visual disturbance;

7. inform all users of the likelihood of symptoms prior to use of VERT; and minimise manipulation of the scene when a user is interacting with it;
8. include in pre-placement VERT sessions: an introduction to fundamental concepts underpinning clinical practice; essential practical aspects; a focus on anatomy; and practice with simple techniques that facilitate the confident development of psychomotor skills;

Recommendations for Educational Institutions

It is recommended that:

9. use of VERT for the development of basic psychomotor/practical skills and to enhance confidence prior to initial clinical placements is continued;
10. inherent spatial ability of students is assessed to assist identification of individuals who are likely to benefit most from VERT experience;
11. a mentoring/'buddying' scheme whereby VERT sessions are facilitated by experienced students is considered;
12. funding for treatment planning systems for integration with the VERT technology is sought.

Recommendations for Radiotherapy and Oncology Departments

It is recommended that:

13. centres develop suitable training packages to supplement training offered by Vertual Ltd. and cascade training to various user groups at a frequency appropriate to local needs;
14. centres appoint VERT Leads and offer an appropriate level of protected time/workload allocation to ensure successful implementation and management of VERT;
15. local VERT Leads encourage student engagement in the process where other groups of staff such as dosimetrists utilise Seminar VERT facilities;
16. local VERT Leads encourage wider use of the facility while ensuring its availability to radiotherapy staff and students;
17. in the medium term, more radiographers are trained to use VERT and afforded opportunities to facilitate teaching and learning sessions.

Recommendations for both Educational Institutions and Radiotherapy and Oncology Departments

It is recommended that:

18. VERT installations are located as close as possible to the main work area;
19. VERT facilities are booked on a regular basis and the time utilised in a meaningful way;
20. pre-placement VERT sessions in educational institutions are supplemented by seminar VERT sessions during initial clinical placements to further enhance knowledge and skills;
21. following use of VERT for pre-placement preparation, the aims of the initial placement are reviewed and consideration given to a change in emphasis from development of simpler psychomotor/practical skills to clinical and team working skills;
22. staff consider using VERT to support 'at-risk' students where appropriate;
23. VERT use is considered for the development of strategies in spatially complex set-ups at an early stage, particularly for those students with relatively poor spatial ability; and
24. centres consider the use of problem-based learning in VERT

8.0 Conclusions

8.1 The aim of the 18-month Project was to assess the potential use and impact of the VERT technology in pre-registration radiotherapy education in England. The Report outlines the implementation and subsequent evaluation of VERT over the initial 18 month period of its introduction into 10 educational institutions and the associated radiotherapy and oncology departments providing clinical training and experience.

8.2 Student response to VERT was very positive. Evaluation throughout the Project consistently demonstrated that students' enjoyment of learning as well as their knowledge, understanding, skills and confidence were enhanced by VERT. However, although successful, VERT can not be the sole means for supporting knowledge and skill development, particularly in the clinical setting.

8.3 Students appeared to gain most benefit from *individual* interaction with VERT, learning from mistakes made in a 'safe' environment and with immediate feedback on their performance via the software.

8.4 Some students, however, did report adverse effects such as headaches, eye strain and disorientation. These were generally relatively minor and minimised by avoiding excessive manipulation of the scene during user interaction and limiting the length of exposure to 3D stereoscopy.

8.5 VERT was useful for development of the strategies, skills and confidence required in clinical practice, particularly for first-year students. Clinical staff confirmed that pre-placement experience in VERT led to increased confidence and improvement in psychomotor skills; and that the skills developed were transferable to the clinical environment.

8.6 Seminar VERT systems were under-utilised in most centres during the Project. Lack of staff; location of the VERT facility; and difficulty gaining access to the facility contributed to under-use. Difficulty in accessing the necessary treatment planning data resulted in some limitation in the use of Immersive VERT to demonstrate techniques and enhance plan evaluation in educational institutions without an in-house treatment planning system and associated CT data.

8.7 It is too early to draw any significant conclusions regarding the impact of VERT on attrition in radiotherapy programmes. A reduction of 5.4% in student attrition was noted for the 2008/9 year although it is impossible to attribute this to the introduction of VERT. Educational institutions are using VERT to enhance their recruitment process but, again, it is too early to draw firm conclusions regarding its impact. Feedback following use of VERT to support 'at-risk' students indicated that VERT had a positive impact on students continuing on the course and thus suggests that VERT may have a role to play in improving retention. Enhanced enjoyment, motivation, knowledge and understanding may also have a positive impact and contribute to improved retention.

8.8 Throughout the Report recommendations have been made to support the continued development of VERT as a valuable tool in radiotherapy education and training.

8.9 Proposed Further Action and Research

Based on evaluation over the 18 months of the Project the following action is proposed:

- continuation of a National User Group managed by Vertual Ltd.;
- review of the progress of Regional and Local User Groups;
- further assessment of how, and how often, VERT is being used;
- a focus on increasing the utilisation of Seminar VERT facilities;
- ongoing appraisal of the impact of VERT on recruitment and retention;
- identification of funding for installation of treatment planning systems within educational institutions.
- further research that eliminates the influence of intuitive view manipulation by experienced personnel in order to clarify the influence of user tracking on student performance in VERT scenarios; and
- further controlled studies to quantify the impact of VERT on knowledge enhancement.

10.0 References

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Questionnaire Distributed to Students During the First Semester

Virtual Environment for Radiotherapy Training (VERT): First impressions

We are keen to gauge your first impressions of VERT and would appreciate you taking a few minutes to provide us with some initial feedback.

Your University: _____

Please rate each of the following aspects on the scales provided by circling the relevant response. The left hand column relates to your experiences using the VERT system installed in your University. The right hand column relates to your experiences using the VERT system in your clinical placement. Please complete one or both columns as relevant. There is also the chance to add your own comments at the end.

University VERT system	Placement VERT system
Using VERT has helped me understand radiotherapy concepts 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable	Using VERT has helped me understand radiotherapy concepts 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable
VERT has enhanced my practical skills 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable	VERT has enhanced my practical skills 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable
I feel motivated and enthused as a result of using VERT 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable	I feel motivated and enthused as a result of using VERT 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable
I have enjoyed using VERT 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable	I have enjoyed using VERT 1. Strongly agree 2. Agree 3. Neither agree nor disagree 4. Disagree 5. Strongly disagree 6. Not applicable

Questionnaire Distributed to Students During the First Semester

University VERT system	Placement VERT system
I have experienced difficulties in using VERT 1. Many problems 2. Some problems 3. Very few problems 4. No problems 5. Not applicable	I have experienced difficulties in using VERT 1. Many problems 2. Some problems 3. Very few problems 4. No problems 5. Not applicable

Approximately how long (in hours) have you spent using the VERT system? _____

Please tell us what you have used VERT for (e.g. learning to use linac handset, practising set-ups, learning about a particular technique).

Please tell us what you have particularly liked about using VERT (for both University and placement systems as relevant).

Please tell us what you have disliked about using VERT (for both University and placement systems). You can also identify any problems/issues you have experienced at this point.

Many thanks for providing this feedback.

Please return this form to your Course Leader/Year Tutor

Pre- and Post-experience Questionnaire

Student questionnaire

Your University: _____

Your student ID number: _____

Please circle the appropriate response.

What is your gender?	Female	Male
Are you left or right handed?	Left	Right
How old are you?	_____	

In relation to using computer technology, how would you describe yourself:

Very confident Confident Not very confident Far from confident

Had you operated a linear accelerator before using VERT?	Yes*	No

*If **Yes**, please give details below:

Had you used the VERT system before using it specifically for pre-placement experience?	Yes*	No

*If **Yes**, please give details below:

How confident did you feel in relation to operating a linear accelerator when you commenced your course?

Very confident Confident Not very confident Far from confident

Pre- and Post-experience Questionnaire

Please complete in relation to your experience in using VERT for gaining practical skills prior to your initial clinical placement.

Which equipment did you gain VERT experience on?	Varian	Elekta	Both

How long did you AS AN INDIVIDUAL get to spend using the VERT system hand pendant?

<20 minutes	20-40 minutes	40-60 minutes	>60 minutes

Please circle the appropriate response below.

I have enjoyed using VERT.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

VERT has enhanced my practical skills.

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

My confidence in relation to operating a linear accelerator after my VERT experience may be described as?

Very confident	Confident	Not very confident	Far from confident

I feel more confident in using a linear accelerator as a result of using VERT?

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Continued overleaf:

Pre- and Post-experience Questionnaire

Please briefly describe what VERT experience you undertook prior to your first clinical placement.

Please tell us how you think VERT has prepared you for your clinical practice (if at all).

Please tell us what you particularly liked about using VERT.

Please tell us what you have disliked about using VERT. You can also identify any specific problems/issues you have experienced.

Please feel free to add any other comments you may have.

Finally, would you be prepared to participate in a Focus Group regarding the impact VERT has had on skills development and confidence (to be held after your initial clinical experiences)?

Yes	**No**

If yes, the please add your contact details below:

Name:

Email: Telephone:

Staff On-line Questionnaire

1. Which radiotherapy department are you based in?

2. Were you aware that the 1st year student you have worked with had received some pre-clinical experience in VERT at the University?

- Yes, before the student started
- Yes, the student informed me when they started
- Yes, but only part way through the student's placement
- No

3. How would you describe the student's SKILLS in operating the equipment (hand pendant) on commencing their clinical placement?

- Very proficient
- Quite proficient
- Not very proficient
- Not at all proficient

4. How would you describe the student's CONFIDENCE in operating the equipment (hand pendant) on commencing their clinical placement?

- Very confident
- Confident
- Not very confident
- Not at all confident

Staff On-line Questionnaire

5. How confident did you feel in the student's capability to operate the equipment (with the hand pendant) safely and confidently following pre-placement VERT experience?

- Very confident
- Confident
- Not very confident
- Not at all confident

6. In your opinion, how does the student's initial skills and confidence in operating the equipment with the hand pendant (following VERT experience) compare with previous students who did not have this opportunity?

- Much better
- Somewhat better
- No different
- Worse

7. To what extent do you think pre-clinical VERT experience has enhanced the student's:

	A lot	A little	No impact	Has had a negative impact	Don't know
Skills					
Confidence					

8. Please add any further comments you may have regarding the use of VERT for developing skills and confidence prior to first clinical placement.

Skin Apposition Techniques: Post-experience Questionnaire

Preliminary questionnaire

Your student ID number: _____

Please circle the appropriate response.

What is your gender? **Female** **Male**

How old are you? _____

In relation to using computer technology, how would you describe yourself?

Very confident **Confident** **Not very confident** **Far from confident**

In relation to operating a linear accelerator, how would you describe yourself?

Very confident **Confident** **Not very confident** **Far from confident**

How many weeks clinical experience have you had on linear accelerators treating electron patients?

0 **1-3** **4-6** **More than 6**

How would you describe your current level of participation in electron set-ups?

Observation only	**Limited participation**	**Active participation**	**Competent under supervision**

Had you used the VERT system before in order to practice electron set ups? **Yes*** **No**

***If Yes, please give details below:**

Skin Apposition Techniques: Post-experience Questionnaire

Post-experience questionnaire

Your student ID number: _____

Please circle the appropriate response.

Which linac did you use during the VERT session: **Varian** **Elekta**

My VERT session was undertaken with:

User tracking turned ON **User tracking turned OFF and 3D stereo turned ON** **User tracking turned OFF and 3D stereo turned OFF**

I have enjoyed using VERT.

Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**

My skills in setting up skin apposition techniques have been enhanced as a result of my VERT experience

Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**

My confidence in setting up skin apposition techniques have been enhanced as a result of my VERT experience

Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**

How satisfied were you with your final set-up (the assessed scenario)?

Very satisfied	**Satisfied**	**Neither satisfied nor dissatisfied**	**Dissatisfied**	**Very dissatisfied**

Please try to explain the response you have given above:

Continued overleaf:

Skin Apposition Techniques: Post-experience Questionnaire

Please tell us how you think VERT has prepared you for your clinical practice in relation to skin apposition techniques (if at all).

Please tell us what you particularly liked about using VERT.

Please tell us what you have disliked about using VERT. You can also identify any specific problems/issues you have experienced.

Please feel free to add any other comments you may have.

Finally, would you be prepared to participate in a follow up interview regarding the impact VERT has had on skills development and the extent to which those skills transfer to clinical practice (to be held after your subsequent clinical experiences)?	**Yes**	**No**

If yes, the please add your contact details below:

Name:

Email: **Telephone:**

Skin Apposition Techniques: Calculating Performance Score

The method of calculating the performance score is detailed below. Student scores for each of these factors were examined in the context of the different arms of the trial i.e.

- 3D stereoscopy ON, Tracking ON
- 3D stereoscopy ON, Tracking OFF
- 3D stereoscopy OFF (tracking therefore unavailable)

Error score: 100% for no collisions and correct beam alignment. Lose 20% for each collision and 2% per mm and/or degree inaccuracy in beam alignment to skin marks

Degree of skin apposition (defined as the standard deviation measurement available via the VERT software: (Benchmark SD / Student SD) x 100

Proximity of applicator to skin surface (defined as the mean measurement available via the VERT): (Benchmark mean / Student mean) x 100

Time (in seconds) taken to achieve an 'acceptable' set-up: (Benchmark time / Student time) x 100

Economy of movement - defined as the number of gantry/couch/collimator movements to achieve what the student deems to be an acceptable set up: (Total number of benchmark movements / Total number of student movements) x100

The overall set-up score was calculated as follows:
(error score x 0.3) + (skin apposition score x 0.2) + (applicator proximity score x 0.2) + (set-up time score x 0.15) + (economy of movement score x 0.15).

Results of Skin Apposition Techniques Study

1. Baseline data from the preliminary questionnaire and spatial ability testing for each arm of the study are included in the table below.

	3D stereo ON, Tracking ON	**3D stereo ON, Tracking OFF**	**3D stereo OFF**
n	36	35	32
Gender	Male: 11 Female: 25	Male: 8 Female: 27	Male: 9 Female: 23
Age	Mean: 23.7 SD: 7.2	Mean: 25.1 SD: 7.9	Mean: 24.9 SD: 8.1
Confidence in computer technology	Very confident: 8 Confident: 21 Not very confident: 6 Far from confident: 1	Very confident: 5 Confident: 24 Not very confident: 6 Far from confident: 0	Very confident: 10 Confident: 19 Not very confident: 2 Far from confident: 1
Confidence in operating a linac	Very confident: 2 Confident: 20 Not very confident: 13 Far from confident: 1	Very confident: 3 Confident: 24 Not very confident: 7 Far from confident: 1	Very confident: 3 Confident: 17 Not very confident: 10 Far from confident: 2
Weeks experience in electron set up participation	0: 14 1-3: 9 4-6: 13 >6: 0	0: 11 1-3: 13 4-6: 9 >6: 2	0: 10 1-3: 9 4-6: 10 >6: 3
Spatial ability score	Mean: 10.8 SD: 4.3	Mean: 11.5 SD: 5.1	Mean: 9.0 SD: 5.6

No significant differences between the 3 trial arms existed in any of the baseline characteristics.

The normalised set-up scores for the assessed appositional technique ranged from 43 to 204 with a mean of 101.8, a standard deviation on 26.3 and 95% confidence limits of 96.6 to 106.9. A Shapiro-Wilk test confirmed that data was not normally distributed.

2. The following table provides descriptive statistics for the set-up scores in each arm of the trial. A slightly higher mean performance score was noted for those students in the 3D stereo arm with user tracking turned off. However, a Kruskall-Wallis Test comparing set-up scores across the 3 groups showed no statistically significant difference (p=0.32).

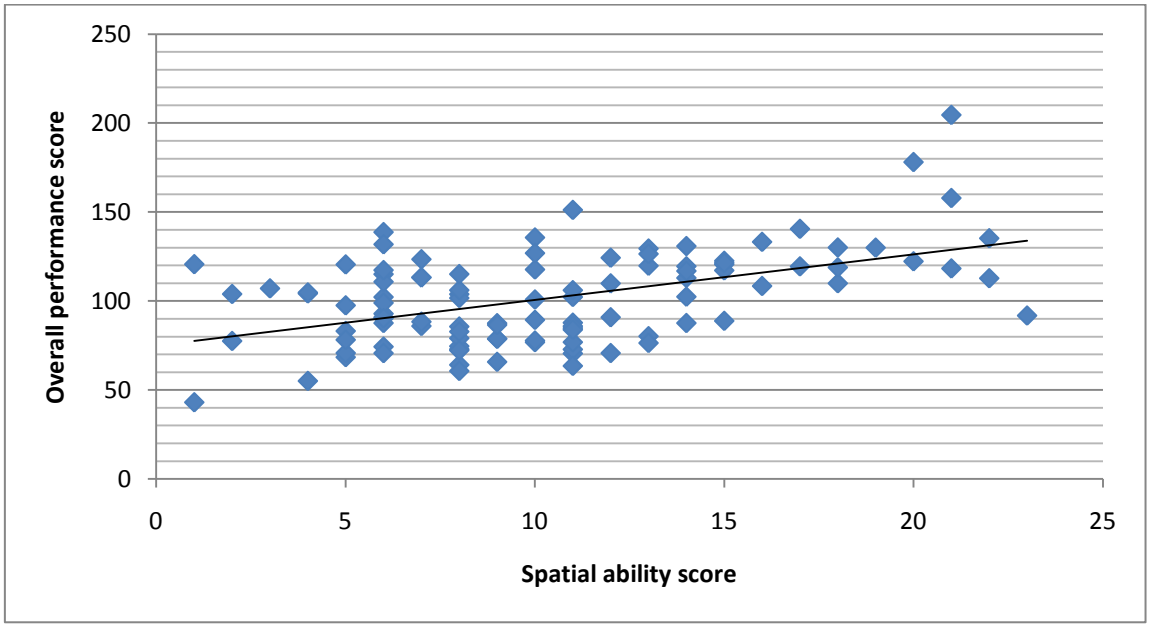
Results of Skin Apposition Techniques Study

3D Stereo ON Tracking ON		***3D stereo ON Tracking OFF***		***3D stereo OFF***	
Count	36	Count	35	Count	32
Mean	98.50	Mean	108.06	Mean	98.53
Standard Error	3.85	Standard Error	4.88	Standard Error	4.64
Standard Deviation	23.15	Standard Deviation	28.92	Standard Deviation	26.30
Range	55-151	Range	68-204	Range	43-158
95% CI	7.83	95% CI	9.94	95% CI	9.48

The difference in the mean set up scores between the '3D ON, Tracking OFF' and '3D ON, Tracking ON' group was 9.56 (± 12.2 at 95%CI), p=0.17 (Mann-Whitney Test).
The difference in the mean set up scores between the '3D ON, Tracking OFF' and '3D OFF' group was 9.54 (± 13.2 at 95%CI), p=0.22 (Mann-Whitney Test).

No significant differences between factor scores (such as extent of skin apposition and time taken to complete set-up) across groups were identified. However those students in the Tracking ON group were significantly worse at aligning the light field to the skin marks (vector discrepancy) compared to those with user tracking turned OFF (p<0.002). Students attributed this to difficulty in being able to position themselves closely enough to the patient in order to visualise alignment accurately.

3. A moderately positive correlation between spatial ability and set-up score was identified: r=0.494, p<0.01.



Relationship between spatial ability and performance score

Final Evaluation Survey

This survey aims to ascertain your views on the implementation of VERT now that the national VERT project is drawing to a close. Your views are important to us and will inform recommendations relating the impact of VERT on curriculum design.

The survey comprises 11 questions and will only take a few minutes to complete.

Thank you for your contribution.

1. Are you ...

- A student
- Academic staff
- Clinical staff

2. Which university are you/your students based in?

3. On average, how often is your VERT facility used?

	>10 hours per week	**5-10 hours per week**	**3-4 hours per week**	**1-2 hours per week**	**<1 hour per week**	**Unsure**
Immersive VERT (In University)						
Seminar VERT (On placement)						

Please add any relevant comments here

Final Evaluation Survey

4. On average, how much time do pre-registration radiotherapy students spend in the VERT facility each week?

	>10 hours per week	5-10 hours per week	3-4 hours per week	1-2 hours per week	<1 hour per week	Unsure
Immersive VERT (In University)	○	○	○	○		○
Seminar VERT (On placement)	○	○	○	○		○

Please add any relevant comments here

5. In your opinion, to what extent has VERT enhanced students' knowledge and understanding of the following:

	A great deal	Somewhat	Not at all	Not sure	N/A
Fundamental radiotherapy concepts such as the isocentre	○	○	○	○	○
Simple radiotherapy techniques	○	○	○	○	○
Complex radiotherapy techniques	○	○	○	○	○
Planning and plan evaluation of dose distributions	○	○	○	○	○
Anatomy	○	○	○	○	○

Final Evaluation Survey

Please add any relevant comments here

6. Please identify other examples of where VERT has enhanced students' knowledge and understanding of radiotherapy concepts. If NONE then please skip to next question.

1
2
3
4
5
6

7. In your opinion, how have the following areas of students' clinical competence been influenced by their use of VERT?

	Much better	A little better	No difference	A little worse	Much worse	Unsure	N/A
General psychomotor skills	○	○	○	○	○	○	○
Confidence	○	○	○	○	○	○	○
Simple set-ups (single fields and parallel opposed)	○	○	○	○	○	○	○
Complex set-ups	○	○	○	○	○	○	○
Electron set-ups	○	○	○	○	○	○	○

Please add any relevant comments here

Final Evaluation Survey

8. In your opinion, how has VERT influenced student enjoyment of their course?

	Much more enjoyable	A bit more enjoyable	No difference in enjoyment	Less enjoyment	Not sure	N/A
Immersive VERT (where used in University)	○	○	○	○	○	○
Seminar VERT (where used on placement)	○	○	○	○	○	○

Please add any relevant comments here

9. To what extent has VERT been integrated into your pre-registration course(s)?

- ○ All modules/units
- ○ Most modules/units
- ○ Some modules/units
- ○ A limited number of modules/units
- ○ No modules/units
- ○ Not sure

Please add any relevant comments regarding the integration of VERT here

Final Evaluation Survey

10. In your opinion, which student group has benefited most from using VERT?

- 1st years
- 2nd years
- 3rd years
- Post registration

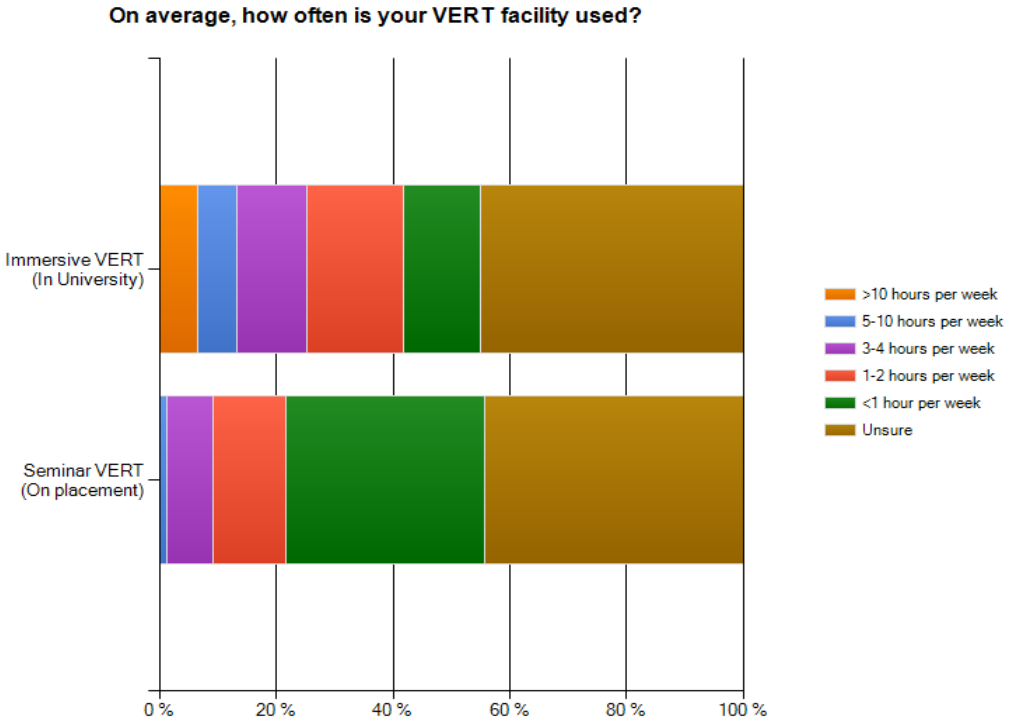
Please explain your answer

11. Finally, please add any additional comments you may have regarding your experiences of using VERT and your thoughts on how its integration into radiotherapy curricula may be enhanced.

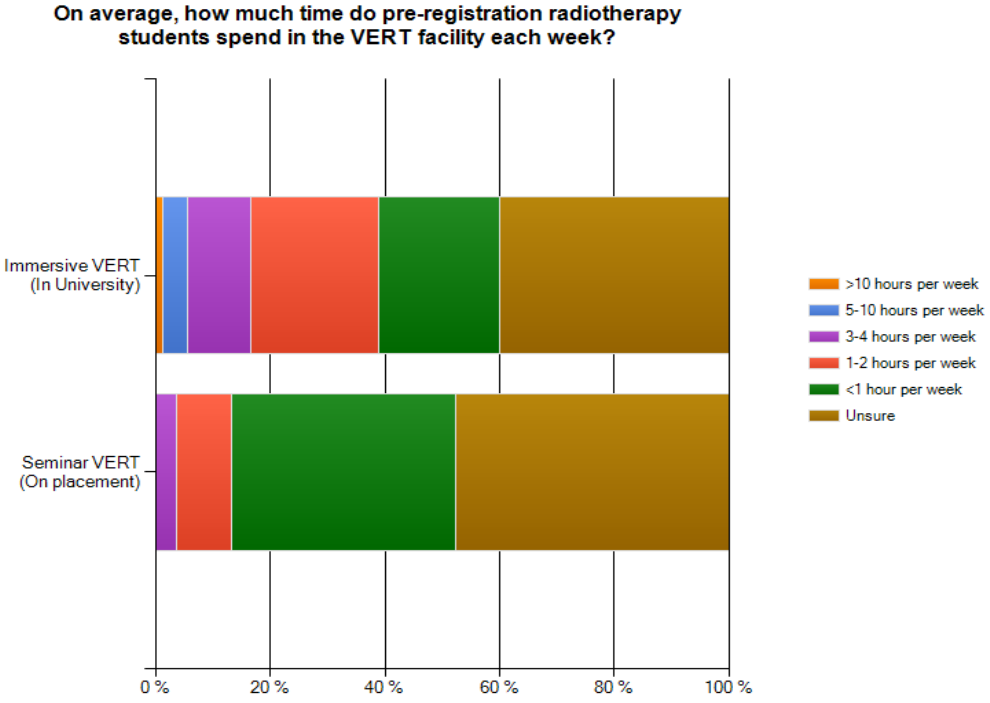
Thank you for taking the time to complete this survey.

Rob Appleyard - national VERT lead for evaluation and research.

Results of Final Evaluation Survey and Reports

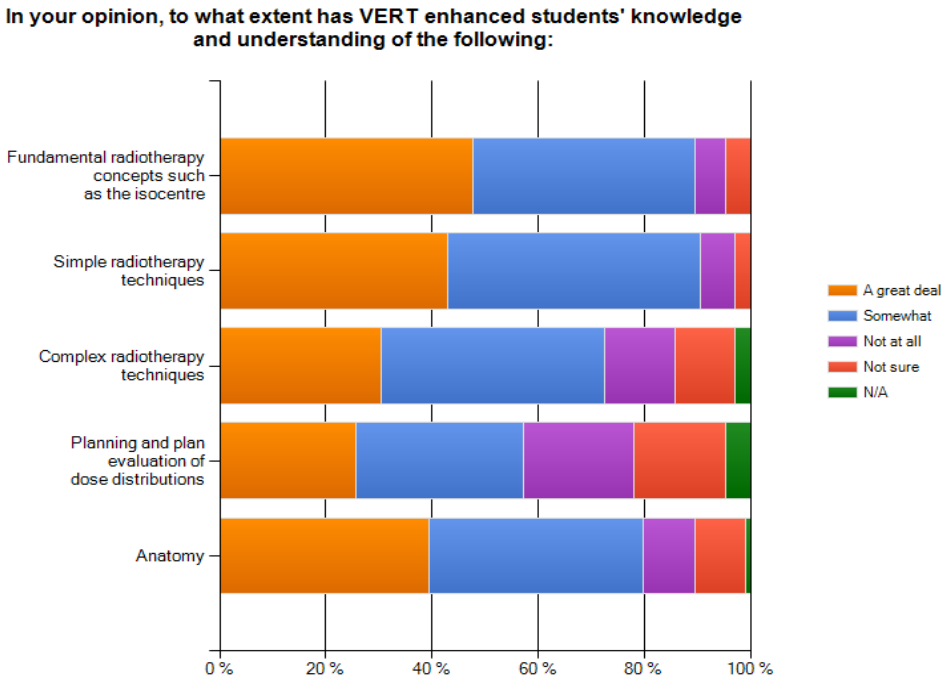


Usage of VERT facilities in educational institutions and departments



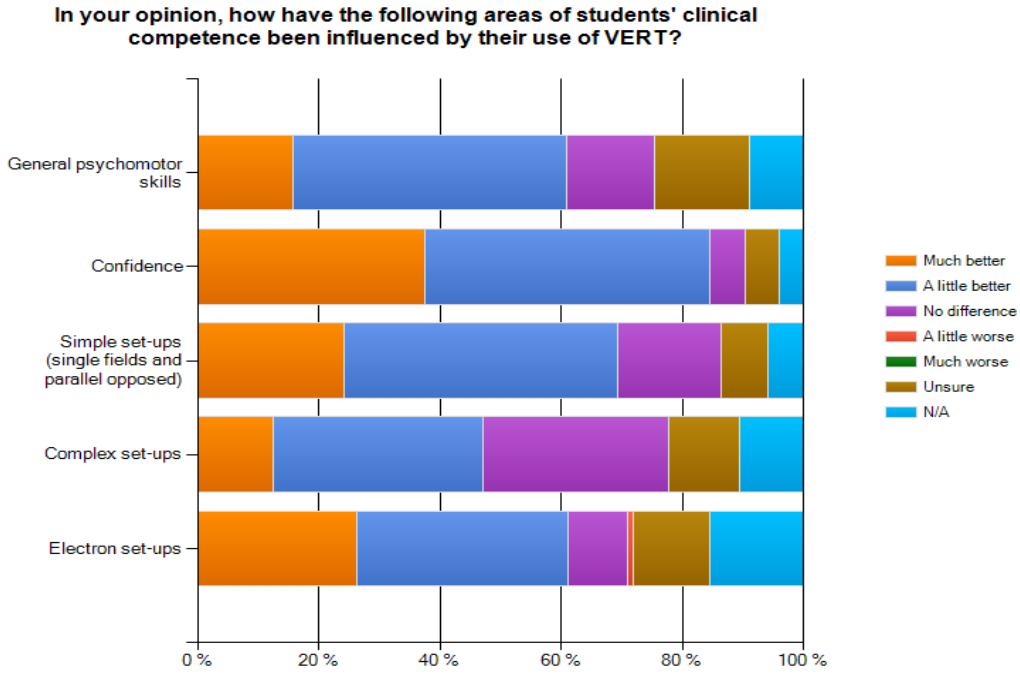
Use of VERT facilities by pre-registration radiotherapy students in education institutions and departments

Results of Final Evaluation Survey and Reports



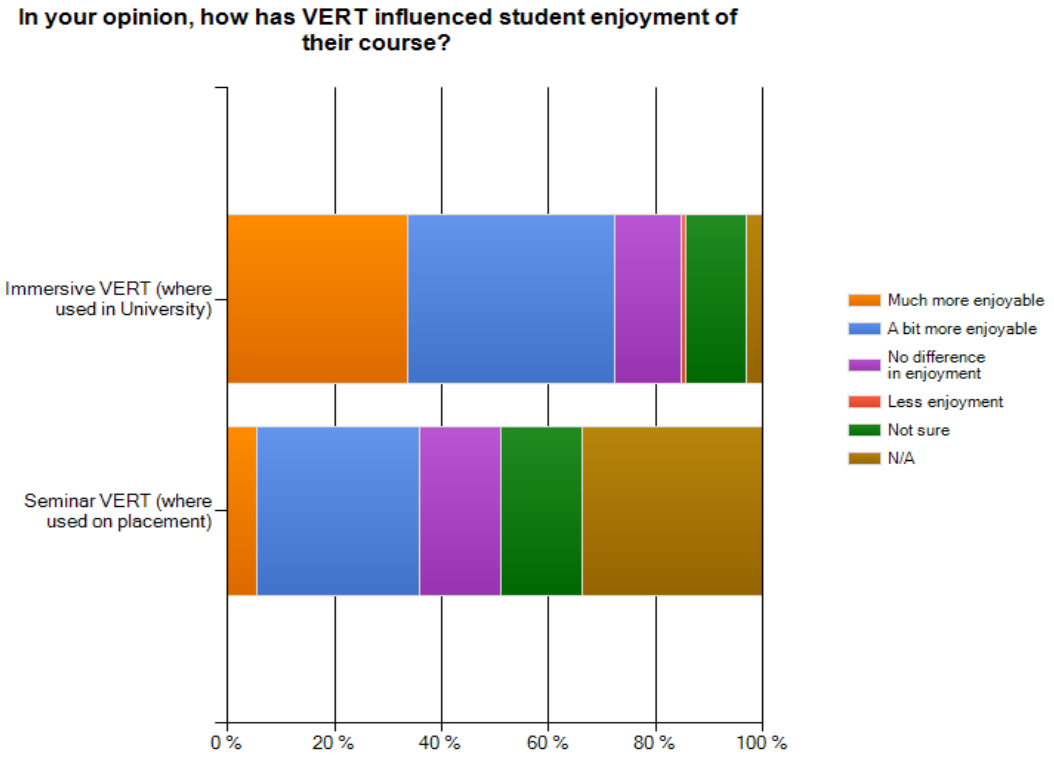
Perceptions of the impact of VERT on knowledge and understanding

Filtering responses by user group (student, academic staff and clinical staff): students and academic staff perceived VERT to be much more effective at enhancing knowledge and understanding, particularly in relation to fundamental concepts and anatomy.



Perceptions of the impact of VERT on clinical competence

Results of Final Evaluation Survey and Reports



Perceptions of the influence of VERT on enjoyment

Additional comments clarified responses:

- To be honest, I haven't really enjoyed using VERT. Not because the equipment isn't useful. Because it is! But because where the VERT suite is, it is extremely cold, and so you are forced to wear extra clothing! In addition, I personally, found it very hard to take the control and have a go, as I felt under pressure a lot of times and became very shy.
- It has been very beneficial to have time away from set, using VERT, to talk through any aspects of treatment I did not understand.
- I love sessions that include VERT. They bring what has been taught, to us so far, to life.
- Didn't really find the sessions I had on placement useful as we had plenty of time on the treatment sets.
- Students seem to have really enjoyed using VERT; not so much when it is lecturer lead - but when the sessions are student lead!
- Students in clinical would always prefer a real linac to VERT.
- They always want more time in VERT (in my experience) but with a large student cohort this can be difficult to facilitate within the wider university timetable of sessions.
- It's made complex concepts more tangible