E-learning for Health.

e-LfH developed and delivered an e-learning course for Radiologists. A feature of the project is the UK wide design and subject experts team who worked collaboratively on-line in developing the programme.

Business Need
Radiologists are central to delivering healthcare in the NHS. Specialising in the detection of disease through the use of a variety of investigative techniques, their work can be vital in finding an accurate and early diagnosis - improving the prospects for treatment - and is fundamental to the management of cancer care. They also play an important role in identifying sources of disease and reducing the possible risks of further spread. There are 7,200 members of the Royal College of Radiologists (RCR) Institute (RCR). In 2003 the NHS identified an urgent need for more trained radiologists. Traditional training schemes were oversubscribed and increasing placements with consultants was impossible as they had no further capacity to absorb more trainees. Additionally the apprenticeship-training model has the disadvantages of relatively inefficient consultant/trainee ratio and inconsistency of training.

The RCR proposed an e-learning approach, the Radiology Integrated Training Initiative (R-ITI) – to increase training capacity without putting additional strain on current resources.

The key drivers were to increase the rate and volume of delivery of trained radiologists without straining existing resources and to improve the consistency of training across the UK.

The RCR and Department of Health are the main stakeholders but all UK radiologist, Postgraduate Deans and others responsible for national training standards, and the NHS have an interest in the quality, accuracy, effectiveness and availability of the final solution.

The Learning Solution

The R-ITI team came together in 2004. The project was a first of its kind in clinical education in UK healthcare.

The critical objectives for the project team were:

- Determine and deliver the knowledge content to support the entire 3-year postgraduate radiology curriculum up to and including the final fellowship examination (FRCR). This equated to ~600 hours of e-learning content
- Procure a development environment, delivery environment and sufficient content development staff to deliver the required content
- Engage with, support and manage the relationship with 350 radiologists acting as subject matter experts, spread across the UK. These clinicians would need to source, review and approve materials in their own time, with no financial reward and the demands of a busy NHS on their shoulders
- Deliver a solution that replicated the image based working practices of a radiologist, delivered the requisite knowledge about practices and
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procedures, blended with other training elements, within a budget of <£2million and timescale of 18 months

- Deliver to a target audience across the UK which had variable IT access and support, and little experience of using or delivering e-learning as part of a blended learning solution

The e-learning should:
- Accommodate different learning styles
- Be multi-sensory
- Make learning for key facts memorable
- Deepen learning through exercises and interactions
- Include on-line tests before, during and after the session to show the user what they know
- Provide opportunities for learners to reflect on learning
- Enable learners to refer back and refresh knowledge
- Accommodate learners at different levels
- Accommodate learners who need to navigate through material in different ways
- Provide learners with opportunity to feed back
- Enable creation of flexible, logical and/or personalised learning paths
- Provide vehicle for tracking evidence of performance
- Be simple and consistent to navigate
- Use technology that is available and accessible in all relevant locations (this excluded large multimedia and simulation environments, or extensive use of sound)

The Learning Solution – who was involved
Thirty radiologists reviewed the entire curriculum and constructed a detailed syllabus structured into modules such as Cardiac, Musculoskeletal, Physics, Professional Skills. The Project team and educationalists and e-learning experts created a detailed learning design, identifying which elements of training would best be provided by e-learning and how these would integrate with other learning modalities.

Each e-learning module was divided into sessions of ~30 minutes of activity, giving a curriculum of 1,000 sessions. Each session was allocated to a subject matter expert (~350 UK radiologists) who provided the draft wording and images.

R-ITI content was developed by 15 e-learning designers, using GiuntiLabs LearneXact LCMS template development environment. This comprises two components - a content development environment and a learning content management system (LCMS).
- Content development: the R-ITI team took the content development environment, based on template pages, and further developed these to ensure a consistent presentation and common metadata across all content.
- LCMS: a web-based, shared environment within which peer review, author review and editorial review could take place interactively, without the time and cost constraints associated with significant travel. It enabled busy clinicians to contribute without adversely affecting service delivery.
Medical language was a particular challenge for the non-medical members of the project team, who therefore generated their own internal dictionary, enabling them to deal with the issue without delaying development.

The R-ITI e-learning content is based entirely on the knowledge and practical experience of hands-on clinical radiologists. The identification and selection of 350 subject experts from the UK radiology community were identified as peer acknowledged experts and recruited to the project. Content uses current best practice in radiology and is presented in ways that suit the needs of learners at different stages of learning.

**E-learning Design**

Interactivity is crucial to engaging and effective e-learning. The design balances maximum throughput and highly interactive sessions.

The technological environment for delivery has constraints. The NHS has a central wide area network (N3) linking to gateway hubs for each Trust. IT provision varies widely from Trust to Trust. Only standard plug-ins and downloads like Java, Flash and Quicktime are used. Sound is not used for reasons of bandwidth and because many PCs have no sound cards to minimise disturbance in the clinical environment.

R-ITI is accessible via the Internet, for home use by trainees.

The design combines text, static and dynamic 2D and 3D graphics, X-rays and images, video to transfer learning. Interaction is maximised, for example by using questions (free text, true/false and MCQs), identification of hot spots, ‘drag and drop’ etc. High quality anatomical images are possible with a Primal Pictures licence.

**Approaches to transferring learning**

R-ITI uses a wide variety of techniques to transfer learning to trainees efficiently and effectively.

**Efficiency**

- The e-learning provides the core knowledge required, the curriculum is seamless and duplication is avoided.
- Sessions have no more than four clearly defined learning objectives, designed to take ~30 minutes to complete. Trainees undertake ‘just-in-time’ learning utilising short periods of down time in their clinical programme.
- Learning paths are designed both at national and individual level, to enable the trainee to navigate through the e-learning sessions most relevant to their current learning needs.

**Effectiveness**

- A medical educationalist assisted in the design of the project, the approach to blended learning, the e-learning models and the development of formative and summative assessment tools.
- All content is continuously reviewed for quality, relevance and impact and a four-year formal review cycle is in place.
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- All content is accessed through the Oracle Learning Management System (LMS). This enables the design and delivery of national and bespoke learning paths, navigating trainees through the material to ensure they focus on the learning appropriate to their stage of training and clinical exposure. It also enables reporting at individual, group and national level.

Templates

Approximately 30 templates are used to create sessions. This ensures a consistent look and feel to the solution, whilst providing maximum flexibility in the organisation and presentation of content.

The following screen shots are taken from R-ITI sessions to illustrate some uses of the technology.
Example 1: Using redrawn images to present clear medical pictures
Doctors are used to viewing images in medical documents and journals as line drawings – R-ITI uses a similar approach.

![Example Image of Pharynx: Normal Anatomy and Examination Techniques](image)

Example 2: Video
Embedding streamed video is used to present scenarios and examples of procedures that are difficult to do in other ways. Video with sound (where appropriate) is used and underpinned with a variety of interactive elements ensuring that trainees did not develop a passive learning style.

2.1 Video without sound:
In this example, the trainee sees a 'real time' heart angiogram
2.2 Video with sound:
This ‘Equality and Diversity’ example is taken from the generic syllabus

Example 3 – Embedding Medical Images

Embedded medical images (here a CT) are used to ensure trainees became used to the images they will see in day-to-day life. Specific features of the image have interactive overlay text, arrows and other highlighting elements – this replicates the way a trainer would highlight areas of interest in an image for a trainee.
Primal Pictures images
This example also shows formative assessment

In this example, the trainee rotates this 3D model to review the anatomy
The gallbladder is a pear shaped sac lying on the visceral surface of the liver.

It approximately measures 10cm in length and 3cm in width, and has a capacity of about 50cm³.

The gallbladder is divided into 3 parts:

- **Fundus** - The fundus is rounded and normally projects below the inferior margin of the liver (see normal variants)
- **Body** - The body lies in contact with the visceral surface of the liver and is directed upward, backward and to the left.
- **Neck** - The neck lies superiorly and is continuous with the cystic duct (see normal Bilary tree anatomy)

The peritoneum covers the fundus and the inferior surface of the gallbladder, binding it to the liver. Occasionally there may be a mesentery and if so the gallbladder hangs free from the liver.

**Hartmann’s pouch** is a focal pouch seen on the ventral surface of the gallbladder just proximal to the neck. This is more prominent in the diseased dilated gallbladder.

**The spiral valves of Heister** are spiral folds of mucosa within the gallbladder at the junction of the neck and cystic duct.
Example 4 – Learning by Doing

All radiologists need to be able to review an image and quickly identify what it shows. To replicate this in the e-learning a combination of Multiple Choice Questions linked to an image ensure that a trainee is accurately identifying what they are looking at. The trainee commits to an answer before the correct answer is revealed. The area of interest is highlighted or additional learning material included, as part of the answer to the question.
Business Benefits

Department of Health
- R-ITI delivered both on time and in budget (£1.7m). Evaluation of its quality and cost-effectiveness has driven the development of the DH e-learning strategy, the development of a wider programme ‘e-Learning for Healthcare’ and the allocation of significant DH and Treasury resources for delivery of similar complementary e-learning across generic and professional training.

- The Chief Medical Officer has described R-ITI as “the most positive development in medical education in 20 years”

Royal College of Radiologists and individual radiologists
- The impact of the initial pilot encouraged the RCR to drive the UK-wide uptake of R-ITI.

- RCR developed the infrastructure to enable continuous updating of the content and is leading the development of national learning paths.

- RCR is now working on e-learning for years 4 and 5 training and continuing professional development.

- Content authors receive Continued Medical Education credits and acknowledgement from peers for work published

Postgraduate Deans
- The Conference of Postgraduate Medical Deans (COPMeD) has actively supported the roll out of R-ITI and the Deans are increasingly using the trainees’ e-learning records towards their annual assessment of progress.
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- “the creating of this e-learning system has enormous potential for patient safety as it gives easier access and greater exposure to the full range of conditions that trainees may come across.”

- “A great quality assurance process … we can now calibrate whether the whole country or a single Trust has passed a set level of learning. It is a huge step forward.”

Service
- The graph shows the increase in trainees at the three pilot Radiology Academies since implementation

Norwich Academy 2005/06 data – formal benchmarked assessments:
After Implementation of R-ITI, first year trainees were assessed using the standardised in-house formal assessment tools (5 years’ historic data).

1. Formal standardised reporting test:
   - Traditional training scheme – trainees reach required level after 16 months
   - R-ITI – trainees reach required level after 7 months

2. Formal assessments at 7 months:
   - Anatomy MCQ (normally taken at 9 months)
   - 25 image A&E reporting test (normally taken at 10 – 12 months)
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- 25 image basic plain film reporting test (normally taken at 15 months)

All R-ITI trainees achieved similar results to previous 'traditional' cohorts. All trainees passed assessment of in-patient reporting.

3. Contribution to service delivery:
   After formal assessment, all trainees began reporting A&E radiographs and inpatient plain imaging, bringing these landmarks forward 3 months and 7 months respectively.

Usage

This graph demonstrates the number of individual enrolments on sessions. The increase from October coincides with roll-out to the whole radiology community.
Trainee and trainer on-line feedback on content:
Continuous feedback is collected from users who can ‘star rate’ and comment on individual e-learning sessions (anonymously if desired). The design team actively use these ratings and comments to shape further development and updates.

Average star ratings of content (294 individual sessions rated):

- 62 positive comments
- 7 suggestions for amendments to content

Selected representative free text examples:
- “Awesome session!”
- “Excellent way to learn”
- “Well paced”
- “Good videos”
- “Good basics and excellent illustrations”
- “Marvellous images”
- “Pulmonary artery anatomy would have been better with CT axial images rather than just 3D pictures”
- “Nice systematic approach with good examples”
- “Clear, logical and concise presentation”
- “A good explanation of the basic principles that were otherwise tricky to understand in standard texts”
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- “This session sets two main objectives and meets them in a well presented and very informative way”
- “With 3 days to go to the FRCR, I found this session useful and the questions at the end were a very nice touch”
- “All you need to know and up-to-date figures with good links”
- “This is fantastic. I wish I’d had something like this when I was learning.”

Qualitative semi-structured interviews in the three pilot Academies (Mar – June 2007) – 20 respondents:

Trainees:
- “R-ITI means you have great access to excellent images and learning tools wherever you are in your own time … you do not have to wait for a consultant or registrar to be ready to teach, you can get stuck into a programme whenever you get a chance.”
- “Infrastructure is fantastic and so are the resources … we are not spoon-fed but we have lots of highly structured training, lots of learning opportunities. You are not just reliant on hoping that your boss is good.”
- “Having done so badly in my exams in the past … at last, R-ITI means I can see light at the end of the tunnel”
- “Not only tracks my progress but brings instant measurability of my progress and results”
- “An excellent learning facilitator with a wealth of radiology knowledge” (2nd year trainee, who studied >150 sessions and spent >120 hours on e-learning in 12 months)

Trainers:
- “It has made training significantly easier because the trainees come to the sessions much better informed, they are much more enquiring. We start from a much higher level of knowledge before the tutorial begins.”
- “The trainees have found the ELD an invaluable learning tool … it is likely to become the focal point for the majority of self-directed learning”
- “For the first time all trainees have a resource that reflects exactly the RCR curriculum”
- “Historically, especially in the early years of radiology training, there was a lot of dead time in that they were just hanging around watching but not being able to do very much. Now … they arrive with a higher knowledge base and know what they are looking for and what is expected of them …they start to contribute more early.”
- “It can be a culture shock starting radiology. (as a qualified doctor) you go from a position of responsibility to being virtually useless in your job… the feeling of belonging (helps) to see where you are going in what you learn”
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• “We knew that getting 10 junior Specialist Registrars through our radiology department with the existing workload was going to be very difficult. (The e learning) gives them a head start.”

In-depth interviews over the life of the project
Combination of in person and phone interviews with a wide variety of stakeholder from trainees, trainers, managers, and strategic leaders in education and workforce.

Learning and communication specialists
• The R-ITI technical team is now called upon by the individual technology suppliers to demonstrate and showcase the integrated use of these technologies.

Summary of Benefit
R-ITI has broken new ground in its structured approach to curriculum generation, development of a robust editorial infrastructure and authoring of e-learning materials. It is unique in that it covers a complete end-to-end curriculum and is the largest single subject e-learning product in Europe.

The impact on trainees and trainers has been profound; R-ITI has revolutionised training in radiology. It has enabled the delivery of nationally quality assured standardised training, an increase in the number of trainees and improvement in their service contribution.

Strategically, R-ITI has driven the development of the national e-learning strategy and is underpinning 21st century approaches to workplace redesign, national
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standards and quality assurance. These outcomes far exceed those expected at the outset of the project.