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*Chapter 6*

# E-LEARNING IN CLINICAL ONCOLOGY

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## ABSTRACT

Over the past two decades, there have been unprecedented advances in the field of non-surgical oncology, resulting in new challenges for education and training. For medical oncology (the use of systemic treatments to treat cancer), there has been an explosion in the number and types of new agents. The major educational challenge is decision making, a complex skill which requires the oncologist to use his specialist knowledge, experience and clinical judgement to identify the treatment, or combination of treatments, that is likely to result in the greatest overall benefit for the individual patient. For radiation oncology, the advances have been largely technological involving the requirement to learn new concepts and new practical skills. The need for education and training is not just for trainees, but also for the trained workforce involved in implementing new techniques. There is also a growing need for cross-specialty and multi-professional education and training with the increasing use of combined modality treatments and skills mix.

This article reviews the challenges for education and training in non-surgical oncology. The focus is on education and training for oncologists but references to other disciplines are made where relevant. The article reviews the e-learning resources that are currently available and compares them against best practice guidance on technology enhanced learning.

## INTRODUCTION

Oncology is the branch of medicine that specializes in the diagnosis and treatment of cancer. It includes medical oncology (the use of systemic treatments such as chemotherapy, hormone therapy and biological therapies to treat cancer), radiation oncology (the use of radiation to treat cancer), and surgical oncology (the use of surgery and other procedures to treat cancer). In many countries (e.g., Europe, North America and Australia), the three specialties have traditionally been separate. In some countries, notably the UK and Denmark as well as most developing countries, medical oncology and radiation oncology are combined into a single specialty called clinical oncology.

Over the past two decades, there have been unprecedented advances in the field of non-surgical oncology. For medical oncology, there has been an explosion in the number and types of new agents. The most critical skill required of the oncologist is decision making, a complex skill which requires the oncologist to use his specialist knowledge, experience and clinical judgement to select the treatment, or combination of treatments, that is most likely to result in the greatest benefit for the individual patient in terms of cure, prolongation of life or symptom control while minimizing side-effects.

For radiation oncology, the advances have been largely technological allowing more precise and higher doses of radiotherapy to be delivered to the tumor while sparing normal tissues. In addition to decision making, the radiation oncologist is also required to continually learn new concepts and new practical skills which impact on target volume delineation, treatment planning and treatment delivery. The need for education and training is not just for trainees, but also for the trained workforce involved in implementing new techniques. The delivery of radiation therapy is a complex multi-step process involving different professional groups, including oncologists, physicists and radiation technologists, at each step. For a new technique to be implemented safely and efficiently, the various professional groups require not only education and training to undertake their own roles and responsibilities but also an understanding of the roles and responsibilities of the other professional groups.

This article reviews the challenges for education and training in non-surgical oncology and the e-learning resources that are available which may help address these challenges.

The article focuses on education and training for oncologists but also refers to initiatives in other fields where relevant.

## CHALLENGES FOR TRAINING AND EDUCATION

In most countries, oncologists are required to undergo a defined period of training before accreditation as specialists. Competency assessment in most modern training programs nearly always includes various forms of workplace based assessments. Many programs also require formal testing through examinations in order to gain specialist certification. Once certified, most countries require oncologists to demonstrate that they are keeping their knowledge and skills up to date through a program of Continuing Professional Development (CPD). In most cases, this is a self-regulated record of time spent in various CPD activities. The US is unusual in that their Maintenance of Certification (MOC) program for radiation oncology also includes a formal examination with multiple-choice questions (MCQ) as well as at least one "Practice Quality Improvement" project (ABR 2015).

There is increasing awareness that current training programs for oncologists may not be as effective as desired when assessed against objective criteria. For example, the UK Royal College of Radiologists Final Fellowship examination in Clinical Oncology (FRCR) consistently has success rates of around 50%. In trying to identify possible reasons for this low pass rate, it is reasonable to postulate that the issue lies with one or more of the following - the quality of the candidates, the format of the examination or the effectiveness of the training. UK trainees are unique in being required to obtain a postgraduate degree in internal medicine (Membership of the Royal College of Physicians) as a prerequisite for acceptance onto the clinical oncology training program. Despite this, the application ratio for higher training in clinical oncology is 3.6:1, making it one of the most competitive medical specialties second only to dermatology at 4:1 (CO-(ST3)-Recruitment 2015; JRCPTB 2015). Both these facts suggest that quality of candidates is not a major issue. Similarly, a recent external review of the FRCR examination (Patterson 2014) concluded that overall, the assessments used performed to a good or acceptable standard. It is therefore reasonable to conclude that the current training and education is not equipping candidates with the competencies to succeed in the FRCR examination.

Similar questions have been raised about the effectiveness of current CPD programs, particularly those that depend on subjective criteria such as time spent ± reflections on CPD activities (Tan 2011). In an external audit of radiation practice and medical decision making in a new Asian oncology centre staffed by four nationally accredited radiation oncologists, 52% of patients were assessed as receiving "suboptimal management" (Shakespeare et al. 2006). Technical performance and decision making in all aspects of the radiotherapy process were identified as the two most statistically significant contributory factors. In a randomized controlled study from Canada evaluating the effectiveness of a radiation oncology e-learning module (Alfieri et al. 2012), the participating residents were given a baseline test containing questions based on typical residency examinations written with an expert involved in national certification. The mean baseline scores of the residents was 36%. Perhaps of more interest, the mean score of experts in the field was only 50%, suggesting that in a significant proportion of clinicians, the learning that they had at the time of certification has not been retained.

There is also discussion as to how best to assess competency. In particular, workplace based assessments, while valuable as formative assessments that prompt supervision, feedback and reflection, may not be reliable as measures of competency and performance (Miller and Archer 2010; Mitchell et al. 2011). Similarly, MCQs are widely used as tests of knowledge but their format is important in determining what is assessed. True/false MCQs test factual recall and have been shown to correlate poorly with clinical expertise. In contrast, MCQs which require the candidate to indicate the most appropriate single response for a clinical scenario (so called single best answer (SBA) questions) have been shown to be better suited for assessing those aspects of knowledge essential for clinical practice, including application of knowledge, data interpretation, problem solving and decision making (Case and Swanson 2001; Tan and McAleer 2008).

Other professionals involved in the treatment of cancer (physicists, dosimetrists, radiation technologists and nurses) also have their own training and CPD requirements. In many countries, these are less formalised than for oncologists and CPD in particular is often regarded as optional rather than mandatory. As a result, funding for CPD activities for these health professionals is often extremely limited.

Core curricula for both radiation oncology (Coffey et al. 2006; Potter et al. 2012; Xiao et al. 2011) and medical oncology (Hansen et al. 2004; Muss et al. 2005) have been developed by various international societies in an effort to standardise training and education of all professionals. For example, the curriculum developed by the European Society of Radiotherapy and Oncology (ESTRO) has been formally endorsed by the national societies of 28 countries in Europe. There is also increasing collaboration across continents such as the Global Radiation Oncology Collaboration in Education (GRaCE) involving clinician educators from Europe, Canada, Australia and New Zealand (Turner et al. 2015).

In addition, there is a growing need for cross-specialty education and training with the increasing use of combined modality treatments (radiotherapy in combination with chemotherapy and other drugs), particularly in those countries where medical oncology and radiation oncology are separate disciplines. Similarly, the increasing use of skills mix, where tasks traditionally carried out by oncologists (e.g., target volume delineation) are now being undertaken by other health professionals, has given rise to a demand for access to training materials for staff wishing to expand their learning beyond the usual professional boundaries. The ultimate challenge for educators in oncology is therefore to deliver effective education and training which will meet the needs of a diverse group of health professionals scattered across the globe in the current financial climate.

## E-LEARNING RESOURCES FOR CLINICAL ONCOLOGY

The term e-learning has many definitions and has been used interchangeably with terms such as online learning, distance learning, self-learning, internet or web-based learning and computer-based learning. In this article, we confine our review to e-learning resources that are available on the internet (i.e., online, internet-based or web-based).

Cook et al. (Cook et al. 2010a) conducted a systematic review of web-based learning for medical professionals and found considerable variation in course configurations, instructional methods and presentation formats (Table 1). The review included 266 studies comparing a web-based learning intervention with no intervention or another educational activity. Nearly all courses (89%) used written text and most (55%) used multimedia. A total of 32% used online communication via e-mail, threaded discussion, chat or videoconferencing, and 9% implemented synchronous components. Overall, 24% blended web-based and non-computer based instruction. Most web-based courses (77%) employed specific instructional methods, other than text alone, to enhance the learning process. The most common instructional methods were patient cases, self-assessment questions and feedback.

We conducted an internet and literature search for examples of web-based learning resources for non-surgical oncology to illustrate the range of instructional designs as described by Cook. We found a vast array of freely available text-based resources, often produced by large national and international cancer organisations or charities for the benefit of patients and health professionals.

**Table 1. Types of course configurations and instructional methods used in web-based learning**

| | |
|---|---|
| • Web-based instructional configurations<br>• Static written text<br>• Multimedia (audio, video, still images)<br>• Links to online resources<br>• E-mail discussion<br>• Online discussion other than e-mail (e.g., threaded discussion, online chat)<br>• PowerPoint presentations<br>• Synchronous (live) discussion<br>• Videoconferencing<br>• Simulation/virtual patient | • Instructional methods<br>• Online lecture or tutorial (video or PowerPoint)<br>• Online discussion<br>• Unlimited usage (access after course has finished)<br>• Intentional spacing (repeating the same course material at least once during the course)<br>• Interactivity (customised animations/graphics)<br>• Practice exercises (at least two cases or questions on the same topic)<br>• Patient cases<br>• Self-assessment<br>• Feedback<br>• Homework assignments<br>• Simulation/virtual experiences (emulation of real life clinical tasks/scenarios)<br>• Adaptation (tailoring of course content or navigation in response to learner needs or characteristics) |

Adapted from Cook et al. (2010a).

Similarly, there was a plethora of freely available PowerPoint lectures with or without audio which were presumably uploaded by their owners. In addition, most international professional societies for both medical and radiation oncology offer member-only learning content in the form of webcasts and online lectures from their conference proceedings. The main purpose of these content is to provide commentary on, or dissemination of, research findings to inform practice in the clinic.

For medical oncology, there are a number of sites offering free self-learning content based on patient cases. Examples include Clinical Care Options, Medscape Oncology, NTK Select and PeerView Press. The instructional design tended to be fairly uniform with learners being asked to follow a set sequence of text, images and/or video/expert commentary interspersed with occasional MCQs (mostly true/false) with feedback. Most sites offer the facility to participate in online discussion threads. Nearly all the sites are sponsored by pharmaceutical companies and the emphasis is on dissemination of information on new drugs.

In contrast, the only freely available resources on radiation oncology we found were Wikibooks and the Applied Sciences of Oncology (ASO) course developed by the International Atomic Energy Agency (IAEA). The Radiation Oncology Wikibook describes itself as "a textbook of radiation oncology." The ASO course was produced for the IAEA to provide cancer education for doctors and other radiotherapy professionals in countries where there is little currently available. Originally distributed on CD, the course is now available as a web-based resource from the IAEA Human Health Campus website. As of 10 October 2015, the course covers eight subject areas - communication, critical appraisal, functional anatomy, molecular biology, pathology, patient care, physics of radiation technology, radiation biology, and systemic therapy for cancer. The content is again set sequences of text and images with MCQs with feedback. Students who complete the ASO course are awarded an IAEA "Certificate of Completion." The website also contains a collection of downloadable zip files of recorded radiotherapy seminars.

Alfieri et al. (Alfieri et al. 2012) from McGill University described a free e-learning module in gynaecological cancers for radiation oncology trainees in Canada. The aim of the module was to facilitate learning of key radiologic anatomy concepts pertinent to radiotherapy treatment planning. The content was said to include radiological images, custom-designed graphics, text with hyperlinks and practice exercises, including target volume delineation and estimating treatment field boundaries on two-dimensional orthogonal radiologic images using Adobe Macromedia Director software. The Peter MacCallum Cancer Centre in Melbourne offers radiotherapy e-learning content on their website. As of 10 October 2015, two modules are available - image guided radiation therapy and adaptive radiation therapy. Content is available without charge but only to professionals in the state of Victoria. The format of the learning content is not specified.

The ESTRO FALCON (Fellowship in Anatomic deLineation and CONtouring) program offers regular online contouring workshops in addition to live courses (Eriksen et al. 2014). Each online workshop focuses on one tumor site and costs between €150-250. Workshops are limited to small groups of 20-25 participants and include 1–1.5 hours of synchronised discussion every week for three weeks using the Cisco WebEx web conferencing system. At the first session, the contouring case, software, faculty and participants are introduced. The contouring software used is EduCase, an online software from RadOnc eLearning Center, USA (www.educase.com). During the first week, the participants are asked to delineate specified regions of interest. At the second session, published contouring guidelines for the tumor site are presented and the delineations from the first week are discussed. During the second week, the participants re-contour on the same case. In the final session, the delineations from the second week are discussed and compared with the delineations from the first week as well as those from the teacher. The participants have email access to a FALCON tutor during the course. It is unclear whether access to the case is available after the course. FALCON also provides a small number of free contouring cases for ESTRO members. Learners can compare their contours with a reference set of contours but no other information (e.g., text or annotations) is given to guide learning. EduCase also offers a number of demo cases on their website although the exact format of the learning content is not specified.

As of 10 October 2015, the UC San Diego Radiation Oncology Learning Center offers six online courses on various advanced radiotherapy on their website. Each course comprises web-based lectures/instructional videos, quizzes, supplemental reading materials and discussion. It is unclear what format the discussion takes. Access to the course is available long-term. The cost varies from $50 for a one-hour course to $1,500 for a 31 hour course. Some online courses can be combined with a visit to the center as a blended course for additional cost.

Radiotherap-*e* (www.e-lfh.org.uk/radiotherap-e) is a self-learning multi-professional resource for the trained workforce involved in the delivery of radiotherapy. The program was developed by the Department of Health in conjunction with the professional societies to provide the knowledge base and practical skills training to support the implementation of advanced radiotherapy techniques in the UK and is one of >80 e-learning programs in the award-winning national e-Learning for Healthcare project. The program covers five advanced radiotherapy techniques in 61 sessions. A variety of media is used to explain the complex principles involved in advanced radiotherapy techniques, including text, images, animations and videos, and different types of self-assessment questions with feedback. There are step-by-step descriptions of practical procedures, and extensive use of clinical examples including patient cases. Customised tools which simulate everyday tasks in the radiotherapy process have been specially developed to allow users to practise practical skills, including a contouring tool, an image registration tool and dose calculation spreadsheets for calculating biologically equivalent doses for different dose-fractionation schedules. Sample sessions are available free on the website. There is no facility for discussion. The content is free to healthcare professionals within the UK National Health Service (NHS). For non-NHS workers or those who do not work in the UK, the cost is £150 for the entire program (or £40-£60 per module) for one year.

Cambridge Cancer Medicine Online (ccmo.co.uk) is a self-learning program developed by members of Cambridge University Hospitals Cancer Division. The program was specifically developed for clinical oncology trainees preparing for the UK Final FRCR examination. The emphasis is on the development of those skills essential for clinical practice, including principles of decision making and application of knowledge. Aspects covered include image interpretation, radiotherapy planning, chemotherapy prescription and interpretation of pathology and laboratory results. The program has two components - a live question bank of single best answer MCQs with feedback which allows users to compare their scores with their peers and >30 interactive modules focussing on principles of treatment and patient case-based discussions of common scenarios encountered in the clinic. Standard content includes text, images, videos and different types of self-assessment questions with feedback. Customised tools have been specially developed to allow users to practise practical radiotherapy planning skills including a contouring tool, a simulator tool which allows users to place radiotherapy treatment fields on orthogonal films, and a dosimetry tool which allows users to create radiotherapy dosimetry plans. With all the tools, users can obtain instant feedback by comparing their efforts with reference answers. Sample sessions and demos of the tools are available free on the website. There is no facility for discussion. Subscriptions are £60 for 6 months or £90 for 12 months for each component. The programme was launched in November 2012 and as of 11 October 2015, there have been 343 registrants from 18 countries with 281,646 attempts at questions (*pers. comm.)*.

A summary of the e-learning content described in this article is given in Table 2.

## CHALLENGES FOR E-LEARNING

There have been a number of meta-analyses of the effectiveness of e-learning in different fields. Cook et al. (Cook et al. 2008) conducted a meta-analysis of 201 studies of internet-based learning in the health professions. They found that internet-based instruction for medical professionals is associated with favorable outcomes across a wide variety of learners, learning contexts, clinical topics, and learning outcomes. Internet-based instruction appears to have a large effect compared with no intervention and appears to have an effectiveness similar to traditional methods. In a separate review (Cook et al. 2010b), they identified that interactivity, practice exercises, repetition, and feedback improved learning outcomes (and interactivity, online discussion, and audio improved satisfaction).

The US Department of Education conducted a meta-analysis of random-assignment or controlled quasi-experimental studies which compared online with face-to-face learning across all age groups and subjects (Means et al. 2009). The most common subject matter was medicine or health care. The report concluded that students who took all or part of their class online performed better, on average, than those taking the same course through traditional face-to-face instruction. They found that elements such as video or online quizzes did not appear to influence the amount that students learnt but learning was enhanced by giving learners control of their interactions with media and prompting learner reflection.

Our review suggests that current medical oncology e-learning content, although abundant and freely available, rarely included those elements identified as important for facilitating learning.

Nearly all the content take the form of existing lecture material, webcasts or didactic patient cases, with the addition of periodic MCQs for self-assessment.

While this is commendable as it allows the distribution or penetration of any individual presentation to be increased significantly, the educational value of the content is perhaps questionable as the emphasis is on transfer of information.

**Table 2. Types of course configurations and instructional methods used in oncology web-based learning. Grey boxes indicate that the element could not be assessed**

| | Instructional Configuration | | | | | | | | | Instructional methods | | | | | | | | | | | | Access |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Static text | Multimedia | Links | Online discussion | E-mail discussion | PowerPoint | Synchronous discussion | Video-conferencing | Simulation | Online lecture | Online discussion | Unlimited usage | Intentional spacing | Interactivity | Practice exercises | Patient cases | Self-assessment | Feedback | Homework assignments | Virtual experiences | Adaptation | |
| International societies and cancer charities | √ | √ | √ | | | √ | | | | √ | | √ | | | | √ | √ | √ | | | | Free or members only |
| Clinical Care Options<br>Medscape Oncology<br>NTK Select<br>PeerView Press | √ | √ | √ | √ | | | | | | √ | √ | √ | | | | √ | √ | √ | | | | Free |
| Wikibooks | √ | | √ | | | | | | | | | √ | | | | | | | | | | Free |
| IAEA ASO | √ | √ | √ | | | | | | | √ | | √ | | | | | √ | √ | | | | Free |
| McGill University | √ | √ | √ | | | | | | √ | | | √ | | √ | √ | √ | √ | √ | | √ | | Members only |
| ESTRO FALCON | √ | | √ | | √ | | √ | √ | √ | | | | √ | | | √ | √ | √ | √ | √ | | Subscription + members only |

**Table 2. (Continued)**

| | Instructional Configuration | | | | | | | | | Instructional methods | | | | | | | | | | | | Access |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Static text | Multimedia | Links | Online discussion | E-mail discussion | PowerPoint | Synchronous discussion | Video-conferencing | Simulation | Online lecture | Online discussion | Unlimited usage | Intentional spacing | Interactivity | Practice exercises | Patient cases | Self-assessment | Feedback | Homework assignments | Virtual experiences | Adaptation | |
| EduCase | | | | | | | | | √ | | | √ | | | | √ | √ | √ | | √ | | Free |
| San Diego Radiation Oncology Learning Center | √ | √ | √ | | | | | | | √ | | √ | | | | √ | √ | √ | | | | Subscription |
| Radiotherap-e | √ | √ | √ | | | | | | √ | | | √ | | √ | √ | √ | √ | √ | | √ | | Subscription |
| Cambridge Cancer Medicine Online | √ | √ | √ | | | | | | √ | | | √ | | √ | √ | √ | √ | √ | | √ | | Subscription |

In contrast, the radiation oncology e-learning content available, albeit limited, tended to include more active learning tools such as interactive animations, simulator tools, practice exercises and different types of questions in addition to MCQs to promote reflection. This is perhaps not surprising as radiotherapy is a craft specialty and many of the tasks in clinical practice are computer-based. What is possibly surprising is that there is so little content available compared to other medical specialties. Nearly all the radiation oncology content available were developed after 2010 whereas the first randomized study of e-learning for health professionals was published in 1999 (Cook et al. 2010b).

It is easy to postulate reasons for the paucity of e-learning content for radiation oncology. The typical cost of creating one hour of e-learning content has been estimated to be between $5,934- $50,371 (Chapman 2010). It is perhaps noteworthy that nearly all the sites offering medical oncology content were sponsored by pharmaceutical companies promoting the latest advances in cancer drug treatment. Similarly, the only free e-learning resource for radiation oncology with more than text-based content is offered by the IAEA, an organisation with considerable financial resources.

Authoring of e-learning content is not always given the same recognition as traditional educational activities. For example, the UK Royal College of Radiologists 2014 CPD scheme (RCR 2014) allows 20 CPD points for authorship of a book chapter but only 3 CPD points for “submission of a case to an online learning tool” (no other form of online content is mentioned), the same as for preparation and delivery of a lecture. This is despite surveys showing that almost unanimously, online instructors assert that preparing and teaching online courses is more time-intensive than classroom teaching (Sloan-Commission 2015).

CPD points for e-learning activities are also more difficult to obtain, partly because of the prohibitive cost of accreditation. For example, the European Accreditation Council for CME (EACCME) charge for accrediting a live course is based on the number of participants (€350 for 0-250 participants) but for e-learning courses, the charge is €750 for each hour of educational content (EACCME 2015).

There may also be the persistent belief amongst educators in oncology that e-learning is a poor substitute for a lecture given by an expert. This is despite the large body of evidence from meta-analyses and the increasing recognition in many non-medical fields that the lecture is not an effective educational tool following the work by the Mazur group from Harvard (Mazur 2009). This is perhaps not surprising as oncology is not a significant part of most undergraduate programs (Mattes et al. 2015) and education and training in oncology is largely delivered by enthusiastic clinicians who have little or no exposure to pedagogy or research in medical education. A survey of new consultants in the UK in 2012 (Benstead et al. 2012) reported that 87% of respondents thought that they had sufficient opportunity to develop teaching skills but only 62% thought the same with regard to research skills, even though 76% have published at least one paper in a peer-reviewed journal. This may perhaps reflect the lower priority placed on teaching compared to research.

The Mazur group has shown that education is much more than the mere transfer of information, skills and knowledge. In a study on the role of physics lecture demonstrations in conceptual learning, they showed that students who understand the underlying concepts before observing the demonstration are more likely to observe it and remember it correctly (Miller et al. 2013). The same is likely to apply to education in oncology as decision making, the critical skill in oncology, largely involves applying a limited number of principles to an innumerable permutations of clinical scenarios and patient factors.

Similarly doctors and other health professionals are more than mere purveyors of information, skills and knowledge. In 1910, the Carnegie Foundation for the Advancement of Teaching, helped stimulate the transformation of North American medical education with the publication of the Flexner Report. Exactly one hundred years later, the Foundation has issued another report, "Educating Physicians: A Call for Reform of Medical School and Residency." Both reports address remarkably similar themes – standardization of learning outcomes, integration of formal learning with clinical experience, cultivation of habits of inquiry, discovery and innovation, and formation of professional values and behaviours (Irby et al. 2010). New forms of online learning involving simulation and gamification may be valuable in helping to achieve these objectives, particularly with the ever shortening periods of engagement between learners and their patients, and between learners and their teachers.

The UK Department of Health has published a best practice guidance for technology enhanced learning (DH/Workforce 2011), The report specifies six key principles for technological applications in medical education, i.e., they must focus on equipping the workforce with the necessary skills for safe and effective patient care, address clearly articulated learning needs that are aligned to service needs, be innovative and evidence-based, deliver high quality educational outcomes, deliver value for money and ensure equity of access and quality of provision.

In order to achieve these objectives, it is necessary for there to be greater emphasis for these programs to be subject to rigorous evaluation and research. Cook and Ellaway (Cook and Ellaway 2015) have proposed a common evaluation framework for evaluating technology enhanced learning in medical education which will allow cross-course comparisons. A summary of their recommendations is given in Table 3.

**Table 3. A minimal recipe for technology enhanced learning evaluation**

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| **Audience and purpose** |
| 1. Who is the intended audience for the evaluation? |
| 2. What will they do with this information? |
| **Evaluation ingredients** |
| 1. Perform usability testing |
| 2. Document key elements of the final product |
| 3. Administer instruments to capture the perceptions of both students and instructors (e.g. the Evaluation of Technology-Enhanced Learning Materials) |
| 4. Prepare and administer course-specific assessments of Kirkpatrick Level 2 outcomes (knowledge, skills, attitudes) |

Cook and Ellaway 2015.

## CONCLUSION

Traditional methods of education and training have been shown to be inadequate in meeting the educational needs of oncologists and other oncology professionals across the world. While internet-based learning has the capacity to meet this need, the content must focus on more than information transfer to be effective. In particular, technological strategies to foster development of higher skills such as critical thinking and decision making are sorely needed. As significant investment will be needed to create high quality content, greater emphasis on rigorous evaluation of e-learning programs and research into optimal instructional design is required. The potential benefit for the oncology community, patients and health professionals, is enormous but as long as the perception that internet-based learning as a format is inferior to face-to-face teaching, it will be difficult to garner the appropriate resources.

## CONFLICT OF INTEREST

LTT is author and co-owner of Cambridge Cancer Medicine Online and Clinical Lead for the Radiotherap-e project.

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