Physica Medica 30 (2014) 358–364

Contents lists available at ScienceDirect

Physica Medica

journal homepage: http://www.physicamedica.com

Original paper

Fit for purpose? Evaluation of an MSc. in Medical Physics

W.J. van der Putten*

Department of Medical Physics and Bioengineering, Galway University Hospitals, and, School of Physics, National University of Ireland Galway, Galway, Ireland

ARTICLE INFO

Article history:
Received 22 March 2013
Received in revised form
6 November 2013
Accepted 14 November 2013
Available online 3 December 2013

Keywords:
Education
Training
University education
Educational survey

ABSTRACT

The National University of Ireland in Galway established a Master in Science (MSc.) program in medical physics in 2002. The course was designed to be 90 ECTS[1] credits and of one calendar year duration. From the outset the MSc. was designed to be part of an overall medical physics training program. MSc. programs are now widely used as part of the training and education of medical physicists. There is however paucity of data on the effectiveness of such courses and the purpose of the study reported here is to provide information on one particular MSc. course in medical physics. This is relevant to medical physicists who are involved in the development and running of medical physics training programs. The study used as methodology the Kirkpatrick levels of professional training. It was conducted through an online survey, both from students who graduated from the course and from students who were in the process of completing the course.

The survey proved to be an effective way to determine attributes of modules such as learning outcomes, knowledge imparted, quality of teaching materials and others. The survey proved to be remarkably able to demonstrate interventions in the individual course modules. Although the course was shown to be effective in the imparting of the knowledge required to become a qualified medical physicist several areas for improvement were identified. These are mainly in the areas of increased practical experience and in course delivery.

Introduction

The systematic and widespread employment of large numbers of physicists in health services worldwide originated with the introduction of megavoltage teletherapy in clinical practice after word war 2. For the first time, hospitals were able to provide effective cancer treatment at a moderate cost. During the development of this therapy it became obvious that safe and efficient treatment with these devices could not take place without appropriate physics support. This was, for instance, recognized in Canada where the then Atomic Energy Control Board insisted, from the early 1950s onwards, on the presence of trained medical physicists wherever a high energy treatment unit was installed [1]. This lead to a significant increase in the number of medical physicists employed. A parallel increase in the number of physicists in diagnostic imaging occurred with the advent of Computed Tomography and Magnetic Resonance Imaging. Up to quite recently, the training of medical physicists was rather ad-hoc. Following a basic degree in physics (often augmented by research degrees – either MSc. or PhD.) it was in essence an “apprentice based” training program without formal qualifications or validations. Apprentice systems in one shape or another have been around for a very long period of time. They have been socially accepted and have in the past been effective in transferring skills from one generation to the next [2]. As society has become more complex and the pace of change of technology is ever increasing the limitations of an apprentice based training program have become evident. Several of these limitations are illustrated in Table 1. The need for a more structured training model which can cope with a rapidly changing technological world has lead to a considerable evolution in the training and education to become a medical physicist. This has been driven on the one hand by the recognition that structured training is more effective in imparting knowledge and can do so in a short period of time and on the other hand by the increasing demands from society for evidence of qualifications [3].

The training of medical physicists requires the acquisition of a body of knowledge and the skills and competences to apply this knowledge in clinical practice. Although there are different ways that can be used to achieve this, they all impart knowledge (commonly based on lectures) as well as skills based, practical clinical training. Masters programs are typically used to confer a

* Tel.: +353 91544311.
E-mail addresses: wil.vanderputten@hse.ie, wilvanderputten@gmail.com.

[1] ECTS : European Credit Transfer System [13].

1120-1797/$ – see front matter © 2013 Associazione Italiana di Fisica Medica. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ejmp.2013.11.002

Table 1
Several disadvantages of traditional Master – apprentice based model for training.

- Master is an individual known for technical skills but who often has little or no pedagogical training or knowledge;
- Master knowledge will often be quite dated by the time apprentice is trained, resulting in obsolete or irrelevant training of apprentice;
- Training system is often unstructured and time consuming;
- Modern medical physics is too complex to be taught by a single individual/

qualification on the practical application of knowledge for problem solving. This, combined with the advantage of a University awarded qualification has made masters programs in medical physics now generally accepted as a pre-condition of the path to become a clinically qualified and adequately experienced medical physicist (QMP). For example, the IAEA in a series of documents that describe the clinical training of medical physicists, states that the QMP shall have, amongst other, appropriate qualifications in medical physics at the post-graduate level [4–6]. Also EFOMP recommended (Policy Statement No.12) a master program as one component of a medical physics education program, which also includes clinical skills training and a comprehensive system of continuous professional development (CPD) [7]. These recommendations have been implemented for radiotherapy, radiology and nuclear medicine [8–10]. As the aim of such courses is the provision of the knowledge required to function as a clinical medical physicist, it is important that these programs deliver what they aim to do. Professional bodies have set standards and provided support in the development of MSc. courses through a process of accreditation. Examples of this are the accreditation programs of the Institute of Physics and Engineering in Medicine in the UK [11] and the Commission on the Accreditation of Medical Physics Education Programs in North America [12]. Although these organizations lay out standards to which the MSc. programs must comply with, there is however very little literature on the evaluation of the effectiveness of such programs. In fact, there is a paucity of literature on the evaluation of the effectiveness of professional MSc. programs and of MSc. programs in medical physics in particular. The report presented here aims to provide such an analysis. A preliminary version of this paper was presented as a poster at the EMPEC 2011 conference in Dublin.

MSc. in Medical Physics, National University of Ireland, Galway

In 2002, the National University of Ireland, Galway initiated a master of science program in medical physics. This course was designed to provide the theoretical basis for a career in medical physics. The need for the course was based on an anticipated increase in need for medical physicists due to a proposed expansion of radiotherapy and medical imaging services in the Republic of Ireland. From the outset, the course was designed for a one calendar year duration, which was, at the time, the only such course in the country.

Outline of course

The course design was based on the requirements of the Institute of Physics and Engineering in Medicine (IPEM) for accreditation of programs as suitable for the entry in the UK program for training in medical physics [11]. The IPEM requirements were chosen as it was anticipated that a considerable number of graduates would go to the UK to complete their clinical training there. The IPEM requirements are inclusion of anatomy, physiology & pathology, radiation, engineering & general safety & quality management, professional topics and introduction to scientific principles & research skills [11]. It was from the outset decided to concentrate the Galway course on the use of radiation in medicine and Table 2 shows the overview of syllabus of the MSc. program. The relative student load is indicated through the use of the European credit transfer system (ECTS) where each credit represents between 25 and 30 h of student effort [13]. Total course duration is one calendar year (September to September).

From the outset course delivery is through a mixture of conventional lectures, self-directed learning and interactive workshops. Over the period of the evaluation (2002–2011) several changes were made to the course. Firstly, from 2004 onwards, a week long course on risk and safety management was introduced. This was based on a similar course that had been developed in Eindhoven University of Technology. This module introduced students to formal risk and safety management theory and tools. At the same time a module on practical radiotherapy treatment planning was introduced utilizing the PLUNC™ treatment planning system [14]. Around the same time an electronic learning environment was introduced (Blackboard™) and currently, the entire lecture content of the course is available through this medium. Finally, during 2010 additional changes were made. The occupational hygiene course changed from a lecture delivered program to self directed learning. The anatomy module now includes an extensive pathology laboratory experience (including dissection) and finally, an extensive practical laboratory in radiation science and radiation therapy was introduced.

Entry requirements for the MSc. program are a 2nd class honors undergraduate degree in the physical sciences or equivalent. In addition, for those students for which English is not their native language, they also need to pass the university requirements of a minimum of 6.0 on the IELTS score [15]. Finally, a total of 115 students were enrolled over period 2002–2010, with 102 students graduated. Of these graduates, 77% are currently involved in medical physics (either full-time employment, in an official traineeship or Ph.D. studies).

During the period in which this evaluation took place, the course was in its' 10th year. It is obviously good practice to review any educational program after such a long period. In addition, the IPEM Training scheme is being modified. Finally, the Irish Health Service Executive has commenced a training program that is accredited by the Committee on Accreditation of Medical Physicists Education Programs CAMPEP [12]. This accreditation requires recognition of associated academic programs [3]. All these events make an evaluation of the program necessary.

Table 2
Overview Syllabus MSc. in Medical Physics NUI Galway indicating the individual modules. Method of delivery: L = lectures; P = practicals; SDL = self directed learning with assignments; CW: computer workshop; WS = workshop.

	Delivery method	ECTS
• Fundamentals of radiation dosimetry	L + P	5
• Clinical instrumentation	L	6
• Occupational hygiene	SDL	5
• Medical imaging	SDL	10
• Physics of radiation therapy	L + P	10
• Medical informatics and statistics	L + CW	5
• Anatomy	L + P	5
• Physiology	L	5
• Hospital and radiation safety incl. workshops		11
- Principles of radiation safety	WS	
- Patient dosimetry and shielding	WS + P	
- Quality assurance in radiology	WS + P	
- Risk and safety management in medicine	WS	
- Laser and NIR safety	WS	
• Research project (duration 4–5 months)	28	
Total course content	90	

Methodology of evaluation

As graduates from the course are scattered across the globe it was not feasible to conduct extensive oral interviews in person. Instead, it was decided to conduct an electronic survey on-line. This survey was constructed using the (freeware) Google Docs™ system. The survey consisted of 94 questions. Answers could be given from dropdown menus, rating scales (5 discrete points) and free text. The survey was submitted to all individuals that had enrolled in the MSc. from 2002 till 2009. Responses were anonymous. A total of 91 answers were received which is response rate of 88%. The answers to the survey questions were automatically uploaded in a spreadsheet following submission. Subsequent analysis was then performed using Microsoft Excel™.

The questionnaire was divided in a number of sections. The first section asked respondents general questions on their background and educational level prior to enrolling in the MSc. course. This included questions regarding possible previous work experience and the reason for studying in Galway. The second part asked general questions regarding course content and their student experience in Galway as well as their post MSc. work experience (if any). It also included specific questions about the usefulness of the course in general and on individual modules in particular in their chosen career. The final part of the questionnaire asked specific questions on the delivery of the individual modules that constitute the overall MSc. program. These questions are reproduced in Table 3.

The purpose of the MSc. in medical physics is to provide the theoretical component of a training program for a professional career in medical physics. A standard for the evaluation of professional training programs is the methodology proposed by Kirkpatrick [16], which uses a four level evaluation process. The Kirkpatrick model has been around for over 30 years as a standard to measure the effectiveness of training programs. Level 1 evaluates the reactions of the participants to the training; level 2 assesses the extent of learning which has taken place; level 3 measures the extent of behavioral change which occurred in the participants due to the training (is the knowledge being used?) and level 4 evaluates the effect of training on the organization in which the participant works. The Kirkpatrick model was chosen, as it would appear to fit the requirements for the evaluation of a professional training program such as that required for medical physicists. Nevertheless, this model was developed over 30 years ago and its relevance today has been questioned (see Discussion).

Results

From the outset it must be stated that the results presented here are in essence the subjective opinions of the respondents to the survey. As such any quantitative data that is reported here must be considered with some caution.

Table 3
Part IV of survey questionnaire, questions asked regarding each course module. Also shown is rating scale (1-5 score).

• The learning outcomes of the module were clearly stated:	Not at all – very well
• The learning experience provided by the lecturer was:	Very poor – highly stimulating
• The teaching materials contributed to the overall learning experience of this topic:	Very poor – excellent
• Feedback on progress was provided:	Not at all – very well
• The evaluation of the module was fair and appropriate:	Not at all – very well
• The physical facilities provided for this module were:	Poor, inappropriate – excellent
• The knowledge imparted in this module has been:	Completely useless – very useful
• Additional Comments:	Free text response

Some results are shown graphically in Figs. 1–5. Figure 1 relates to the nature of the students that entered the MSc. program. The data indicates that a considerable cohort of entrants to the course (30–40%) do this after several years in the workforce well past obtaining their undergraduate degree. 24% of respondents in fact stated that they had permanent posts prior to enrolling in the MSc. program. The fact that there is considerable interest in an MSc. in medical physics for students, who had already embarked on a different career, has significant implications for any proposed changes to the course in the future. The reason why individuals would want to study medical physics are equally divided between scientific interest, beneficence (the wish to do good) and attractive career prospects (Fig. 2) It should be noted that the interest in "good career prospects" (e.g. good salary and job security) is not predominant. This remained the case even after the start of the current economic recession. This is surprising and indicates that a considerable number of students enter medical physics because of both the scientific challenges posed by the field and the wish to work in an emotionally satisfying career (Fig. 3).

Of interest to the university is the reason why students choose Galway as their place of study. This is shown in Fig. 4. Several reasons are given but both course content and the fact that the course had external accreditation featured prominently.

With respect to the overall structure and content of the course, most respondents (64%) were happy with the overall content and topics, with 29% complaining of it being too general and the remainder 7% considering the course to be too specific. When asked what should be changed, respondents considered that gaining practical experience was the most important change to implement. Interestingly, the Fundamentals of radiation dosimetry module was considered by a large number of students as suitable for deletion as a taught module yet the majority of respondents strongly supported this topic as one that should have a significant practical

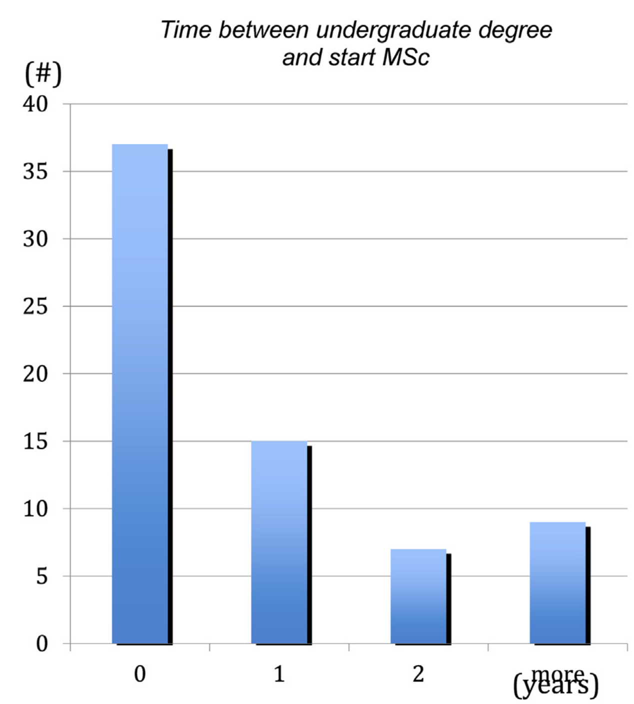

Figure 1. Interval (in years) between completion of undergraduate degree and start of MSc. in Medical Physics in Galway. Vertical Axis: number of students for which information was available.

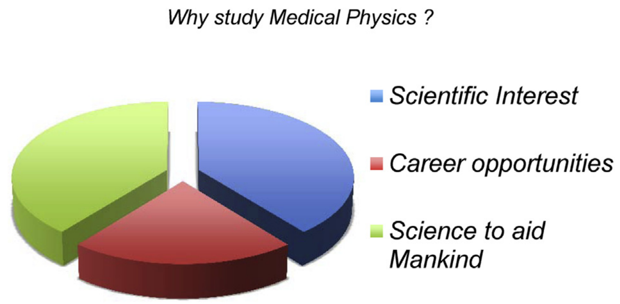

Figure 2. Reasons given for studying Medical Physics (Note: respondents could give more than one answer).

component. Students were asked a few general questions about the learning environment and facilities in Galway. A summary of the answers to these questions is given in Table 4.

The final component of the survey concerned itself with aspects of the individual modules of the course (Table 2). Table 5 shows survey data for all modules of the course for the last full year of the survey (students graduated in 2011). The data in the table is based on 16 respondents and shows average score of topic with accompanying standard deviation. Although the open form comments are not shown, their general content reinforced the conclusions noted elsewhere such as need for practical work, workshops and the use of self directed learning.

Figure 5a–d shows important aspects of several of the core modules of the course as a function of time, from the start of the program to the finish of the survey. Only four modules are shown: Fundamentals of radiation dosimetry, Physics of radiotherapy, Medical imaging and the research project. In case of the first three both the clarity of the learning outcomes and the knowledge imparted are shown (as perceived by the students) and in case of the project both project aims and experience gained are shown.

Finally, Fig. 6 shows responses by the students on the usefulness of several modules in their subsequent career. This is indicated on a scale from 1 to 5, with 1 being useless and 5 being essential. The modules were Fundamentals of radiation dosimetry, Physics of radiotherapy, Medical imaging, Clinical instrumentation and Hospital safety. The answers above deal with Kirkpatrick level 1 and 2 evaluation of training programs and indicate the experience the students achieved and the effectiveness of the learning.

Discussion

As mentioned in the methodology section, the Kirkpatrick model was chosen to evaluate the effectiveness of the course.

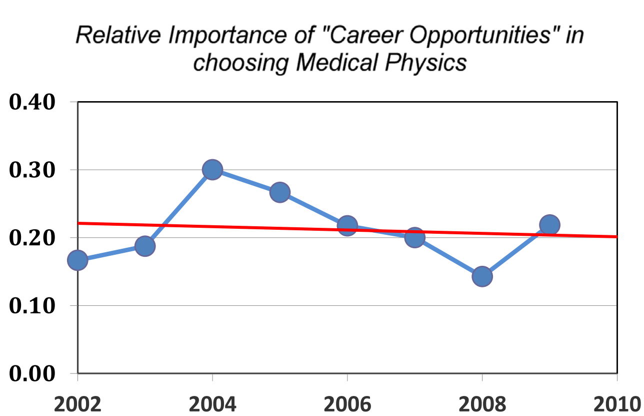

Figure 3. Relative importance (0 = not important at all, 1 = only thing which matters) of perceived career opportunities to study medical physics.

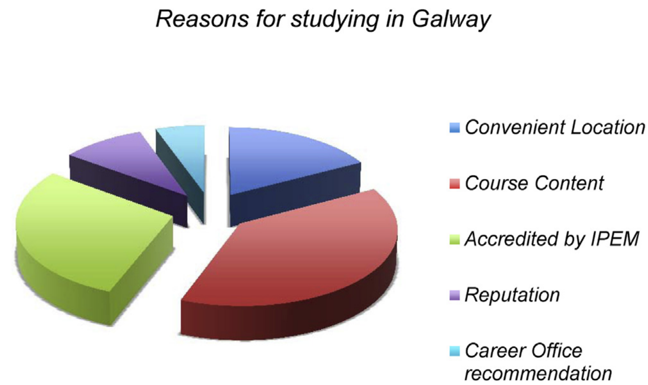

Figure 4. Reasons given to choose Galway for study.

Assessment of Levels 1, 2 and to a lesser degree level 3 of the Kirkpatrick evaluation model could take place through the survey. The only level that could not be readily ascertained is level 4, as this would have required a survey of employers and workplaces. This proved difficult to do within the time frame of this investigation and will be the subject of a future study. Although the Kirkpatrick model is one of the few models in widespread use in the evaluation of educational courses, it is now over 30 years old and there is considerable critique of it as to its relevance in modern educational practice [17,18]. However, alternative models are scarce. One such model proposes to measure return of investment (ROI) as a measure of training effectiveness in an organization [17]. It is difficult to see how that would work in a health care environment. Other criticisms are that it is too simple to take account of the myriad of variables, in both trainees and trainers and the cultural environment in which the training takes place, to have relevance or to have conclusions drawn in one place transferred to another. Nevertheless, as stated, the model has been in existence for a while and has been applied taking due notice of the caveats expressed above. The survey gives a good indication of the effect of the MSc. on the individual students with respect to Kirkpatrick level 1 and 2. Kirkpatrick level 3 aims to measure behavioral change in the participants. This is not applicable to an MSc. course as the individuals on the course are rarely employed in the organization. It is interpreted here as how the acquired knowledge is of use in the graduate's career. The evaluation presented here demonstrates that the MSc. in Medical Physics successfully imparts knowledge according to Kirkpatrick level 1 and 2. Both the students' experience in Galway and their perception of the level, depth and extent of learning that they acquired were positive. It is difficult to draw firm conclusions regarding Kirkpatrick level 3 (how the knowledge is used in graduate's career). Figure 6 provides a pointer to this. Here, respondents indicate the respective usefulness of a number of the individual modules in their subsequent careers. This question was only relevant to those individuals who were working in medical physics or similar careers. The figure seems to indicate that the course materials are very useful in their career. With respect to Kirkpatrick Level 4 (impact of a course graduate in his/her workplace) this is difficult to assess without conducting a survey of employers. However, some indication can be found in the fact that of the students involved over the period, 82% are employed in medical physics or are pursuing a PhD in medical physics or a related topic. This would seem to indicate that the course should be considered successful according to Kirkpatrick level 4. Nevertheless, the impact of these individuals on the organization in which they are employed and the role played by the MSc. that they completed must be something which should be evaluated by a separate survey of employers.

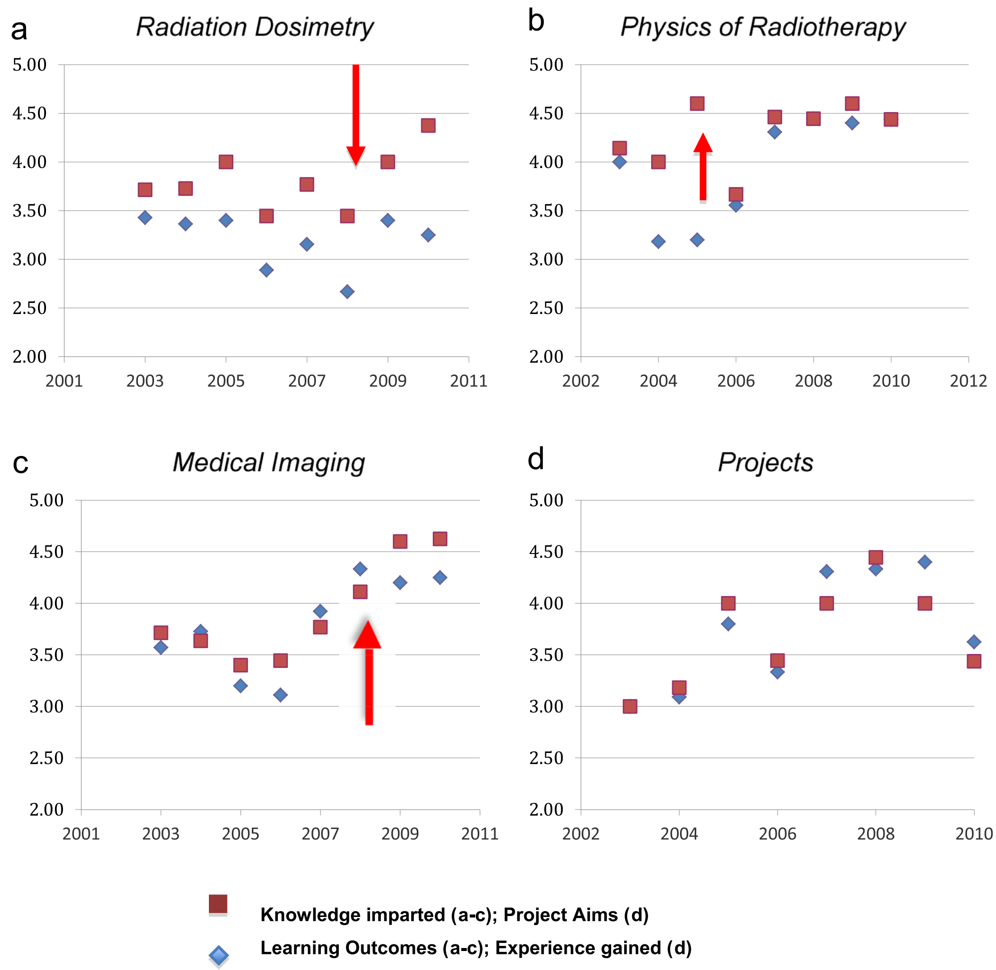

Figure 5. Learning Outcomes and Knowledge Imparted for Modules of Radiation Dosimetry, Radiotherapy and Medical Imaging. Project aims and Experience gained for Research Projects. Also indicated (arrows) are interventions in individual modules. 5a: change of lecturers, 5b: Extensive access to radiotherapy equipment during department commissioning, 5c: introduction of viva examinations.

The reason for studying in Galway is of course of interest to local university management but some aspects have a wider significance to similar programs elsewhere. It is clear from the survey that both appropriateness of course content as well as external accreditation are amongst the most important factors that govern a student's choice. The rationale for studying medical physics is equally divided between scientific interest and beneficence. It is interesting and somewhat surprising to note that economic factors (exemplified by perceived career opportunities) seem to play less of a role, even as economic circumstances deteriorated! This is further confirmed by the fact that 45% of student intake had prior work experience and of these, 56% had permanent positions prior to enrollment. In other words, approximately 25% of entrants to the MSc. course either took leave or resigned from permanent jobs in order to start the MSc. in medical physics.

Table 5 shows the evaluation of all modules for one year of the course (2010–2011 academic year). This shows that all modules score well (over 2.5) which indicates a positive learning experience. Nevertheless, the data does indicate that there is room for improvement in several of the courses. Although subjective in nature, the data does confirm some of the anecdotal comments made by students over the year.

Table 4
General rating of MSc. course (Rating on 1-5 score with 1 very poor and 5 excellent; also indicated is standard deviation).

- The overall climate for learning: 4.04 ± 0.72
- The course facilities were: 3.54 ± 0.91
- The library facilities were: 3.64 ± 0.90
- Overall rating of learning experience in Galway: 4.04 ± 0.75

In the past (and prior to the survey being conducted) changes were made to the course. These changes were based on subjective observations by teaching staff as well as comments by students. To review possible effects of these changes on the learning experience, two fundamental aspects of four of the core modules of the course, respectively Fundamentals of radiation dosimetry, Physics of radiotherapy, Medical imaging and the research project were evaluated over the duration of the course's existence. These are learning outcomes (blue (in web version) diamonds) and knowledge imparted (red (in web version) squares) for taught modules (Fig. 5a–c) and project aims and experience gained for the research project (Fig. 5d).

The diagrams clearly show the effect of interventions. The course Fundamentals of radiation dosimetry was taught by a single lecturer up to 2008 and no laboratory practice was provided. Since 2008–2009 a multitude of lecturers now provide the course, clearly improving "knowledge imparted". In 2011 a comprehensive laboratory exercise was developed for both Fundamentals of radiation dosimetry and Physics of radiotherapy. However, this came too late to be included in the survey. However, the effect of practical experience can clearly be seen in the module Physics of

Table 5
Survey data for all modules of the course for the last full year of the survey (students graduated in 2011). Shown are individual questions with answers in range 1 (very poor) to 5 (excellent). Also shown is standard deviation. 2010–2011 year had 16 respondents to survey.

	The learning outcomes of the module were clearly stated	The learning experience provided by the lecturer(s) was	The teaching materials provided, contributed to the overall learning experience	Feedback on progress was provided	The evaluation of the module was fair and appropriate	The physical facilities provided for this module were	The knowledge imparted in this module has been:
Anatomy	3.69 ± 1.14	4.13 ± 0.89	3.88 ± 1.36	3.69 ± 0.87	3.47 ± 1.25	4.50 ± 0.52	4.31 ± 0.87
Physiology	4.19 ± 0.66	4.25 ± 0.68	4.25 ± 0.77	3.20 ± 1.08	3.47 ± 1.13	3.63 ± 0.81	4.31 ± 0.87
Radiation Dosimetry	3.25 ± 0.93	3.33 ± 0.72	3.06 ± 1.06	2.94 ± 1.00	3.47 ± 0.83	3.56 ± 0.89	4.38 ± 0.62
Clinical Instrumentation	4.13 ± 0.62	4.06 ± 0.57	3.94 ± 0.57	3.19 ± 1.11	3.56 ± 0.63	3.75 ± 0.68	3.88 ± 0.89
Physics of Radiotherapy	4.44 ± 0.63	4.31 ± 0.60	4.13 ± 0.81	3.31 ± 0.95	4.00 ± 0.65	3.88 ± 0.62	4.44 ± 0.73
Medical Imaging	4.25 ± 0.77	4.44 ± 0.63	2.81 ± 1.11	3.60 ± 1.18	3.73 ± 0.80	3.31 ± 0.95	4.63 ± 0.50
Occupational Hygiene	2.81 ± 0.98	2.06 ± 0.68	3.00 ± 1.03	2.25 ± 0.93	3.27 ± 1.03	3.00 ± 1.25	2.13 ± 0.89
Medical Informatics	3.81 ± 0.98	3.69 ± 1.08	4.00 ± 0.73	4.00 ± 0.73	3.93 ± 1.03	3.47 ± 1.25	4.50 ± 0.52
Workshops	4.00 ± 0.73	3.73 ± 0.80	3.81 ± 0.91	N/A	N/A	3.63 ± 0.96	4.38 ± 0.62
			Adequate choices for project topics were on offer.	The experience that you gained in the project matched your expectation.	The aims of the project were made clear from the outset	You had adequate resources to carry out the project	You had ready access to your project supervisor
Research Project	N/A	N/A	100% yes	3.63 ± 0.89	3.44 ± 1.15	4.00 ± 0.82	4.44 ± 0.63

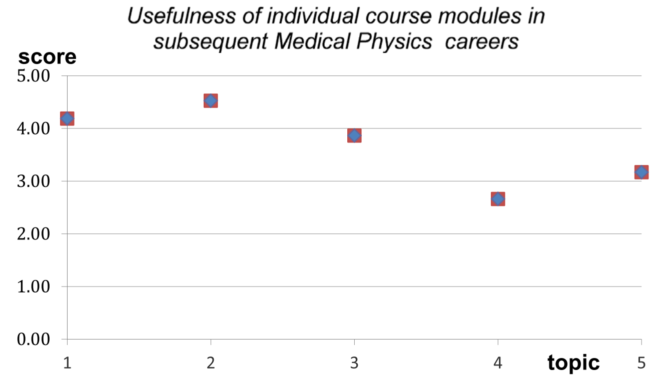

Figure 6. Perceived Usefulness of individual course modules in subsequent medical physics careers. Topics: 1: Fundamentals of Radiation Therapy, 2: Physics of Radiotherapy, 3: Medical Imaging, 4: Clinical Instrumentation, 5: Hospital Safety. (Score: 0 = completely useless; 5 = essential).

radiotherapy. University Hospital Galway only acquired radiotherapy during the academic year 2004–2005 with clinical operations only started in April 2005. The students in that year had practically unlimited access to the treatment machines whilst they were being commissioned. The diagram clearly shows that this free access was of great benefit to the students in the transfer of knowledge. However, this was an exceptional circumstance that is unlikely to be repeated in the future. Access to clinical systems is difficult due to high patient loads and it is likely that in the future solutions need to be found in e-learning environments such as virtual linear accelerators [19]. Finally, the imaging course introduced in 2008–2009 oral examinations to augment the written essays. This clarified learning outcomes and improved knowledge, which is reflected in the score. It is of note that the Medical imaging course also scored highly in “knowledge imparted”. This module is the only one that is delivered through the concept of self directed learning. Following introductory lectures, the students are given the task to prepare essays and are subsequently examined on these through short viva exams (one per sub-module) conducted by two of the course staff. The concept of SDL appears to be very appealing to the students and is also considered to be a highly effective method of imparting knowledge to adult learners [20]. Anecdotally, students mentioned that the series of viva interviews were very helpful in preparing them for job interviews following graduation.

The training of medical physicists involves both the imparting of theoretical knowledge but also the acquisition of technical and clinical skills and competences. In a one year MSc. only a limited amount of practical experience can be provided. This is through the student participating in workshops and through the conduct of a small research project. From the data it is obvious that the learning experience for both of these improved as course faculty became more experienced with project supervision. On the other hand, increasing pressures of work on clinical staff (which mostly provide project supervision) and a large cohort of students during 2009 and 2010 led to a subsequent reduction in quality of the project work as perceived by the students.

The students are well aware of the need to have clinical experience in order to compete in the job market and there was an overwhelming request to increase the amount of practical experience during the course (88% vs. 12%). They also suggested what should be dropped. Dosimetry was seen as a subject that could be dropped from the formal taught lecture modules, but the same students also deemed it important to gain practical experience in this topic. Observations such as this provide some pointers to the future development needs of the course.

All courses improved somewhat in their overall score post 2009. This coincided with the introduction of the Blackboard™ electronic learning environment. It is without doubt extremely convenient to have all course materials in one location. Nevertheless, the current use of the Blackboard™ system is more akin to that of a convenient file storage location and it would be interesting to survey students when a more widespread and integrated use of Blackboard™ is made in the delivery of the course.

Conclusion

Although the MSc. in medical physics scores reasonably well according to past students, the evaluation has pointed several deficiencies and areas for improvement. These relate to lack of practical experience and on the need to improve knowledge imparted. As discussed, since the completion of the survey, a comprehensive practical laboratory practice has been developed that forms part of the examinable component of the course. In view of the success of self directed learning, it is felt that this is an area that can be explored more. Finally, it is impractical to conduct surveys of the depth and breadth as reported here on an annual basis. Nevertheless, regular surveys of students (possibly every 2–3 years) should become an integral part of any course program.

Conflict of interest

The author is Adjunct Professor of Medical Physics in the National University of Ireland, Galway. This is an honorary position.

Acknowledgments

I gratefully acknowledge all current and past students of the MSc. in medical physics for their contribution to the course and to the survey. I also would like to thank all my colleagues in the Department of Medical Physics and Bioengineering in Galway University Hospitals who, in spite of a very busy clinical workload, willingly gave their time and supported the MSc. with great enthusiasm.

References

[1] Aldrich JE. The Canadian organization of medical physics. In: Aldrich JE, Lentle BC, editors. A new Kind of Ray. Montreal, Quebec: The Canadian Association of Radiologists; 1995.
[2] Upgrading informal apprenticeship models skills for employment policy brief. Geneva: The International Labour Organization; 2011.
[3] Bogdanich W, Rebelo K, Harris R. The radiation boom; they check the medical equipment, but who is checking up on them?. New York Times; 27th January 2010.
[4] IAEA Training Course Series Issue 37. Clinical training of medical physicists specializing in radiation oncology. Vienna: IAEA; 2009.
[5] IAEA Training Course Series Issue 47. Clinical training of medical physicists specializing in radiation oncology. Vienna: IAEA; 2010.
[6] IAEA Training Course Series Issue 50. Clinical training of medical physicists specializing in radiation oncology. Vienna: IAEA; 2011.
[7] Eudaldo T, Olsen K. The European Federation of Organisations for medical physics. Policy Statement No.12: the present status of medical physics education and training in Europe. New perspectives and EFOMP recommendations. Phys Med 2010;26(1):1–5.
[8] Eriksen JG, Beavis AW, Coffey MA, Leer JW, Magrini SM, Benstead K, et al. The updated ESTRO core curricula 2011 for clinicians, medical physicists and RTTs in radiotherapy/radiation oncology. Radiother Oncol 2012;103(1):103–8.
[9] Geleijns J, Breatnach E, Cantera AC, Damilakis J, Dendy P, Evans A, et al. Core curriculum for medical physicists in radiology. Recommendations from an EFOMP/ESR working group. Insights Imaging 2012;3(3):197–200.
[10] Del Guerra A, Bardies M, Belcari N, Caruana CJ, Christofides S, Erba P, et al. Curriculum for education and training of medical physicists in nuclear medicine: recommendations from the EANM Physics Committee, the EANM Dosimetry committee and EFOMP. Phys Med 2013;29(2):139–62.
[11] IPEM (Institute of Physics and Engineering in Medicine). Training prospectus for medical physicists and clinical engineers in health care. York. UK: IPEM; 2008.
[12] www.campep.org/guidelines.pdf, [accessed 18.03.13].
[13] http://ec.europa.eu/education/lifelong-learning-policy/ects_en.htm, [accessed 18.03.13].
[14] Schreiber Eric, Xu Zijie, Lorenzen Amy, Foskey Mark, Cullip Timothy, Tracton Gregg, et al. PLanUNC as an open-source radiotherapy planning system for research and education. Med Phys June 2006;33(6).
[15] http://www.ielts.org/, [accessed 18.03.13].
[16] Kirkpatrick DL. Techniques for evaluating training programs. Train Dev J June 1979:78–92.
[17] Galloway DL. Evaluating distance delivery and e-learning; is Kirkpatrick's model relevant? Perform Improv 2005;44(4):21–6.
[18] Holton III Elwood F. The flawed four-level evaluation model. Hum Resour Dev Q 1996;7(1):5–22. Spring.
[19] www.vertual.co.uk, [accessed 18.03.13].
[20] Malone SA. A practical guide to learning in the workplace. Dublin: The Liffey Press; 2005.