Challenges and opportunities for a CAMPEP-accredited Medical Physics Graduate Program in Galway, Ireland

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Abstract. Established in 2002, this long running MSc in Medical Physics program was awarded CAMPEP accreditation in 2015, thus being one out of only two CAMPEP approved graduate programs outside North America. The program is a full-time, one-year taught master course delivered by a close university–hospital collaboration. This paper will give an outline of the current program structure and will identify challenges likely affecting the areas of teaching, research and course administration. Strategies to address these challenges will be discussed. Since the accreditation, the number of students enrolled in the program increased from 8 in 2015/16 and 16 in 2016/17 to 21 in 2017/18 and 25 in 2018/19. The number of non-EU students in these cohorts was 2, 5, 4, and 9 respectively. Non-EU students predominantly originate from North America and Saudi-Arabia. The total number of applicants averages at approximately 55 per year. A further increase in student intake has been advocated but might impact negatively on the quality of the clinical training which forms a vital part of the program. Students are given access to clinical systems for laboratory exercises as well as for pursuing research projects, thus gaining some clinical experience which will increase their employability. However, local clinical access has to be limited. In order to mitigate the situation, the program cooperates with medical physics departments nationwide and internationally. Curricular challenges arising from clinical implementations of ever-evolving technologies and from a rapidly changing medical physics landscape in general will be expanded on.

1. Introduction

In the early 2000s the rapid expansion in radiotherapy services and the introduction of significant quantities of high end medical technology into many hospitals throughout the Republic of Ireland created the need for further development and expansion of existing medical physics and clinical engineering services. These developments also required increased efforts in the education and training of the next generation of medical physics and clinical engineering professionals.

This was recognized by the late Professor Wil van der Putten in 2002 and to address these requirements he established a Master of Science (MSc) in Medical Physics program based at the National University of Ireland, Galway (NUIG), located at the West coast of the Republic of Ireland (Figure 1).

The MSc program is a full-time one-year taught master course (90 credits) delivered in close collaboration between the School of Physics, NUIG, and the Department of Medical Physics and
Clinical Engineering (MPCE) of University Hospital Galway (UHG), with hospital-based medical physics staff playing an active role in teaching individual modules.

Initially accredited by the Institute of Physics and Engineering in Medicine (IPEM), UK, from 2002 to 2014, in 2015 the program received accreditation by the North American Commission on Accreditation of Medical Physics Education Programs (CAMPEP).

This article will give an outline of the current program structure and governance, will identify challenges to the program, and will discuss strategies to address these challenges.

![Figure 1. Location of Galway, Republic of Ireland [1].](image)

2. Course Syllabus and Delivery
The training of medical physicists requires the acquisition of a body of knowledge and the skills and competencies to apply this knowledge in the clinical practice. In compliance with the CAMPEP curriculum [2], the program introduces students to traditional medical physics topics, including Human Body Structure (Anatomy), Human Body Function (Physiology), Radiation Fundamentals and Dosimetry, Fundamentals of Medical Imaging, Physics of Radiation Therapy and Concepts of Radiobiology, as well as Radiation Protection and Safety.

Students are also exposed to other areas that are crucial in a clinical setting, including Clinical Instrumentation, Risk and Safety Management with human factors engineering, Monitoring for Health Hazards at Work, Introduction to Biostatistics as well as Professionalism and Ethics. The latter is a valuable addition to the course, instilling in the student the patient-focused approach of the profession at an early stage in their careers.

The course content is delivered through a mixture of traditional lectures, online lectures, tutorials and self-directed learning. The Medical Imaging module is taught through the concept of self-directed learning, that is, each sub-module (e.g., Theory of Image Formation, X-Ray Imaging) is introduced by a lecture. Subsequently, the students are asked to complete topic-related assignments and are be examined on these through short viva exams. The viva interviews are perceived by the students as a helpful preparation for job interviews after graduation [3], thus contributing to the employability of the MSc graduates.
In order to give students the skills to be able to apply their theoretical knowledge in the clinical practice the program offers a series of demonstrations and practical exercises, both university-based and hospital-based. Physics laboratory exercises (e.g. γ-ray spectroscopy, α and β radiation attenuation measurements and Monte Carlo simulation of radiation interactions) complement the lectures on radiation and dosimetry fundamentals. Moreover, to take just two examples, dose output measurements at a linear accelerator and brachytherapy source calibrations conducted in a hospital setting deliver some – albeit limited – practical clinical training. The practical component of the program is further strengthened by the curricular requirement that students have to complete a research project, further discussed below.

Demonstrations of quality assurance procedures in diagnostic radiology and radiotherapy as well as a computer workshop on practical radiotherapy treatment planning complete the clinical training component of the program.

All elements of the program are delivered in close collaboration between university-based and hospital-based medical physics staff. Hospital-based staff will share their clinical experience with students but also have the opportunity to further develop their own professional skill set through lecturing as well as lab and project supervision thereby engaging in continuing professional development.

3. Program Governance

The management, further development and quality assurance of the MSc in Medical Physics program is conducted and overseen by two Program Directors and a Program Board. The appointment of two program directors reflects the close collaboration between university and hospital. The Academic Director is responsible for liaising with the College of Science and the wider university in matters of course administration while the Clinical Director will develop the clinical aspects of the program and will interact with the accrediting body. The program board is composed of the program directors, the respective heads of the School of Physics, NUIG and the Medical Physics and Clinical Engineering department, UHG, hospital-based and university-based teaching staff, and an external academic clinician. There will also be a student representative, providing feedback from the current class. The board meets three times per year to discuss student admission and progression throughout the course, to deal with past courses, and to review upcoming courses and future course developments.

In order to identify deficiencies and areas for improvement within the program and thereby enabling evidence-based course developments, different feedback procedures have been put into place, complementing the tasks of the program board.

In compliance with university policy students are asked to fill out an anonymous online feedback form after completion of each program module. However, on average, only about 25% of the students avail of this feedback mechanism. On an annual basis, the program is assessed by an external examiner. The role of the external examiner is not only to certify that academic standards, student performance and the quality of the program are appropriate to meet national and international expectations, the examiner will also meet the class without the presence of faculty. The students’ responses are anonymized and relayed to the program board and the university.

Informal feedback will be obtained through direct staff-student engagements but also through the wider medical physics community which is involved in the supervision of student research projects and also in the recruitment of program graduates.

A scientific study on the effectiveness of the MSc, based on a survey among graduates from the first 10 years of the program was conducted and published by van der Putten [3].

In response to the study and feedback received, improvements to the program have been implemented. These include the addition of a comprehensive practical laboratory practice, the expansion of the statistics module and the revision of the medical imaging curriculum.
4. Research Project

Although designed as a taught master course, the curriculum requires the completion of a research project. Students are encouraged to pursue their research projects on clinically relevant subjects. The choice of clinical projects is hospital service driven and generally relates to the implementation and performance evaluation of new technologies and treatment techniques or the evaluation of therapeutic or diagnostic outcomes. Recently, a project establishing guidelines for patient precaution times after brachytherapy prostate cancer treatments with radioactive sources received the local Health Care Group award for outstanding research [4].

During their clinical project work most students are based full-time in the Medical Physics and Clinical Engineering Department, UHG. Pursuing their research projects in a clinical environment provides students with additional first-hand experiences of the routine work of a medical physicist. It also provides them with an understanding of the clinical workflow in a busy university affiliated teaching hospital. Experiences such as these add to the student’s future employment prospects.

MSc projects are not only conducted in the local public and private hospitals but are also performed in cooperation with Medical Physics departments outside of Galway, thereby contributing to an active Irish research landscape. In addition, it is important to note that in compliance with the internationalization strategy of the university, individual projects have been conducted in collaboration with Canadian and German medical centres as well as with student’s respective home institutions. Several of the past MSc graduates have been awarded PhD scholarships to further their research careers.

In preparation of the research component students will give a short oral presentation about their projects to faculty for early feedback. Typically, the presentation will include the motivation, a literature review, the student’s scientific method for approaching the research question, and a project timeline.

The project will be examined through another oral presentation towards the end of the practical work as well as a research thesis.

5. Challenges

The expansion in terms of student numbers enrolled on the MSc program since its commencement in 2002 is presented in Figure 2.

![Figure 2. Development of student numbers 2002 – 2018.](image)

The time series shows a variation in student numbers with an absolute minimum of 3 students in the class of 2011/2012, coinciding with a general economic downturn in the Republic of Ireland. Since
receiving CAMPEP accreditation in 2015, the student intake has continuously increased from 9 in 2015/16 to 25 in 2018/19. The CAMPEP accreditation allows recruitment of applicants from North America who after graduating from the MSc program are eligible to continue their clinical careers in the US or Canada. However, the prestigious CAMPEP accreditation also attracts international students from other world regions. Thus, on average, about one third of the students enrolled are international, non-EU students, predominately from Saudi Arabia and North America. Generally, the accreditation creates opportunities for all MSc graduates to pursue their clinical careers not only in Ireland or their respective home countries but also in the US and Canada.

Challenges to the program are arising from several factors. The accessibility of practical clinical training constitutes a vital part of the program however the availability of clinical placement opportunities at a local level has to be limited and will be even further compromised by the high student numbers observed. Additionally, on a local level, access to the latest technologies for teaching purposes might be inadequate given a rapidly evolving clinical landscape. Therefore the MSc program intensified collaborations with clinical medical physics departments in Ireland and internationally, providing further placements for student research projects and access to technologies that might not be available locally.

A lack of dissemination of results from research projects has been identified as a development opportunity. Although the students have the opportunity to present results at the annual scientific meeting of the national medical physics society, the Irish Association of Physicists in Medicine (IAPM), the number of scientific journal publications is scarce. Therefore, in 2017 the program established three-month write-up stipends, which are available after course completion. Two stipends were awarded to outstanding student projects with a presumed high publication probability [5, 6].

With a multi-national student cohort the program has to embrace diverse educational backgrounds. Noticeably, students have different levels of experience with practical laboratory exercises. Consequently, the already comprehensive practical laboratory practice has been further advanced and project supervision in terms of contact hours has been increased.

6. Conclusions
This highly successful CAMPEP accredited medical physics graduate program has a strong practical clinical component with about 75% of its graduates pursuing a medical physics-based career [3], including PhD studentships and radiotherapy residencies. With its dynamic structure the MSc program is well placed to respond to the challenges of an ever changing medical physics landscape.

References
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