Postgraduate education in Medical Physics - Response to COVID-19 restrictions for delivery of radiation physics practicals: A student survey

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Abstract— **Interruptions to in-person delivery of scientific training due to the restrictions imposed by the COVID-19 pandemic have called in most case for lateral development of online modules. Here we consider the impact and potential future use of such online resources and learnt experience developed for radiation physics practicals as part of Medical Physics training. A student questionnaire survey suggests positive benefit to the understanding of concepts and processes with the majority (19 out of 24) indicating *Agree*/or *Strongly Agree* to such improvement in overall understanding and (20 out of 24) knowledge of radiation measurements for Medical Physics. The majority of responses supported the continuing use of resources developed for remote teaching needs of the past academic year (>21 *Agree* or *Strongly Agree*) for preparation or on-going support of on-site lab practicals. However, the consensus (54%) was not in agreements that existing material could solely support student-led study of the subject at local training centres after the pandemic. As result of this feedback, we plan to maintain access to online resources for future students for preparation and support of the on-site practicals. Some occasions where the experience learnt could be taken forward may include a supplementary role of continuing professional development across international networks, especially when close links can be formed with local training centres providing hands-on experience.**

Keywords— **Medical Physics, E-learning, Clinical Scientists Training, COVID-19.**

I. INTRODUCTION

The COVID-19 pandemic demanded significant changes to higher education. Higher Education Institutions (HEIs) had to adapt rapidly in order to continue delivering education during the past academic year (2020-2021), especially in areas of medical practice [1,2]. Medical Physics training was not insular to these changes. In particular, not only delivery of the academic components of training was affected in terms of format shifting to real-time and asynchronous on-line options [3], but often access to the hospital-based training environment was also affected with restrictions imposed by the pandemic [4].

As an example here we are looking at the academic component of medical physics training in one of the largest HEIs in England – King's College London (KCL) – with over 120 part-time students/trainees distributed in 3 academic years. The MSc in clinical science (Medical Physics stream) at KCL provides the academic component for an annual intake cohort of 40 Trainees, approximately half of the Medical Physics Trainees in England under the Scientific Training Program (STP) coordinated by the National School of Healthcare Sciences and Health Education England (HEE). Trainees who attend the Masters course are spread in various geographic locations in the south of England, spanning from Northampton to Brighton and Maidstone to Southampton, over a range of 70 miles radius (or about 2 hours of travel time) from London. There is a small cohort of students outside the STP scheme who attend the full-time course. They are both national and international students, who share some modules with the STP students. The geographical spread of students was an added consideration in adapting to any COVID-19 related measures for academic delivery. As part of the autumn term of this program all students attend radiation physics labs covering essential concepts applied to Medical Imaging and Radiotherapy.

As per governmental regulations during the 2020 autumn period of the pandemic, face-to-face delivery in all UK HEIs was restricted with all group teaching activities replaced by real-time or asynchronous remote learning. As such, practicals were converted within the short interim period preceding final regulatory restrictions, into a format blending pre-recorded material, including on-site recorded video clips of the lab processes, on-line group activities and on-line tutorials leading to a final coursework assessment.

With some distance of time and access to the resources generated from the process, we are now revisiting the teaching of the radiation practicals under COVID-19 restrictions with emphasis on the student learning experience. Although the generation of teaching resources was unplanned and in response to urgent circumstances, it has shown an opportunity potentially applicable to remote support of lab training processes such that may occur in the specialized area of Medical Physics where decentralizing sparse training resources may be desirable. In order to better understand the potential of such opportunities, we developed a questionnaire and conducted a small survey of the student experience from the radiation physics practicals during autumn 2020.

II. PREPARATION FOR THE REMOTE DELIVERY OF RADIATION PRACTCALS

While e-learning (e-L) in medical physics has long history and we have introduced some lectures with e-L since

2001 [5, 6], the delivery of practical labs is challenging and complex.

This practical academic activity could have three main components/steps:

-Preparing specific topical demo of the practical

-Recording a series of video clips demonstrating the practical activity

-Preparing spreadsheets with real data, which will help students calculate relevant parameters.

In our case we prepared three separate radiation physics practicals and all students performed these through on-line delivery at specific times. The subjects of the practicals were:

- *Radionuclide Dose Calibrators*: involving basic measurements for the understanding of quality control and the influence of source positioning and geometry in radionuclide calibrators (fig 1).
- *Half Value Layer (HVL*): involving measurements of HVL for two different materials using an X-ray unit aiming to the understanding of radiation attenuation and radiation filtration concepts (fig 2).
- *Contamination Monitors*: involving the calibration of different types of contamination monitors aiming to lead to a greater understanding of the workings, limitations and uses of different types of contamination monitors and test sources.

For each of these practicals we prepared the three components:

-Video clips were pre-recorded according to the protocol of the specific lab (with handheld camera, mp4 format). All steps of the measurements were shown and the lecturer guiding the video explained specific steps and possible errors during the process;

-Demos were prepared including clips from specific software, images showing the effect of various radiation levels and spectra on final image quality. Specific equipment and material were shown and explained;

- Data from previous years (from past lab practicals) was used for the preparation of spreadsheets with existing real measurements. The students were asked to use these data to calculate specific parameters, associated with the practical;

-Additional questions were added to each lab protocol, which the students had to discuss as part of their final lab report, thus testing their understanding of the subject.

On the day of the practical the students had a remote session with the lecturer (through MS Teams). They observed the video of the activity and were encouraged to ask questions. Following this they were asked questions related to the lab practical, using the demo material. Finally they were explained how to proceed in using the spreadsheet with data to prepare their practical lab reports.

III. Student survey of remote delivery of radiation practical

The remote Radiation Physics practical were conducted immediately after the remote academic lectures on the subject. After submission of lab reports we conducted a survey. The survey was completed anonymously and attempted to record the level of prior knowledge as the student cohort has a varied academic background (eg undergraduate Physics or Engineering, some with existing MSc or PhD in related or non-related subject). The stream of study i.e. STP or stand-alone full-time student, was also recorded. There were responses from 24 students (18 STP and 6 full-time students). The results of the survey (as per the questionnaire) are presented in detail below.

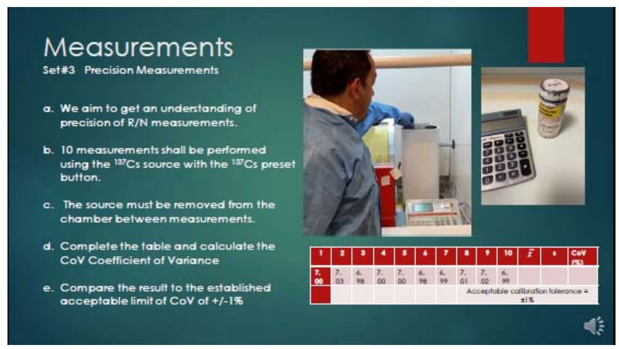

Fig. 1 Radiation Physics practicals – excerpt from the recorded material on radionuclide calibrator measurements.

Fig. 2 Radiation Physics practicals – excerpt from the recorded material on Half Value Layer measurements.

Level of prior knowledge: The responses to the relevant question ("*Prior to the sub-module, how would you rate your level of understanding and experience in radiation labs (e.g. from previous studies, practical experience etc)?*") resulted to an average of 2.83±1.3 (on the scale from 1 to 5, 5 being higher level) with 2.5±1.24 and 3.38±1.16 for the STP and full-time cohorts respectively.

Self-appraisal of post-activity knowledge: The responses to the relevant question ("*Following the completion of the sub-module, how would you rate your level of understanding and experience in radiation labs?*") resulted to an average of 3.7±0.8 (on the scale from 1 to 5, 5 being higher level) with 3.55±0.85 and 4.16±0.4for the STP and full-time cohorts respectively.

In more detail, responses indicated positive benefit to the understanding of concepts and processes (fig. 3) with the majority (19 out of 24) indicating *Agree* or *Strongly Agree* to such improvement in overall understanding and (20 out of 24) knowledge of radiation measurements for Medical Physics. In some responses free text feedback indicated praise for the material while in others the varying degree of self-engagement and online-fatigue was flagged up during these times of fully online imposed learning with absence of face-to-face interaction; As an example a comment read:" *The lab groups we were put in were really great … as it forced contact between some otherwise lonely students*". Some free text responses also highlighted varying degree of understanding and engagement among the different elements of the module and on a couple of occasions that associated coursework didn't always seem self-explanatory.

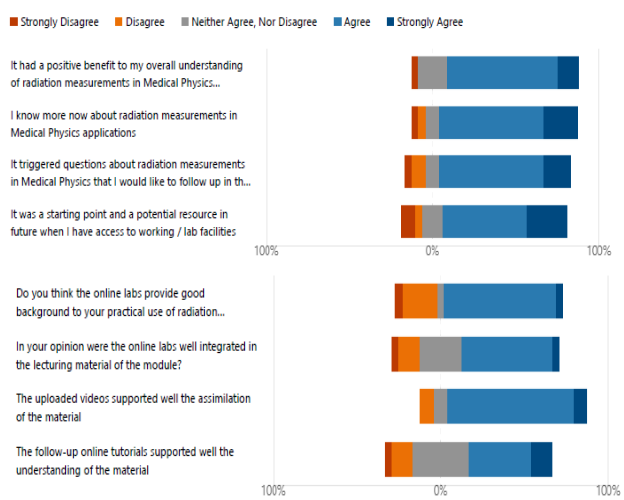

Fig. 3 Radiation Physics practicals – Survey results on online resources evaluation.

Future utilisation of online resources: Additionally to our assessment aim, the survey attempted to probe on the potential value of the developed resources for any future teaching applications looking ahead into a post-COVID-19 restriction era. This may be in the form of support of medical physics academic teaching when face-to-face activities resume as well as support of wider training needs which may span a wider geographical range e.g. for continuing professional development across international networks. To this end, the following question was included: "*Considering the possibility of students being able to access the labs next year, how would you evaluate the use of the existing recorded/online material in radiation labs?*"; Responses are summarised in fig 4. The majority of responses supported the use of resources developed for the remote teaching needs of the past academic year (>21 *Agree* or *Strongly Agree*) for preparation or on-going support of on-site practcal. However, the consensus (54%) was not in agreements (13 *Disagree* or *Strongly Disagree*) that existing material could solely support well student-led study of the subject at local training centres (usually hospitals) thus avoiding visit to the HEI. Free text comments included: "*The online material was good, but I think a physical visit would always be preferable*" and "*in person labs are much better but obviously when this is not allowed the online labs were a good alternative. I think giving next year's students access to the online material before they visit the labs would be really helpful and help alleviate some anxiety students may feel about [performing lab exercises] for the first time*".

As an outcome of this feedback, we plan to maintain access to the online resources for future students as a preparation and support material for the on-site practical sessions. Some of the experience learnt could be taken forward for the preparation of on-line workshops when the geographical spread of participants limits regular face-to-face interaction. Such cases may include continuing professional development across international networks, especially when close links can be formed with local training centres providing hands-on experience to which on-line resources may have a supplementary role.

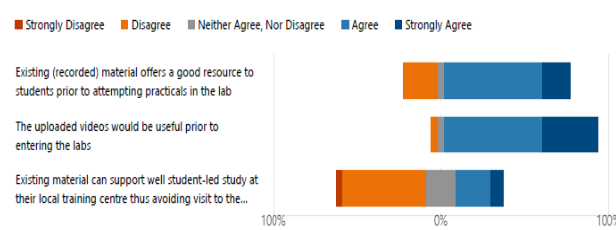

Fig. 4 Radiation Physics practicals – Survey results on future use of resources.

IV. CONCLUSIONS

Online resources developed for the acute demands of remote academic teaching of laboratory components for medical physics during the pandemic, may have a role as supportive framework for future learning activities. The results from the assessment of the practicals reports showed similar level of understanding (similar marks), compared to previous face-to-face lab activities. However, both - the students survey and our own views - indicate that face-to-face practicals should be performed in all cases where the circumstances permit. Another interesting outcome of this remote practicals delivery was that students will benefit from access to such online materials prior to face-to-face lab-based activities.

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