EMERGENCY REMOTE TEACHING DURING THE COVID-19 OUTBREAK – THE EXPERIENCE OF THE ICTP AND UNIVERSITY OF TRIESTE MASTER PROGRAMME IN MEDICAL PHYSICS

S. Renato Padovani[1], Slavik Tabakov[2], Vassilka Tabakova[2],Renata Longo[3]
[1]ICTP, Italy, [2]King's College, London UK, [3]Trieste University, Italy

Abstract— **The paper describes the ad-hoc use of e-learning at the Master programme of ICTP and the University of Trieste – an emergency response of the Covid-19 pandemic. The paper shows results from a questionnaire with students from 21 countries and draws conclusions that this experience has been effective and useful and has saved the programme delivery, but e-learning should be blended with classical one**

Keywords— **eLearning, LMS, VLE, Emergency Remote Teaching, Covid-19, pandemic, Medical Physics education**

I. Introduction

The COVID-19 pandemic in spring 2020 required the immediate suspension of educational activities in presence at ICTP and University of Trieste for a period of 4 months. Many papers have been recently published analysing the effectiveness of the online educational methods adopted during the pandemic for single institutions (1) up to national scale (2) and for different school levels.

The event has required an immediate switch from in-presence class to e-learning - online distance learning (ODL) of courses, tutorials and exams of the first academic year of the Advanced Master (Post-master) in medical physics (MMP), a joint ICTP and Trieste University 2-year post-graduate programme (3,4).

Because the change of the educational method was not planned, this experience can be better identified as Emergency Remote Teaching (ERT) (5). Teachers had to immediately convert their educational method and material for the ODL using the Zoom platform for teaching and the ICTP Learning Management System (LMS), a Moodle platform, as the repository for the education material, exercises, assignments, and for the online exams.

After this experience with e-learning, a survey has been conducted on the 25 Master's students to understand acceptance, views and to get recommendations. In order to try to assess the effectiveness of the ERT experience, a comparison of the marks on the courses affected by the ODL with the marks received, by other MMP students of the past years is made.

This paper is reporting the results of the survey on the students and the comparison of the marks.

II. Materials and method

A Google form has been developed for the 25 MMP students of the first academic year that began in January 2020 (the annual programme is delivered in 3 trimesters). From these, 23 students (92%) submitted answers on the Goggle form. These 23 students were from 21 Low-and-Middle Income (LMI) countries. None of them had previous experience with ODL using LMS.

From March to June 2020, courses and exams were delivered using Zoom and the ICTP LMS, based on a Moodle platform, in a form of emergency remote teaching. Existing teaching material with minor changes, due to the restricted time, was used. In particular, the 10 courses/modules of the first term January-April 2020 were delivered online for half of the lectures and with online exams, while the 11 courses of the second term April-July had online lectures and in-presence exams.

The questionnaire, aiming to explore the acceptance and the effectiveness of the ERT, was designed to include questions on the online accessing mode, the teaching methodology and material, the online exams, the ICTP learning management system (LMS) and on the overall ERT experience, asking also for comments and advices. Table 1 reports the questions, included in the Google form together with multiple choice or graded possible answers.

Table 1. The online questionnaire addressed to the Master of advanced studies in medical physics students.

Question	Answers
On the mode of accessing to ODL	
On the equipment of accessing to ODL	Mobile phone, tablet, laptop, desktop
On the quality of internet connection	Poor, sufficient, good, excellent
Rate the equipment and facilities to participate to online lectures	1 – insufficient to 5 - excellent
Rate the guidelines provided to follow online lectures and LMS (Learning Management System) platform (Moodle)	1 – insufficient to 5 - excellent
The teaching material	
Rate the quality of the online teaching	1 –

material (lectures)	Insufficient, to 5 - Excellent
Give a franc evaluation of the lecture material. For which course the material was insufficient, not appropriate for an online lecturing, not sufficient for the study of the topic. Give recommendations	(open text)
On the quality of the online exercises (exercises on Moodle)	1 – Insufficient, to 5 - Excellent
Give a franc evaluation of the exercise material. For which course was not sufficient/useful for the study. Give recommendations	(open text)
The online exams	
Give your evaluation of the online exam method taken via Moodle or Zoom for the assessment of your knowledge - Multiple choice question (MCS) - Numerical exercise - Assay question - Oral	Easy, Optimal, Acceptable, Difficult
Weakness of the online exam methodology	(open text)
Recommendations for online exams	(open text)
The ICTP LMS (Moodle platform)	
The Learning Management System (LMS): ICTP Moodle platform. - The LMS is fundamental for ODL - [The LMS is containing all the necessary material to study and prepare the exam - The LMS was always used by teachers - The LMS was used to address questions to teachers - The present content of the LMS can be proposed in the future by ICTP for distance learning - The LMS should contain video registration of all lectures - The LMS should contain video registration of some important topic - The LMS together with online lectures allow to reach the same educational efficacy of conventional (in presence) lecturing	1 - Strongly disagree, 2 - Disagree, 3 - Neither agree or disagree, 4 - Agree, 5 - Strongly agree
Do you think that you have gained experience with the ODL, which you could use in your own country?	Yes, No, Maybe
Give recommendations to improve the LMS	(open text)
Give a franc evaluation of the experience with the LMS	(open text)
The ODL experience	
Your evaluation of the ODL experience. : - It was possible and easy to submit questions to lecturers - Personal attention of lecturers was useful to overcome communication difficulties - The interaction with other students was sufficient - Online lectures are effective than traditional - Frustration and lack of interest due to the lockdown situation - Was an occasion to gain a new experience of learning method - Online lectures can be a better accepted method for learning in normal conditions - A pre-recorded video would improve learning effectiveness giving more flexibility - Online lectures should shorter and a lot of short breaks are necessary	1 - Strongly disagree, 2 - Disagree, 3 - Neither agree or disagree, 4 - Agree, 5 - Strongly agree
On the environment: - Home environment is suitable for participation to online lectures - Home distractions is affecting the effectiveness of online lectures - Higher motivation is required to follow online lectures - After the lectures it was easy to discuss the lecture topic with other students	1 - Strongly disagree, 2 - Disagree, 3 - Neither agree or disagree, 4 - Agree, 5 - Strongly agree
Any comment, suggestions and recommendations	(open text)
After the lockdown experience, any comment and recommendations for the improvement of the online distance learning efficacy	(open text)

Apart from the information from the Questionnaire, one of the indicators for the effectiveness of the ODL teaching was the comparison of the mean marks of the exams of this group of students with the mean marks of the same courses delivered by the same teachers in the past 4 cycles, from 2016 to 2019.

III. Results and discussion

The first group of questions are related to the technology and environment supporting the online learning. In some cases internet connection and personal equipment was rated as insufficient to a remote activity as expected (figure 1).

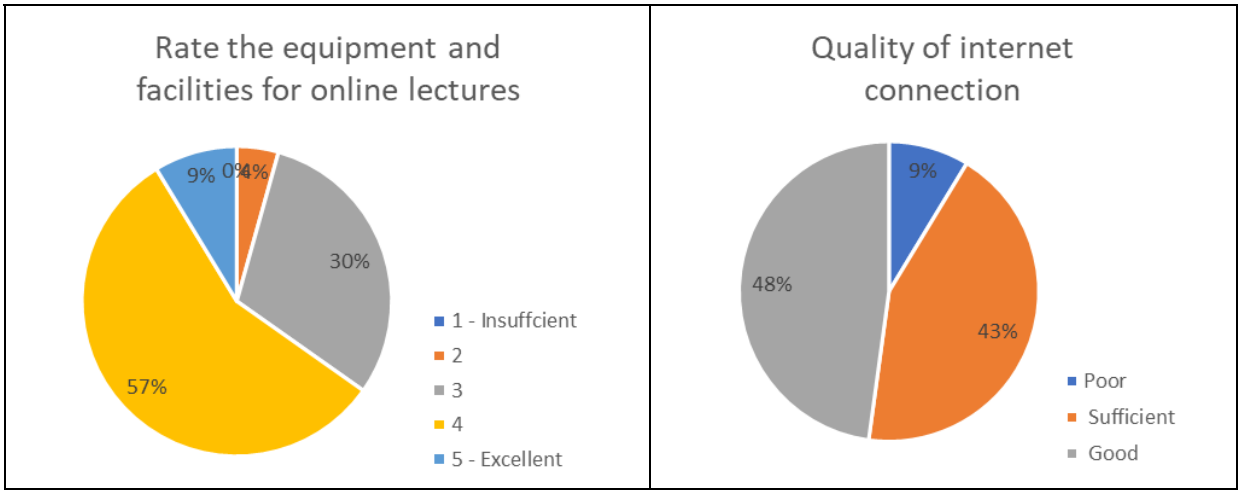

Fig. 1. Equipment, facilities and internet connection qualities as rates by the MMP students.

Students were following remote teaching at home, usually shared flats where students where working at the same time. Distractions, motivation and limited students and teacher interactions are frequently rated as limiting factors for an optimal ODL experience while home environment is frequently considered a favourable condition (figure 2).

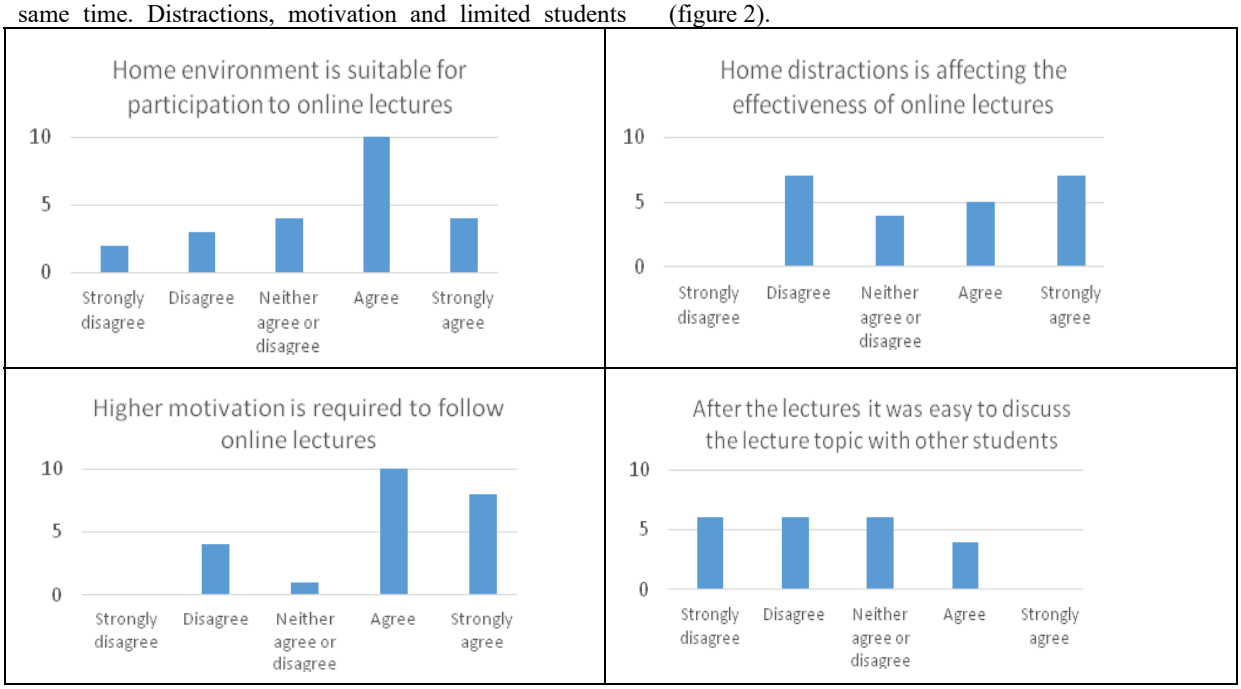

Fig. 2. Home environment and distractions, motivation and limited interactions are frequently limiting factors for an optimal ODL experience.

Teaching material on the LMS (ICTP Moodle), developed for the 26 course of the first year and for the clinical training of the second year of the programme, consists of slides for the online lectures, with voice over only for a module, exercises in form of multiple choice questions (MCQ), essay and numerical exercises, sometimes for each lecture topic, assignments in the form of short lecture to prepare and deliver online. This last activity is requested only for extensive courses. Educational material, in fact, has not been changed from the material delivered in conventional lecturing to the immediate shift to online lecturing. Each course material is complemented with additional teaching materials delivered to the students:

literature in form of book chapters, guidelines, exercises from the past exams. Students have assessed the teaching materials and exercises as Good (4), even when these materials have not been designed specifically for ODL but they are coming from several years of experience and updates based on the feedback from the previous alumni (Figure 3).

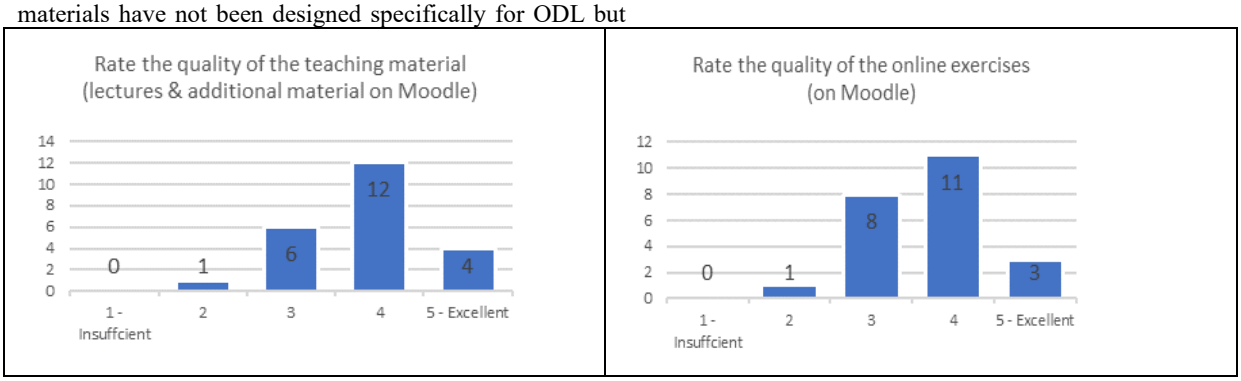

Fig.3. Overall quality of teaching material.

In some cases students have used communication services provided by our website LMS like the chat, newsroom, etc.

Students have also provided individual comments on the lecture material, summarised in Table 2 below, where limitations on ODL are expressed mainly for practical topics, like measurements, QC tasks.

Table 2. Specific comments from students

- Lecture material was perfect but prefer to learn in person when the subject is new
- I wish to have lecture recorded, especially for measurements or other practical tasks
- Sometimes the teacher needed to explain additional things on a whiteboard
- It was not sufficient for some of the courses requiring practicals, where only procedures were discussed.
- Some courses are hands on tasks, so through online the students had no any chance to see, observe as well as perform the activities
- I did chat meeting, like questions and discussions, with some classmates that was helpful.

The examinations with LMS were specifically discussed with the Faculty of the programme. There were concerns related to the supervision during the exam and the possibility students to exchange information via smartphones or other means. The request to have web camera and microphone ON all the time during the exam could help, but would not be able to solve in principle the problem of students' supervision. The online written exams (paper exams) have been adopted due to the constraints of the period, but probably it would be more appropriate to have individual online oral exams - a methodology which was used by two of the teachers. The online exams have used some of the Moodle quiz types: multiple choice questions (MCS) with 3-5 answers provided in random order; numerical questions that allow a numerical response with units that is graded by comparing against various answers with tolerances; calculative questions that are like numerical questions but with the constants used selected randomly from a set when the quiz is taken; and, essay questions. In many exams, questions have been submitted in a random order to each student and also in sequential order, the last impeding to the student to go back to check or correct previous submitted answers.

Students have evaluated the type of questions included in the different exams, e.g. online written or online oral exam. In general, all type of modes are considered acceptable, with a larger preference for the MCQs and the oral form (figure 4). Many students complained for the short time allowed, typically 1-2 minutes for MCQ and 5-10 minutes for essay and numerical tests, for the randomly proved questions that are not following a typical flow of the questions following course and topics development. Again, students complained that in some exams there was a sequential delivery of the random questions without giving the opportunity to review the answers or to have an overview of all exam that allows to identifying easy and difficult questions. Some students recommend using more assignments during the course.

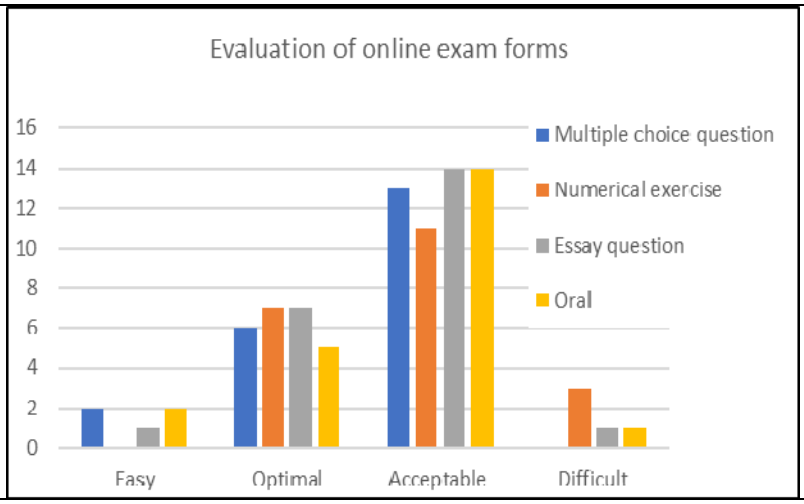

Fig. 4. Students' evaluation of the different forms of the online exams via LMS, with different type of questions or in oral online modality.

The LMS, based on the ICTP Moodle platform, is used for the MMP and the development began in September 2019 thanks to the support and the advices of one of the authors that shared her long experience at the King's College (London, UK) developing and maintaining the LMS for medical physics and engineering and other programmes (6).

Figure 5 shows that students have considered the LMS fundamental for the ODL - collecting all the necessary material and allowing to communicate with teachers and students, e.g. via chats. They consider the present development almost ready for the ODL in the future, but with lectures with more video recording or PPT with voice over. 19 of the 23 students (82%) are considering the LMS ready to provide ODL compared to 4 students (17%) that disagree (figure 5). It is important to note that 78% of the students give marks Agree and Strongly agree to the question 2 from this set – i.e. they have received through ODL the materials which are necessary for their studies.

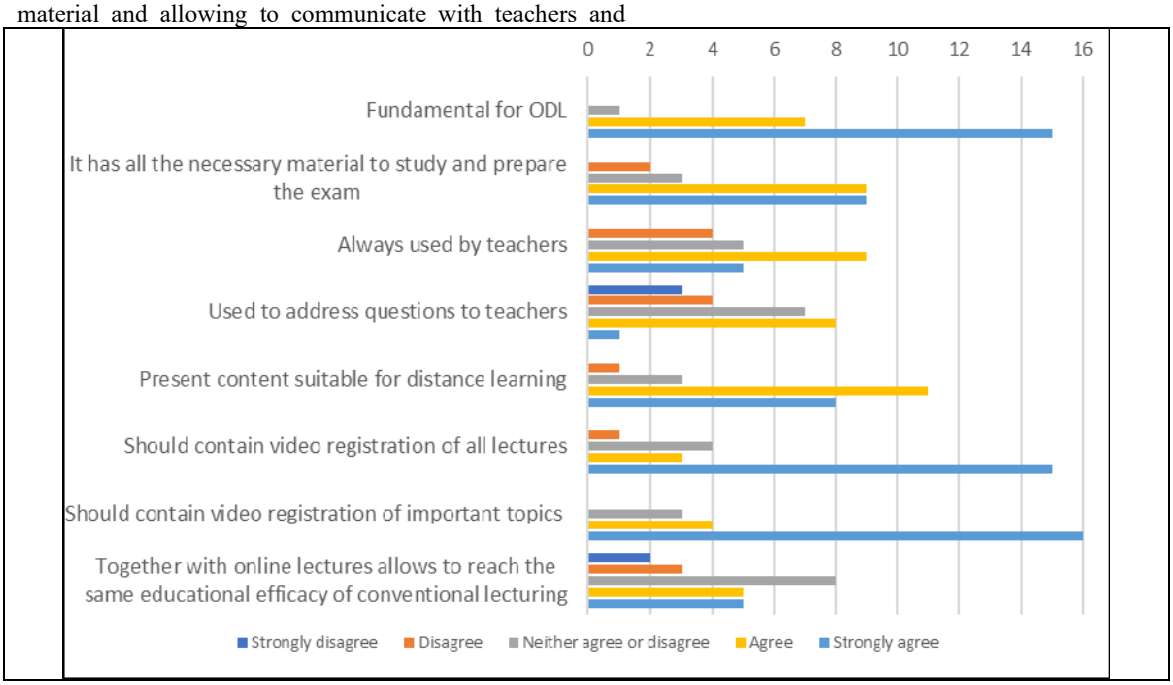

Fig. 5. The evaluation of the ICTP LMS developed for the MMP able to support a programme based on ODL.

Students have been asked to give an overall assessment of the ODL experience. Figure 6a illustrates that 25% of the students do not find this experience useful (what is mainly due to equipment, internet connection and home environment), however 75% of the students find the ODL experience very useful. On the contrary, figure 6b reports that only 17% evaluate ODL equivalent to conventional teaching, however communication with teachers and classmates have been evaluated acceptable for the 60% and the 78%, respectively.

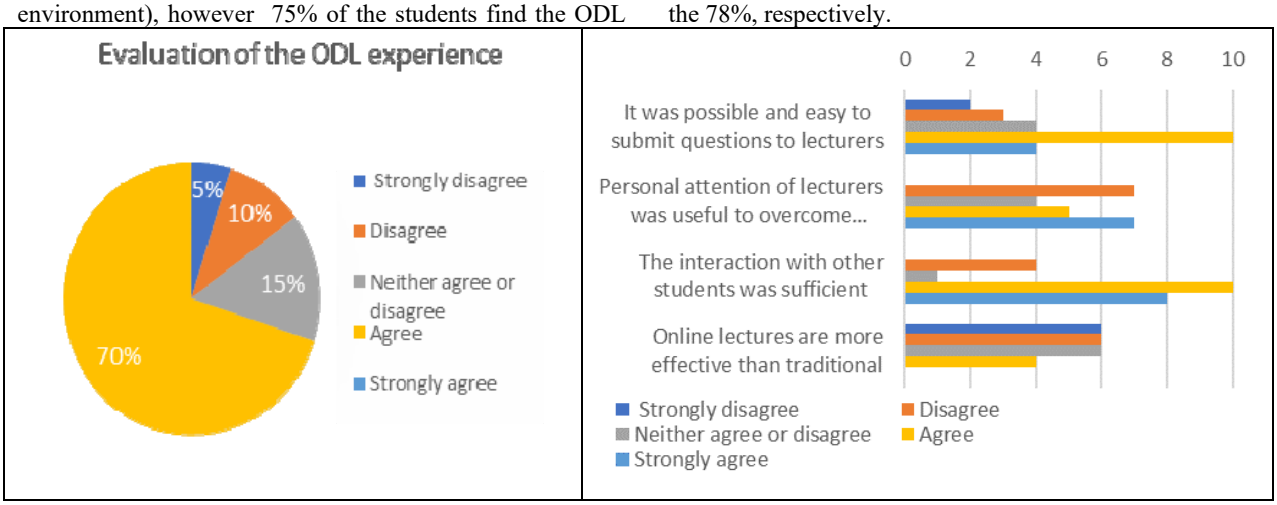

Fig. 6. a) Overall evaluation of the ODL experience. b) Evaluation of effectiveness of ODL and inter-communication level with classmates and teachers.

Effectiveness of the teaching has been evaluated on 17 of the 21 courses/modules of the 1st and 2nd terms (these courses had the same teacher as the past years). The average difference of the mean marks of each course for 24 students interested by the ODL, compared with the 64 students of 4 past cycles (2016, 2017, 2018 and 2019) is -0.6±1.7. In the Italian university scoring system, the range of positive marks in an exam is from 18 to 30 (*with laude*) and -0.6 marks correspond to a percentage difference of 4%. This minor difference in the marks of the exams of the students using ODL during the lockdown, compared with students from the previous years with classical teaching, shows that the use of the e-learning has been very effective. However we have to indicate that this results is only based on the theoretical part of the courses. Medical physics education requires extensive practice, including clinical experience, which can only be delivered in classical way.

IV. Conclusion

The Covid-19 lockdown was a period of mixed emotions during which we tried to find an equilibrium between the frustration of the pandemic and the quality of the education delivery at the MMP programme. All teachers/lectures in the Faculty delivered extra work in order to adapt their existing materials for the LMS delivery. Significant additional work was also associated with the administration of the LMS delivery.

The majority of the students expressed their appreciation of the ODL opportunity that has opened a window on a different way to teach and learn and on the great potentiality that these methods and technologies can represent, in particular, in low and medium income (LMI) countries where knowledge can be spread across a country, as well as in nearby countries. In fact, online education is more economical and convenient, but it requires extra preparation up-front. Probably it is effective only if the number of participants is reduced and when students have active communication with the teacher.

We realised that teachers have to learn ODL methods and instruments and adjust the teaching methods and educational material. We understood that the assessment of the gained competencies has to be made in a more complex form, for example with more assignments using the LMS but also with an oral online exam. We also have to underline that the full educational package of the each student has to include the practical exercises in clinical setting – i.e. the education has to be hybrid – a mix of e-learning and classical learning.

Finally, with this experience we, as teachers, learned a lot about the ODL methods, the only and useful option during the lockdown, allowing us to continue the delivery of the annual academic programme. It was also a great experience for the students and for their future as clinical medical physicists, trainers and teachers in their countries to support the development of the medical physics.

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Corresponding Author: Renato Padovani, ICTP Trieste, Italy
rpadovan@ictp.it

Part of the students and colleagues who took part in the ICTP-University of Trieste Master programme survey