

## Online learning of physics during a pandemic: A report from an academic experience in Italy

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**Summary.** — The need for online learning, as a consequence of the social distancing imposed by Sars-Cov II, has opened a new window on teaching physics in academia. Frontal lectures have left space for online teaching, teachers have been facing with a new way of spreading knowledge, adapting contents and modalities of their courses. Students have coped with a new way of learning physics, which relies on free access to materials and their informatics knowledge. We investigated on how online didactics has influenced lecturers' teaching of physics and students' assessments, motivation, and satisfaction in learning physics during the pandemic in 2020. The research involved bachelor and master students attending the degree course in Physics and lecturers of the Physics Department at the University of Cagliari. The Multivariate ANalysis Of VAriance (MANOVA) supported significant mean differences concerning gender and university level with higher values for girls and master students in almost all variables investigated. Correlations showed that student-student, student-teacher interaction, and the organization of the courses are significantly related to satisfaction and motivation in learning physics. The results of this study can be used to improve the standards of teaching in Physics at the University of Cagliari.

### 1. – Introduction

The spread of Covid-19 virus in spring 2020 [1] completely changed the field of education at all levels. In the case of higher education, universities were forced to move and rapidly change their course organization from face-to-face to remote, online lectures only. This new situation led to an unexpected possibility of studying the effect of this sudden change in didactics in students' and lecturers' academic lives. During the pandemic, academic courses were not planned as online from the beginning and, thus, it was not possible to study the effects of online learning on students and lecturers as researchers generally do in the case of well-designed online courses [2-6]. Thus, we decided to focus on how the transition from face-to-face to digital educational environments affected the

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process of teaching and the outcomes of online learning in physics courses at university level. Standard procedures commonly used in literature do not apply to our case, but we still referred to previous research in that field to individuate topics to investigate [7]. This procedure follows the line of previous research during the pandemic [8,9].

Here, we report an academic experience with online physics courses at the University of Cagliari in Italy. The aim of this study is to understand how students and lecturers received and dealt with the shift from frontal instruction to remote learning in the period March–June 2020. By providing their feedback, we hope to help instructors tune their efforts to build a more effective (remote) learning environment.

## 2. – Methodology

Based on the literature (see mainly [7]), we identified several topics that were considered relevant to investigate on how online learning can affect learning and teaching physics in the case of academic courses held for students attending the degree in Physics. Concerning students, we considered to evaluate simultaneous and asynchronous activities, students' attitudes towards online learning, technical and social aspects such as student-student and student-lecturer interaction, IT skills, and abilities. Furthermore, course structures and organization were also of interest. Motivation, expectations, and satisfaction towards online learning were also investigated. Concerning lecturers, we were interested in studying how online teaching modified their way of organizing the course, their expectations in online teaching, their motivation towards the new way of making lectures and their overall satisfaction at the end of the course.

The student sample consisted of 80 students, 47 boys (58.8%) and 33 girls (41.2%); 53 from the bachelor's courses and 27 from the master's; 54 of them were between 18 and 22 years old (67.5%), 15 (18.8%) between 23 and 27 years old, and 11 (13.7%) between 28 and 32 years old. 86.3% of the students attended the courses entirely online, whereas the remaining 13.8% were in a mixed mode (some students were able to attend some frontal lectures at the beginning of March before universities were closed down due to the pandemic). We also collected 26 answers from lecturers. They were all men aged from 30 to 69. Lectures were scheduled during the second semester and covered different topics, from introductory to specialized physics courses, with both theoretical and laboratory courses. The platform mainly used to perform lectures was Adobe Connect by Adobe, but multiple solutions were explored by lecturers according to their needs.

To perform these statistical analyses and facilitate data interpretation, in both samples we identified some items, measured on the 4-point Likert scale, that define the same construct. Reliability in terms of internal consistency was measured by coefficient Cronbach's  $\alpha$  to assess the accuracy of the measurement instruments (values higher than .70 are considered acceptable). To determine whether there are any statistically significant differences between the means of the factors based on gender (girls and boys) and the degree of the course (bachelor or master) we carried out a multivariate analysis of variance (MANOVA). We were also interested in verifying if variables related to online didactics were correlated with psychological aspects such as student motivation, satisfaction, and the outcome of learning. All analyses have been performed with SPSS (ver. 17.0) software. A detailed version of this study including the two questionnaires, the list of the items and the results of the analysis will be presented in a forthcoming paper [10].

### 3. – Results

Results of the MANOVA showed a significant multivariate effect of gender (Wilks' Lambda = 0.72,  $F_{11,62} = 2.23$ ,  $p < 0.05$ ) and course (Wilks' Lambda = 0.46,  $F_{11,62} = 6.57$ ,  $p < 0.01$ ). Concerning differences in the distribution of means for gender, girls reported higher mean values than boys about student's perception of the availability of the lecturer ( $F_{1,72} = 5.88$ ,  $p < 0.05$ ), student-student interaction ( $F_{1,72} = 9.05$ ,  $p < 0.01$ ), motivation towards online didactics ( $F_{1,72} = 13.13$ ,  $p < 0.01$ ) and towards the use of information technology (IT) devices ( $F_{1,72} = 4.39$ ,  $p < 0.05$ ). It should be noted that boys' motivation towards online learning is very low,  $1.88 \pm 0.80$ .

Concerning the course, there are significative differences between master's and bachelor's evaluations about student's perception of the availability of the lecturer ( $F_{1,72} = 16.79$ ,  $p < 0.01$ ), usefulness of the material of the course ( $F_{1,72} = 14.60$ ,  $p < 0.01$ ), student-teacher interaction ( $F_{1,72} = 32.89$ ,  $p < 0.01$ ), student-student interaction ( $F_{1,72} = 13.50$ ,  $p < 0.01$ ), motivation in online didactics ( $F_{1,72} = 11.65$ ,  $p < 0.01$ ), motivation to attend a virtual class ( $F_{1,72} = 4.06$ ,  $p < 0.05$ ), and satisfaction ( $F_{1,72} = 12.60$ ,  $p < 0.01$ ). In all these cases, master's students reported higher values with respect to their bachelor's peers. Even if it did not appear as a multivariate effect on the interaction between gender and course, the univariate F-tests for each interaction between variables showed significant effects on the student-student interaction ( $F_{1,72} = 14.17$ ,  $p < 0.01$ ), satisfaction ( $F_{1,72} = 3.94$ ,  $p < 0.05$ ), and motivation in online didactics ( $F_{1,72} = 7.51$ ,  $p < 0.01$ ), in attending a virtual class ( $F_{1,72} = 4.56$ ,  $p < 0.05$ ) and in using IT devices ( $F_{1,72} = 5.28$ ,  $p < 0.05$ ). The analysis also showed that while for the bachelor students the means in the levels of interaction, satisfaction, and motivation between boys and girls are similar, on the transition to the master course there is a high increase in the means only for girls.

We note the existence of a relation between the perceived usefulness of the material of the course, lecturer's availability, and student-lecturer interaction. Lecturer's availability strongly correlates with a good student-lecturer interaction ( $r = 0.69$ ,  $p < 0.01$ ) and with the perceived usefulness of the material of the course ( $r = 0.72$ ,  $p < 0.01$ ). In turn, the perceived usefulness of the teaching material strongly correlates with a good student-lecturer interaction ( $r = 0.71$ ,  $p < 0.01$ ). Concerning the overall students' perception of the online didactics, the scales of satisfaction, motivation, and utility of the online environment in learning correlate to each other. Moreover, the student-student interaction variable shows the highest correlations with students' satisfaction and motivation. Finally, student satisfaction is strongly correlated with lecturer's availability and student-lecturer interaction.

Concerning lecturers, a detailed analysis will appear in a forthcoming paper [10]. We have investigated correlations between factors indicated in sect. 1. Results showed that the lecturers' motivation correlates with the final overall satisfaction level for online learning ( $r = 0.66$ ,  $p < 0.01$ ), while there is no significant correlation between expectations and items related to satisfaction and motivation.

### 4. – Discussion and conclusion

In this descriptive study, 80 students attending the physics degree in Physics and 26 lecturers of the Physics Department at the University of Cagliari participated in a research aimed to investigate how they experienced online didactics imposed by the COVID-19 pandemic in spring 2020. A qualitative analysis showed that students reported the highest mean values in the evaluation of their IT skills and capabilities. However, they

encountered many problems with the official online platform selected by the University. Online didactics have been evaluated as negative in the case of laboratories courses, where the lack of hands-on and laboratory experiences has played a negative role in fostering their interest in the course. On the contrary, it has been evaluated as positive for all theoretical courses, where supplementary materials such as video lectures or slides were also available. Lecturers reported a low motivation in online teaching, mainly because of the lack of in-class interaction.

The work has some limitations: due to the small number of participants, we cannot search for a proper cause-effect structure between variables, rather we focused on correlations between them. We found a significant correlation between variables related to the lecturer's role in teaching (such as usefulness of the material, their availability and interaction with students). Moreover, despite showing the lowest averages, a pleasant student-student interaction was the variable that showed the highest correlations with students' satisfaction and all scales of motivation. The overall sample's perception of online didactics has been positive. Both students and lecturers recognized the usefulness of some practices of online learning, such as the use of video-lectures and the availability of supplementary material, but they hope for in-class frontal interaction even in the future. Mean analysis showed that online didactics is better perceived by masters than bachelor students. This suggests the need for suitable pedagogical interventions for younger students who just started their academic careers [8, 9]. Interestingly, female students reported better results than ones male students in items related to motivation, satisfaction, and student-student interaction. This should suggest implementing more and more actions aimed to encourage female students in their careers. Online courses can also be useful to foster inclusion at the Physics Department.

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