The effects of the Covid-19 pandemic seen through the lens of the Italian university teachers and the comparison with school teachers' perspective

Carlo Giovannella[1,2], Marcello Passarelli[1,3]

[1]ASLERD (https://en.wikipedia.org/wiki/ASLERD)
[2]Dept. SPFS, University of Rome Tor Vergata, Rome, Italy
[3]CNR – Institute of Educational Technology, Genoa, Italy

Abstract. In this paper, we report one of the first investigations conducted at the National level with university teachers, with the aim to capture their perceptions about the capability of the learning ecosystems to react to the lockdown imposed by the pandemic and the recourse to on-line learning. The study, conducted about two months after the beginning of the lock-down, shows that: a) learning ecosystems reacted promptly and in a satisfactory manner to assure the didactic continuity at both the systemic and individual level; b) the teaching activities were mainly confined to transmissive ex-cathedra lectures in the attempt to reproduce standard university dynamics; c) the working load increased with respect to face-to-face activities; d) the intention to use on-line learning in the future is driven by preconceptions rather than experiences and by the capability to manage one's own time. The comparison with the outcomes of a similar study conducted with school teachers shows that the latter adopt a broader spectrum of didactic activities (although they still tend to remain in their comfort zone), experienced a heavier increase of the working load, and were more influenced by the situation they experienced. Although both teachers categories recognized the relevance of digital pedagogy, in the case of school teachers - as shown by the causal structure of the variables considered in our studies - it should be urgently included in teacher education curricula, while in the case of the university teachers it appears to be a possible route to support integration of on-line activities with standard face-to-face ones.

Keywords: COVID-19 pandemic, on-line learning, emergency remote education (ERE), learning ecosystems' reaction, university teachers, school teachers, future perspectives, network analysis, causal discovery

1. Introduction

Starting with the first months of 2020, the entire world had to take action to counteract the effects of the pandemic caused by SARS Covid 2 [1]. In several Countries, including Italy, a protracted lockdown caused all educational processes to be

transferred online. Schools, universities and other educational centres had to reorganize their activities in a very short time and use virtual environments.

Today we know that, despite some criticalities, most of the educational ecosystems have withstood the impact of the pandemic (in the sense that school closures did not lead to discontinuing the education of students) and that the infrastructures have proved sufficiently robust to ensure the delivery of online processes. On the other hand, we also realized that it is still necessary: a) to adopt measures to ensure individual access to the network to minimize the infrastructural digital divide; b) to reduce reliance on services offered by multinationals, which may try to capitalize the support they provide [2,3].

It is also quite clear, now, that the quality of on-line processes and the effects they produce on society do not depend only on infrastructure but also involve social and psychological issues, as well as the preparation of teachers and the "mental setting" of all actors participating in the educational processes. Furthermore, as expected, the importance of technology appears quite different for the various educational levels. The implications of cultural and social differences are at present not yet fully clear.

Very few are the publications that have described education during previous pandemics, and they are focused exclusively on school ecosystems [11-13]. Many, on the other hand, are the publications that - albeit often in the form of pre-prints - started to appear since April/June 2020, including those realized by the authors of this paper [2-4 and references therein]. At present, it is impossible to make reference to all such small contributions; here, we can refer the reader to lists of resources like the one that can be found in [14]. All of them are contributing to compose the big fresco providing evidence and details that, in the future, can be examined to identify universality and peculiarities of the contexts.

Our study aims at contributing to this common effort on many original aspects: despite of the recent large number of contributions, only few describe the outcomes of surveys conducted with university faculty [15-18] or university personnel at large [19], in particular at the national/global level; none, to the best of our knowledge, has been dedicated to analyse the perceptions of Italian university teachers. What makes this work unique is that we report about their perceptions and opinions collected two months after the beginning of the lockdown, i.e. in a situation in which the teaching processes achieved what we could define a "steady state". In addition, since our survey represents a nationwide study it can be useful for future transnational comparative studies. Last but not the least, results from this work can be compared with the results obtained by a similar investigation conducted with school teachers [2], so as to identify differences in the beliefs and attitudes of the two different categories of teachers.

This comparison can be useful in the future, when the need will arise to identify actions that can better integrate online activities with face-to-face courses conducted in a safe environment.

2. Method

2.1 Questionnaire

The survey was carried out by means of a three-section questionnaire comprising 81 items, quite similar to that used in [2] although adapted to the university context. The first section comprises six socio-biographical background items (gender, age, university nature, teaching area, geographical location and university name). The second presents 36 items (21 questions requiring a multiple choice or numerical answer and 15 open questions or requests for explanatory comments); it investigates respondents' perceptions about how the learning ecosystem responded to the pandemic and the operating conditions at what we consider the "steady state" of lockdown measures (i.e. after about two months from the beginning of the universities' lockdown). The third section comprises 39 items (19 questions requiring a multiple choice or numerical answer and 20 open questions or requests for explanatory comments); these investigate any changes in university teachers' opinions about technologies and online learning and their expectations for the future. The complete questionnaire is available at [5].

In the following, we report the outcomes of an analysis of respondents' answers with the aim of providing a snapshot of the situation in Italy and investigating university teachers' perceptions about the capability of learning ecosystems to react, the operational conditions, and the type of educational activities carried out (variables listed in Table 1). We also investigate which of these variables might have modified teachers' perception of technology and their expectations for the future (variables listed in Table 2).

This is one of the first nationwide studies to investigate the effects of the pandemic on university teachers' perceptions of online learning. Our study is grounded on previous experiences – descriptive investigations - conducted by one of the authors with a sample of university students [4]. Despite these previous investigations, the need remained for a bespoke questionnaire and an exploratory research method intended to shed light on the network of relationships that connect the variables listed in Tables 1 and 2.

2.2 Participants

Participants were contacted directly via emails and mailing lists. Since our goal was to obtain a picture of the situation of Italian universities about two months after the introduction of the lockdown (March 5th, 2020), the survey was active for one month, from May 1st, 2020 to June 1st, 2020. It was completed by 546 University teachers (280 male, 263 females, 3 non-binary) employed mainly in public university (98%). In terms of age, 7.7% were between 30 and 40 years old, 33.2% between 40 and 50 year old, 36.1% between 50 and 60 years old and 23.1% over 60 years old (mean age = 52.4, perfectly aligned with the national average for university teachers [6]).

Participants reported teaching in 16 different scientific and humanistic cultural areas with a prevalence of STEM (33.9%) and Medicine and Surgery (19.2%). As far as the macro-regional distribution is concerned, 357 participants were from University of Messina and 53 from University of L'Aquila, while the rest are employed in more than 25 Universities all over Italy. Due to the large participation of university teachers from the Universities of Messina and L'Aquila, we tested differences in the mean value of the parameters that we investigated and reported significant differences in Tables 1 and 2.

As an additional control, we measured the possible fatigue effect induced by the length of the questionnaire. This turned out to be very low, with less than 5% of multiple choice and numerical-answer questions being skipped, even towards the end of the survey.

In this paper, we restrict our analysis to the answers given to multiple choice and numerical-answer questions.

3. Results

To explore university teachers' feelings and opinions as well as the complex network of relationships that connect the variables investigated in sections II and III of the questionnaire we pursued multiple strategies, as in [2-3].

First, to investigate a) the perceived capability of learning ecosystems to react to the epidemic, and b) the details of the operational conditions that have been put in place, we carried out descriptive and univariate analyses (section 3.1). For Likert-type response scales, we carried out one-sample t-tests against the midpoint of the scale (5.5 for 10-point scales, 0 for scales ranging from -5 to 5, 0 for the 0-100% scales). The results are reported in Tables 1 and 2.

Subsequently, to obtain a bird's-eye view of the variables' relations, we employed the paradigm of network analysis for visualizing the partialized correlations between variables and infer the direction of causality for some of these associations (section 3.2).

The description of the results will be presented in this section using the same track already adopted in ref. [2-3], while in section 4 we will present a comparative analysis between the two cases of University teachers and School teachers.

3.1 Descriptive and univariate analyses

Technological context. Overall, the previous experience with on-line learning (PEOL) of the respondents was quite low, M = 3.45 [3.22, 3.70] on a 10 point Likert-like scale (1-10), and even lower for university teachers from Messina (ME) and L'Aquila (AQ). This result indicates relatively low usage of technology in tertiary education, even as a support to traditional face-to-face activities.

As far as access to the Internet, more than 55% of participants reported having broadband or ultra-broadband access, less than 33% have an ADSL connection,

almost 9% use their smartphone data connection, while the rest relies on mobile/satellite data connection or other forms of internet connectivity.

More than 84% of participants use a laptop to connect online and only slightly more than 34% a desktop computer. Tablets are used by 13% of the respondents and about 12% use smartphones. Of course, several participants reported using more than one kind of device.

Only less than 5% percent lamented the lack of or limited availability of devices suitable for carrying out online activities, while more than 31% complained about insufficient bandwidth.

Readiness of the learning ecosystems. Despite the low level of familiarity with on-line technologies, in less than one week more than 71% of university teachers got used to on-line activities, a percentage that became higher than 93% in less than two weeks. At the "steady state", only less than 5% were unable to get used to them.

Table 1. Survey Section II: teachers' perception about the capability of the learning ecosystems to react, the operational conditions and the features of the educational activities carried out. We used a 10 point Likert-like scale (1-10) unless otherwise indicated.

Variable	**Average**	**t-test**	**Difference between groups**
University Readiness to switch to on-line education (UR)	M = 8.54 [8.40, 8.69]	*t(545)* = 41.01, *p* < .001, *Cohen's d* = 1.76	F(2, 543) = 21.72, p < .001, R_2 = .07 higher for ME
Technological Adequacy of On-line Environments (TAOE)	M = 7.78 [7.61, 7.95],	*t(536)* = 25.83, *p* < .001, *Cohen's d* = 1.11	F(2, 534) = 7.19, p < .001, R_2 = .02 higher for ME
Previous Experience in On-line Learning (PEOL)	M = 3.45 [3.22, 3.70]	*t*(518) = -16.94, *p* < .001, *Cohen's d* = -.74	F(2, 516) = 5.82, p = .003, R_2 = .02 slightly lower ME, lower AQ
Teachers' Technological Readiness (TTR)	M = 6.97 [6.81, 7.13]	*t(527)* = 18.20, *p* < .001, *Cohen's d* = .79	F(2, 525) = 2.55, p = .079, R_2 < .01
Teachers' Pedagogical Readiness (TPR)	M = 6.84 [6.67, 7.02]	*t(513)* = 15.41, *p* < .001, *Cohen's d* = .68	F(2, 511) = 8.10, p < .001, R_2 = .03 higher for ME
Workload Increase (WI) %, tested against the baseline of 0	M = .35 [.33, .38]	*t*(533) = 29.13, *p* < .001, *Cohen's d* = 1.26	F(2, 531) = 11.92, p < .001, R_2 = .02 lower for ME
Teachers' Time Management Capacity (TTMC) (scale -5, +5)	M = .68 [.44, .92]	*t(541)* = 5.56, *p* < .001, *Cohen's d* = .23	F(2, 539) = 7.13, p < .001, R_2 = .04 higher for ME
Educational Activity: Lecture-Discussion (EALD) (scale -5, +5)	M = -1.08 [-1.31, -.87]	*t(538)* = -9.72, *p* < .001, *Cohen's d* = -.42	F(2, 536) = 3.92, p = .020, R_2 = .01 *(slightly lower ME)* lower AQ
Educational Activity: Transmissive-Interactive (EATI) (scale -5, +5)	M = -.96 [-1.19, -.74]	*t(537)* = -8.40, *p* < .001, *Cohen's d* = -.36	F(2, 535) = 2.79, p = .062, R_2 < .01

Educational Activity: Asynchronous-Synchronous (EAAS) (scale -5, +5)	M = 1.16 [.92, 1.41]	*t(519)* = 9.25, *p* < .001, *Cohen's d* = .41	F(2, 517) = 2.61, p = .074, R_2 < .01
Educational Activity: Individual-Collaborative (EAIC) (scale -5, +5)	M = -.96 [-1.23, -.70]	*t(459)* = -7.11, *p* < .001, *Cohen's d* = -.33	F(2, 516) = 3.25, p = .040, R_2 < .01 slightly lower AQ
Reproducibility of Classroom Dynamics (RCD)	M = 5.64 [5.43, 5.85]	*t*(542) = 1.32, *p* = .187, *Cohen's d* = .06	F(2, 540) = .21, p = .812, R_2 < -.01

Table 2. Survey Section III: teachers' perception about technologies and their expectations for the future. We used a 10 point Likert-type scale (1-10).

Variable	**Average**	**t-test**	**Difference between groups**
Sustainability of On-line Education (SOE)	M = 5.94 [5.72, 6.17]	*t*(539) = 3.94, *p* < .001, *Cohen's d* = .17	F(2, 521) = 0.27, p = .129, R_2 < .01
Change in the Idea of Educational Experience (CIEE)	M = 4.95 [4.71, 5.19]	*t*(523) = -4.50, *p* < .001, *Cohen's d* = -.20	F(2, 537) = 2.05, p = .76, R_2 < .-01
Improvement in the Attitude towards Technologies (IAT)	M = 5.68 [5.44, 5.91]	*t*(531) = 1.48, *p* = .140, *Cohen's d* = .06	F(2, 529) = 2.58, p = .077, R_2 < .01
Intention to Work in On-line Learning (IWOL)	M = 5.78 [5.52, 6.03]	*t(527)* = 2.10, *p* = .036, *Cohen's d* = .09	F(2, 525) = 0.12, p = .888, R_2 < -.01
Importance of Teacher Education in Digital Pedagogy (ITEDP)	M = 7.25 [7.03, 7.47]	*t(523)* = 15.57, *p* < .001, *Cohen's d* = 0.68	F(2, 521) = 0.32, p = .726, R_2 < -.01
Extent to which University should Rely on On-line Learning (UROL)	M = 5.64 [5.43, 5.85]	*t(525)* = 1.33, *p* = .183, *Cohen's d* = .06	F(2, 523) = 0.87, p = .419, R_2 < -.01
Degree of University e-Maturity (UeM)	M = 7.49 [7.33, 7.65]	*t(521)* = 24.21, *p* < .001, *Cohen's d* = 1.06	F(2, 543) = 13.39, p < .001, R_2 = .05 higher for ME

Such a rapid answer has been supported also by the promptness of the Italian Universities in testing and in making available on-line environments and video conferencing facilities in less than one week. Consequently (see Table 1), the University Readiness to switch to online education (UR) and the Technology adequacy of the online environments (TAOE) were perceived as very high, respectively M = 8.54 [8.40, 8.69] and M = 7.78 [7.61, 7.95]. Only about 16% of participants reported difficulties in accustoming themselves to novel technological environments.

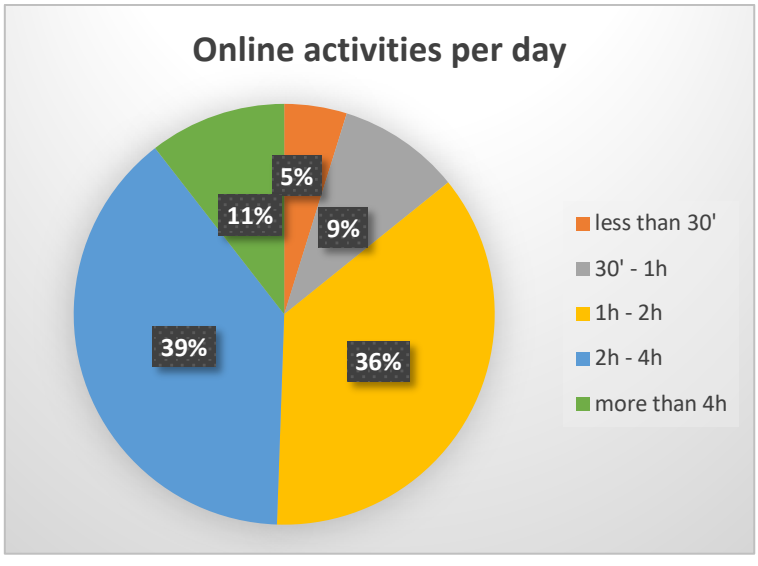


Fig. 1. Time teachers spent online per day by to support and deliver distance learning

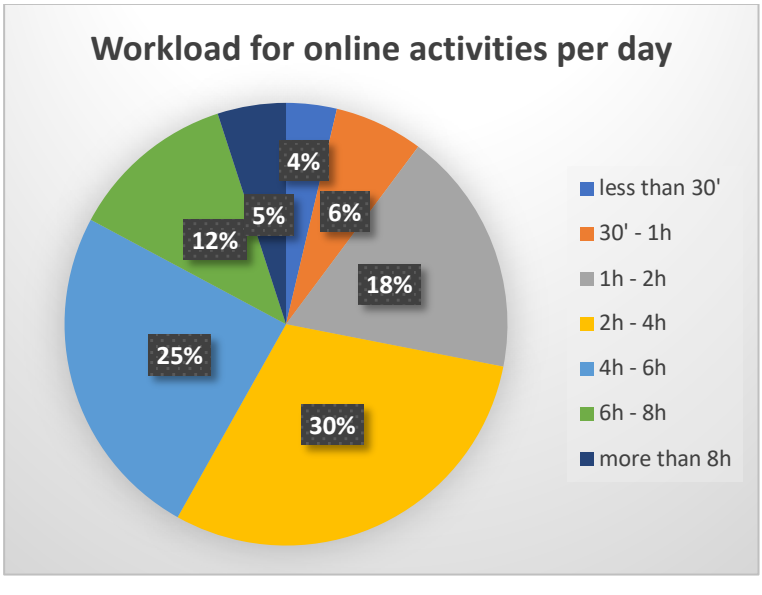


Fig. 2. Teachers' overall time-based workload per day to support and deliver distance learning

Workload and time organization. As expected, the shift to online education generated a perceived increase in workload (estimated to be around 35% more than usual).

Despite all of this, in teachers' opinion, these operational conditions induced a higher self-reported capacity to manage their own time with respect to pre-COVID outbreak conditions: see (TTMC) in Table 1. Fig. 1 and Fig. 2 show the time spent on-line by university teachers to deliver distance learning and the overall time-based workload to support and deliver distance learning.

Teaching activities. We asked teachers to rate the teaching activities they carried out during the lockdown along four axes: lessons vs. discussions (EALD in Table 1), transmission vs. interaction (EATI in Table 1), asynchronous vs. synchronous (EAAS in Table 1), and individual vs. collaborative (EAIC in Table 1) - all scales ranging from -5 to +5. As shown in Table 1, respondents deemed their lockdown affected teaching activities to be more lecture-based (M = -1.08 [-1.31, -.87], transmissive (M = -0.96 [-1.19, -.74]), synchronous (M = 1.16 [.92, 1.41]), and directed to individuals (M = -.96 [-1.23, -.70]).

These results can easily be explained by the attempt to reproduce the ex-cathedra lectures dynamics and content sharing. In fact, about 82% of the university teachers used technology to share contents, and about 50% to deliver synchronous lectures, to produce contents and for assessment. About 40% of participants reported using technology to carry on synchronous exercises. Less than 20% used it to support collaborative activities, less than 13% to organize activities of a more innovative nature and around 10% to support personalization of the didactic processes.

Similarly, if we consider assessment modes, we can see that synchronous oral interviews were by far the preferred mode (around 84%). Individual assignments and online tests were used by less than 18% of the respondents, while collaborative and group assignments were used by less than 12% of the university teachers.
These results may be stemming from either limited technological or pedagogical preparedness, or from the intention to minimize the effort and time needed to design new and innovative activities suitable for the new setting.

As for the difficulties university teachers faced during their online experiences (Fig. 3), the main one (reported by more than 56% of respondents) concerns the expressive modalities, D_LE, which are felt to be very limited with respect to f2f interaction.

The second item in the ranking, as already mentioned above, is limited internet bandwidth, D_LC (31%). Apparently, the lack of technological skills is not felt to be a significant problem by more than 97% of the teachers, at least when implementing the educational strategies described in the previous section. However, about 16% encountered difficulties accustoming themselves to novel technological environments, D_HT, while 8% reported difficulties using multiple environments (including tools and apps), D_MT, and lamented a lack of technical assistance. It is interesting to note that 24% of the university teachers missed having a blackboard, D_MB.

A notable aspect is the difficulty that 21% of the sample experienced due to unsuitable home environments, D_IHE, which may also have generated a perceived lack of concentration (9%), while 5% felt a certain discomfort in using a webcam.

Another interesting aspect is the relative lack of perceived problems associated with the General Data Protection Regulation (GDPR), namely 9%. This seems to indicate that most restrictions related to GDPR are of little significance for university teachers or can be freely bypassed, at least in emergency conditions.

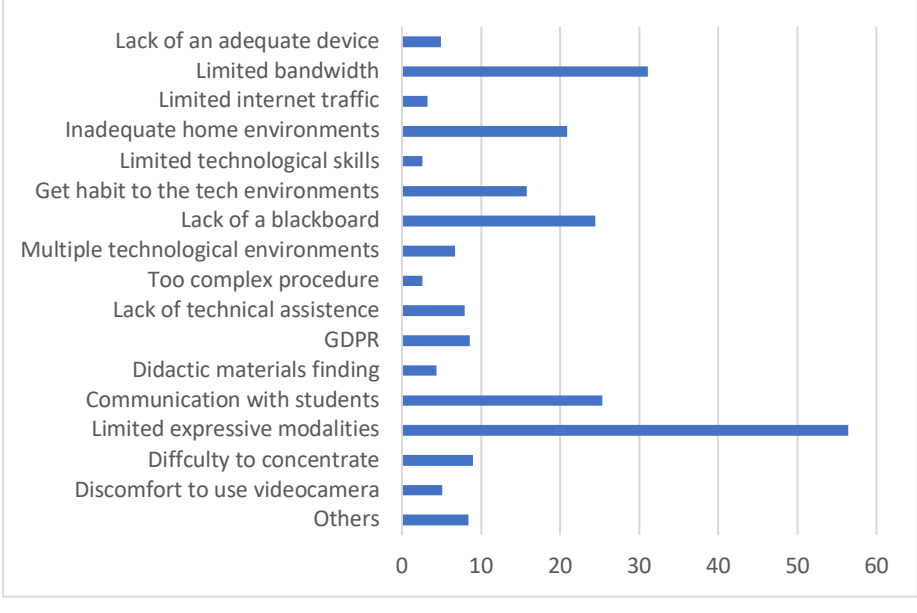


Fig. 3. Difficulties faced by teachers (%).

A look into the future. Being at the "steady state" of the operational conditions, we also tried to stimulate an initial reflection about possible future developments.

Interestingly, we observed (Table 2) that - apart from UeM (the degree of University e-maturity) that as shown in the following is strongly related to UR and TAOE (Table 1) - the mean values of all variables we considered do not depend on the subgroups of respondents (e.g. teachers belonging to ME or AQ universities).
It is clear that university teachers did not change their idea on the educational experience (CIEE) while, on the other hand, they strengthened their belief in the sustainability of on-line education (SOE) and appear quite convinced about the need and importance of teacher education in digital pedagogy (ITEDP).

Finally, the preferred future teaching mode is mostly f2f (50%) but half of the teachers (43.5%) would prefer, and feel ready, to continue in blended configuration or fully on-line (6.5%). Such percentages are higher than what we would have expected during the pre-COVID time.

The scenario and data described above, however, do not allow us to clearly identify the possible relationships among the investigated variables (Tables 1 and 2),

nor their possible causal dependencies. In the next sections we will try to shed light on this aspect.

3.2. Causal discovery

The discovery of causal structures in observational data is based on Pearl's concept of d-separation [7], by which we mean a set of criteria that can determine whether two (sets of) variables are independent, given a set of other variables. A simple implementation of this iterative procedure is the PC algorithm, which identifies the causal structure reported in Fig. 4 (using $\alpha = .01$ and an order-independent and non-conservative version of the algorithm (see [8] for details). It should be noted that a major drawback of this procedure is that it relies on strict assumptions, which are rarely met in real-world data. For example, accurate causal discovery would require that there are no hidden variables (and especially hidden common causes) in the network. As such, results from the PC algorithm should be interpreted tentatively, and not regarded as factual results. However, in a purely exploratory analysis such as this one, they can aid and guide interpretation of results.

As already seen in previous work, Teachers' Technological Readiness (TTR) appears to be strictly related to Teachers' Pedagogical Readiness (TPR) that together with the Technological Adequacy of On-line Environments (TAOE) contributes to the University e-Maturity. This result is expected, since e-Maturity is a complex construct comprising not only the quality and adequacy of technological settings and available digital competencies but also other variables, including effectiveness in the management of digital environments and the learning processes adopted for them and the vision of the development of the digital setting [9]. UeM together with TAOE determines UR, i.e. the belief in the readiness of the learning ecosystem.

The capacity of teachers to manage their time (TTMC) influences the perception of working load increase (WI), that of operating in an adequate home environment (D_IHE), the intention to work with on-line learning in the future (IWOL), and the increase of the attitude towards technologies (IAT). The previous experiences with on-line learning (PEOL) do not seem to have a relevant effect, possibly because the mean value of PEOL is quite low (see Table 1). A central position is assumed by the capability to reproduce the standard classroom dynamics that is supported by TAOE and by synchronous activities, EAAS.

The very peculiar aspect of the causal structure of Fig. 4 is that FBL is not the terminal of the chain but the starting point. It means that intention to use in the future the blended learning configuration is not derived by the experience done during the lockdown but, rather, an a priori decision, a sort of preconception that determines IWOL, sustainability of the on-line learning (SOE), the extent to which University should Rely on On-line Learning (UROL), and IAT. The importance of teacher education in digital pedagogy (ITEDP) acts as a parallel bridge between IWOL, SOE and UROL.

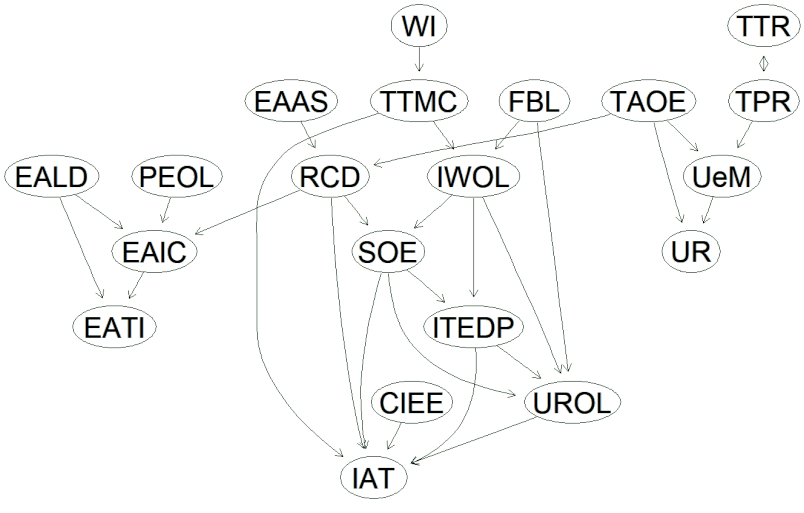


Fig. 4. Causal structure of the main variables considered in this study.

4. Comparison with school teachers

Universities and schools are different learning ecosystems with different needs and this generates differences in teaching styles, approaches and attitudes. Thanks to the investigation we have conducted, almost in parallel, with school teachers [2] we are now in the unique position to be able to compare these two ecosystems through the point of view of their teachers. Data on school teachers was collected from May 13th, 2020 to May 24th, 2020,. The sample includes 336 teachers (91% women; the population has 83% women) employed in primary (142), lower secondary (84) or upper secondary (110) schools. The sample seemed representative of the teachers population age (49.10 vs 48.90, $p = .684$) [22] and school level ($p = .118$). The survey collected all variables described in the present study, so a direct comparison of responses is possible.

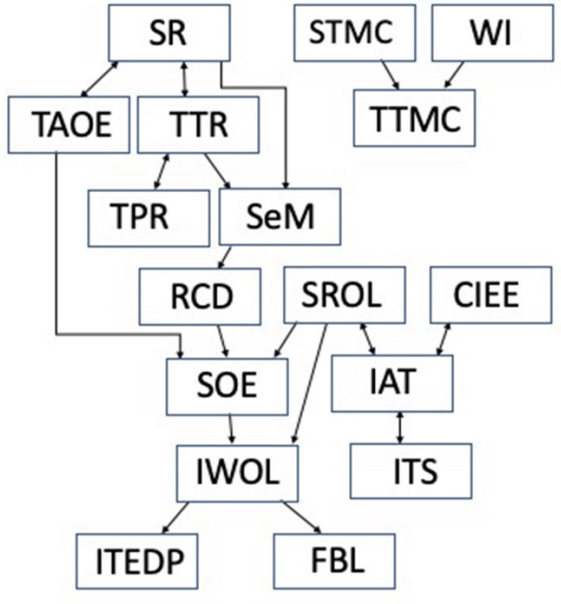
Universities have dedicated and more advanced ICT infrastructures and services and this is possibly reflected in the perception about the readiness of the learning ecosystem, see comparative tables. The value of US/SR TAOE and UeM/SeM are much higher in the case of universities. As we have seen above, university teachers got used very quick to on-line activities – 71.5% in less than one week and more than 93% in less than two weeks - and this can be ascribed partially to switching time (that for universities has been in average a few days, contrasting with the two weeks for schools) and partially to type of activity, that in the case of universities has been almost exclusively transmissive lectures. Although school teachers, too, tried to remain in their comfort zone, when confronted with University teachers appear to have put in place somewhat more interactive and collaborative activities (maybe also due to the different type of audience and their specific needs).

Table 3. Survey Section II: Comparison between university teachers' and school teachers' perception

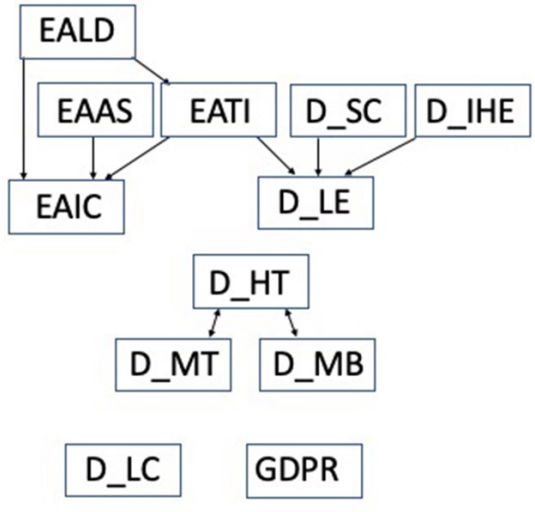
Variable	Average University	Average School
University/School Readiness to switch to on-line education (UR/SR)	M = 8.54 [8.40, 8.69]	M = 6.23 [5.98, 6.48]
Technological Adequacy of On-line Environments (TAOE)	M = 7.78 [7.61, 7.95]	M = 6.36 [6.10, 6.62]
Teachers' Technological Readiness (TTR)	M = 6.97 [6.81 7.13]	M = 5.93 [5.72, 6.14]
Teachers' Pedagogical Readiness (TPR)	M = 6.84 [6.67, 7.02]	M = 5.85 [5.65, 6.05]
Workload Increase (WI) %	M = .35 [.33, .38]	M = .65 [.63, .68]
Teachers' Time Management Capacity (TTMC) (scale -5, +5)	M = .68 [.44, .92]	M = -.43 [-.74, -.12]
Educational Activity: Lecture-Discussion (EALD) (scale -5, +5)	M = -1.08 [-1.31, -.87]	M = .37 [.13, .60]
Educational Activity: Transmissive-Interactive (EATI) (scale -5, +5)	M = -0.96 [-1.19, -.74]	M = 1.06 [.81, 1.31]
Educational Activity: Asynchronous-Synchronous (EAAS) (scale -5, +5)	M = 1.16 [.92, 1.41]	M = .85 [.58, 1.12]
Educational Activity: Individual-Collaborative (EAIC) (scale -5, +5)	M = -.96 [-1.23, -.70]	M = -.36 [-.67, -.05]
Reproducibility of Classroom Dynamics (RCD)	M = 5.64 [5.43, 5.85]	M = 5.32 [5.08, 5.57]

Table 4. Survey Section III: comparison between university teachers' and school teachers' perception about technologies and their expectations for the future.

Variable	Average University	Average School
Sustainability of On-line Education (SOE)	M = 5.94 [5.72, 6.17]	M = 5.17 [4.93, 5.42]
Change in the Idea of Educational Experience (CIEE)	M = 4.95 [4.71, 5.19]	M = 5.18 [4.89, 5.47]
Improvement in the Attitude towards Technologies (IAT)	M = 5.68 [5.44, 5.91]	M = 6.30 [6.01, 6.59]
Intention to Work in On-line Learning (IWOL)	M = 5.78 [5.52, 6.03]	M = 5.14 [4.83, 5.46]
Importance of Teacher Education in Digital Pedagogy (ITEDP)	M = 7.25 [7.03, 7.47]	M = 8.04 [7.81, 8.27]
Extent to which University/School should Rely on On-line Learning (UROL/SROL)	M = 5.64 [5.43, 5.85]	M = 5.22 [4.96, 5.48]
Degree of University/School e-Maturity (UeM/SeM)	M = 7.49 [7.33, 7.65]	M = 6.36 [6.13, 6.59]



a)



b)

Fig. 5. Causal structure of the main variables considered in this study reported in ref. [2].

We can also observe that the individual technological endowment seem to be more performant in the case of university teachers: more than 55% have broadband or ultra-broadband access to the internet against 44% in case of school teachers, less than 5% lamented the lack of or limited availability of suitable devices against 12% of the

school teachers, 31% complained about insufficient bandwidth instead of 36% of the school teachers. Quite similar in percentage, instead, the usage of the devices (laptop, desktop, tablet, mobile phone) and the opinion about the lack of criticalites in the level of digital skills owned before the lockdown.

Coherently with the lower complexity of the didactic activity delivered by university teachers, we observe a difference in the perceived increase of the working load (35% at university and 65% in schools) and in the capacity to manage the time (.68 for university teachers and -.43 for school teachers). Possibly, this is also the reason we observe a substantial increase in the attitude towards technologies (IAT) in the case of school teachers with respect to university teachers, the meaningfully higher relevance attributed by schools teachers to teacher education in digital pedagogy, the lower values for sustainability (SOE) and for the extent to which the learning ecosystem should rely on on-line learning in the case of schools.

The most interesting difference between university and school teachers can be observed in the development of the causal structure of the variables we have investigated in our studies.

In the case of school teachers, see Fig. 5, as one can expect, the digital context constituted by technological infrastructure and digital competence induces a perception of sustainability of on-line learning and thus influence the intention to work with e-learning and to adopt in the future a blended configuration.

In the case of university teachers, instead, as discussed above (see Fig 4) it's the intention to adopt the blended configuration that determines the intention to work with on-line learning and, thus, the perception of sustainability and the opinion about the extent to which the learning ecosystem should rely on on-line learning.
In other words, the mind of university teachers seems, on average, much more structured and their "perception" guided by an a priori belief on how learning activities should be delivered.

Also, the centrality of the capability to reproduce the classroom dynamics, i.e. ex-cathedra lectures, suggests that it could be much more complex to introduce innovative didactic approaches into the university than into the school. ITEDP represents, in fact, a possible bridge to go from IWOL to UROL, but not one of the terminals of the causal chain like in the case of school teachers.

This seems to indicate that the training of university teachers in digital pedagogy, and possibly more in general in didactics and pedagogy, is even more urgent than for schools teachers if one wishes to go beyond a transmissive and individualistic approach, i.e., knowledge transmitted from the "magister" to the "disciple" solely by means of ex-cathedra lectures.

5. Conclusions and future work

The present paper provides a snapshot of the university learning ecosystems' reaction to the pandemic from the teachers' perspective and explores the directed network of relationships among the set of variables that we have considered in this survey. The outcomes of such analysis allowed us also to compare the mindset of university and school teachers with respect to on-line learning.

This study demonstrates the reasonable (perceived) e-maturity and robustness of both the Italian University system and the technological infrastructure, that were considered capable to assure educational continuity in less than a week in almost all cases. Such a quick reaction has been possible also thanks to the presence of pre-existing infrastructures and dedicated maintenance and development services, as observed in ref. 15. It should be noted, though, that the technological infrastructures leveraged the availability of video conferencing cloud applications that assured the reproducibility of the classroom dynamics, i.e. the delivery of ex-cathedra lectures. This appears to be a common outcome of several national and international surveys [15, 17, 19]. In particular, videoconferencing has been used by the teachers with no or low previous experience in on-line learning [17,19]. Only in the case of Norway it has been observed that a consistent percentage of teachers tried to introduce more interactive and collaborative approaches and activities [19].

Another common finding is the perception of the working load increase [15,17,19] generated by on-line learning to restructure activities and content and also to learn, often self-learn, new tools and strategies. In general, however, the perceived amount of working load increase seems to be lower than in the schools [2 and reference therein].

The casual relationships among the variables investigated highlights an important difference between the university teachers and school teachers: although both categories tend to remain within their comfort zone, the latter tend to be more open-minded and their mindset seems to be influenced by experience and, possibly, by the multifaceted needs of the students. The former, on the other hand, tend to rely on preconceptions and, partially, personal comfort. Because of this, school teachers tend to consider the training in Digital Pedagogy as a necessary consequence of a possible future integration of on-line activities into the educational process while in the case of the university teachers such training is deemed as an important opportunity but not a strictly needed one.

In our opinion, this is not a result that emerged by chance, but rather mirrors a cultural heritage that is not easy to modify. University Italian teachers, in fact, are not selected on the basis or their ability to teach but only on their ability as researchers (that more and more include also the capability to attract financial resources). In addition, they are expected to transmit the knowledge in a situation in which the teacher/students ratio is quite low. Apart from very few exceptions, the co-creation of knowledge is stimulated only during the thesis, i.e. at the end of the student curricula. This is a typical situation that clearly boosts a knowledge-based transmissive didactic. Such structured mindset is quite difficult to change also because of the quite high average age of university teachers, 52 years [5], that possibly tends to discourage a lifelong learning approach on an aspect that is not deemed relevant also by the university educational system.

The modernization of university teaching is a big issue that the pandemic brought to light and that cannot be solved on an individual basis, requiring instead a systemic intervention at the governmental level. Nevertheless, the pandemic and the forced switch to the on-line could represent an occasion and a stimulus, at least, for the design and implementation at a local level of adequate actions that could be undertaken thanks to the autonomy of universities to improve the quality of the teaching. Such modernization can leverage the more positive attitude toward the

integration of the on-line learning in future processes [this work and ref. 15], but for sure also needs actions to increase systematically the digital literacy and the pedagogical preparedness of the university teachers [see also ref. 16 and 18] and cannot rely only on self-learning [19]. A permanent support to help teachers in the design of the learning activities [18] and in keeping students engaged [17] is also deemed as very important, especially since teachers are now facing the new challenge of teaching, in parallel, face to face and at a distance.

Overall, the present work should be considered as a further step toward additional analysis, research and surveys. The set of variables that have been investigated in this and in previous works offer a quite robust framework for comparative and evolutionary studies that could be, in any case, developed further and/or integrated.

In the close future we intend to analyse more in depth the textual answers and comments provided by participants to the present survey, in order to confirm the scenario that has emerged up to now from the quantitative analysis, to point out all relevant details and possible contradictions that may have been hidden behind it, and/or to highlight possible differences in opinions, if any, among teacher categories.

All future analyses will be conducted with the aim to catch from one side an instant picture of an extraordinary happening represented by educational processes delivered during a pandemic, and from the other to extract lessons to be learnt for the future of the technology enhanced learning, its integration in the educational processes, for the further development of a digital pedagogy and an adequate digital education literacy. A future high quality education for all, see SDG 4 [10], needs to consider the digital dimension, the avoidance of the digital divide and the sustainability of the digital infrastructures, all aspects that have not been sufficiently emphasised in the description of the UN 2030 Sustainable Development Goals. Because of this, on a medium-long term it would be also very important to promote comparative studies on the data that are being collected all over the world while we write.

References

1. UNESCO, https://en.unesco.org/themes/education-emergencies/coronavirus-school-closures (2020). Accessed 2020/09/25
2. Giovannella, C., Passarelli, M., Persico, D. (2020) Measuring the effects of the Covid-19 pandemic on Italian Learning Ecosystems at the steady state: the school teachers' perspective, Interaction Design and Architecture(s) Journal (IxD&A), N. 45, 264 - 286
3. Giovannella, C., Passarelli, M., Persico, D. (2020) La didattica durante la pandemia: un'istantanea scattata dagli insegnanti a due mesi dal lockdown, BRICKS, N. 4, 24 - 41
4. Giovannella, C. 2020. Effect induced by the Covid-19 pandemic on students' perception about technologies and distance learning. In "Pedagogical Approaches, Ludic and Co-Design Strategies & Tools Supporting Smart Learning Ecosystems and Smart Education, Springer Verlag, in print
5. Me and the Distance Learning at Covid-19 Time – University Teachers Questionnaire https://docs.google.com/forms/d/e/1FAIpQLSe_WwYAsp73IufAExjFmODwP_Za48sGmMeiAbZ-9c_MpnNpbg/viewform

6. http://ustat.miur.it/media/1157/focus-il-personale-docente-e-non-docente-nel-sistema-universitario-italiano-aa-2017-2018.pdf
7. Hayduk, L., Cummings, G., Stratkotter, R., Nimmo, M., Grygoryev, K., Dosman, D., ... & Boadu, K. (2003). Pearl's D-separation: One more step into causal thinking. Structural Equation Modeling, 10(2), 289-311.
8. M. Kalisch, M. Maechler, D. Colombo, M.H. Maathuis and P. Buehlmann (2012). Causal Inference Using Graphical Models with the R Package pcalg. Journal of Statistical Software 47(11) 1–26, http://www.jstatsoft.org/v47/i11/.
9. Sergis S., Sampson D. G., From Teachers' To Schools' ICT Competence Profiles, in Theorizing Why in Digital Learning: Opening Frontiers for Inquiry and Innovation with Technology, Springer, 307-327 (2014)
10. UNESCO. https://en.unesco.org/education2030-sdg4/targets. Accessed 2020/09/25
11. Fox, R.: SARS epidemic : Teachers ' experiences using ICTs. Education. 319–327 (2003)
12. Fox, R.: ICT Use During SARS: Teachers' Experiences. Journal of Technology and Teacher Education, 15(2), (2007)
13. Cauchemez, S., Ferguson, N. M., Wachtel, C., Tegnell, A., Saour, G., Duncan, B., & Nicoll, A. (2009). Closure of schools during an influenza pandemic. The Lancet infectious diseases, 9(8), 473-481.
14. https://www.daad.de/en/information-services-for-higher-education-institutions/centre-of-competence/covid-19-impact-on-international-higher-education-studies-and-forecasts/
15. Time for class: Covid-19 edition. Part 1: a national survey of Faculty during Covid-19 https://tytonpartners.com/library/time-for-class-covid19-edition-part-1/
16. Covid-19 Faculty Preparedness. Top Hat Field Report. https://philonedtech.com/results-from-top-hats-covid-19-faculty-survey-about-online-teaching/
17. Nambiar D., (2020) The impact of online learning during COVID-19: students' and teachers' perspective, The International Journal of Indian Psychology, vol. 8, 783-793 https://tophat.com/teaching-resources/infographics/tophat-faculty-survey/
18. Langford M., Damşa C. (2020) Online Teaching in the Time of COVID-19: Academic teachers' experiences in Norway, https://www.jus.uio.no/cell/digitaldugnad/report-university-teachers-16-april-2020.pdf
19. Marinoni G., van't Land H., Jensen T., (2020) The impact of Covid-19 on higher education around the world. IAU Global Survey Report https://www.iau-aiu.net/IMG/pdf/iau_covid19_and_he_survey_report_final_may_2020.pdf