

*An Italian Large Case Study on Emergency Remote Teaching:
Factors and Predictors Which Affect Higher Education Students' Attitude*

Matteo Bozzi, Politecnico di Milano, Italy
Roberto Mazzola, Politecnico di Milano, Italy
Italo Testa, Università Federico II, Italy
Juliana Elisa Raffaghelli, Università degli Studi di Padova, Italy
Susanna Sancassani, Politecnico di Milano, Italy
Maurizio Zani, Politecnico di Milano, Italy

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Abstract

In the last few years many studies on concerns about Emergency Remote Teaching have been implemented, but few focused on the Italian academia. The present large case study involved 3,670 undergraduate and postgraduate learners enrolled on both Architecture and Engineering at the Politecnico di Milano. It aimed to investigate their assessment of remote teaching through an online questionnaire, with reference to changes in their subjective perception of difficulties in the switch from in-presence to remote teaching. Students' opinion was expressed based on a five-point Likert scale. The overall questionnaire, consisting of 66 items which referred to 6 different constructs, was empirically validated through factor analysis and a positive reliability analysis was completed. Our results highlighted that the overall participants' perception of difficulties worsened. These findings did not depend on the students' educational level of degree, while the faculty which they were attending influenced the females' evaluation. While females enrolled on Architecture did not appear to suffer the change of educational approach, the subjective perception of the ones enrolled on Engineering was markedly worse. On the contrary, faculty did not seem to influence the males' opinion, which was negative but not as negative as the opinion expressed by the females enrolled on Engineering.

Keywords: COVID-19, Distance Learning, Online Education, Online Learning, Remote Learning, Emergency Remote Teaching, Online Teaching, Higher Education, Engineering, Architecture

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Introduction

The 21st century has just begun. Yet we are all witnesses to an epochal event which will probably feature in history books. In December 2019 a sequence of pneumonia cases of unknown origin occurred in Wuhan, Hubei, China: a new coronavirus, later named SARS-CoV-2 (Severe Acute Respiratory Syndrome-Corona Virus-2), was circulating and spreading at an inconceivable rate (Huang et al., 2020; Yang et al., 2020). Before long this virus spread throughout the world, becoming a global health emergency which was declared a pandemic by the World Health Organization on 11th March 2020 (World Health Organization, 2020a, 2020b).

Among the most notable consequences of this worldwide sanitary crisis, we may include its dire impact on the education systems of almost every country all over the world (Aristovnik et al., 2020; Chierichetti & Backer, 2021; Colclasure et al., 2021; Gillis & Krull, 2020; Kuhfeld et al., 2020; Owusu-Fordjour et al., 2020). To tackle the crisis and limit the viral circulation, indeed, many countries of all continents decided to close their educational institutions (Bond et al., 2021; Chou & Chou, 2021; Costado Dios & Piñero Charlo, 2021; Crawford et al., 2020; Education Bureau, Government Secretariat (Hong Kong), 2020; König et al., 2020), with a consequent and sudden transition from in-presence to distance learning. To understand the true dimension of this phenomenon, 1,598 billion students from 194 countries were affected by the closure of education institutions in April 2020 (UNESCO, 2020), while at the beginning of 2021 the number of learners forced not to attend them was still 250 millions (Tang et al., 2021).

In this panorama, Italy was an interesting case due to the fact that it was probably the first Western nation hit by the COVID-19 pandemic and one of the most seriously affected by its huge wave (Crawford et al., 2020). Before the declaration of pandemic by the World Health Organization, the Italian government had already adopted a nationwide lockdown since 9th March 2020 (Italian Prime Minister, 2020a); consequently, schools of every order and tertiary education institutions were forced to adopt distance learning abruptly, which was later identified by Hodges et al (Hodges et al., 2020) as an Emergency Remote Teaching (ERT). Despite the gradual easing of the most stringent restrictions from May 2020 (President of the Italian Republic, 2020), the academic year ended in the online modality. Moreover, on account of the cyclical worsening of the health emergency (Italian Prime Minister, 2020b, 2020c, 2020d, 2020e; President of the Italian Republic, 2021), remote and blended learning were adopted also in the following academic year, until July 2021.

In the Italian academic scenario, hegemonically dominated by the traditional methodology of transmittal lectures in a number of programmes, despite some exceptions (Bozzi et al., 2018, 2019; Bozzi, Ghislandi, et al., 2021; Bozzi, Raffaghelli, et al., 2021; Zani & Bozzi, 2018), this sudden health emergency forced higher education institutions to experience new educational approaches for a long time. Although the acute phase of COVID-19 emergency appears to be behind, the students' opinion about the remote and blended learning experienced during the pandemic should be analysed to better design the new academic courses of the next years. Given the fact that ERT was associated with social isolation and the connected stressful consequences on students and teachers (Chen & Lucock, 2022), it is extremely important to identify the factors affecting students' experiences, and to understand the predictors that have influenced their perception of teaching and learning during that period. Indeed, the pandemic may represent an extreme scenario in which researchers can investigate how students respond to innovation in teaching and learning methodologies.

In the present research we examined the remote teaching adopted during the COVID-19 pandemic at the Politecnico di Milano, the largest Italian university which offers Architecture, Design and Engineering degrees. The study, which was conducted in the second term of the academic year 2019- 2020 and across the next academic year 2020-2021, focused on both Architecture and Engineering students' evaluation of ERT, with specific reference to changes in their subjective perception of difficulties in the passage from pre-pandemic teaching methodology to remote teaching. The research questions (RQ) were:

- (RQ1) Did the Politecnico di Milano students' perception of difficulties change in the switch from in-presence educational strategy to remote instruction?
- (RQ2) If this is the case, did the perceived difficulties increase or decrease?
- (RQ3) How were these results influenced by independent variables like faculty, students' gender and educational level of degree?

Materials and Methods Research Design

In March 2020 the COVID-19 pandemic compelled all the Italian educational institutions to suddenly pass from in-presence to remote teaching. Due to the fact that the health emergency periodically deteriorated in Italy, Politecnico di Milano was forced to alternate blended and remote teaching also in the following academic year 2020-2021.

To investigate the learners' opinion about ERT and its effects on these students, we adopted a survey method and created an ad-hoc questionnaire which was administered online in July 2021, at the end of the second term of the academic year 2020-2021. Submitted to both Politecnico di Milano bachelor students (B) and master's students (Ma), this questionnaire consisted of 66 items pertaining to 6 different constructs, as illustrated with more detail in previous studies (Mazzola et al., 2022, 2023). The overall number of learners enrolled on Architecture, Design and Engineering who participated voluntarily in this survey, was 3,920 and they gave explicit consent to use the collected data for research purposes. According to Cohen et al. (2018, pp. 217–218) this was a quota sample, a type of non-probability sample, thus it represented itself or examples of itself in a comparable population. However, on account of the massive amount of data collected in the present large case study we focus on 3,670 students enrolled on Architecture (A) and Engineering (E), who correspond to about 93.6 percent of the sample, and analyse only one out of six aforementioned constructs, named Remote Teaching.

Participants

The survey involved 3,670 learners, aged 19-25, 487 (13.3%) of whom enrolled on A and the remainders 3,183 (86.7%) on E. With regard to a specific item of the questionnaire, 1,366 participants self-reported as female (F), 2,304 as male (M) and nobody chose other alternatives. Furthermore, taking into account their educational level of degree, 2,497 learners were bachelor students (B) and the remainders 1,173 master's students (Ma).

Assessment Tool

The present study focuses on one of the six constructs which characterise the overall questionnaire. Participants expressed their evaluation of 14 items through a five-point Likert scale, whereby a score equal to 3 corresponded to neutrality (neither negative nor positive, neither ineffective nor effective, neither worse nor better).

This section of the tool was adapted from previous and already used questionnaire items (Chakraborty et al., 2021; Marzoli et al., 2021; Petillion & McNeil, 2020). Considering these foregoing studies, a three independent factors structure was hypothesised. The three factors were:

- F1) Organisation and effectiveness of the remote teaching
- F2) Modification of the students' perception of difficulties in the passage from in-presence to remote teaching
- F3) Academic learners' variation in the assessment of their instructors since the period preceding the COVID-19 pandemic

However, in the present study we discuss the results regarding only the second factor.

To empirically validate this section of the questionnaire and check this hypothesis, a confirmatory factor analysis was carried out. According to Kline (2016, pp. 274–275), the calculated value of both the Tucker-Lewis Index (Steiger, 1990) ($TLI = 0.93 > 0.90$) and the Root Mean Square Error of Approximation (Tucker & Lewis, 1973) ($RMSEA = 0.073 < 0.08$ reasonable approximate fit) confirmed it.

Afterwards, to check the internal consistency of the yielded unidimensional scales Cronbach's alpha statistics was employed (Cortina, 1993; Cronbach, 1951; Field et al., 2013; Streiner, 2003; Taber, 2018). This reliability analysis, summarised in Table 1, supported the three-factor model (Field et al., 2013; Gardner, 1995; Green et al., 1977; Taber, 2018; Tavakol & Dennick, 2011).

Table 1. Reliability analysis for each factor.

Factor	Items number	Cronbach's alpha	Strength of association	average_r
Organisation and effectiveness of the remote teaching	2	0.71	Good	0.55
Modification of the students' perception of difficulties in the passage from in-presence to remote teaching	6	0.86	Very good	0.51
Academic learners' variation in the assessment of their instructors since the period preceding the COVID-19 pandemic	6	0.83	Very good	0.43

The learners' opinion about every item was expressed based on a five-point Likert scale. As a measure of the students' opinion referring to the three aforementioned factors, we considered the mean value of the Likert scores assigned to the questions regarding every specific factor.

Results

A preliminary inquiry consisted in analysing the possible modification in participants' perception of difficulties in the passage from in-presence to remote teaching (factor 2) through descriptive statistics. Moreover, the students were arranged in different groups to investigate the influence of the diverse independent variables considered, i.e. faculty, gender and educational level of degree, on these assessments. Table 2 shows some results achieved through this methodological approach.

Table 2. Descriptive statistics outcomes for different groups of learners.

Group	Independent variable	Number of students	Mean Score	Standard error
All students		3670	2.76	0.0132
A	Faculty	487	2.92	0.0397
E		3183	2.74	0.0139
M	Gender	2304	2.77	0.0168
F		1366	2.74	0.0212
B (EQF6)	Educational level of degree	2497	2.74	0.0156
Ma (EQF7)		1173	2.81	0.0244

Considering that the neutral opinion corresponded to a mean score equal to 3, the students' subjective perception appeared to have generally worsened. There seemed to be no significant differences between F and M, whose mean scores are similar and decidedly close to the mean score of the overall participants. On the contrary, the independent factor "Faculty" might have affected the learners' assessment. The opinion of the students enrolled on A, indeed, was not far from neutrality and appeared to be notably better than the one of the learners enrolled on E. Finally, more difficult to interpret was the role played by the independent factor "Education level of degree" at this step owing to the small and not negligible difference in the mean score achieved by B and Ma.

To confirm or confute the results suggested by the descriptive statistics, an inferential analysis was implemented by using the statistical opensource software R (version 4.2.2) in the integrated development environment RStudio (<https://www.rstudio.com/> accessed on 9 June 2023). On account of the large amount of students in every cohort, the central limit theorem allowed us to accept the assumption of normality of all the samples. To investigate the hypothesis of homogeneity of variances across the groups, both Levene and Brown-Forsythe tests were implemented. They were both statistically significant at α -level 0.05 (Levene: $\Pr(>F) = 4.204 \cdot 10^{-5} \ll \alpha = 0.05$; Brown-Forsythe: $\Pr(>F) = 9.52 \cdot 10^{-5} \ll \alpha = 0.05$), thus we could conclude that their null hypothesis was incorrect and argued that the assumption of homogeneity of variances had been violated. As a consequence, a three-way robust factorial ANOVA was carried out to analyse data. Table 3 summarises the findings of this test.

Table 3. Outcomes of a three-way robust factorial ANOVA.

Independent variable	Value	p-value
Faculty	15.4338801	0.0002 \ll 0.05
Gender	0.1103150	0.7500 \gg 0.05
Degree	0.2145333	0.6440 \gg 0.05
Faculty:Gender	7.0155564	0.0090 \ll 0.05
Faculty:Degree	2.6762057	0.1040 \gg 0.05

Gender:Degree	1.5926629	0.2090 >> 0.05
Faculty:Gender:Degree	2.0485756	0.1540 >> 0.05

This inferential test revealed a statistically significant main effect of the independent variable “Faculty” on the change in the participants’ perception of difficulty in the passage from in-presence teaching to remote teaching ($p \ll 0.05$), as well as a likewise statistically significant interaction effect between the independent variables faculty and gender. Nevertheless, according to Field et al. (2013, p. 522) there is no point in interpreting that main effect in the presence of this statistically significant interaction effect. Interestingly, the educational level of degree did not play any role in the learners’ subjective perception of difficulty.

To evaluate the intensity of the effects we calculated the correlational effect size r with its confidence interval at level 0.05 comparing different groups of students. Table 4 summarises the findings related to the effect sizes. A positive effect size means that the mean score of group 1 was higher than the mean score of group 2 and vice-versa.

Table 4. Effect sizes and confidence intervals.

Group	Students number	Mean score	Standard error	r	Confidence interval (95%)
A	487	2.92	0.04	0.08	[0.04; 0.11]
E	3183	2.74	0.01		
A - M	178	2.83	0.06	0.02	[-0.02; 0.06]
E - M	2126	2.76	0.02		
A - F	309	2.97	0.05	0.15	[0.10; 0.21]
E - F	1057	2.68	0.02		
A - M	178	2.83	0.06	0.07	[0.02; 0.13]
E - F	1057	2.68	0.02		
A - F	309	2.97	0.05	0.08	[0.04; 0.12]
E - M	2126	2.76	0.02		
E - M	2126	2.76	0.02	0.05	[0.02; 0.09]
E - F	1057	2.68	0.02		
A - F	309	2.97	0.05	0.07	[-0.02; 0.16]
A - M	178	2.83	0.06		

Discussion and Conclusions

The participants’ perception of difficulties seemed to change in the passage from in-presence instruction to remote teaching imposed by the COVID-19 pandemic. Considering the overall students involved in this study, it generally increased (more difficulties perceived). High levels of anxiety and depression, widely spread among students worldwide (Aristovnik et al.,

2020; Browning et al., 2021; Cao et al., 2020; Chen & Lucock, 2022), and the learners' unreadiness for remote teaching (Tang et al., 2021) might explain these findings.

Among the different cohorts taken into account, females enrolled on Engineering appeared to mostly suffer the change of educational approach. Their assessment was markedly negative (mean score 2.68) and appreciably lower than the one of all the other students' groups, as highlighted by the calculated effect sizes. On the contrary, females enrolled on Architecture assigned the best assessment (mean score 2.97), corresponding substantially to the neutral opinion, and it seemed that they did not suffer for the passage from in-presence to remote teaching. This interesting difference in the females' subjective perception could be related to their different previous educational pathway, but this issue needs to be investigated more deeply and this is a limitation of this study.

Unlike females, males' assessment was generally negative without any notable difference related to the independent variable "Faculty," as highlighted by the effect size confidence interval which crosses the zero value. Thus, males' subjective perception of difficulties worsened in the passage from in-presence educational strategy to remote instruction, but their evaluation was still appreciably better than the opinion of the females enrolled on Engineering. These findings might be related to males' higher expertise in computer skills than females enrolled on Engineering (Aristovnik et al., 2020). On the other hand, females enrolled on Architecture could have developed more effective study patterns with relation to remote teaching than males (Bisht et al., 2020) and presented more positive attitudes toward this new educational approach (Alves et al., 2020).

However, these results allow to explain the reason why there was not a statistically significant difference comparing males' and females' assessment regardless of faculty. The mean scores of females enrolled on Architecture and Engineering were very different from each other and also different from the males' mean score, but they tended to balance at the same value of the males' one. As a consequence, the overall independent variable "Gender" was not significant.

Similarly, when we compared the subjective perception of the overall learners enrolled on Architecture and Engineering a statistically notable difference could be pointed out ($p = 0.0002 \ll 0.05$, $r = 0.08$). Nevertheless, these findings did not allow to argue that there was a diverse opinion between the overall students enrolled on Architecture and Engineering. As already emphasised, males reported the same assessment regardless their faculty, thus this result reflected the different evaluation of females enrolled on Architecture and Engineering and was a consequence of the different impact on them of the change of educational approach. Interestingly, the educational level of degree did not appear to play any noteworthy role, even though B were younger and less experienced than Ma.

Due to the fact that we worked with a non-probability sample (Cohen et al., 2018), our findings cannot be generalised to a wider population. Nonetheless, our results yield some implications that policy makers and higher education institutions may take into account. As regards educational innovation, for instance, the students' perception of difficulties seems to suggest that a sudden and radical change may be problematic.

Policymakers, lecturers and practitioners should make the most of the experience gained in the COVID-19 pandemic, for example by promoting the information technology skills of

students and faculty members. Moreover, a specific attention to females appears to be necessary.

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