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Remote STEM Education: Gap Analysis from the Perspectives of Students and Faculty

D.A. Maisano, G. Carrera, L. Mastrogiacomo and F. Franceschini

Politecnico di Torino, Dept. of Management and Production Engineering

STRUCTURED ABSTRACT

Purpose: This study aims to assess the current critical aspects (or *gaps*) in remote STEM education, from the dual perspectives of students and faculty from different European universities. Initiated about four years after the onset of the COVID-19 pandemic, the study explores the critical aspects affecting educational outcomes, in the context of the ongoing EU-funded REMOTE project.

Methodological approach: The research involved the design and implementation of structured questionnaires through the LimeSurvey platform, focusing on various critical aspects of remote learning and assessment, such as *resource availability*, *training adequacy*, *technical responsiveness*, *online assessment feedback*, and *social dynamics*. Data were collected from over five hundred students and nearly two hundred faculty members, from four different European universities.

Findings: The results show some discrepancies between student and faculty perceptions regarding the *adequacy of assessment feedback*, which is particularly critical for students but not for faculty, and *student-faculty interaction*, which is particularly critical for faculty but not for students. On the other hand, a consensus emerged between the two counterparts on the intrinsic challenges to *educational quality* and *academic integrity*. In addition, the analysis revealed a general agreement among the universities involved in the questionnaires, despite their different geographic and cultural contexts, with a substantial absence of gender bias for both students and faculty.

Practical/social implications: These insights may be relevant for educational policymakers and institutions to continue to refine online teaching strategies and assessment methods.

Keywords: Quality of education, Remote learning/assessment, Gap analysis, Questionnaire.

Paper type: Research paper

INTRODUCTION

The global shift to remote learning, accelerated by the COVID-19 pandemic, has profoundly impacted educational paradigms, particularly within the STEM (science, technology, engineering, and mathematics) disciplines. Today, more than four years after the start of the pandemic, both faculty and students have significantly increased their awareness and training for remote learning. Numerous digital platforms with advanced tools have emerged, facilitating customised learning paths that respond to the specific needs of students and give the possibility to choose content and delivery modes more flexibly than in the past. Lecturers – thanks to continuous training, both external and autonomous – have also developed advanced skills in the use of educational technologies (Broadbent et al., 2023; Casadesús et al., 2024). Remote learning is increasingly complementing, rather than replacing, in-presence teaching, as demonstrated by the growing use of hybrid teaching techniques. For example, the use of innovative digital tools allows, subsequent to theoretical in-person lectures, virtual visits to laboratories or research environments that are often difficult to access physically.

However, despite the significant progress made within higher education institutions (HEIs) worldwide in adapting to remote teaching and assessment methods, critical issues and intrinsic difficulties remain. These challenges continue to raise significant questions about the effectiveness of remote learning in promoting essential educational outcomes, such as knowledge acquisition, critical thinking, problem-solving skills, and collaborative learning (Iglesias-Pradas et al., 2021; Lockee, 2021; Wang et al., 2021). Remote learning, while offering additional opportunities for students and faculty, has introduced new challenges, including reduced social interactions, emerging technological barriers, and an increased demand for student autonomy in learning (Palvia, et al., 2018). These challenges underscore the necessity of a thorough evaluation of remote learning practices to gauge their effectiveness and identify areas for improvement, aiming to ensure optimal student engagement and learning outcomes (Guangul et al., 2020; Carter et al., 2020).

Research in this area has pinpointed several crucial aspects for the effective implementation of remote learning: student engagement, teaching methodologies, the role of academic staff, and the integration of information technology. Students in remote settings are expected to exert greater control over their learning, utilizing various technology-mediated forms of assessment that serve not only to measure their academic progress but also to enhance their digital literacy (Fidalgo et al., 2020; Ho et al., 2021). However, there remains a substantial gap in understanding how to effectively adapt teaching methodologies to the specificities of remote teaching and assessment (Gupta et al., 2020; Flores et al., 2022). Academic staff certainly play a critical role in the transition to online education,

responsible for designing engaging content and employing pedagogical strategies that promote active learning and student participation. Concurrently, the role of advanced computing technologies and platforms, fundamental to the delivery and management of remote education, warrants further exploration to better integrate these tools with effective teaching practices (Reedy et al., 2021).

The present study, conducted approximately four years after the onset of the pandemic, seeks to systematically investigate the prevailing challenges and to identify potential *gaps* in remote STEM education, from the dual perspectives of students and faculty members. In particular, it aims to answer some main research questions:

- "*What are the current challenges of remote STEM education, as perceived by students and lecturers?*";
- "*What are the main discrepancies between perceptions of students and lecturers regarding the effectiveness of remote learning and assessment?*";
- "*Are any differences observed between the partner universities involved in the survey?*".

This study is an integral part of the project "Assessing and evaluating remote learning practices in STEM" (REMOTE), financed by the European Union under the "Cooperation partnerships in higher education" action of the Erasmus+ program. It involves four universities – Universitat de Girona (UdG) from Spain, Politecnico di Torino (PoliTO) from Italy, Universitat Internacional de Catalunya (UIC) from Spain, Universidade do Minho (UMinho) from Portugal – and three external agencies for quality assurance in higher education – AQU Catalunya (Spain), ANVUR (Italy), and A3ES (Portugal). Starting with a comprehensive literature review and dozens of interviews with academic experts conducted in the early part of the project, a series of potentially critical aspects of remote teaching and assessment in the STEM field emerged for both students and teachers (Casadesús et al., 2024). These aspects serve as the starting point for the development and dissemination of structured questionnaires across the aforementioned European partner universities, aimed at illuminating the peculiarities of remote teaching, learning, and assessment experiences, focusing on resource availability, technical responsiveness, training adequacy, online assessment methods, and social dynamics. A preliminary analysis of the data collected through these questionnaires will focus on identifying significant gaps in remote education, discerning any systematic differences between students' and faculty perceptions, and exploring the impact of various demographic and institutional factors. Data from a relatively large sample of respondents (i.e., several hundred students and lecturers from the above four European universities) will be analysed.

The rest of this article is organized into four sections. The first one provides a description of the methodology, divided into two parts pertaining to the construction and administration of questionnaires. The second section illustrates and comments on the preliminary results. Then, the conclusions summarize the main findings of the analysis, practical implications, limitations and insights for future developments. Finally, the appendix section contains additional more detailed material on the questionnaires.

METHODOLOGY

Construction of questionnaires

A thorough analysis of the scientific literature allowed to identify a set of potentially problematic aspects (or *constructs*), which characterise remote learning/teaching in STEM areas (see Table 1). It can be seen that the majority of the aspects are common to both students (S) and lecturers (L), while other more specific aspects apply only to one or the other part. For each construct, a "triplet" of different *items* (i.e., questions relevant to the construct itself) were formulated (e.g., items 2.3.1, 2.3.2 and 2.3.3 for construct 2.3). This sort of redundancy will be used to provide robustness to the results of the study.

The answers to each item are expressed on a 7-level scale with increasing direction in terms of gap (the higher the level, the wider the gap). The constructs were developed separately for student and lecturers. Each questionnaire has an initial part of demographic information, which is here omitted for simplicity. Tables A.1 and A.2 (in the Appendix section) show the items of both the questionnaires. Even for the several overlapping aspects/constructs in the two questionnaires (cf. the last two columns of Table 1), the items were customised to suit the respective target populations.

Administration of questionnaires

Both questionnaires were administered to the four partner universities of the REMOTE project and each university identified appropriate samples of lecturers and students. The questionnaires were administered through the LimeSurvey platform and were completed during the month of February 2024. Table 2 shows the number of respondents who completed the relevant questionnaires. Some disparities in participation can be observed, partly commensurate with the size of the universities involved, and partly related to other contingent factors (e.g., differences in terms of incentives for completion, dissemination channels used, respondents' sensitivity, etc.). In general, the overall

number of respondents can be considered in line with expectations and acceptable for the intended statistical analysis (Ross, 2017; Franceschini et al., 2022).

Table 1 – List of aspects/constructs considered potentially problematic, based on a literature review. Some aspects apply to both students (S) and lecturers (L), while others apply to only one of the two respondent parties.

Dimension	Aspect / Construct	Description	Applicable to (S)	Applicable to (L)
1. Resource availability and accessibility	**1.1** Accessibility to materials	Ease of access to teaching materials from any location.	✓	✗
	1.2 Accessibility to evaluation resources	Ease of access to resources (software and hardware) for an effective online evaluation.	✓	✓
	1.3 Access equity	Equal access to technological resources for online teaching and assessment.	✓	✓
2. Technical responsiveness	**2.1** Connection and web platform adequacy	Technological stability and reliability of online platforms for lectures and exams, in addition to the quality of the Internet connection.	✓	✓
	2.2 Student-lecturer interaction	Effectiveness of communication, mutual interaction and support in an online learning context.	✓	✓
	2.3 Technical problem solving	Ability to manage technical problems during online lectures and exams.	✓	✓
3. Training	**3.1** Preparation and training for managing lectures	Preparation and training of lecturers on the use of online technologies to conduct exams and online evaluation.	✗	✓
	3.2 Preparation for managing the evaluation	Preparation and training of lecturers on the use of online technologies to conduct online exams effectively, including the creation of assessment materials.	✗	✓
	3.3 Institutional support to lecturers	Level of support and assistance provided to lecturers by the institution for online teaching and evaluation.	✗	✓
4. Online assessment	**4.1** Adequacy of assessment methods	Adequacy of assessment methods in use to the online context.	✓	✓
	4.2 Adequacy of evaluation feedback	Promptness and quality of feedback provided to students following exams.	✓	✓
	4.3 Quality of education	Online activities can undermine the achievement of the expected learning outcomes.	✓	✓
5. Social dynamics	**5.1** Gender diversity	Online activities can for some reason undermine gender equality.	✓	✓
	5.2 Community	Online activities can undermine the sense of belonging to the university community.	✓	✗
	5.3 Academic integrity (honesty)	Extent to which online exams maintain high ethical standards, including anti-fraud measures.	✓	✓

Table 2 – Number of respondents that completed the questionnaires administered at the four European partner universities: Politecnico di Torino (PoliTO), Universitat de Girona (UdG), Universitat Internacional de Catalunya (UIC), and Universidade do Minho (UMinho).

Questionnaire	European universities				Overall
	PoliTO	UdG	UIC	UMinho	
Students (S)	248	137	136	32	**553**
Lecturers (L)	89	18	28	41	**176**

PRELIMINARY RESULTS

The results were subjected to an analysis – still in progress – of which here are some preliminary results. First of all, a pre-processing of the answers given by the individual respondents was carried out, based on two elaborations:

1. *Aggregation of the answers (expressed on a rating scale from 1 to 7) of each triplet of items referring to the same aspect/construct, through the median operator.* For example, assuming that a certain respondent gives the following answers to a certain triplet of items:

$$1.1.1 \rightarrow 6, 1.1.2 \rightarrow 7, \text{and } 1.1.3 \rightarrow 4, \quad (1)$$

the median associated with aspect/construct 1.1 will be 6. This aggregation gives robustness to the results, filtering out possible outliers. Furthermore, the median is a central tendency indicator compatible with the *ordinal* scale properties of ratings (Franceschini et al., 2022).

2. *Transformation of the (median) ratings for all aspects/constructs of the questionnaire into a single ranking and, subsequently, association of a rank with each aspect/construct.* With reference to the ratings in the first two columns of Table 3, the following ranking would be obtained:

$$1.3 \prec (1.1 \sim 2.3 \sim 4.1 \sim 5.1 \sim 5.3) \prec (1.2 \sim 2.2 \sim 4.2 \sim 4.3) \prec 2.1 \prec 5.2, \quad (2)$$

where the symbol "$\prec$" means "*less critical than*", and the symbol "$\sim$" means "*indifferent to*". So, aspects/constructs are ranked in order of increasing *criticality* (understood as the width of the gap).

Table 3 – Example of transforming (median) ratings, obtained from the scale levels into (mean) ranks. The ranking in Eq. 2 was then converted into the specific ranks shown in the last column of the table.

Aspect/construct	(Median) rating	Rank
1.1	2	4
1.2	3	8.5
1.3	1	1
2.1	4	11
2.2	3	8.5
2.3	2	4
4.1	2	4
4.2	3	8.5
4.3	3	8.5
5.1	2	4
5.2	5	12
5.3	2	4

The rank of the individual aspects/constructs within the ranking is then determined, i.e. their relative position (e.g., 1st, 2nd, 3rd); if several values have the same rank (i.e., they are tied in the

ranking), the so-called *mean rank* is conventionally used (Franceschini et al., 2022). The resulting rank of each aspect/construct will be used as a variable of interest for subsequent analyses. The transformation of questionnaire ratings into ranks was introduced to facilitate comparability between the results of different questionnaires[1].

Data were then subjected to statistical analysis (still ongoing), of which some preliminary results are provided here. Table 4 contains the average values of the variable of interest (rank) for the aspects/constructs of interest, both at a general level ("Overall" in the last column) and at a university-disaggregated level. The Pareto diagram in Fig. 1 shows that the most critical constructs at a general level are: *community* (5.2), *academic integrity* (5.3), *adequacy of evaluation feedback* (4.2), *quality of education* (4.3) and *adequacy of assessment methods* (4.1). Considering the data disaggregated by university, it can be seen that – apart from a few small variations – they seem to confirm the general trend. In other words, there is a good degree of agreement among the respondents, regardless of which university they belong to. This impression can also be appreciated quantitatively, considering the Pearson product-moment-correlation coefficients in Table 5.

Table 4 – Summary of the student-side questionnaire results. The table shows average values of the response variable (rank) for the aspects/constructs of interest, both at an overall level and at a university-disaggregated level. "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho.

Aspect/Construct	European universities				Overall
	PoliTO	UdG	UIC	UMinho	
1.1	4.8	5.0	4.9	4.9	**4.9**
1.2	5.7	5.6	5.7	6.4	**5.7**
1.3	4.7	4.6	4.7	6.4	**4.8**
2.1	5.9	5.3	5.5	6.0	**5.6**
2.2	6.3	6.1	6.2	6.1	**6.2**
2.3	5.4	5.6	6.0	6.0	**5.6**
4.1	7.5	7.2	6.9	7.3	**7.3**
4.2	7.9	7.9	7.7	6.8	**7.8**
4.3	7.2	7.9	8.1	7.4	**7.6**
5.1	4.1	5.3	5.7	4.3	**4.8**
5.2	10.3	8.9	8.4	8.4	**9.4**
5.3	8.1	8.6	8.2	7.8	**8.3**

[1] Rating scales may be used subjectively, as there is no absolute reference shared by all respondents. For example, let us consider the seven-level ordinal scale representing the width of the gap: *very low*, *low*, *moderately low*, *intermediate*, *moderately high*, *high*, and *very high*; "indulgent" respondents will tend to assign higher levels whereas "severe" respondents will tend to assign lower ones. For this reason, it would be questionable to aggregate ratings by different respondents through indicators of central tendency.

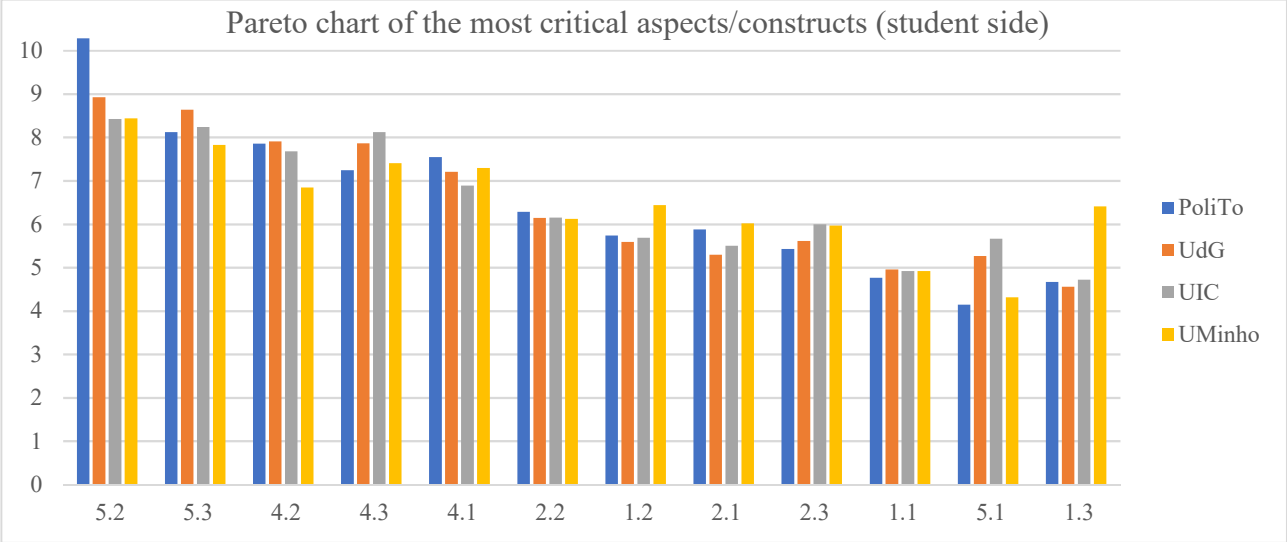


Figure 1 – Pareto chart relating to the summary data in Table 4, resulting from the analysis of the student-side (S) questionnaires. Aspects/constructs are ordered in descending order with respect to the "Overall" values in the last column of Table 4. "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho.

Table 5 – Pearson product-moment-correlation coefficients (and relevant *p*-values in brackets), related to the university-disaggregated data in Table 4 (student-side analysis) (Ross, 2017). "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho. The analysis was conducted using Minitab® statistical software.

(S) Correlations: PoliTO; UdG; UIC; UMinho

	PoliTO	UdG	UIC
UdG	0.938		
	(0.000)		
UIC	0.897	0.987	
	(0.000)	(0.000)	
UMinho	0.901	0.834	0.801
	(0.000)	(0.001)	(0.002)

A similar study was carried out for the questionnaires administered to lecturers. In particular, a certain alignment is confirmed in the answers given by respondents from the different universities (cf. Table 6, Fig. 2, and Table 7). However, the most critical aspects/constructs are somewhat different from those ones resulting from the student-side questionnaires. On the lecturer side, the aspects perceived as most problematic in general are: *student-lecturer interaction* (2.2), *quality of education* (4.3), *preparation for managing the evaluation* (3.2), and *academic integrity* (5.3). Let us note that aspect 2.2 has little criticality on the student side (cf. Fig. 1); on the other hand, aspect *adequacy of evaluation feedback* (4.2), while critical on the student side, is not critical on the lecturer side.

Table 1 – Summary of the lecturer-side questionnaire results. The table shows average values of the response variable (rank) for the aspects/constructs of interest, both at an overall level and at a university-disaggregated level. "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho.

Aspect/Construct	European universities				Overall
	PoliTO	UdG	UIC	UMinho	
1.2	6.5	5.1	6.1	6.7	**6.4**
1.3	5.7	7.1	5.2	6.5	**5.9**
2.1	5.0	4.8	5.4	5.9	**5.2**
2.2	9.3	8.1	8.2	9.3	**9.0**
2.3	4.5	5.4	4.9	6.1	**5.0**
3.1	8.4	7.5	8.3	7.5	**8.1**
3.2	8.8	9.1	9.3	8.1	**8.7**
3.3	5.5	5.6	6.7	6.7	**6.0**
4.1	8.0	7.9	6.8	7.5	**7.7**
4.2	4.7	4.7	4.7	4.0	**4.6**
4.3	9.2	8.4	8.6	8.0	**8.7**
5.1	7.3	7.5	6.3	6.0	**6.9**
5.3	8.0	9.9	10.1	8.8	**8.7**

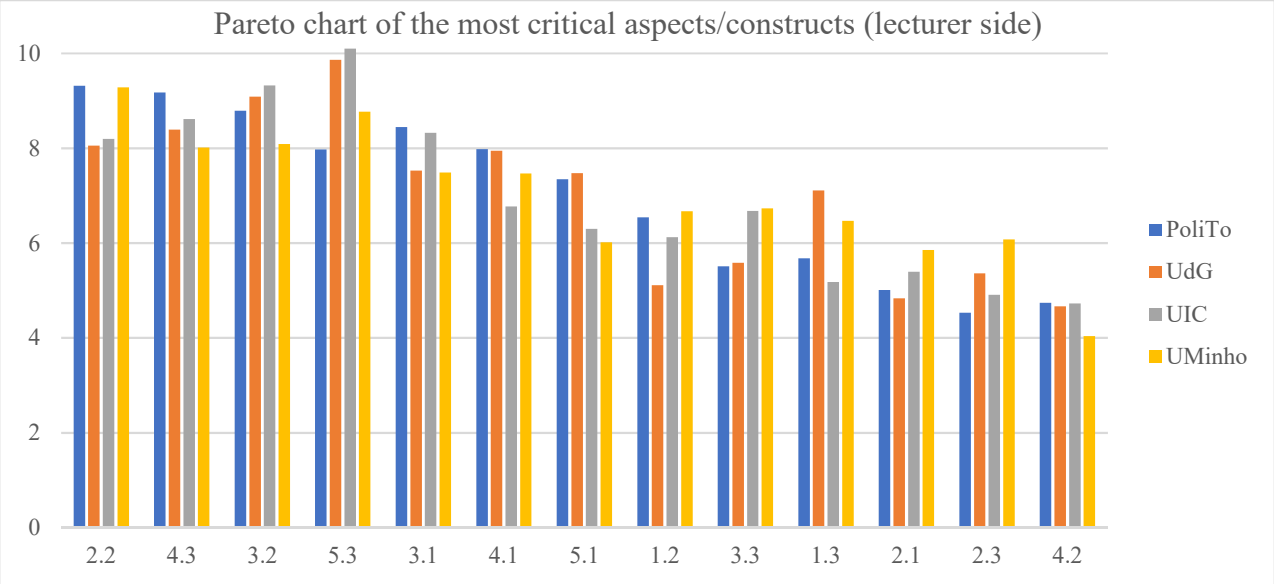


Figure 2 – Pareto chart relating to the summary data in Table 6, resulting from the analysis of the lecturer-side (L) questionnaires. Aspects/constructs are ordered in descending order with respect to the "Overall" values in the last column of Table 6. "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho.

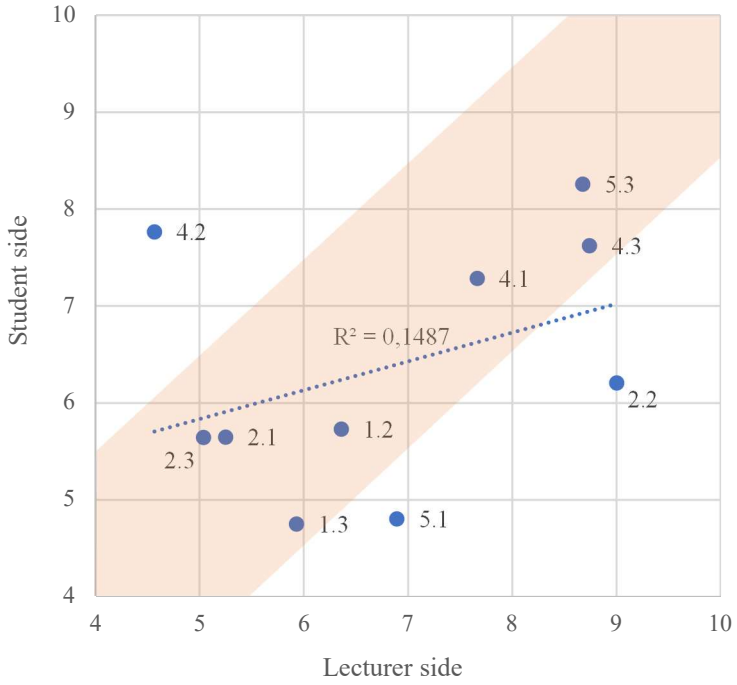
To better grasp this diversity of views between the student and lecturer populations, let us consider the two-dimensional map in Fig. 3, which positions the aspects/constructs of interest according to the overall indicators in Table 4 (S) and Table 6 (L). The map shows no correlation ($R^2 \approx 15\%$) between the two populations of respondents. The only aspects/constructs considered problematic for both populations are (5.3) and (4.3), in top-right position. On the other hand, the aspects positioned near

the bottom-right corner – e.g., (2.2) – are considered problematic on the lecturer side but not on the student side, while those positioned near the top-left corner – e.g., (4.2) – are considered problematic on the student side but not on the lecturer side.

Table 2. Pearson product-moment-correlation coefficients (and relevant *p*-values in brackets), related to the university-disaggregated data in Table 6 (lecturer-side analysis) (Ross, 2017). "PoliTO" stands for Politecnico di Torino, "UdG" stands for Universitat de Girona, "UIC" stands for Universitat Internacional de Catalunya, and "UMinho" stands for Universidade do Minho. The analysis was conducted using Minitab® statistical software.

(L) Correlations: PoliTO; UdG; UIC; UMinho

	PoliTO	UdG	UIC
UdG	0.840 (0.000)		
UIC	0.852 (0.000)	0.863 (0.000)	
UMinho	0.836 (0.000)	0.808 (0.001)	0.859 (0.000)



Aspect / Construct
1.2 Accessibility to evaluation resources
1.3 Access equity
2.1 Connection and web platform adequacy
2.2 Student-lecturer interaction
2.3 Technical problem solving
4.1 Adequacy of assessment methods
4.2 Adequacy of evaluation feedback
4.3 Quality of education
5.1 Gender diversity
5.3 Academic integrity (honesty)

Figure 3 – Map of the positioning of the analysed aspects/constructs, from the dual perspective of students (vertical axis) and lecturers (horizontal axis). The numerical values are the "Overall" ones from Table 4 and Table 6 respectively, which represent the average values of the response variable (i.e., rank) for the aspects/constructs of interest.

The study found no evidence of a significant gender effect in the responses, suggesting that of remote-learning issues affect all students and lecturers, regardless of gender. For instance, Fig. 4 illustrates the results for students, where the percentages of female and male respondents are nearly

equal at 46.5% and 53.5%, respectively. Similarly, for lecturers the results show no significant gender effect, although the percentages of female and male respondents differ to a greater extent (34.1% and 65.9%, respectively).

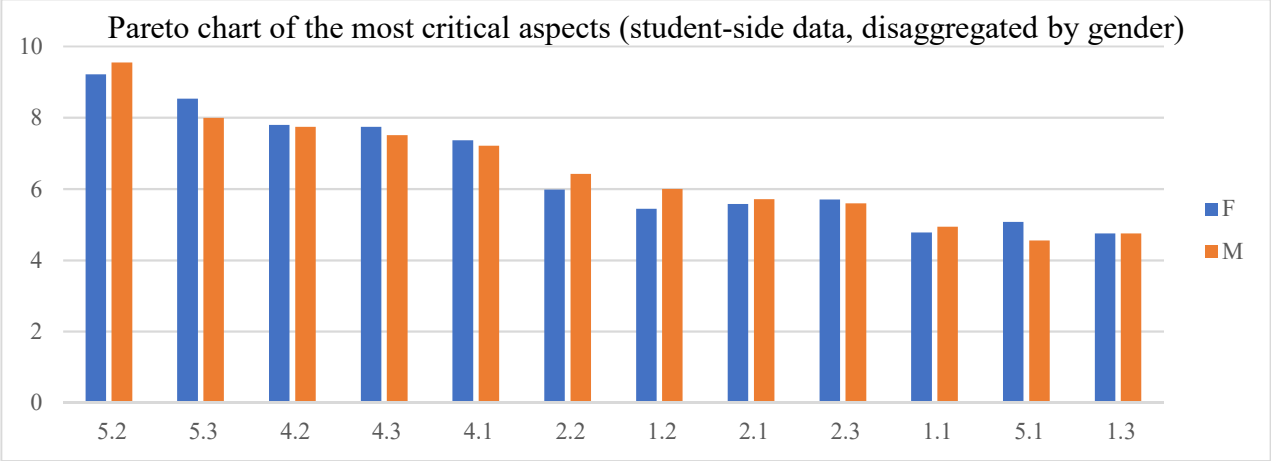


Figure 4 – Pareto chart relating to the summary data in Table 4, resulting from the analysis of the student-side (S) questionnaires.

CONCLUSIONS

This research was conducted under the EU-funded project REMOTE, exploring the most significant challenges currently facing online teaching and assessment, from the dual perspectives of students and lecturers. The initial phase of the analysis involved the design of two questionnaires to probe potentially critical aspects of remote learning and assessment, identified through an extensive review of the scientific literature. With the collaboration of all project partners (i.e., universities and agencies for quality assurance), these aspects were pinpointed, leading to the implementation of the questionnaire via the LimeSurvey online platform. Subsequently, questionnaires were distributed across the four European universities involved in the project. Respondent samples varied in size due to inevitable differences in the number of faculty and students and other contingent factors (e.g., possible incentives for completion, promotional activities, questionnaires issued during vacation periods, exam sessions, or other potentially challenging times for respondents, etc.). Nevertheless, an acceptable overall sample size was achieved, including more than five hundred students and nearly two hundred faculty members.

The analysis of the questionnaire results revealed that the most problematic aspects of online teaching and assessment for students include *sense of belonging to the university community* (5.2), *academic integrity* (5.3), *adequacy of evaluation feedback* (4.2), *quality of education* (4.3), and *adequacy of assessment methods* (4.1). On the other hand, the most critical issues for lecturers are *student-lecturer*

interaction (2.2), *quality of education* (4.3), *preparation for managing evaluation* (3.2), and *academic integrity* (5.3). Interestingly, both students and lecturers identified *quality of education* (4.3) and *academic integrity* (5.3) as among the most critical aspects. However, discrepancies between the two groups were noted: students deemed *adequacy of evaluation feedback* (4.2) particularly relevant, whereas it was less critical for lecturers; conversely, *student-lecturer interaction* (2.2) was perceived as more critical by lecturers compared to students.

A relevant aspect of the analysis is the general agreement found among the partner universities involved in the questionnaires, which span diverse geographic and cultural realities; this lends a certain generality to the results obtained. Furthermore, a substantial absence of gender bias was observed in the questionnaire responses, both among students and lecturers. In addition, it is worth noting that the questionnaire ratings were transformed into corresponding ranks, which were then used as response variables; this approach prevented (i) inappropriate *promotions* of scale properties (from *ordinal* to *cardinal*), and (ii) questionable comparisons between respondents using somewhat heterogeneous rating scales (Franceschini et al., 2022).

Regarding the outcomes of this research, the debate will continue within the REMOTE project, involving experts and high-profile individuals from the academic world. It will also be interesting to consider the perspective of the agencies for quality assurance, to understand their interpretation of the results. The focus may also broaden to include collateral phenomena such as the rise of private online universities, which, often driven by opportunistic reasons, do not always provide educational services at the level of traditional universities, despite seeking accreditation for an increasing number of courses of questionable quality (Cunha et al., 2020).

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APPENDIX

Table A.1 – Student-side questionnaire, entitled "Challenges in remote learning: your experience as a student".

Dimension	Aspect/Construct	Item	Scale
1. Resource availability and accessibility	**1.1** Accessibility to materials	**1.1.1** How often do technical issues prevent you from accessing online teaching materials?	1 - Never … 7 - Always
		1.1.2 Assess the likelihood of facing challenges in accessing teaching materials due to compatibility issues with your devices or software.	1 - Very unlikely ... 7 - Very likely
		1.1.3 To what extent do the available teaching materials meet your diverse learning needs?	1 - Fully meets needs … 7 - Not at all
	1.2 Accessibility to evaluation resources	**1.2.1** How frequently do you encounter technical issues with software or platforms during online assessments?	1 - Never ... 7 - Always
		1.2.2 Rate the adequacy of the resources (like software, hardware) provided for conducting online evaluations.	1 - Fully adequate … 7 - Completely inadequate
		1.2.3 Assess the likelihood of encountering insufficient or outdated evaluation resources in future online assessments.	1 - Very unlikely ... 7 - Very likely
	1.3 Access equity	**1.3.1** How often do you perceive disparities in access to online learning resources among different student groups?	1 - Never ... 7 - Always
		1.3.2 Rate the extent to which you believe your own access to technological resources for online learning is equal to that of your peers.	1 - Completely equal … 7 - Not equal at all
		1.3.3 To what extent do you think the problem of the "digital divide" (e.g. unequal levels of Internet connectivity) hinders equal access to online education?	1 - Not at all … 7 - To a great extent
2. Technical responsiveness	**2.1** Connection and web platform adequacy	**2.1.1** Rate the reliability of the online platforms used for lectures and exams in terms of uptime and accessibility.	1 - Very reliable … 7 - Very unreliable
		2.1.2 How adequate do you find the user interface and overall user experience of the online learning platforms?	1 - Very adequate ... 7 - Very inadequate
		2.1.3 Evaluate the impact of technical issues on the online platforms on your overall learning experience.	1 - No impact ... 7 - Major impact
	2.2 Student-lecturer interaction	**2.2.1** How often do you experience difficulties in reaching out to lecturers for assistance in an online setting?	1 - Never ... 7 - Always
		2.2.2 Rate the effectiveness of the communication channels used for interacting with lecturers online.	1 - Very effective ... 7 - Very ineffective
		2.2.3 Evaluate how supported you feel by your lecturers in the online learning context.	1 - Fully supported … 7 - Not supported at all

Dimension	Aspect/Construct	Item	Scale
	2.3 Technical problem solving	**2.3.1** How frequently do you encounter technical issues that disrupt your participation in online classes or exams?	1 - Never ... 7 - Always
		2.3.2 Rate the effectiveness of the support provided when encountering technical issues during online learning.	1 - Very effective ... 7 - Very ineffective
		2.3.3 How often do technical issues remain unresolved for prolonged periods, affecting your learning experience?	1 - Never ... 7 - Always
4. Online assessment	**4.1** Adequacy of assessment methods	**4.1.1** Rate the level of fairness of the online assessment methods in comparison to traditional in-person exams.	1 - Just as fair … 7 - Much less fair
		4.1.2 How often do the online assessment methods fail to accurately evaluate your understanding of the course material?	1 - Never ... 7 - Always
		4.1.3 Rate the extent to which the online assessments encourage critical thinking and problem-solving skills.	1 - To a great extent … 7 - Not at all
	4.2 Adequacy of evaluation feedback	**4.2.1** Rate the timeliness of the feedback provided after completing online assessments.	1 - Very prompt … 7 - Extremely delayed
		4.2.2 Evaluate the extent to which feedback on online assessments helps you understand your mistakes and learn from them.	1 - Extremely helpful … 7 - Not helpful at all
		4.2.3 Rate the level of detail provided in the feedback for understanding your performance in online assessments.	1 - Highly detailed … 7 - Very superficial
	4.3 Quality of education	**4.3.1** Rate the effectiveness of the online course format in facilitating deep understanding of the subject matter.	1 - Highly effective … 7 - Not effective at all
		4.3.2 How often do you feel that online courses fail to provide the same level of education quality as in-person courses?	1 - Never ... 7 - Always
		4.3.3 Assess the adequacy of resources (like libraries, laboratories) available to you in an online learning format.	1 - Fully adequate … 7 - Completely inadequate
5. Social dynamics	**5.1** Gender diversity	**5.1.1** To what extent do you believe that online activities promote gender equality?	1 - To a great extent … 7 - Not at all
		5.1.2 Evaluate the extent to which gender biases affect the learning experience in your online courses.	1 - Not at all ... 7 - To a great extent
		5.1.3 How inclusive do you find the online learning environment in terms of gender representation?	1 - Very inclusive ... 7 - Not inclusive at all
	5.2 Community	**5.2.1** Rate the effectiveness of online platforms in facilitating a sense of community among students.	1 - Highly effective … 7 - Not effective at all
		5.2.2 Rate the sense of belonging to the university or academic community you experience in an online learning setting.	1 - Feel a strong sense of belonging … 7 - Do not feel a sense of belonging at all
		5.2.3 To what extent do you feel connected to your peers in the online learning environment?	1 - Very connected ... 7 - Not connected at all
	5.3 Academic integrity (honesty)	**5.3.1** How frequently do you encounter situations in online exams where academic integrity is compromised?	1 - Never ... 7 - Always

Dimension	Aspect/Construct	Item	Scale
		5.3.2 Assess the likelihood of students engaging in dishonest behaviors due to the perceived ease of cheating in online environments.	1 - Very unlikely ... 7 - Very likely
		5.3.3 Evaluate the extent to which you believe online exams maintain principles of ethical conduct (e.g., faireness, honesty, integrity, etc.).	1 - To a great extent … 7 - Not at all

Table A.2 – Lecturer-side questionnaire, entitled "Challenges in remote teaching and assessment: your experience as a faculty member".

Dimension	Aspect/Construct	Item	Scale
1. Resource availability and accessibility	**1.2** Accessibility to evaluation resources	**1.2.1** How much do hardware/software limitations affect your ability to conduct effective online evaluations?	1 - Not at all ... 7 - Extremely
		1.2.2 How often do you have to compromise on evaluation quality due to resource accessibility issues?	1 - Never ... 7 - Always
		1.2.3 How adequate are the evaluation tools provided to you for assessing students online (e.g., Moodle, Google Classroom, Zoom, Survey Monkey, etc.)?	1 - Perfectly adequate … 7 - Completely inadequate
	1.3 Access equity	**1.3.1** Considering students' personal financial constraints, how fair do you find the availability/accessibility of digital tools and resources at your university, on campus?	1 - Very equitable … 7 - Not equitable at all
		1.3.2 How equitable do you believe the distribution of digital tools and resources is for students, when accessing them from outside your university (e.g., from home or other external locations)?	1 - Very equitable … 7 - Not equitable at all
		1.3.3 To what extent do you perceive a disparity in technological resource access among students, which affects their ability to participate in online learning?	1 - No perceived disparity ... 7 - Extreme perceived disparity
2. Technical responsiveness	**2.1** Connection and web platform adequacy	**2.1.1** How would you rate the quality of audio and video streaming on your current online platform?	1 - Excellent … 7 - Very poor
		2.1.2 How often do you find that the web platform's features limit the types of remote teaching/assessments you can perform?	1 - Never ... 7 - Always
		2.1.3 How frequently do you experience interruptions due to connectivity issues in online teaching?	1 - Never ... 7 - Always
	2.2 Student-lecturer interaction	**2.2.1** How would you rate the overall quality of interaction you have with students in an online teaching environment?	1 - Excellent … 7 - Very poor
		2.2.2 How often do you feel that the online platform hinders meaningful dialogue with students?	1 - Never ... 7 - Always
		2.2.3 How frequently do you encounter barriers to providing immediate feedback to students during online assessment?	1 - Never ... 7 - Always

Dimension	Aspect/Construct	Item	Scale
	2.3 Technical problem solving	**2.3.1** In instances of technical difficulties, how promptly do you receive support from the IT department?	1 - Very promptly … 7 - Not promptly at all
		2.3.2 How often do you encounter technical problems that disrupt online teaching or assessment?	1 - Never ... 7 - Always
		2.3.3 How effectively can you communicate technical issues to the relevant support team to get them resolved?	1 - Very effectively … 7 - Not effectively at all
3. Training	**3.1** Preparation and training for managing lectures	**3.1.1** How adequate do you find the provided training for conducting online lectures? (If no training was provided at all, answer "Completely inadequate")	1 - Very adequate … 7 - Completely inadequate
		3.1.2 How relevant do you find the training content to your actual teaching needs? (If no training was provided at all, answer "Not relevant")	1 - Highly relevant … 7 - Not relevant
		3.1.3 How much do you feel that the training enhances your effectiveness as an online lecturer? (If no training was provided at all, answer "Does not enhance")	1 - Greatly enhances … 7 - Does not enhance
	3.2 Preparation for managing the evaluation	**3.2.1** How effectively does the training prepare you for creating online assessment materials? (If no training was provided at all, answer "Not effectively at all")	1 - Very effectively … 7 - Not effectively at all
		3.2.2 How sufficient do you find the training for using online tools and technologies in assessments? (If no training was provided at all, answer "Insufficient")	1 - Very sufficient … 7 - Insufficient
		3.2.3 How relevant is the training content to the specific types of assessments you administer? (If no training was provided at all, answer "Not relevant")	1 - Highly relevant … 7 - Not relevant
	3.3 Institutional support to lecturers	**3.3.1** How responsive is the institution to your needs and challenges in online teaching?	1 - Very responsive ... 7 - Not responsive at all
		3.3.2 How effectively does the institution facilitate access to necessary online teaching resources?	1 - Very effectively ... 7 - Not effectively at all
		3.3.3 To what extent do you feel supported by the institution in developing your online teaching skills?	1 - Fully supported … 7 - Not supported at all
4. Online assessment	**4.1** Adequacy of assessment methods	**4.1.1** How effective do you find the current online assessment methods in accurately evaluating student knowledge?	1 - Very effective ... 7 - Not effective at all
		4.1.2 How confident are you in the reliability of the results obtained through online assessments?	1 - Very confident … 7 - Not confident at all
		4.1.3 How well do the assessment methods align with the learning objectives of your courses?	1 - Perfectly align … 7 - Do not align at all
	4.2 Adequacy of evaluation feedback	**4.2.1** How timely do you provide feedback to students following online assessments?	1 - Very timely … 7 - Extremely delayed
		4.2.2 How clear and understandable do you believe your feedback is to students?	1 - Very clear … 7 - Not clear at all

Dimension	Aspect/Construct	Item	Scale
		4.2.3 How effective is the feedback you provide in enhancing student learning and understanding?	1 - Very effective … 7 - Not effective at all
	4.3 Quality of education	**4.3.1** To what extent do you believe online teaching methods engage students as effectively as in-person methods?	1 - To a great extent … 7 - Not at all
		4.3.2 How effective do you find online activities in achieving the expected learning outcomes?	1 - Very effective … 7 - Not effective at all
		4.3.3 How adequate do you find the online course materials in covering the course curriculum comprehensively?	1 - Very adequate … 7 - Completely inadequate
5. Social dynamics	**5.1** Gender diversity	**5.1.1** How effective do you think online platforms are in fostering an environment of gender equality?	1 - Very effective … 7 - Not effective at all
		5.1.2 To what extent do you believe that online education addresses the specific needs and perspectives of all genders?	1 - Fully addresses … 7 - Does not address at all
		5.1.3 To what extent do you think online learning environments can contribute to reducing gender disparities in education?	1 - Greatly contribute … 7 - Do not contribute at all
	5.3 Academic integrity (honesty)	**5.3.1** How prevalent do you believe cheating or dishonest practices are in online assessments?	1 - Not prevalent ... 7 - Very prevalent
		5.3.2 How effective are the current measures implemented to ensure academic integrity in online exams?	1 - Very effective … 7 - Not effective at all
		5.3.3 How sufficient do you find the institutional policies and support in addressing academic integrity issues in online learning?	1 - Very sufficient … 7 - Insufficient