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WP4-A7 Report.

Integration and harmonization of gap analysis results with state of the art realized in the mapping exercise

REMOTE
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REMOTE: Assessing and evaluating remote learning practices in STEM

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Integration report

30 September 2024

Executive summary

This research aims to examine the challenges and opportunities in monitoring and evaluating remote learning in STEM higher education, prompted by the rapid shift to online education during the COVID-19 pandemic. This report synthesizes data collected from interviews with 33 global education experts, as well as surveys from 553 students and 176 lecturers across four European universities and three Delphi studies. It integrates both qualitative and quantitative methods to explore key factors affecting the quality of remote learning and assessment. The findings highlight the importance of accessible and equitable technological tools, the need for adaptive and motivating assessment methods, and the critical roles that students, lecturers and external quality assurance agencies (EQAAs) play in shaping successful remote education environments. The report concludes with recommendations for improving online STEM education and proposes best practices for all parties involved.

This work has been developed through the partnership of the Erasmus+ co-funded project "REMOTE: Assessing and evaluating remote learning practices in STEM"

1. Introduction

Remote learning, often referred to as e-learning or online learning, uses information and communication technologies to deliver education in both synchronous and asynchronous formats, and it has changed the way lecturers and students communicate, interact, and behave (Wang et al., 2021). With the rise of digital devices and advancements in technology, remote learning has transformed education, offering diverse formats like massive open online courses (MOOCs) and fully online degrees. Moreover, the COVID-19 pandemic accelerated the shift to online learning, forcing institutions to adopt digital platforms like Zoom and Google Classroom. However, despite its advantages in increasing access to education, challenges both for students (Palvia et al., 2018), academics (Eckley et al., 2022), and education institutions (Gupta et al., 2020) persist. Concerns include inadequate online pedagogy, quality of education, academic integrity, reduced student-teacher interaction, and issues with assessment, especially in hands-on disciplines like STEM fields.

The REMOTE project aims to address the challenges of remote teaching and assessment. This research is conducted in collaboration with multiple Higher Education Institutions (HEIs), including Politecnico di Torino (PoliTO), Universitat Internacional de Catalunya (UIC), University of Girona (UdG), and University of Minho (UMinho), as well as external quality assurance agencies (EQAAs) across Europe. This report, which falls under WP4, seeks to establish a benchmark and set of guidelines for the effective monitoring and evaluation of remote learning activities in STEM higher education, from the perspectives of both EQAAs and HEIs. The first objective of WP4 is to build upon the results from the gap analysis and state-of-the-art review. The second objective focuses on translating these normative actions into practical, user-friendly benchmarks and guidelines. This approach aims to facilitate the implementation of assessment strategies for both remote and hybrid teaching models, ensuring clarity and effectiveness.

Ultimately, WP4 seeks to contribute to the development of a benchmark that does not currently exist for assessing and evaluating STEM learning activities. The goal is to improve the student learning experience by providing a robust framework for evaluating remote and hybrid teaching models, with the long-term aim of enhancing educational outcomes. This framework will not only underpin the assessment of teaching performance and student learning

experiences in STEM programmes within the COVID-19 context but, more importantly, it will serve as a guide for future remote and hybrid teaching models. The long-term goal is to achieve an improved learning experience for students.

The report is organized as follows: following this introduction, a brief methodological note provides an overview of the research approach. Section 3 presents a summary of the reviewed literature. This is followed by section 4, which details the results of the interviews and questionnaires conducted. Finally, section 5 outlines the recommendations and main conclusions drawn from the study.

2. Methodological note

The information in this report derives from WP2 and WP3 of the REMOTE project, both of which are grounded in a prior literature review aimed at understanding e-assessment quality in STEM education. This report integrates methodologies and best practices identified through two interconnected phases: qualitative insights from expert interviews conducted under WP2 and quantitative data from surveys conducted under WP3.

To detail the exploratory research, the first phase (related to WP2) involved qualitative data collection through structured interviews with 33 global experts. These experts included researchers, higher education administrators, and representatives from EQAAs. The interviews were designed around three specific questions concerning e-assessment quality. All interviews were recorded, publicly accessible, and subsequently transcribed. The transcriptions were analyzed in detail, resulting in thematic clusters that shed light on expert perspectives regarding e-assessment practices.

The second phase (associated with WP3) employed quantitative methods to assess the perceptions of both students and lecturers. Questionnaires were administered through LimeSurvey to participants from the four partner universities. The questionnaires targeted degree courses within STEM disciplines and gathered responses from 553 students and 176 lecturers across the four universities. The design of the questionnaire was informed by a literature review from the REMOTE project, which identified key variables and potentially problematic aspects of remote learning and teaching in STEM areas. Responses were captured on a seven-point Likert scale, where higher values indicated a wider perceived gap in e-assessment quality.

Within WP3, a series of three Delphi studies was conducted to analyze instruments for measuring the quality of online assessment. The first study focused on the student perspective, the second on the lecturer perspective, and the third on synthesizing the results of the previous two. Two rounds were sufficient to reach a consensus. In the first round of each Delphi study, participants allocated 100 points across four dimensions for the student instrument and five dimensions for the lecturer's perspective, with an open-ended question allowing for justification. In the second round, participants reassessed their point distribution based on the feedback from the first round and provided suggestions for improving remote assessment. The results of the first round were shared prior to the second.

3. Context

(1) To better establish the context of the current research, the participants of the REMOTE project carried out a literature review which revealed that most studies only tangentially addressed the topic of e-assessment. Casadesús et al. (2024) were one of the primary contributors to the discourse, among several other collaborators. They conducted a literature review categorizing contributions to e-assessment in four main areas: (1) students, (2) teaching methodologies, (3) academic staff, and (4) information technologies (IT). First, in the context of students, literature emphasizes their active role in online education, highlighting the flexibility and variety of resources available to them. Online assessments such as quizzes, essays, and presentations help measure academic progress while enhancing digital literacy, though there is a notable lack of research specifically focused on online assessment methods.

(2) In terms of teaching methodologies in online education, the review makes it clear that they remain underexplored, despite the growing importance of virtual learning environments. Effective methodologies prioritize student engagement, interaction, and personalization to cater to diverse student populations. However, analyzing and implementing such methodologies is challenging, especially across different regions and educational contexts. The literature highlights a need for more research on inclusive and flexible teaching practices in the online learning space.

(3) Academic staff in online learning environments serve multiple roles, from instructors to mentors, playing a critical part in guiding students through virtual courses. They design and develop engaging materials and

implement pedagogical strategies to foster active learning. Additionally, academic staff are responsible for maintaining academic integrity and assessing student performance in virtual classrooms. While studies have compared face-to-face and online teaching, there remains a research gap in exploring the pedagogical implications of online instruction and assessment in depth.

(4) The role of IT in online education is substantial, with technologies like Learning Management Systems (LMS) facilitating content delivery, communication, and assessment. IT creates interactive virtual environments and enables data collection for personalized learning. However, the literature primarily focuses on the technical aspects of these technologies, with little exploration of how IT supports teaching methodologies.

The review concludes that there is a lack of comprehensive frameworks for quality assurance in e-assessment, underscoring the need for further research to develop such dimensions.

Other articles identified briefly touch on the topic and, although they provide relevant insights, they do not delve deeply into the specifics of e-assessment. For instance, Chen et al. (2018) explore student perception and engagement in online STEM classes, and Usher and Barak (2018) compare learning outcomes between physical campuses and online settings. A notable exception is the study by Guangul et al. (2020), which examines e-assessment within the context of academic dishonesty. Their findings suggest that using a combination of assessment methods, such as report submissions alongside online presentations, can help mitigate academic dishonesty by allowing for better verification of the authenticity of student work. This underscores the need for more focused research to develop comprehensive frameworks for quality assurance in e-assessment within higher education.

4. Results

The integration of quantitative and qualitative methodologies in this study provides a multifaceted view of the quality assurance landscape in remote learning and assessment in STEM degrees. To offer a more comprehensive understanding, the results of the interviews, questionnaires, and Delphi studies are presented from two distinct perspectives. On the one hand, educators and HEIs offer valuable insights into the design, implementation, and administrative

challenges associated with distance assessment. On the other hand, students contribute first-hand accounts of their learning experiences, accessibility issues, and motivational factors. By combining these perspectives, this analysis captures a broad range of factors influencing the effectiveness and quality of distance education and quality assessment.

4.1. Interviews

The interviews with 33 experts were designed to uncover dimensions that could significantly impact the enhancement of student learning in online environments. Experts were asked three exploratory questions, informed by a prior literature review, to guide the open discussion:

1. How do you imagine the university of the future?
    a. What teaching methodologies do you mostly imagine?
    b. Which learning technologies do you think will prevail?
2. How will the students of the future differ from those of today?
3. How do you think remote learning practices will change in this future university?
    a. Do you think that remote learning practices can affect students differently depending on gender?
    b. Do you think that STEM studies require remote learning practices different from other fields of study?

Despite the differing perspectives of students and lecturers, the analysis revealed consistent aspects that explain the core elements of quality assurance in e-assessment:

1. **Tools:** this dimension encompasses the technological infrastructure necessary for online learning, along with considerations of equity and diversity. Effective online learning environments depend on the robustness of the tools used, ensuring they are accessible and inclusive for all students.
2. **Assessment methodologies:** this dimension highlights the need for evaluation strategies that are balanced, human-centric, and motivating. Effective assessment should be designed to engage students and accommodate both online and offline learning contexts.

Going into greater detail, from the perspective of professors, technological tools play a pivotal role in the remote learning process, particularly in terms of assessment. Lecturers emphasize the need for effective assessment tools to enhance student learning and motivation. Several participants highlight the importance of assessments as learning tools, with one noting that “assessment

is one important part of students' motivation". Beyond assessments, there is a broader recognition that digitalization is transforming education, but it should not compromise the core essence of learning. As one respondent states, "Digitalization will change the way we learn and teach, but it will not fundamentally alter the meaning of education." The diverse needs of different disciplines also require adaptable tools, tailored to the unique methodologies of each field. Moreover, lecturers advocate for the integration of online and offline learning methods, envisioning a future where "the boundaries between online and face-to-face are blurred", thereby enriching the educational experience through a blended approach.

Assessment methodologies, both online and offline, are essential to evaluating student performance according to lecturers. Faculty members stress the benefits of combining these modes, with one participant stating that "learning and assessment have stronger effects when done face-to-face". Another important theme is balancing technological integration with maintaining the human element in education. Several lecturers underscore the need to preserve social connectivity and emotional engagement, with one cautioning that "it's important to teach students how to remain human beings". Furthermore, the success of evolving assessment practices relies heavily on faculty collaboration and ongoing professional development. As one professor notes, "Lecturers need to collaborate even more effectively," while another emphasizes the importance of continuous adaptation to new challenges. These insights reflect the critical role of motivated and engaged faculty in ensuring successful assessment methodologies in the remote learning environment.

For their part, students emphasize the importance of technological tools in creating equitable and effective learning experiences in remote education. A key theme is access to technology, with students highlighting the need for reliable digital tools to fully engage in their education. One student notes that accessibility allows them to learn remotely while still participating in essential STEM activities, such as laboratory work and outcome assessments. Another emphasizes the role of digital inclusion in helping disadvantaged students and those with disabilities, although students also stress the continued need for access to quality facilities and labs in STEM fields. Equity is another central theme, with students recognizing how online learning bridges socioeconomic gaps and expands educational opportunities. For instance, one participant points out that online education can democratize access, offering adult learners – including women who missed earlier opportunities – a chance to further their education. The diversity of online learning, particularly in terms of gender, disabilities, and age, is another major focus. This perspective highlights how remote learning can foster inclusivity, providing access to diverse student populations across socioeconomic and demographic lines.

Students also believe that assessment methodologies should strike a balance between online and offline evaluations. While they appreciate the

flexibility and continuous assessment opportunities provided by online methods, they also recognize the value of in-person evaluations, and of preserving social interactions and emotional engagement in a tech-driven environment. This balance helps provide a more comprehensive and flexible evaluation of student performance, enhancing the overall learning experience. Lastly, students see continuous assessment and feedback as key motivators. Frequent testing, active participation, and ongoing feedback from lecturers are viewed as essential to keeping students engaged and motivated throughout their educational journey. These insights reflect the need for assessment methodologies that not only evaluate learning outcomes but also actively foster student motivation and engagement.

4.2. Questionnaires

Turning to the results from the questionnaires, which were informed by the literature review, several key areas as summarized in Table 1 were identified as potentially problematic in the evaluation of remote learning and assessment within STEM education.

Table 1: Dimensions studied in the questionnaire

Dimension	Aspect
1. Resource availability and accessibility	**1.1** Accessibility to materials **1.2** Accessibility to evaluation resources **1.3** Access equity
2. Technical responsiveness	**2.1** Connection and web platform adequacy **2.2** Student-lecturer interaction **2.3** Technical problem solving
3. Training	**3.1** Preparation and training for managing lectures **3.2** Preparation for managing the evaluation **3.3** Institutional support to lecturers
4. Online assessment	**4.1** Adequacy of assessment methods **4.2** Adequacy of evaluation feedback **4.3** Quality of education
5. Social dynamics	**5.1** Gender diversity **5.2** Sense of belonging to the community **5.3** Academic integrity (honesty)

The analysis of responses from 176 lecturers and 553 students across the four universities revealed that most issues identified were common to both groups, although some aspects were more specific to either students or lecturers. Additionally, the study found no significant gender-based differences in the responses, indicating that the challenges associated with remote learning impact students and lecturers uniformly, irrespective of gender.

Focusing specifically on students, the analysis identified several critical ideas at a general level. These include:

- Sense of belonging to the community (5.2)
- Academic integrity (5.3)
- Adequacy of evaluation feedback (4.2)
- Quality of education (4.3)
- Adequacy of assessment methods (4.1)

For lecturers, the analysis revealed that the most critical aspects differ somewhat from those highlighted by students. The primary concerns for lecturers include:

- Student-lecturer interaction (2.2)
- Quality of education (4.3)
- Preparation for managing evaluations (3.2)

- Academic integrity (5.3)

Combining the perspectives of students and lecturers, academic integrity and quality of education emerge as shared concerns, underlining the importance of developing robust strategies to reinforce both aspects. Notably, student-lecturer interaction (2.2) is not a significant concern for students, while the adequacy of evaluation feedback (4.2) – which was critical for students – does not emerge as a major issue for lecturers. These dimensions show a consistent trend across the four partner universities, indicating similar concerns and priorities regarding the remote learning experience. This can be easily visualized in Figure 1, which highlights an area along the diagonal, indicating agreement between both perspectives, with divergences appearing outside this area.

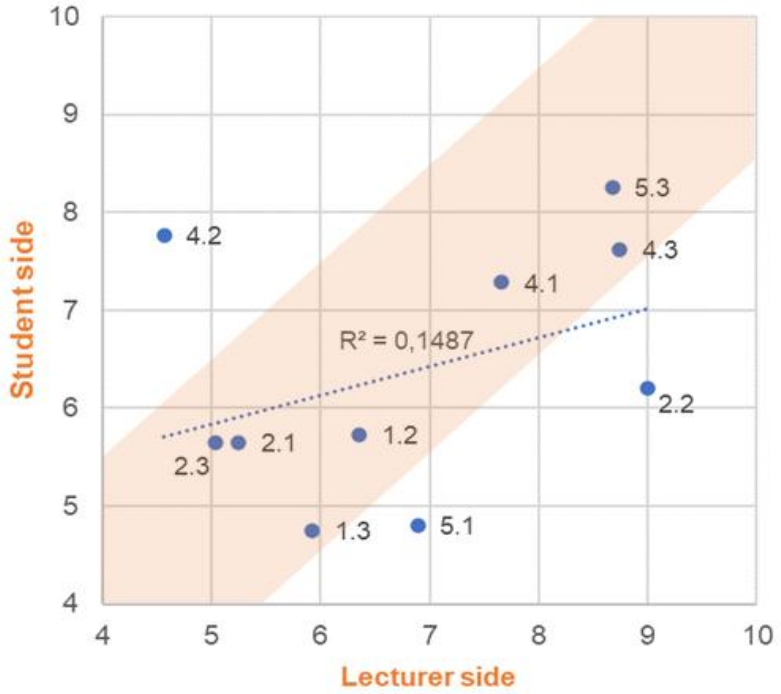

Figure 1: Scores for each dimension from the perspectives of lecturers and students

Finally, the study found no significant gender differences in the responses, indicating that the challenges associated with remote learning affect all students and lecturers equally, regardless of gender.

4.3. Delphi studies

Three Delphi studies were conducted, with two rounds each. In the first round, each expert was asked to assign a score from 1 to 100 to each dimension and provide qualitative comments to elaborate on their ratings. In the second round, respondents were presented with the average results obtained from the first round. This feedback allowed them to reflect on their initial ratings and comments, and to make any adjustments or additional considerations based on

the group's collective insights. Once again, we distinguish between students' and lecturers' perspectives.

4.3.1. Student perspective

The first Delphi study aimed to understand students' perspectives on the impact of remote learning across four dimensions: resource availability and accessibility, technical responsiveness, online assessment, and social dynamics. This study gathered insights from six expert respondents from the Politecnico di Torino. The respondents, consisting of a mix of master's students and early-stage PhD candidates of varying ages and genders, evaluated these four key dimensions of their educational experience. The results, with the average score for each dimension assessed, can be seen in Figure 2.

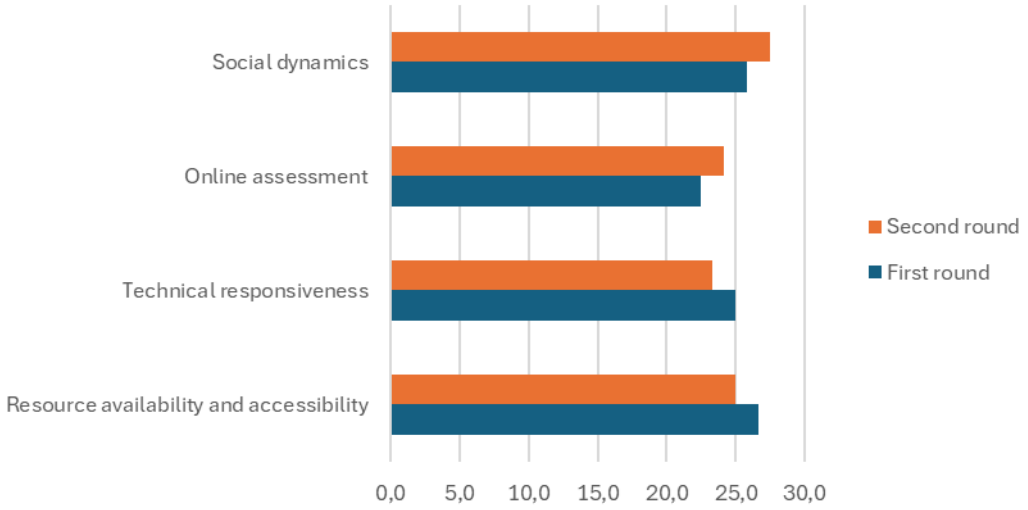

Figure 2: Bar chart of the first Delphi study scores

In comparing the results from the first and second rounds of assessments, several trends emerge across the four dimensions.

Resource availability and accessibility sees a slight decline in its average score from 26 in the first round to 25 in the second. While the initial high satisfaction level indicates that resources are generally adequate, respondents in the second round stress the need for better organization of materials on a single platform and reducing access costs to enhance equity.

Technical responsiveness also experiences a decrease in its average score dropping from 25 in the first round to 23.3 in the second. Initial feedback reveals that technical issues are primarily viewed as individual problems, with a focus on the importance of prompt responses from universities and lecturers. In contrast, the second round yields suggestions for proactive measures, such as implementing virtual assistants and improving infrastructure, indicating a shift towards a more systematic approach to addressing technical challenges.

Online assessment shows a slight improvement with scores rising from 22 in the first round to 24.2 in the second. While concerns about academic integrity

and timely feedback remain prominent in the first round, the second round of responses emphasize the necessity for hybrid assessment methods, including oral exams and interactive projects, suggesting a more innovative approach to evaluation.

Social dynamics experience a rise from a score of 25 in the first round to 27.5 in the second. This increase reflects a growing recognition of the importance of fostering peer interaction and networking to build a stronger academic community. Respondents advocate for more opportunities for engagement, both online and offline.

4.3.2. Lecturer perspective

The second Delphi study sought to understand lecturers' perspectives on the impact of remote learning on five dimensions: resource availability and accessibility, technical responsiveness, online assessment, social dynamics, and training. The results, with the average score for each dimension assessed, can be seen in figure 3.

In the first round, **resource availability and accessibility** receive a high satisfaction score of 20, with lecturers emphasizing the importance of centralized resource management and equal access for all students. This dimension sees a significant improvement in the second round, achieving an average score of 24. Respondents acknowledge that while resources are generally adequate, there remains a need for better organization and cost reduction through centralized platforms.

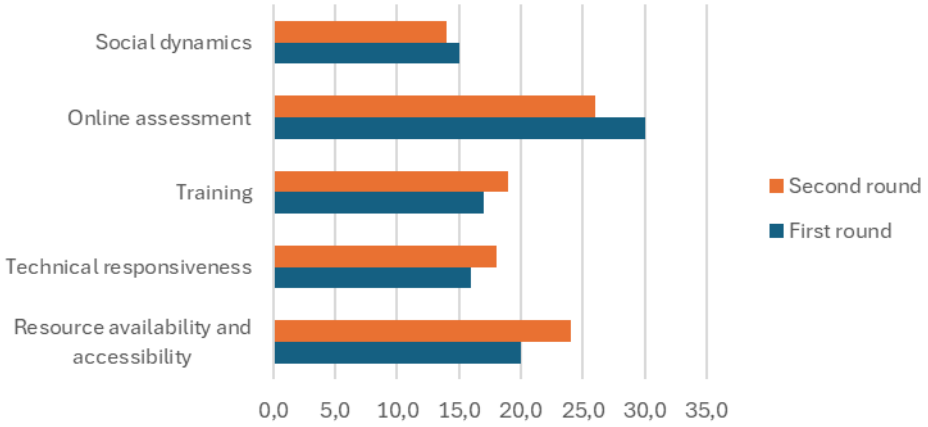

Figure 3: Bar chart of the second Delphi study scores

Technical responsiveness exhibits moderate satisfaction with a score of 16 in the first round, with respondents reporting technical issues and recommending virtual assistants and better support for lecturers. In the second round, this dimension improves slightly, scoring an average of 18. Respondents reiterate the need for enhanced technical support through virtual assistants and suggest improvements to infrastructure.

Online assessment, initially scoring high at 30, highlights concerns regarding the need for hybrid assessment methods and alternatives like oral exams to uphold academic integrity. This dimension sees a shift in the second round, with an average score of 26. Respondents emphasize the importance of integrating hybrid methods, such as oral exams and interactive projects, while also highlighting the need for timely feedback.

Social dynamics receive a low score of 15 in the first round, with calls to enhance student interaction and a better sense of community. In the second round, the score slightly decreases to 14, indicating ongoing challenges in fostering a sense of community and interaction among students.

Finally, **training** scores 17 in the first round, reflecting the need for better preparation and institutional support for online education tools and assessments. In the second round, this dimension improves to a score of 19, with a strong call for more comprehensive training and institutional support to facilitate effective online teaching and assessment.

4.3.3. Focus group

After conducting a thorough analysis of the Delphi study results to validate the findings from both the student and lecturer surveys, a focus group was proposed, led by Universitat de Girona and Universitat Internacional de Catalunya. This focus group, which included six participants (two university lecturers from each institution, two students, and two experts in higher education institutions), aimed to delve deeper into the results, providing an opportunity to explore and understand key insights in greater detail. The ultimate objective was to establish a highly practical and actionable roadmap for universities and lecturers, specifically aimed at enhancing the overall quality of teaching. The results of the focus group are summarized below for each dimension studied.

1. Resource availability and accessibility

Ensuring equitable access to technological resources is crucial for students from diverse socioeconomic backgrounds. Proposals include implementing device loan programmes, particularly by repurposing old devices from lecturers or institutions, to assist students who lack access to computers. Additionally, educational materials should be designed to be mobile-friendly, as many students rely on mobile devices rather than computers. Other suggestions include providing technology scholarships and reducing taxes on technological products to make them more affordable for students, ensuring that all students have the tools necessary for remote learning.

2. Technical responsiveness

To enhance technical stability in online platforms, institutions need robust technical systems, including adequate server capacity and quick recovery mechanisms to handle disruptions. New features and updates should be

thoroughly tested in parallel environments to avoid disrupting the platform's normal operation. Improving the quality of interactions between students and lecturers is also critical. Proposals include holding periodic in-person meetings or virtual meetings with cameras on to foster more personal connections. Informal face-to-face interactions, even for non-academic activities, can also help strengthen relationships and improve student engagement in remote learning environments.

3. Online assessment

Online assessments should shift from traditional exams to more personalized and interactive methods like oral evaluations, which reduce cheating and encourage deeper student engagement. Practical activities in the virtual classroom and hands-on tasks allow real-time assessment of students' skills. Another approach is implementing "competency development journeys", where students reflect on their learning and present evidence of progress, enabling continuous and formative assessments. This method fosters critical thinking, encourages self-assessment, and allows educators to provide personalized feedback that supports individual student growth over time.

4. Social dynamics

Fostering a sense of community in virtual learning environments is a challenge, and organizing both in-person and virtual social activities can help students feel connected to their academic community. Semi-social activities with cameras on, outside of formal coursework, can encourage student bonding. Academic integrity is also a key focus, with a call to instil values of honesty from early education. Governments, universities, and families should work together to promote these values. Additionally, strict penalties for academic fraud are proposed to deter cheating during online assessments and uphold the standards of academic integrity.

5. Training

Institutions should prioritize continuous professional development for lecturers to improve their ability to teach and assess in online settings. A key focus should be on new assessment methodologies tailored to digital environments, such as personalized exams and tools for optimizing qualitative feedback. Lecturers also need training on the full functionality of digital platforms to enhance the learning experience. Additionally, new assessment strategies are necessary, not just a transfer of traditional methods to a virtual environment, but approaches that align with the unique demands of online teaching and learning.

5. Recommendations and conclusions

Based on the gaps identified in the literature review, as well as the findings from the exploratory work conducted in WP2 and WP3, this report aims to propose recommendations to address and reduce these gaps, and to develop more inclusive and effective quality assurance policies that address the needs and concerns of all students, lecturers and HEIs. A few important guidelines can be derived from the current research, which, based on consistent results across universities, underline the urgency for shared strategies to improve the remote learning experience. These recommendations target both students and lecturers.

Assessment methodologies (online and offline) for students and STEM degrees

- Balanced assessment: concerns about maintaining educational standards in an online context highlight the need for assessment methods that accurately reflect the skills and knowledge acquired. Thus, assessment methodologies should strike a balance between online and offline evaluations. While students appreciate the flexibility of online assessments, they also recognize the value of in-person evaluations and face-to-face academic support.
- Continuous feedback: online assessments allow for ongoing feedback throughout the course, enhancing flexibility and providing a comprehensive evaluation of student performance. Lecturers should provide prompt, detailed feedback to help students recognize strengths and identify areas for improvement.
- Assessment as motivation: lecturers emphasize that assessment is an important part of students' motivation, underscoring the relevance of well-designed assessment strategies in fostering engagement.
- Multifaceted assessment for integrity: using a combination of assessment methods, such as report submissions alongside online presentations, helps not only mitigate academic dishonesty by better verifying the authenticity of student work, it also accommodates different learning styles.

Faculty development and institutional support

- Ongoing professional development: the success of evolving assessment practices relies heavily on continuous professional development. Faculty members emphasize the importance of ongoing adaptation to new challenges and familiarizing themselves with online platforms.
- Collaboration among faculty: lecturers note that theyneed to collaborate more effectively to ensure the success of remote learning environments and evolving assessment methodologies.
- Support for faculty: lecturers stress the need for institutional support and training to effectively manage and evaluate online lectures and assessments.

Resource availability, accessibility, and technical responsiveness

- Equitable access to resources: students and lecturers alike highlight the need for reliable digital tools, stable internet connections, and responsive web platforms to fully engage in their education and facilitate smooth assessment.

- Digital inclusion: students emphasize the importance of digital inclusion, particularly in supporting disadvantaged students and those with disabilities, while maintaining access to quality facilities and labs in STEM fields.
- Tools tailored to STEM: different disciplines require adaptable tools tailored to the unique methodologies of each field.

Social dynamics and community

- Building community in online learning: students and lecturers highlight the importance of fostering a sense of community in online learning environments. Strong student-lecturer interaction and two-way feedback is crucial for creating an effective and engaging remote learning experience that improves learning outcomes.
- Gender and inclusivity: remote learning has the potential to support students from diverse backgrounds, particularly female students in traditionally male-dominated STEM fields, whilst bridging socioeconomic gaps and expanding opportunities for students from diverse cultural and societal contexts. Online learning can enable inclusivity across gender, socioeconomic, and cultural lines.
- Maintaining human elements: several lecturers highlight the need to preserve social connectivity and emotional engagement, ensuring that technology does not replace the human aspects of learning.

Specifically for EQAAs, best practices to be implemented include regularly updating assessment guidelines to reflect the latest advancements in online education and e-assessment practices, ensuring that standards remain relevant and effective. Additionally, quality agencies should offer support and resources for educators to help them adapt to online and hybrid teaching environments. This can include training programmes, workshops, and access to best practices in e-assessment that promote equity and inclusivity.

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