Erasmus + Project: Crisis Resistant Digital Education and Training

How to go forward with our educational efforts in the post-pandemic period

1. INTRODUCTION

The COVID-19 pandemic forced many universities to sudden and uncoordinated transition, without being prepared or having time to explore suitable educational strategies for tailoring their courses to the online delivery or to prepare support mechanisms for both educators and students. These sudden COVID-19 transitions, also called emergency remote teaching, try to replicate in-person teaching which was obviously hard to accomplish. In addition, this temporary and urgent switch to online education is completely different to a systematic and structured development of courses planned to be delivered online. This immediate need for digitalisation in education forced many educators to only online teaching.

In general, the development of the online university course lasts six to nine months, which was obviously not available at this point in time (Hodges et al. 2020). In addition, unfortunately, very often universities didn't have enough support personnel that is familiar with online teaching and learning practices which lead to suboptimal delivery of courses and resulted in education which was not suitable counterpart in a virtual form.

Despite being rushed to offer their courses, educators and students significantly increased the pace of adopting and implementing online teaching practices. On the one hand, the very high workload of teaching staff resulted in transferred course materials in an online form and their ability to organise the course in a virtual environment. On the other hand, students experienced many difficulties and obstacles while shifting to online education (e.g. for live education – Tang et al. 2021). As such, lessons learned and best practices acquired across different institutions need to be gathered and shared within the engineering education community. However, there were many mistakes as well, which have to be clearly stated and recognised. For that reason, considerable effort needs to be dedicated in the post-pandemic era to the sustainability of online practices and their incorporation into regular programmes to reap the perceived benefits.

Due to these hurried transitions, many educators and students gained a wrong perception of online teaching, without considering all the benefits that this teaching type could offer if these courses would be developed in a structured manner or if newly acquired teaching practices during COVID-19 would be integrated for a better hybrid education.

2. ONLINE TEACHING VS. EMERGENCY REMOTE TEACHING

Scholars and educators differentiate various instances of online teaching and learning such as distance learning, distributed learning, blended learning, online learning, mobile learning, and others (Rodgers et al., 2020). However, during the COVID-19 pandemic, what institutions really experienced and conducted was - emergency remote teaching. It can be described as fully remote teaching which replaced previously face-to-face or blended teaching approaches and will be abandoned after the end of the crisis. For that reason, there is a necessity to clearly distinguish between the terms emergency remote teaching and online teaching.

The utilization of online teaching methods, tools and technologies has been an established practice for many years before the pandemic. Online learning can be defined as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access" (Singh & Thurman, 2019). During the sudden shift caused by the pandemic, the systematic approach necessary for creating these learning experiences in online teaching courses was frequently overlooked. In the pre pandemic era , these courses are developed as voluntary and planned activities (Lemay et al. 2021). E-learning has been supported by various digital technologies like Web 2.0 applications and services, even before COVID-19. The global education technology sector, also including online learning, was growing by about 15.4% a year worldwide (Toth-Stub 2020). However, it is necessary to distinguish the way e-learning was conceptualised before – mostly as an alternative to traditional in-person education. The main advantages of e-learning perceived by the general education community are flexibility, accessibility and cost-effectiveness, especially in terms of life-long learning (Horvath et al. 2022).

Although there have been reported many positive experiences of online education in terms of life-long learning, the extent to which this can be recognised within university education still remains unaddressed. Learning at their own pace, learning from home and overall flexibility (The Future of Learning Report 2022) which were offered by online education opens different possibilities for merging them with in-person education into blended learning (potential future approach).

As an initial step, Means at all. (2004) initially suggested taking into account nine criteria which can guide the process of defining the constraints and offerings that the tailored online education should provide. The overview of these moderating variables is provided in Figure 1.

By exploring the proposed overview of variables, one of the first aspects that need to be taken into account when planning our online education is class size, as it heavily influences the strategies that you could implement. This is related to the synchronicity of education and to what extent teachers will be able to provide feedback to students. Synchronous communication can be performed via live video- or audio-conferencing and student-educator interaction, while asynchronous communication implies no real-time interaction between students and educators. For that reason, interaction has a huge role in their classification of moderating variables, as it emphasises the social aspect of online education (not only „technical" information transfer). As it can be easily perceived, many of these variables are related to "instructional core" (Cohen

and Ball 1999) - interactions between educators and learners around educational materials. An important aspect which needs to be additionally considered was the accessibility to all students (Lederman 2020), by including criteria such as internet access, quiet study locations and access to good technology (computers). Also, some experts (Lederman 2020; June 2020) emphasise the students' balance of learning and private obligations.

All these abovementioned aspects can be carefully considered when developing online courses, while emergency remote teaching (ERT) requires a slightly different approach. Due to the nature of this transition, ERT includes temporary online delivery of teaching and supporting material prepared in a short timeframe. However, our main focus should be oriented toward exploiting lessons learned during the pandemic and exploring possibilities for the further improvement of our education delivery.

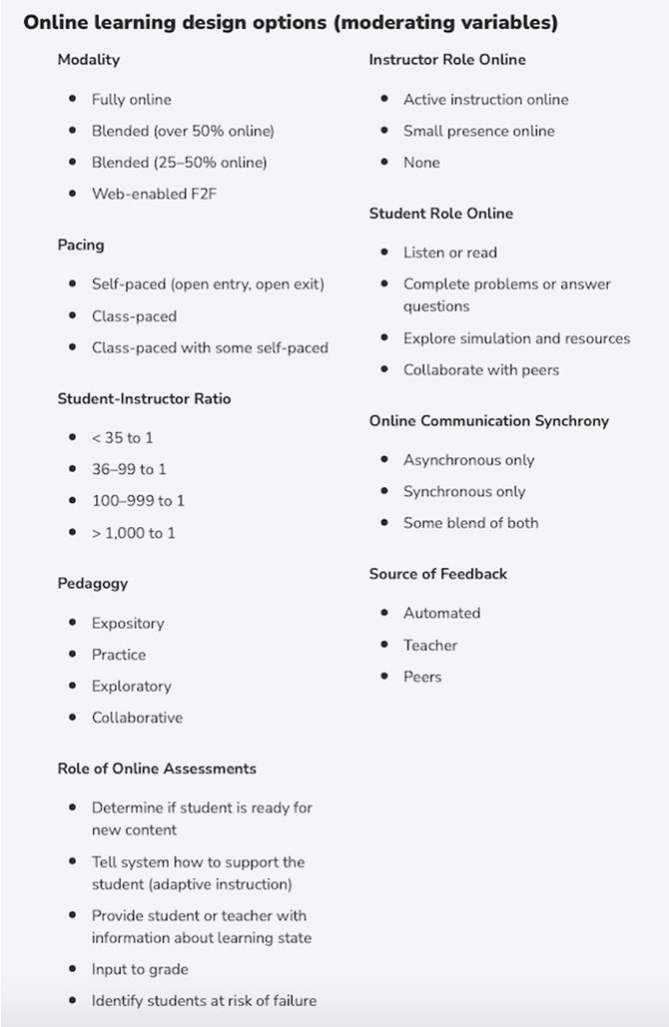

Figure 1: Online learning design options - Means at all. (2004)

3. COVID-19 TEACHING EXPERIENCES

During the period from March 2020 to February, educational institutions were closed for almost half an academic year (Haelermans et al. 2022). Many institutions had to swiftly decide on an online platform which can fulfil a certain list of requirements. Within that context, Basilaia et al. (2020) suggested the following generic list of requirements:

1) To allow 50 or more students to join a lecture/tutorial session via videoconferencing tool;

2) To use a discussion format to make the teaching process engaging and "natural";

3) To record and upload the teaching content (in case of low connection quality);

4) To tailor the teaching content for different types of digital platforms;

6) To allow students to submit the course deliverables via online form.

Due to the ad-hoc shift to online education, many institutions were not able to fulfil all these requirements with their online platforms or LMS (learning management systems).

Before going deeper into exploring COVID-19 teaching experiences, there is a need to differentiate between the way students perceive online and in-person courses (Kaufmann, 2015). Also, their perception is heavily influenced by the type of the course in which they are enrolled. On the one hand, Xu and Jaggars (2011) reported that an analysis of Virginia's community colleges (hundreds of courses) indicated worse students' performance in terms of course persistence and final grades. On the other hand, some studies (Cole et al., 2017; Fendler, Ruff, & Shrikhandle, 2018) even report that students will achieve better learning results in online settings. However, research literature often emphasises the social aspect of learning and an active student role (Lemay et al. 2020). Sudden and forced transition to online education due to the COVID-19 crisis required additional research studies to better understand the impact it had on educator and student perception of online learning.

In a US study (Lederman 2020), educators reported that the COVID period caused significant changes to the courses they planned to deliver and made them update learning objectives, assessments and activities. Also, as mentioned before, the personalised feedback in a different format (than a physical environment) requires their upskilling and stronger institutional support. Immediately after the first semester of the COVID-19 era (March, 2020), survey results (June 2020) listed the main challenges as:

- Professional development in online pedagogy (39% of respondents)
- Better education technology tools and training on how to use them (21%)
- Better Wi-Fi connectivity (10%)
- Clearer guidance on grading and other policies (7%)
- Other (23%)

Favale et al. (2020) reported that e-learning technical issues experienced by users can undermine the quality of the teaching-learning process. The Economist Intelligence Unit reported that 60 percent of educators expressed the reduced engagement by students (due to the reduced focus) and the lack of their capacity and competence to deliver highly-engaging lectures and tutorials. Still, only 7 percent of students believe that remote learning has nothing to offer to their education.

Internet access and available technology can cause major issues related to the emergency remote and online education. For example, 95% of students in Switzerland, Norway, and Austria have access to a computer to use for their home educational obligations, while only 34% of students in Indonesia. In some countries (e.g. Australia), institutions were able to provide digital equipment to students; however, this was not the case in general.

As an additional example, according to Vegas (2020), 96% of students in the Netherlands are suitably equipped with Internet access for online education. After the period from March of 2020 to May of 2020 when schools were closed, they reopened them to a certain extent (smaller groups) until June 7, and finally, everything was back in in-person form after June 8. On the other hand, a majority of countries in South Asia, Africa, and Latin America had their schools closed for at least a full year. As such, students in the Netherlands experienced less learning losses compared to some other countries (Haelermans et al. 2022). This study also shows that students with less-educated parents and students from lower-income households had more difficulties with the learning process and were less successful in obtaining learning outcomes. It is important to differentiate used teaching media in low-income countries (via TV or radio) and high-income countries (mostly online).

If students have suitable access to the Internet and needed technology, studies show that they are able to retain 25-60% more content when learning online in comparison to only 8-10% in a physical environment (Li and Lalani 2020). The explanations can be found in the flexibility to study "on demand" (when they want) and how they want (going through materials in different styles – back and forth, repetition etc.). The higher odds of online teaching success can be supported by the structure of the teaching/learning process. Therefore, instead of only uploading video-recordings, there is a need to foster the student learning process through collaborative tools and continuous maintenance of student engagement (e.g. games / serious games, interactive activities). This can be achieved by a clear formulation of engagement rules (regular Q&A sessions or foster discussion groups). On the other hand, some K-12 and college studies (Loeb 2020) indicate that, overall, online education is not as effective as in-person courses, due to the social pressures and various ways educators have to improve student engagement (emphasised in the case of students with weaker academic background). It is important to mention that student experiences also depend "on the learning styles, acceptance of new learning modalities and levels of engagement" (Khalil 2021).

According to the study performed by Lemay et al. (2020), students perceived this sudden transition to online education as mainly successful. However, students reported high levels of

stress and anxiety and had significant issues with their focus during lectures and tutorials. Still, overall, they expressed positive emotions about coming back to their onsite education.

Of course, some institutions managed to mitigate the impact of some of these issues, while in other institutions they remain unresolved. Of course, there are some preconditions which have to be fulfilled in order to improve hybrid education approaches.

Lemay et al. (2020) and Khalil (2021) discussed that their findings on COVID-19 experiences overlap with previous studies on online learning. Students experience a lack of social onsite education benefits due to the isolation and distance from their colleagues (e.g. in classroom or campus). For that reason, educators and institutions should encourage and foster networking and communication among students (Kaufmann & Vallade, 2020). Still, some students clearly stress the advantages of online education, especially within the context of theoretical courses and enhanced time management. For more practical and project-based courses (Khalil 2021), students prefer to conduct them onsite to enable face-to-face discussions and easier delivery of joint activities.

The gained experience should help educators to complement their existing teaching strategies and offer students an additional avenue for better fulfilling the aimed course learning outcomes. During the recent period, many educators participated in different professional development training related to digital teaching and environments. Still, this needs to be further emphasised for the following post-COVID period to establish preconditions for further educational improvement.

4. REPLACING IN-PERSON OR IMPROVING HYBRID TEACHING?

In the pre-COVID period, although many educators implemented various forms of different online teaching, studies (Lederman, 2020) showed that their confidence was still low in terms of the quality that online education offers. The general assumption was that the pandemic period will improve the way educators perceive the quality of remote and online teaching strategies. However, according to some initial surveys (O'Keefe et al. 2020), this was not the case. Still, results indicate a positive trend towards a higher awareness of the online education possibilities and usage of technology to deliver the courses.

Currently, the dominant way of education delivery is done through face-to-face communication and physical environments such as classrooms and labs. Online education cannot provide the same level of social interaction as education conducted in a physical environment. There are some research findings which point to directions on what and how to integrate online elements into our overall education (Loeb 2020). For example, online education can be delivered in many forms, ranging from small collaborative teams to MOOCs (Massive Open Online Courses). By attending additional online classes, students can catch up and compensate if they missed something during regular classes. Therefore, future trends also indicate customization and improvement of education delivery mostly by introducing various information technologies – computer-aided and remote teaching, flipped classroom etc. (Ward, 2013) This mixed-mode approach is done only by individuals and not as a systemic collaborative effort on the institutional level. Since funding limitations within the context of higher education become more and more evident, this may be the route for overall educational improvement and the provision of alternative and complementary teaching approaches on a larger scale.

The way education is conceptualized changes at a fast pace, and the successful incorporation of online education could potentially have a major role. Immediate response to COVID-19 pandemic made by HEIs led to many gains such as improved e-learning infrastructure and broadly distributed online teaching and learning on a certain level of quality.

In order to plan further teaching improvements related to new educational technologies, several aspects need to be addressed (Vegas 2022): 1) scaling up educational intervention; (2) supporting customized and personalized learning; (3) improving learner engagement. This is particularly emphasized in low- and middle-income countries (Vegas 2022).

One should not merely focus on the pros attached to the adoption of online learning during the crises but should also take account of developing and enhancing the quality of virtual courses delivered in such emergencies (Affouneh et al., 2020). A lot of time and cost is involved in e-learning. It is not as easy as it seems, a considerable amount of investment is needed for getting the devices and equipment, maintaining the equipment, training the human resources, and developing the online content. Therefore, an effective and efficient educational system needs to be developed to impart education via online mode.

To analyze the quality of performed courses, there are different metrics offered e.g. by the Online Learning Consortium: Quality Scorecard Suite or Quality Matters. Of course, by

assessing courses through rigorous quality criteria, different improvement areas will be spotted and potentially addressed. However, it is important to clarify that the comparison of a purely face-to-face course to an emergency online counterpart is unequable and without too much value. Different media offer different benefits and require a customized approach for creating a course in one or the other environment. The usual approach for measuring and monitoring the course success is through the fulfilled learning outcomes, but also interest and engagement of students. However, emergency remote teaching should be clearly distinguished from online teaching, and therefore Hodges et al. (2020) suggest contextualization of the assessment criteria based on the CIPP model (context, inputs, process, and products).

The proposed assessment questions for emergency remote teaching were as follows:

- Given the need to shift to remote instruction, what internal and external resources were necessary in supporting this transition? What aspects of the context (institutional, social, governmental) affected the feasibility and effectiveness of the transition? (context)
- How did the university interactions with students, families, personnel, and local and government stakeholders impact perceived responsiveness to the shift to ERT? (context)
- Was the technology infrastructure sufficient to handle the needs of ERT? (input)
- Did the campus support staff have sufficient capacity to handle the needs of ERT? (input)
- Was our ongoing faculty professional development sufficient to enable ERT? How can we enhance opportunities for immediate and flexible learning demands related to alternative approaches to instruction and learning? (input)
- Where did faculty, students, support personnel, and administrators struggle the most with ERT? How can we adapt our processes to respond to such operational challenges in the future? (process)
- What were the programmatic outcomes of the ERT initiative (i.e., course completion rates, aggregated grade analyses, etc.)? How can challenges related to these outcomes be addressed in support of the students and faculty impacted by these issues? (product)
- How can feedback from learners, faculty, and campus support teams inform ERT needs in the future? (product)

The quality assurance strategy should be agreed on the institutional level and collaboration policies should be set to allow knowledge transfer between departments possessing different digital competencies (Khalil 2021).

5. POST-COVID EFFORTS – HOW TO PROCEED?

Many experts claim that COVID-19 accelerated the introduction and implementation of various information technologies in educational systems worldwide (Li and Lalani 2020), despite the significant challenges that were experienced during this process. In addition, some educators claim that it was easier to communicate with students using some advanced online tools (e.g. Lark) and they plan to retain these practices in the post-COVID period, as they "can go hand in hand". According to Li and Lalani (2020), investments in e-learning haven't decreased, and potentially some similar scenarios to e-commerce innovation in the post-COVID period can be expected. Within that context, a robust and stable remote learning infrastructure should be considered a prerequisite for any further hybrid educational activities.

Although the transition to online education conducted by HEIs can be considered as successful, it was still not perceived as a suitable replacement for an in-person teaching and learning experience (Burns et al. 2020, Hattar et al. 2021, Horvath et al. 2022). To summarize, educators mostly identified accessibility and engagement issues (Curtin, 2021). In the following period, students would like to return back to university locations, but also to keep the flexibility to approach the course contents on-demand and remotely or to share their opinions and claims through asynchronous discussion.

Vegas (2020) claims that the majority of institutions returned back to the way they educated their students (as defined in emergency remote teaching) and haven't capitalised on the lessons learned for future education. These missed opportunities to embrace technological advancements did not lead to improved curricula or teaching methods. Still, the educational community should reap the benefits acquired during the COVID-19 period that could have long-term effects on the quality of education. Despite the fact that the culture of certain HEI has a major role in institutionalising the educational innovations, the provision of strategies and methods for educators can motivate and inspire many of them to evolve the way a course is being delivered.

Despite the support that faculty members can receive in terms of organising the course, creating multimedia resources, and using and preparing learning management systems, it is important to consider variations in the digital skills and literacy of educators (Khalil 2021). Higher education institutions, as universities, should therefore prepare for similar situations and to assign necessary institutional resources to conduct e-learning in a more appropriate manner. Also, they should support educators to reach a required level of their readiness and digital literacy to perform online education, as it is often neglected by a significant portion of educational personnel.

The Future of Learning Report 2022 indicates several directions for further improvement of education, out of which some are relevant for university education:

- New partnerships
- New models for tertiary education
- Fresh approaches to assessment and exams
- Continued course optimization for mobile devices
- The application of new digital technologies

On the lower level, in terms of execution of e-learning processes, there are recent trends (Nieves 2021):

- Exploration of new interactive learning spaces, e.g. virtual tours and lectures
- Educators need to invest more in the development of their IT competences
- Development of auxiliary and immersive learning platforms which can help in the learning process
- Successful "morphing" into blended learning

To be more specific, one of the initial steps is to revisit the previous courses and explore means for effective distance learning – both in terms of teaching strategies/procedures and necessary infrastructure. Learning practices need to further evolve, including remote teaching, new collaborative tools and associated pedagogical advancements for an improved individualized and hybrid education. As stated by Horvath et al. (2022), an educator should together with students, agree on the combination of online and offline education.

Beforehand, there is a need to carefully consider which online education elements should be kept in future educational endeavors (Table 1).

Table 1: Online education elements (based on Horvath et al. 2022)

Octaberlina and Muslimin (2020),	Use of compressed files, introduction of breaks, support of student-teacher communication, Introduction of new teaching styles (suitable for online)
Rahman (2021)	Use of innovative tools, student-friendly content development, teacher training
Tang et al. (2021)	Support for peer-to-peer learning and collaborative work, introduction of gamified approaches, organisation of live online education
Horvath et al. (2022)	Usage of online platform solutions, Use of innovative tools, student-friendly content development, support of student-teacher communication, introduction of gamified approaches

In addition, some authors (Kee 2021) emphasise the importance of emotional support given to the students. Dhawan (2020) and Martin (2020) claim that student mental health and motivation should be also in the focus of educators.

Within hybrid education, online consultation and focused Q&A sessions could complement the traditional way of delivering lectures and tutorials (Horvath et al. 2022). Zhang et al. (2021) reported that blended learning approaches improved the affective and cognitive learning aspects, which leads to the direction of how to complement online-only education. For practical and hands-on course activities, there is a huge potential to integrate different modalities such as VR/AR technologies or computer-aided models/simulations to complement traditional onsite activities (e.g. Khalil 2021). This would allow them a safe environment to test their skills and competencies and encourage them for real-life endeavors (relevant for medical practice, but also engineering).

Based on the exploration of COVID-19 courses' content and structure, there are two potential ways to go forward – either focused on the development of the online programme or on the improvement of traditional in-person teaching. Also, these new e-learning technologies offer various support for transitioning current educational practices into student-centred ones. Some studies indicate that online segments can help to follow a certain schedule and organize coursework, while offline/in-person segments can foster engagement and socialization (group activities, discussion sessions) within the course context. In addition, it is worth discussing which elements of online and onsite education should be considered compulsory or elective.

After the pandemic, people changed their perception of the educational process and consider new learning approaches. The changed perception and experience during the pandemic period opens many opportunities, but also, obliges educators to tackle these requirements in the post-pandemic period. For example, educators should tailor their teaching practices toward the requirements of the online environment. Online education (and lessons learned from COVID-19 period) seems to be very promising and complementary to onsite education, and it is up to institutions to take the advantage of these newly obtained educational insights to improve the effectiveness of undergraduate programmes.

6. TACKLING FUTURE CRISES

The emphasis on crisis-related scenarios would allow educational institutions to proactively plan for any future disaster/crisis events in terms of delivery of their teaching (Seville et al., 2012, Dhawan 2020) and usage of supporting technologies (Meyer & Wilson, 2011), or as Todorova & Bjorn-Andersen (2011) stated - "The key lesson for others may be to embrace e-learning technology before disaster strikes!". Tull (2017) stated that crisis situations (natural disasters) can actually motivate the adoption of advanced IT and e-learning technologies.

In general, disruptive events (even unfortunate ones) could be perceived as a challenge (Daniel, 2020) and an opportunity (Azorín, 2020). Within that context, Dhawan (2020) conducted a full SWOC Analysis of Online Learning approaches and technologies during crises (Figure 2).

Figure 2: SWOC Analysis of Online Learning (Dhawan, 2020)

Based on the study conducted by Dhawan (2020), potential opportunities for online teaching during a crisis are in accordance with their general potential benefits. However, the emphasis is put on the contextualization of an implementation strategy. For that reason, it is crucial to conduct preliminary and preparatory activities to anticipate future crisis situations. The opportunities such as familiarity with education technology and flexibility of teaching content could inspire educators to continue on the same path. This would include the continuation of

their efforts in terms of improving online education. The whole COVID-19 situation forced both students and educators to adapt and solve issues they experienced during their teaching-learning process, but also lead to required modifications of pedagogical approaches. Another opportunity which can broaden the reach of teaching material is inclusivity (users of different age groups, locations etc.).

Of course, these opportunities come in parallel with various challenges that need to be tackled in the forthcoming period (Dhawan 2020). In general, to keep the same quality (or reasonable level) of online learning represents a huge challenge for educators, especially in terms of student engagement and participation which is hard to accomplish. Due to the possible digital divide phenomenon, it is necessary to provide learning material on as many digital platforms, so that it is easily accessible. Of course, besides increasing/maintaining the level of IT and administrative support for introducing these online practices, educators need to be instructed and guided throughout this process of improving their digital competencies. During the post-pandemic period, HEIs should try to search for alternatives during any type of crisis/disruptive event, and to foster both synchronous and asynchronous ways of online teaching/learning. However, due to the given circumstances, asynchronous activities could be often preferred within the context of crises.

In order to successfully overcome challenges during these crisis situations, it would be advisable to explore and analyze various available technological and pedagogical solutions available for teaching/learning. The main criteria should be used based on the initial CResDET findings taking into account characteristics of crisis, but also required course/curriculum learning outcomes.