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Smart Education?

Understanding the impact of the COVID-19 pandemic in higher education institutions

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Master Thesis

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To my family

Abstract

The usage of technological tools is increasing in the educational field, and smart education became a new trending among institutions. In 2020, a sudden pandemic caused by the virus SARS-CoV-2 has spread across the world, changing the form of delivery of several services, including education. This research aims to understand the impact of the COVID-19 pandemic on higher education institutions, through the identification and characterization of the main activities carried out by faculty and students, the tools used in this new educational approach, the different actors involved in this process and their perceptions.

To answer these questions, a qualitative methodology was applied. For data collection, ten professors and twenty students from different fields and associated with higher education institutions were selected for in-depth and semi-structured interviews, conducted in person or remotely. The interviews went through a complete transcription process and were then structured and analyzed according to Gioia's methodology.

From the results obtained, it is possible to identify how institutions have provided the learning during this period of physical distancing. The students are attending classes in an online environment, supported by communication software such as Zoom and Microsoft Teams, or Learning Management Systems, for instance, Blackboard. Some aspects are different in a remote educational environment, for instance, doing other things while are attending classes is a typical activity among students, but professors cannot control this because it is not easy to keep students' attention in online classes. Also, professors found other ways to fill the gaps caused by the unavailability of physical facilities to provide laboratory classes. Besides, the adoption of continuous evaluation has been increasing among institutions to perform students' assessments. Institutions have been playing an essential role in supporting professors and students in this different format of learning delivery.

Some negative perceptions of the remote educational environment are loss of body language, lack of interaction, and lack of faculty training. On the other hand, this teaching and learning approach is leading an increase in learning opportunities, is more flexible and convenient, and allowed the continuation of academic activities during the pandemic period.

Keywords: Smart Education, COVID-19 pandemic, higher education institutions.

Resumo

O uso de ferramentas tecnológicas está aumentando no campo educacional, e *smart education* tornou-se uma nova tendência entre as instituições. Em 2020, uma súbita pandemia causada pelo vírus SARS-CoV-2 espalhou-se por todo o mundo, alterando a forma de prestação de vários serviços, incluindo educação. Esta pesquisa tem como objetivo compreender o impacto da pandemia do COVID-19 nas instituições de ensino superior, através da identificação e caracterização das principais atividades realizadas por professores e alunos, as ferramentas utilizadas nessa nova abordagem educacional, os diferentes atores envolvidos nesse processo, bem como as suas perceções.

Para responder a essas perguntas, foi aplicada uma metodologia qualitativa. Para a coleta de dados, dez professores e vinte alunos de diferentes áreas e vinculados a instituições de ensino superior foram selecionados para entrevistas em profundidade e semiestruturadas, realizadas pessoalmente ou remotamente. As entrevistas passaram por um processo completo de transcrição e foram estruturadas e analisadas de acordo com a metodologia de Gioia.

A partir dos resultados obtidos, é possível identificar como as instituições proporcionaram o aprendizado durante esse período de distanciamento físico. Os alunos estão participando das aulas em um ambiente on-line, através de plataformas de comunicação como Zoom e Microsoft Teams ou Learning Management Systems, como por exemplo, Blackboard. Alguns aspetos são diferentes em um ambiente educacional remoto, por exemplo, fazer outras coisas enquanto assiste às aulas é uma atividade típica entre os alunos, mas os professores não conseguem controlar isso porque não é fácil manter a atenção dos alunos nas aulas on-line. Além disso, os professores encontraram outras maneiras de preencher as lacunas causadas pela indisponibilidade de instalações físicas para fornecer aulas de laboratório. A adoção da avaliação contínua vem aumentando entre as instituições para realizar a avaliação dos alunos. As instituições têm desempenhado um papel essencial no apoio a professores e alunos nesse formato diferente de entrega do aprendizado.

Algumas perceções negativas do ambiente educacional remoto são perda de linguagem corporal, falta de interação e falta de treinamento de professores. Por outro lado, essa abordagem de ensino e aprendizagem está levando a um aumento nas oportunidades de aprendizagem, é mais flexível e conveniente e permitiu a continuação das atividades acadêmicas durante o período de pandemia.

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List of abbreviations

F2F – Face-to-face

EL – E-learning

BL – Blended Learning

ICT - Information and Communication Technology

ICTs – Information and Communications Technologies

LMS – Learning Management Systems

WHO – World Health Organization

IT – Information Technologies

CS – Communication Software

IS – Information Systems

1   Introduction

Education is changing over the last years, and the traditional face-to-face (F2F) educational environment does not address the student's needs anymore (Frost & Chopp, 2004). The universities are concerned not only with attracting new students but also with the students' experience, seeing them as customers (DeShields, Kara, & Kaynak, 2005). Because of this, Smart education has become a new trend in the global educational area and different teaching and learning approaches emerged, such as E-learning (EL) and B-learning or blended learning (BL) (Zhu, Yu, & Riezebos, 2016). Smart education is defined as an activity that takes place outside the traditional classroom, providing a large flexibility regarding the time and place and is delivery through technological tools (Bajaj & Sharma, 2018; Z. Zhu & He, 2012). EL is the leaning delivery through the electronic media (Choudhury & Pattnaik, 2020); on the other hand, according to Garrison and Vaughan (2008), BL is a mix between F2F and EL approaches.

The progress of Information and Communications Technology (ICT) supported the shift between traditional to distance learning in high education institutions. However, this change was not smooth because, until now, due to cultural aspects, students still preferred face-to-face interactions (Delfino, Manca, Persico, & Sarti, 2004). According to Ally and Prieto-Blázquez (2014), once the educational model based on classroom interactions emerged before the advent of ICT, it is faced as outdated. The use of technology in traditional environments facilitates personalized learning services and the students' empowerment to improve the learning experience (Z. Zhu & He, 2012).

The current worldwide situation caused by the COVID-19 pandemic has had an unexpected impact on several service areas that were growing, for example, hotels, events, and tourism. Nevertheless, in other areas, it is possible to redesign the service offerings for the new reality of social distance, one of which is education. The higher educational institutions around the world faced an extraordinary situation where access to a physical environment was limited. Therefore, they reacted quickly to carry on academic activities during the pandemic, adapting the F2F education through technology tools, give some guidance to faculty about the best practices in a virtual environment. In this shift to a remote environment, several aspects are affected such as the activities performed, the forms of interaction and the pedagogy methodology used in this new dynamic of classes. Thus, it is essential to understand the impact of all this change from students and faculty, and who are the principal stakeholders involved in this process. Besides, due to the isolation, faculty and students are going through emotional and psychological strains that can affect the teaching and learning processes and the related outcomes.

This thesis aims to understand the adaptation process of the higher education institution stakeholders in this pandemic situation caused by COVID-19, where it forced them to a remote educational environment. From this, it is necessary to map the activities performed and platforms used by those involved in the teaching and learning process, as well as to characterize the perceptions and feelings involved during the adaptation process. To understand how COVID-19 pandemic impacted faculty and students enrolled in higher education institutions, the specifics research questions bellow are suggested:

RQ1: What are the activities performed by faculty and students related to the remote educational environment?

RQ2: What are the tools used by faculty and students in the remote educational environment?

RQ3: Who is involved in this adaptation process from the traditional to remote educational environment?

RQ4: What are faculty' and students' perceptions in a remote educational environment?

RQ5: What are the lessons learned and what can be improved from this unexpected experience with remote education?

To address these research questions, a qualitative methodology was applied to identify and characterize the touchpoints between students and faculty in a remote education environment considering the pandemic situation caused by COVID-19. With a 30-individual sample comprising students and faculty in higher education institutions, semi-structured individual in-depth interviews followed by literal transcriptions and coding supported this research. Some dimensions emerged from analysis, such as Activities, Actors, Feelings, IT Platforms and Perceptions, and the relation between these dimensions also is explained.

This thesis is organized in 7 chapters.

Chapter 1 covers the introduction, that englobes the description of the problem, the research questions, and how this document is organized.

Chapter 2 reviews the literature regarding the relevant themes and concepts in this research, the teaching and learning environments, and how ICT is applied in educational environments.

Chapter 3 characterizes the theoretical problem identified and the research gaps.

Chapter 4 explains the methodology adopted to gather data and analyze them to the development of this project.

Chapter 5 presents the results regarding the findings of this research.

Chapter 6 brings the discussion related to the findings and what already exist in the literature.

Finally, in chapter 7, the conclusions of this thesis are presented, the limitations that boundary this research is exposed, and some future challenges in this topic are suggested.

2   Literature Review

This chapter brings the most relevant literature related to a remote educational environment, namely, smart education, the application of ICT on education field, e-learning and blended learning, presenting definitions, advantages, disadvantages, and challenges.

2.1   Smart Education

The research interest in the smart education field is increasing quickly, mainly because the association of education with the latest technologies is a new requirement to prepare the students for the technology challenges that the digital era brings (Kiryakova, Angelova, & Yordanova, 2018; Singh & Miah, 2020). There are several definitions of smart education, according to Bajaj and Sharma (2018), smart education is an activity that takes the learning process outside the traditional F2F learning environments and can be done anytime and anywhere. Using smart technologies to create intelligent environments and provide a personalized learning service supported by smart pedagogies is the definition proposed by (Z. Zhu & He, 2012). According to Kiryakova et al. (2018), smart education is a change of educational paradigms to the needs of the technology natives based on smart technologies and devices. Kim and Kim (2013) synthesize smart education as personalized learning based on ICT or smart devices that focus on increasing learners' skills development where it is possible to adopt cooperative and individual learning processes, and Zhu et al. (2016) summarizes smart education as an intelligent, personalized and adaptive type of education.

Improving the learners' quality of continuous education and offering personalized instruction with a creativity-centred educational approach, are the main objectives of smart education, (Zhu et al., 2016). In order to make this feasible, it is essential to cultivate teaching skills that support the creative use of smart devices and technologies that are encompassed in a smart educational environment (Crook, 2016), because innovative pedagogy methods and tools are required to maximize active learning and intensify students' creativity (Lytras, Visvizi, Daniela, Sarirete, & Ordonez De Pablos, 2018). Besides pedagogical theory and teaching skills, educational technology leadership, educational structures, and educational ideology are other challenges for smart education (Zhu et al., 2016).

Structuring this new educational approach to facilitate understanding related to this field is an important task. Thus, some authors have proposed structures to support smart education theory. Jung (2001) proposed a framework based on three variables, *Teaching*, *Communication*, and *Learning*. The teaching variable considers the content expandability and adaptability in this environment, the communication variable encompasses the interactions in academic, collaborative, and interpersonal contexts, and the learning variable covers the learners' autonomy and collaboration.

MacDonald, Stodel, Farres, Breithaupt, and Gabriel (2001) proposed two blocks, one for *Superior Structure* that gives support to the other that encompass *Outcomes* and *Consumers' Demands*. The *Superior Structure* is the necessary foundation that makes possible to reach the learners' needs and summarizes in anticipate learners' needs, consider learners' motivation, establish a collaborative and healthy learning environment, design a curriculum based on program goals, use appropriated pedagogical strategies, conduct regular learner evaluation and ensure the program is convenient to the learners. The *Outcomes* expected are lower costs, personal advantages, and superior learning outcomes. Moreover, *Consumers' Demands* are quality content, delivery, and service.

Tikhomirov, Dneprovskaya, and Yankovskaya (2015) proposed three dimensions as a framework for Smart Education: *Organizational*, ICT, and *Educational Outcomes* dimensions. The *Organizational* dimension is related to the strategy of smart education development that allows flexibility to create an adaptive educational trajectory, combining different learning forms, openness regarding admissions requirements, the use of knowledge management and individualization and customization of the program for each learner. The ICT dimension is responsible for developing a smart environment that uses smart educational technologies and tools that are integrated, allows interactivity and mobility, and make available social interaction tools to involve students in communication with teachers. Finally, the *Educational Outcomes* are the essential dimension for this framework, to train a new generation of students, and to develop interconnected professional communities, a set of content, knowledge, and cognitive skills are delivery in a quick way to students.

2.2   Information Communication Technology in Education

Information and Communication Technologies (ICTs) are at the centre of the globalization processes (Van Laar, Van Deursen, Van Dijk, & De Haan, 2017), and the skills related to ICTs are needed to survive the 21st century's challenges (Butt, Siddiqui, Soomro, & Asad, 2020). According to Toro and Joshi (2012), Information and Communication Technologies are defined as an assortment of technological resources and tools used to communicate and to generate, distribute, save, and manage information. In an educational context, ICTs are not only related to devices usage but additionally allied with pedagogical approaches and associated with a set of skills and competencies that teachers and students must enhance to improve the ICTs tools' potential (Zuppo, 2012).

In a literature review, Fu (2013) summarizes the benefits that ICTs brings to education:

- Assist students in accessing digital information efficiently and effectively
- Support student-centred and self-directed learning
- Produce a creative learning environment
- Promote collaborative learning in a distance-learning environment
- Offer more opportunities to develop critical thinking skills
- Improve teaching and learning quality

According to Cervera and Johnson (2015), the main reasons for integrating ICT in education are: to meet the need to develop digital skills required by this new era, to help bridge the digital divide to guarantee the active participation of citizens in the current context, and this integration brings benefits for teaching and learning. Butt et al. (2020) states that ICTs revolutionize the teaching and learning process into a powerful, appealing, and pleasant way to connect the traditional learning environment with daily life routines.

Toro and Joshi (2012) related the major challenges of introducing ICTs in education are lack of top-level commitment, lack of awareness, and the high costs of infrastructure, course development, and delivery.

2.3   E-learning

According to Laurillard (2004), e-learning is the usage of technologies in the service of learning or learner support. On the other hand, Choudhury and Pattnaik (2020) go more in-depth and

define e-learning as learning delivery through electronic media in an environment that is adequately designed for this activity.

Different forms of communication are considered in the e-learning approach: asynchronous and synchronous (Benson, 2010). While asynchronous e-learning is characterized as intermittent on-demand access, pre-recorded, just in time and poorly collaborative type of learning, synchronous e-learning is provided in real-time, the classes are scheduled and conducted in virtual classrooms with live transmissions, and more collaboratives using online chats to increase the interactions between students and teachers (Dharmawansa, Nakahira, & Fukumura, 2013).

Some researches focus on the advantages of the implementation of e-learning, in a literature review Arkorful and Abaidoo (2015) highlight the main advantages: the flexibility regarding the time and place; the improvement of the knowledge due to the easy access to information; the elimination of the barriers concerning the learners' shyness providing participation and discussions through online forums; the minimization of the costs when travels from/to universities are taken into consideration; the possibility of students to follow learning self-paced; the support related to the scarcity of academic staff.

The e-learning approach also presents some disadvantages. In a review of 138 papers published in the last two decades, Choudhury and Pattnaik (2020) identified the main disadvantages related with EL are: transactional distance; upfront cost; no peer to peer exchange; words and messages can be misunderstood; the instructor cannot see learners body language; learner feedback difficult; internet fatigue; blurring lines of work and home; digital divide; and absence of effective evaluations.

Selim (2007) identifies eight categories of critical success factors perceived by students that need to be considered in the development or implementation of e-learning courses in universities:

1. Instructor's attitude towards and control of the technology

2. Instructor's teaching style

3. Student motivation and technical competency

4. Student interactive collaboration

5. E-learning course content and structure

6. Ease of on-campus internet access

7. Effectiveness of information technology infrastructure

8. University support of e-learning activities

Once the learning dynamics are different in an e-learning environment than in a traditional F2F approach, new challenges arise for this teaching and learning approach. Tîrziu and Vrabie (2015) summarize the main challenges of e-learning as follows: support and guidance for students to consider the usage of the LMS; teaching and learning activities that involve interactivity, collaboration, interaction with peers and practical activities; the access to platforms considering the availability of tools (computers, laptops, tablets, smartphones...) and the quality of the internet connection that can affect the learning process; attitudes on IT and e-learning mainly how people perceive F2F approach better than an online environment.

2.4   Blended learning

Blended learning is defined as teaching and learning approach that consists of a mix between the best practices of F2F and EL, that results in a different approach, mainly regarding the communication timing, integrating synchronous (oral communication) with asynchronous (text-based communication), and, the communications ways modes, combining the direct with the mediated (Garrison & Vaughan, 2008). According to O'Byrne and Pytash (2015), hybrid learning and mixed-mode learning are also terms used to refer to this teaching and learning approach. However, there is no exact proportion between each kind of approach to consider b-learning (Garrison & Kanuka, 2004; Monk, Guidry, Pusecker, & Ilvento, 2020). Thus, since providing access to resources through a learning management system (LMS) for a previous study for lectures until replacing contact hours from a F2F environment to an online environment is considered a blended learning approach.

In a literature review, Sharpe, Benfield, Roberts, and Francis (2006), integrated eight dimensions that encompass the possibilities of blended learning:

• Different modes of delivery, face-to-face and distance education

• Technology mixtures of web-based technologies

• Chronology synchronous and asynchronous interventions

• Locus practice-based vs. classroom-based learning

• Roles multi-disciplinary or professional groupings

• Pedagogy different pedagogical approaches

• Focus acknowledging different aims

• Direction instructor-directed vs. autonomous or learner-directed learning.

Also, Garrison and Vaughan (2008) highlight that the underlying assumption for applying a blended learning approach is to maintain the educational mind open to a wide range of possibilities.

Many of the recent BL studies focus on verifying the improvement of results between groups that only have face-to-face classes against groups where the b-learning approach is applied. To measure the effect of BL and F2F students' achievements, Demirer and Sahin (2013) measure the grades and projects for the two groups and conclude that there is no significant difference between the grades in both groups. However the authors found the group enrolling in a BL environment transferred their knowledge in projects better than the group in a F2F environment. Monk et al. (2020) measure students' grades in a management information system course to verify if a blended learning environment provides, in fact, better outcomes than a traditional course and concludes that b-learning is comparable to F2F considering grades, even though a F2F environment is more attractive for students. Keith and Simmers (2013) found through grade comparison between technology-savvy millennials from the United States and China taking F2F classes and blended classes, respectively, that the Chinese students enrolled in a BL environment had higher performance than the American students in a F2F environment. McKenzie et al. (2013) advocate that students' who have access to formative assessments using a b-learning approach are more successful in summative assessments than those who not have.

More recent literature on blended learning seeks to understand students' experience and engagement in classes where they use a blended learning approach. Farley, Jain, and Thomson (2011) investigated the students' perceptions of different learning environments through

undergraduate finance students' group over three years and found that students still have a strong preference for F2F environments. Manwaring, Larsen, Graham, Henrie, and Halverson (2017) researched about the students' engagement in b-learning classes in higher educational institutions, and their findings show if, on the one hand, the multitasking that b-learning brings has a negative influence on the students' engagement, on the other hand when students have multiple choices in learning activities the level of engagement increases. The usage of b-learning tools increases the students' attendance and satisfaction in classes (Stockwell, Stockwell, Cennamo, & Jiang, 2015).

To attend the student's flexibility needs in higher education institutions (McInnis & Hartley, 2002), the approach blended synchronous learning emerged. Bower, Dalgarno, Kennedy, Lee, and Kenney (2015) defined blended synchronous learning as a teaching and learning approach in which remote students can participate in F2F class through synchronous media technologies, such as video conferencing. That means, in this approach, professors give lectures to two different audiences at the same time: onsite and remote students (Rogers, Graham, Rasmussen, Campbell, & Ure, 2003).

In addition to increase the acceptability of e-learning (Garrison & Vaughan, 2008), blended learning encompasses the convenience of students learning at their own pace without losing personalized monitoring in the learning process; nevertheless, the integration between such different teaching and learning approaches as F2F and E-learning remains a challenge (McKenzie et al., 2013).

To date, the literature focused on b-learning applies to research conducted in controlled environments, where it was possible to maintain the face-to-face classes combined with online components, where institutions were able to adapt their pedagogical plans, both in terms of content, and in terms of reflection on the subject best way to pass the content, considering the onsite and online approaches.

3 COVID-19 pandemic

On December 31, 2019, a respiratory infection of a unknow cause was reported to the World Health Organization (WHO) office in China. Two weeks later, Chinese researchers shared the genetic sequence of the novel coronavirus, and on January 13, 2020, the first case of this new disease was confirmed outside China, in Thailand (World Health Organization, 2020b)

Coronaviruses are a large family of viruses that may cause disease in animals or humans. The disease spreads primarily from person to person through inhalation to respiratory tracts of small infected particles with the coronavirus (World Health Organization, 2020a). At that time, WHO's recommended quarantine for people exposed to the disease but that are not ill, isolation for people who are ill, and physical distancing for everyone.

On February 11, 2020, the novel coronavirus disease was named COVID-19; the name is not related to an animal, location, or group of people to avoid any stigmatization. One month later, WHO characterized COVID-19 as a pandemic (World Health Organization, 2020a, 2020b). China managed the COVID-19 spreads due to several measures of isolation, and many countries around the world started to adopt the same measures as well.

Between March 04 and 15, 2020, educational institutions in Europe, the Americas, Asia, Africa, and Oceania started to cancel the presential classes to avoid the quick spread of COVID-19 and began as soon as possible with remote classes in order to continue the academic year (UNESCO, 2020). According to UNESCO (2020), on April 01, 2020, 1,598,099,008 students in 194 countries or territories were affected by the COVID-19 pandemic, and this represents 91.3% of total enrolled learners. These are extraordinary numbers, and the educational sector had to answer quickly implement remote solutions and give support all students that were private for presential education due to the pandemic COVID-19.

According to Marinoni, Land, and Jensen (2020) in a global survey report:

- 67% of higher education institutions reported that classroom teaching had been replaced by distance teaching and learning.

- 24% reported that most activities are currently suspended, but the institution is developing solutions to continue teaching and learning, through digital or self-study means.

- 7% reported that teaching had been cancelled.

- 2% reported that teaching and learning are not affected.

Marinoni et al. (2020) highlights that this transition in an emergency situation from face-to-face to online environment brings many challenges for the academic community, and three main challenges arouse, that were:

1. Technical infrastructure and accessibility - it is not easy to guarantee that all students have proper tools and access to the Internet to attend remote classes, mainly in developing countries.

2. Distance learning competencies and pedagogies - the necessity to employ different pedagogical approaches to keep the students motivated.

3. The field of study - the need for laboratory access for courses that depends on practical classes, for instance, clinical medicine and veterinary.

The education sector is going through a transformation due to the COVID-19 pandemic, and the ICTs are helping to avoid the considerable interruption on the teaching and learning process around the world despite all difficulties faced along this period.

This research considers the extraordinary and emergency reality caused by the COVID-19 pandemic, where the primary higher education institutions' concerns were to carry on the academic activities. For this reason, there was no time for the adaptation of pedagogical plans through the new reality of social distancing, since most institutions took between two to seven days to start classes in remote format. Therefore, further research is needed to understand how this adaptation process occurred namely, how the sudden change in the teaching and learning approach impacted the learning process in higher education institutions, covering the faculty and student's perspective.

4   Methodology

This section describes the rationale for the chosen methodology, as well as the procedures used for data collection and analysis, including the sample design.

4.1   Comparative analysis of existing approaches and reasons for the choice of adopted approach

According to Edmondson and McManus (2007), it is possible to classify a research theory referring to the state of prior work in the related area, namely, mature, nascent, and intermediate. A mature theory is a result of a well-developed prior work, supported by many studies and a substantial agreement between researchers about the constructs and models proposed. On the other hand, a nascent theory has fewer prior work and suggest new connections among phenomena. In the middle of mature and nascent theories, lays the intermediate theory, that has a more developed prior work than the nascent theory and presents explanations about the phenomena.

For each type of theory, there is a corresponding methodological fit in the respective stage of the research. Regarding the type of data collected, a nascent theory fits better with open-ended data that need to be interpreted for meaning; the best type of data for mature theory is quantitative data; for intermediate theory, the ideal is work with the two types of data, qualitative and quantitative. Interviews, observations, and material collected from field sites are proper methods to gather data in nascent and intermediate theories, while surveys are a suitable method for mature and intermediate theories. Considering the methodological approaches, thematic content analysis is a suitable technique for nascent theories; content analysis, exploratory statistics, and preliminary tests are recommended for intermediate theory; statistical inference and standard statistical analyses are adequate for a mature theory (Edmondson & McManus, 2007).

This research considers an extraordinary scenario, the COVID-19 pandemic, and aims to understand how its impact on faculty and students was, and on the adaptation process between the shift from a presential class to a remote environment. Consequently, there is few prior work related to it, so guidelines recommended by Edmondson and McManus (2007) for nascent theory apply to this research.

4.2   Method used in the project

To identify and characterize which are the touchpoints between students and higher education institutions in a remote educational environment considering the current situation, a qualitative research methodology was chosen.

Regarding the data collection, to learn about students' and faculty concerns, perceptions, reactions, and thoughts related to a smart educational environment, semi-structured face-to-face in-depth interviews were employed with open questions. Due to the need for physical distancing, some interviews were conducted remotely. The interview scripts was developed based on the frameworks proposed by Jung (2001), MacDonald et al. (2001) and Tikhomirov et al. (2015), in this way four remote education dimensions were covered: communication dimension, teaching dimension, learning dimension and outcomes dimension. Thus, the main dimensions proposed by the literature were included in the interview script. Two different types

of scripts were developed, one for the students and another for faculty (*see Appendix A and Appendix B*).

 To collect the data, a theoretical sample reached through a snowball sample technique proposed by Goodman (1961) of 20 students that attend bachelors', masters', and doctoral programs in institutions that adopted remote education in the last months due to the current pandemic worldwide situation, and enrolled in courses that have been taught remotely was selected. Besides that, the sample selection covered different educational areas like Engineering, Health, and Social Sciences, to bring the maximum diversity of knowledge, challenges, and experience. Also, a theoretical sample of 10 higher education institution's professors who adopted remote education in the last months was selected, to have a clear understanding of the remote education experience. Table 1 shows in detail the sample distribution for this research. Each interview took around 30 minutes, personally or via Skype, Zoom, Google Meet, or Microsoft Teams, and all of them were recorded for further analysis; the 30 interviews totalized 15,37 hours of recording data. The data collection period for this research occurred between April 29 and June 9, 2020, that is, during the process of adapting to the new teaching format adopted by higher education institutions where the interviewees attend or teach.

After being recorded, the interviews went through a full-transcription process, and data analysis was supported by the software NVivo12 and followed the Gioia Methodology (Gioia, Corley, & Hamilton, 2013).

In this methodology, raw data are highlighted with informant terms, that are consolidated in themes and after that dimensions, to maintain the data collected structured. The data structure is a crucial component for demonstrating rigor in qualitative research, allowing the researchers to configure their data into a sensible visual aid and provides a graphical representation of how they progressed from raw data to terms and themes in conducting the analysis (Gioia et al., 2013).

The main dimensions that emerged in this data analysis where: Activities, Actors, Feelings, IT Platforms, Perceptions, and Type of Education. The next section details the main dimensions, relating them with the themes and terms that emerged from data collected on interviews.

Sociodemographic data	Faculty *n = 10*	Students *n = 20*
Age		
18 - 20	-	3
21 - 25	-	9
26 - 30	1	3
31 - 35	2	3
36 - 40	2	2
41 - 45	1	-
46 - 50	1	-
50 +	3	-
Field		
Applied Social Sciences	2	6
Arts	-	2
Engineering	1	10
Exacts Sciences	2	-
Health Sciences	2	2
Human Sciences	3	-
Gender		
Female	6	11
Male	4	9
Nationality		
Brazilian	4	15
Portuguese	6	4
Portuguese-Brazilian	-	1
Residence Country		
Portugal	6	12
Brazil	4	8
Teaching time		
Up to 5 years	2	*Do not apply*
6 - 10 years	2	*Do not apply*
More than 10 years	6	*Do not apply*
Ongoing degree		
Bachelor	*Do not apply*	9
Integrated Masters	*Do not apply*	4
Masters	*Do not apply*	6
PhD	*Do not apply*	1
Current year		
1	*Do not apply*	11
2	*Do not apply*	4
3	*Do not apply*	3
4	*Do not apply*	2
Exchange student	*Do not apply*	2

Table 1 - Sample distribution

5   Findings

This chapter presents the main results obtained through the interviews analysis. The main dimensions are introduced and explained, and the themes and terms that emerged during the analysis of all data collected also are presented.

The consolidated dimensions related to the experience in a remote educational environment are presented in Table 2. The second column shows the amount of times that the dimension was mentioned in all interviews. The dimensions *Perceptions*, *Activities*, *IT Platforms*, *Actors*, *Feelings*, and *Type of Education* are the most referred in the interviews, and to understand the impact of COVID-19 pandemic they will be detailed in the next sections. However, the opening of the other dimensions is detailed in *Appendix D* and *Appendix E*.

Dimensions	References
Perceptions	630
Activities	487
IT Platforms	413
Actors	337
Feelings	291
Type of Education	232
Communication	140
Evaluation	140
Content	127
Pedagogical aspects	110
Type of class	69

Table 2 - Remote Educational Dimensions

Figure 1 depicts the relation between the main dimensions that emerged in the data analysis process. The *Actors* use *IT Platforms* that give support to the actors to perform *Activities*. Also, the *Actors* have *Perceptions* regarding the remote educational environment, which lead the *Actors* to experience some *Feelings* related to it. Besides, the *Perceptions* help the *Actors* assess the *IT Platforms* and notice the importance of the *Activities*.
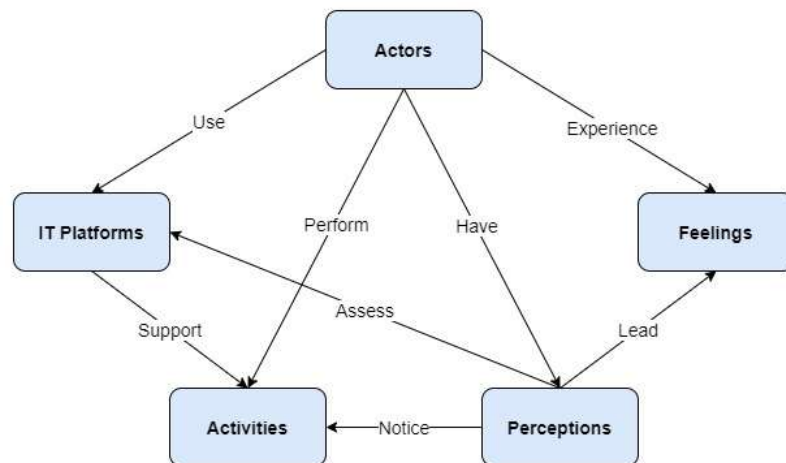

Figure 1 –Main dimensions in a remote educational environment

5.1 Perceptions

This dimension represents the way that faculty and students understood or interpreted the other dimensions. To a better understanding it is divided in three types of perceptions: negative, neutral, and positive. Also, there is another division regarding the level of the perception, if is in an organizational level, personal level, or technical level. The organizational level is related with perceptions that require management intervention. The technical level considers perceptions related with the hardware or software. And the personal level brings the perceptions related to intrapersonal features.

Table 3 presents the perceptions at the organizational level, considering the number of faculty and students that mentioned them. Some students complained about the lack of financial support for the institutions and, due to the short time available to start the classes in a remote environment, and appropriate faculty training did not happen. Faculty and students mentioned the lack of control in exams application in a remote educational environment, and some professors are looking for alternatives to avoid students cheating on exams; for instance, the reduction of the available time to deliver the final document has been a used practice among professors. The interviewees agree that the educational field is passing through a digital transformation, and due to the classes adaptation for an alternative delivery format, the continuity of academic activities was possible, even with this pandemic context. Institutions are reinforcing the psychological support for students and faculty members during this pandemic period.

"...in this aspect they are not flexible at all and many people are complaining about not having money to pay."

Bachelor Engineering student, 20, about lack of financial support

"They have no time freedom to take the exam, they are all currently online for 90 minutes taking the exam, at a specific time as if they were inside a room."

Human Sciences Professor, 58, about avoid cheating in the exams

"I had to change the way of teaching a little."

Engineering Professor, 33, about adapting to the new reality

Perceptions	Faculty n = 10	Students n = 20
Negative		
Inadequate physical structure	2	1
Lack of control in exams application	2	3
Lack of financial support	1	5
Lack of tools	2	4
Lack of training	2	5
Platforms diversity	1	1
Slow feedback	1	5
Neutral		
Avoid cheat	8	7
Easy access to info	2	2
Psychological support	5	15
Regular feedback	0	1
Positive		
Adaptation	7	13
Available	3	7
Communication diversity	0	1
Continue with academic activities	1	4
Costs reduction	1	2
Digital transformation	7	5
Improvement	1	6
Increase learning opportunities	3	6
Less rework	1	2
Organized	5	9
Quick feedback	3	8

Table 3 - Perceptions: Organizational level

Table 4 depicts the perceptions at the technical level, also separated by faculty' and students' mentions. Regarding this theme, the unique term that emerged related to neutral perceptions was "Integrated Solution" mentioned by only 4 students. Some platforms are not intuitive; also, connection failure summed with overloaded servers are negative perceptions mentioned by interviewees. Privacy and security are concerns mentioned by the majority of faculty and students. However, other platforms are mentioned as intuitive and equipped with a diversity of tools. Besides, interviewees mentioned that the previous experience with the platforms used and the facility to quickly learn the dynamics of new platforms due to the students being technology natives are positive perceptions.

"I already had a drop in internet connection here about to teach and I panicked."

Applied Social Sciences Professor, 28, about connection fail

"I am concerned about possible attacks that may happen, but at this moment, given that platforms end up making life easier, we end up taking the risk."

Master Engineering student, 22, about privacy and security concerns

"I am already graduated in Literature and it was distance, semi-presential. So, I was not surprised at all regarding the remote teaching methodology."

Bachelor Applied Social Sciences student, 30, about previous experience

Perceptions	Faculty n = 10	Students n = 20
Negative		
Connection fail	6	10
Not intuitive	3	6
Overloaded server or software	3	3
Privacy and Security concerns	7	11
Positive		
Intuitive	3	8
Previous experience	6	8
Tools diversity	5	6
Technology native	1	5

Table 4 - Perceptions: Technical level

Finally, Table 5 shows the main terms mentioned in this theme, considering the number of sources and the occupation of each one. Students mentioned the difficulty of concentrating on online classes. Besides, interviewees mentioned the loss of body language, human contact, and interaction as differences between the learning delivery ways. Students see as harmful the cancellation of laboratory classes, and they prefer the F2F environment over the remote classes. Also, a conceptual conflict emerged during the interviews, some professors mentioned that this format is not distance education, but an adaptation of the presential environment. However, some positive perceptions mentioned considering the educational approaches such as flexibility, time availability, convenience, and involvement. Besides, perceptions regarding platforms also emerged, for instance, quality and dynamics. The platforms that simulate a F2F environment are more welcomed by faculty and students. Interviewees also mentioned how they motivate themselves and keeping the compromise to continue academic activities.

"At least in my view, contact and information exchange are lost a little when there is this distance between ... the physical distance."

Master Engineering student, 26, about lack of human contact

"I'm not doing distance education ... I'm replacing my face-to-face classes with online ones."

Exact Sciences Professor, 53, about conceptual conflict

"If my colleagues make an effort, I also have to make the effort, my teachers are trying, I also have to try, I think it is ... the motivation comes a little from everyone's inspiration, to be present."

Master Engineering student, 21, about motivation

Perceptions	Faculty *n = 10*	Students *n = 20*
Negative		
Disinterest	4	4
Disorganized	0	8
Distraction	2	10
Does not replace	5	9
Harmful	2	9
Impersonal	4	4
Increase of tasks	5	4
Lack of human contact	7	10
Lack of interaction	9	8
Lack of time	3	4
Loss of body language	7	3
Unfair	2	6
Uninteresting	1	7
Unproductive	2	5
Neutral		
Conceptual conflict	3	0
First experience with remote education	2	2
Similar interaction	1	3
Positive		
Adherence	4	1
Good quality	3	5
Independent	1	4
Interesting	2	7
More available time	3	8
More involvement	4	4
Motivation	4	11
Commitment	4	6
Productive	3	2
Convenient	2	11
Flexibility	3	11
Good dynamics	3	11

Table 5 - Perceptions: Personal level

5.2 Activities

At this dimension, the activities performed by faculty and students during this time of remote classes are consolidated, Table 6 shows the activities reported.

Activities	Faculty n=10	Students n=20
Attend or Give classes	10	20
Attend or Give practical classes	9	12
Autonomous study	6	20
Elaborate assignments	6	18
Elaborate exams	7	0
Give feedback	1	0
Go to university	2	4
Guide a thesis	2	0
Leisure	1	7
Provide conditions for remote classes	9	12
Share content	10	18
Spend time with family	0	4
Stay at home	5	13

Table 6 – Activities

The activities mentioned are detailed below:

Attend or Give classes – In this activity, faculty mentioned that they have to control the interaction to ensure a good dynamics in classes and balance the students' interaction to avoid that students less comfortable with the remote environment have a lack of participation during classes. Students' actions are related to taking notes and taking questions. Faculty and students mentioned that in this remote environment is typical students do other things while they are connected to online classes, and the faculty must use pedagogical techniques to keep students' attention during the classes. Also, they noted that some students avoid attending online classes, mainly because they do not adapt to this type of educational approach.

Attend or Give practical classes - Considering the COVID-19 pandemic, practical classes went through some modifications once it was impossible to attend the practical classes in laboratories and perform experiments due to the social distancing. To overcome this difficulty, some faculty substituted lab experiments for simulations supported by the software. Although in some courses, it was impossible to make this change, other alternatives were to show videos and pictures with the experiment working and substitute the experience by assignments related to the experiments and ask students to present this research in classes.

Autonomous study - Here, students mentioned some characteristics regarding the independently conducted study. Organizing schedules during this period of isolation has been a technique widely adopted by students. The access to classes recordings is related as an advantage of the remote educational environment and look for extra content also is a practice adopted among students to fully understand the content. Besides that, some students create groups to study together through IT communication platforms.

Elaborate assignments - Once a considerable part of students' evaluations modified from presential exams or laboratory reports to individual or group assignments, developing assignments has high importance in this context. Here students have group meetings to discuss the assignment topics under development, write reports with the support of simultaneous edition software, and prepare slides and record presentations.

Elaborate exams – Due to the impossibility of applying presential exams, faculty explored other possibilities for exams application; consequently, alternative IT tools and other exams format were used to make this possible. The LMS, such as Moodle and Blackboard, was the alternative more adopted among faculty.

Give feedback – This activity is related to the feedback that faculty give to students regarding the assignment's presentation, usually applied in a continuous evaluation format where students use the feedback to improve the next assignment delivery.

Go to university – The routine to go to university was mentioned by students and faculty as an activity that helps maintain good habits in daily life and is suitable for social living.

Guide a thesis – This activity was less affected by the shift to a remote environment. Faculty mentioned that the only change was where the orientational meetings took place, instead of the professors' office, now the meetings are scheduled through IT communication platforms.

Leisure – Activities related to hobbies were consolidated in this theme. Sports practicing, reading books, watching movies and series, and playing video games were the activities mentioned by faculty and students.

Provide conditions for remote classes – Checking internet connection, tools availability, and software accessibility were steps that some institutions followed to guarantee the minimum condition to faculty and students attend classes in a remote environment. Also, giving proper training to teachers to use the technological tools that fit each situation better was a step followed by many institutions. Faculty give additional academic support to students in order to ensure a fully content understanding.

Share content – In a remote educational environment, sharing screens and using digital boards are forms to improve the interaction during classes. Some professors recorded the live stream classes to provide students an additional way to independent study. Before sharing videos, usually, they pass through an edition process. During the exams in a remote educational environment, professors ask students to take pictures of the answers and upload them on the platform. In assignments elaboration, students share files through file management services to create reports and slides. Professors also share files with students, usually through LMS, communication software, or email.

Spend time with family – Due to the remote classes, students mentioned that they have more available time to spend time with their families.

Stay at home – Different opinions have emerged in this aspect. While some are used to staying at home and are comfortable with this situation, others have a hard time maintaining the routine. Consequently, academic performance is negatively affected.

5.3 IT Platforms

This dimension presents the types of IT Platforms that faculty and students are using to perform the activities presented in the previous table, Table 7 presents the themes consolidated.

Communication Software (CS) and *Learning Management Systems* (LMS) are the most relevant themes in this dimension. Thus, Table 8 shows these two themes in detail. Zoom, WhatsApp, Microsoft Teams, Google Meet, and Skype are the leading platforms that teachers and students use to communicate, while Moodle, Blackboard, and University Information System are the primary LMS. It is essential to highlight that the LMS is also an important communication

channel between teachers and students, and can be synchronous or asynchronous communication, depending on the platform.

Type of Platform	Faculty *n=10*	Students *n=20*
Analytics, Statistics and Spreadsheet software	2	1
Communication software	10	20
Edition software	6	10
Engagement tools	2	2
File management services	2	8
Learning Management Systems	9	20
Online library	0	1
Preventive software	2	2
Remote desktop software	0	1
Social networks	2	4
Streaming platforms	4	3

Table 7 - Types of IT Platforms

Analytics, Statistics, and Spreadsheet software are usually used in practical classes, Excel, R, RapidMiner and SPSS are the tools mentioned in this category.

Edition Software is used to create presentations, documents, videos, mathematical equations, and elaborate exams, the tools mentioned in this theme are Canva, Design Science, Equation, Exam.net, Google Docs, iDrew, and Microsoft Forms, Microsoft PowerPoint, Microsoft Word, and Panopto.

Engagement tools are used to improve the dynamics in remote classes. Kahoot and MindMaster are the platforms mentioned by faculty.

File Management Services are online repositories that allow faculty and students to share content; the platforms mentioned were Google Drive, Microsoft OneDrive, and WeTransfer.

Online Library, as Knovel, allows students to access a wide range of academic papers to improve the research process.

Preventive Software is related to antivirus and anti-plagiarism.

Remote Desktop Software is used for students to have access to university computers. AnyDesk and TeamViewer were tools mentioned in this theme.

Social Networks such as Instagram and Linkedin are used for some professors to share extra content and for students to communicate among them.

Streaming platforms are used as a complement content suggested by faculty for autonomous study or practical classes, also is used to perform leisure activities. The platforms mentioned are TED Talks, YouTube, and Netflix.

IT Platforms	Faculty *n = 10*	Students *n = 20*	Type
Blackboard	3	4	LMS
Corujito	1	1	LMS
Discord	0	3	CS
Facebook Messenger	0	2	CS
Google Classroom	0	1	LMS
Google Hangouts	1	1	CS
Google Meet	1	6	CS
Microsoft Teams	7	5	CS
Moodle	5	14	LMS
Professor Website	0	1	LMS
Skype	2	5	CS
Slack	1	2	CS
Telegram	1	2	CS
University IS	3	7	LMS
WhatsApp	3	19	CS
Zoom	9	16	CS

Table 8 - IT Platfoms

5.4 Actors

Besides the faculty and students, other actors are involved in the teaching and learning process. With an extraordinary situation as the COVID-19 pandemic, other actors have an essential role in the professor's and students' lives; for instance, family and psychologist, for international students, roommates, are also a vital presence daily life routine. The institution also plays an essential role in a remote educational environment. Despite the physical distance present in this new reality, students continue interacting with their colleagues, not only to develop assignments but also to spend some time, even this contact is only virtual. Table 9 depicts the actors mentioned by interviewees during the data collection.

Actors	Faculty *n = 10*	Students *n = 20*
Class' representant	1	2
Colleagues	0	20
Family	1	8
Institution	7	18
Invited professor	0	1
Professors	8	20
Psychologist	1	4
Roommates	0	4
Students	9	13
Students' Association	0	3

Table 9 – Actors

5.5 Feelings

This dimension is related not only with the feelings that interviewees mentioned, but also the emotions presented during the interview. This category is divided in two blocks, one for negative feelings mentioned/ presented and other one for positive.

Due to the increase of tasks mentioned before, interviewees feeling exhausting and overwhelmed. Feeling alone, anxious, confined, and demotivated are feelings that emerged due to the isolation demanded by the pandemic. Students mentioned that online dynamics inhibit their participation during classes. Some interviewees present a resistant to change from a F2F environment to a remote one. Interviewees also mentioned that they feel vulnerable regarding some IT platforms, mainly communication platforms. The feeling dissatisfied appears related to tools performance and educational approaches.

Previous experience with IT Platforms facilitates the classes' dynamics, and students feel more comfortable with their usage. The LMS is the platform more reliable due to the usage of an institutional account to log in to these platforms, so faculty and students feel more secure using them. The satisfaction presented in Table 10, usually is related to the alternative that institutions found to maintain the academic activities and the performance of an educational approach with a specific type of content.

Table 10 shows all feelings that emerges in data collection and below some quotes to illustrate the most mentioned feelings are presented.

"It's been very exhausting for me, I'm exhausted, both physically and mentally"

Exact Sciences Professor, 53, about exhausting

"Regarding face-to-face education, switching to distance education, I do not support it, I do not see any advantage."

PhD Engineering student, 24, about resistant to change

"What I do not like? I don't like video calls, sometimes I don't want to show my face, right?"

Bachelor Health Sciences student, 23, about shyness

"In Brazil I had already done some courses, I wanted to see the equipment here. And I could only see one in the first class..."

Bachelor Engineering student, 24, about frustration

"I didn't like it, because it failed a lot, there were incompatibilities, I didn't like it."

Human Sciences Professor, 45, about dissatisfied

"I was already very adapted in this virtual world, for me it was not a blow. It was not a new thing; I think it helped a lot."

Master Applied Social Sciences student, 31, about comfortable

"To really pass a pure theory, maybe the ... these classes in a virtual environment, they are proving to be more efficient."

Engineering Professor, 33, about satisfied

Feelings	Faculty *n = 10*	Students *n = 20*
Negative		
Afraid	0	5
Exhausting	3	4
Feeling alone	3	4
Frustration	0	6
Missing presential classes	2	2
Overwhelmed	4	2
Reflective	0	2
Resistant to change	5	7
Shyness	3	9
Uncomfortable	4	2
Vulnerable	3	8
Anxiety	2	4
Bored	0	1
Confined	0	6
Confused	1	6
Demotivated	4	6
Difficulty to fit in	0	4
Dissatisfied	7	12
Distrust	3	0
Positive		
Carefree	7	5
Comfortable	6	16
Encouragement	2	0
Proud	1	1
Satisfied	9	13
Secure	4	13

Table 10 – Feelings

5.6 Type of Education

In this dimension, the educational approach mentioned are presented, Table 11 shows the number of interviewees that mentioned each one.

F2F – Also mentioned by the interviewees as presential classes, this is the traditional model that institutions adopted. Due to the COVID-19 pandemic, institutions were forced to shift to other approaches or cancel academic activities.

E-learning – On the interviews, this approach is usually related to previous experience with online courses, and these courses might lead or not lead to an academic degree, sometimes mentioned by interviewees as distance learning or EAD (Ensino à Distância, in Portuguese).

Remote – Sometimes referred as online classes, this term was adopted by interviewees to refer to the current teaching and learning approach.

Blended learning – When asked about the future of education, interviewees believe that institutions will adopt a hybrid approach even when the physical distance barrier no longer exists, this term was also referred by the interviewees as a mixed educational approach.

Educational Approach	Faculty *n=10*	Students *n=20*
F2F	6	17
E-learning	1	3
Remote	10	20
Blended	7	9

Table 11 - Type of Education

5.7 Connecting dimensions

To provide a more in-depth view of the results, this section presents the results of connecting some dimensions.

These relations arose from the construction of coding matrices in NVivo12. Coding matrices are the result of the coding intersections between two lists of selected items, in this case, each list of items represents a dimension. The matrix cells represent the number of interviews that simultaneously mentioned those two dimensions, so it is possible to verify the dimensions that are related in a more representative way. It is also possible to go beyond dimensions, for a more in-depth visualization, themes and terms can also be related through the coding matrices.

The *Perceptions*, related with the *IT Platforms, Type of Education* and *Activities* were selected to allow a better understand about how the faculty and students assess the performance of the tools in use, notice the relevance of activities performed in the remote educational environment and an overview about each educational approach.

Table 12 shows a strong relation between CS and LMS with negative and positive perceptions.

Type of Platforms	Negative perceptions *n=30*	Neutral perceptions *n=30*	Positive perceptions *n=30*
Analytics, Statistics and Spreadsheet software	0	0	1
Communication software	22	4	24
Edition software	3	0	5
Engagement tools	0	0	1
File management services	0	0	2
Learning Management Systems	17	2	18
Online library	0	0	0
Preventive software	2	1	0
Remote desktop software	0	0	0
Social networks	0	1	3
Streaming platforms	1	0	4

Table 12 - Platforms *vs* Perceptions

Considering *Communication Software*, the platform Zoom is connected to negative perceptions to the technical level, and interviewees also mentioned *Privacy and Security Concerns*. On the other hand, positive perceptions are related to terms allocated at the personal level, faculty and students mentioned that Zoom is a platform with *Good Dynamics*, and WhatsApp is a *Convenient* software.

Learning Management Systems presents at the technical level negative perceptions linked to Blackboard as an *Overloaded Server or Software* and University IS as a *Not Intuitive* platform. Also, considering positive perceptions, Moodle is mentioned as *Organized* at the organizational level.

"I attended two classes on Zoom and then I deleted the application due to lack of security"

Bachelor in Applied Social Sciences, 37, about the platform Zoom and privacy and security

"WhatsApp seems to be more practical, just pick up the phone, do not change windows or anything, there is no time when a question, pick up the phone and ... it seems faster and more efficient."

Integrated Masters in Engineering student, 21, about the platform WhatsApp and convenience

"A big problem that I have observed is ... in Blackboard itself, it is very weak the system, it overloads very easily, so you are here, you will ask a question, out of nowhere you fall, just by turning on the microphone ... so sometimes their system is complicated."

Bachelor in Engineering student, 22, about the platform Blackboard and overloaded server

"I think the platform is very intuitive, things are clear on it, the teachers put all the necessary information"

PhD Engineering student, 24, about platform Moodle and organization

Crossing the dimensions *Type of Education* and *Perceptions*, is possible to see at Table 13 negative and positive perceptions linked to *Remote*, *F2F*, and *Blended* approaches.

Educational approach	Negative perceptions *n=30*	Neutral perceptions *n=30*	Positive perceptions *n=30*
Blended	2	1	8
E-learning	0	0	3
F2F	11	0	15
Remote	30	2	28

Table 13 – Type of Education *vs* Perceptions

F2F is mentioned by interviewees considering positive perceptions at the personal level as an approach that presents a *Good Dynamics* and has *More Involvement* during the classes. When respondents were asked about replacing presential classes with online classes, some negative perceptions stood out; therefore, these 11 interviewees that suggested negative perceptions presented in Table 13 for presential classes are related to the fact that respondents prefer F2F over online classes.

Blended is highlighted with positive perceptions at a personal level. Faculty and students believe that this approach provides a *Good Quality* of education, is an *Interesting* pedagogic proposal, and with the adoption of this hybrid format, they will have *More available time* to spend in other activities.

Regarding the *Remote* educational approach, interviewees presented negative and positive perceptions at the three levels. Considering negative perceptions, *Lack of training* at the organizational level refers to technological issues and the pedagogical inconsistency among faculty. At the technical level, *Connection fail* was an issue that the interviewees mentioned. Besides, at the personal level *Lack of human contact*, *Loss of body language*, and *Lack of interaction* were disadvantages referred by faculty and students, besides that, a remote educational environment presents more opportunities to *Distraction*, and according to interviewees, a remote educational environment *Does not replace* a presential environment. However, considering positive perceptions, at the technical level, *Previous Experience* with the platforms used in this new approach, and the fact that students are *Technology natives* were facilitators to the classes. At the personal level, some advantages were highlighted *More available time*, *Flexibility*, and *Convenient*, and this format with live-streaming classes is more *Reliable* than when the classes are pre-recorded. Finally, at the organizational level, the *Increase of learning opportunities*, the possibility to *Continue with academic activities*, and the *Adaptation* process faced by all actors involved in this environment were mentioned as excellent opportunities that emerged with this teaching and learning approach.

"I do not see the distance course replacing the face-to-face."

Master Integrated Engineering student, 30, about Remote environment does not replace F2F

"If we hadn't had the technology available to make up for the possibility it's in classes, I think it would have been a lot worse without a doubt because we'd have been stuck, eventually working over the summer or starting the semester over or ending the year later…"

Human Sciences Professor, 48, about continue academic activities with Remote education

Table 14 highlights the *Activities* and the respective *Perceptions* more relevant when crossing these two dimensions.

Attend or Give classes is positively related with flexibility, dynamics, motivation, and feedback and negative related with interaction, uninteresting and the internet connection.

Autonomous Study is positively related with flexibility, motivation, increase of learning opportunities and negatively related with organization, discipline, concentration, and human contact.

Share content is positively related with convenience, adaptation, organization, tools diversity, and is an intuitive activity.

Stay at home is convenient, but also results in an increase of tasks and distraction.

			Activities			
			Attend or Give classes	Autonomous Study	Share content	Stay at home
Positive perceptions	Personal	Convenient	2	2	3	4
		Flexibility	4	5	0	2
		Good Dynamics	7	1	1	0
		Motivation	5	7	0	0
	Organizational	Adaptation	1	0	3	0
		Increase learning opportunities	2	3	0	0
		Organized	2	2	3	0
		Quick feedback	3	1	2	0
	Technical	Intuitive	1	2	4	0
		Tools diversity	2	1	4	0
Negative perceptions	Personal	Disinterest	3	0	0	1
		Disorganized	0	2	0	0
		Distraction	2	3	0	6
		Increase of tasks	0	0	0	3
		Lack of discipline	1	2	0	2
		Lack of human contact	2	2	0	1
		Lack of interaction	4	0	1	0
		Uninteresting	3	0	0	1
	Technical	Connection fail	4	1	0	0
		Delay	2	0	1	0

Table 14 - Perceptions vs Activities

6   Discussion

Based on the results presented, this chapter provides a discussion about the impact of COVID-19 pandemic in higher education institutions.

From the findings presented in the previous chapter, the research questions proposed at the beginning of this research can be answered to clarify the impact on the faculty and students' daily life routines.

The dimension *Activities* presents the answer to RQ1, here is possible to see what the main tasks are performed in a remote educational environment. Once classes are happening through technological tools, is typical students do other things during the class' time, and this is an issue to faculty. As opposed to a face-to-face environment, faculty and students do not have physical contact, and most of the time, microphones and webcams are turned off, so it is hard faculty to identify if they are keeping students' attention or ensure if they fully understand of the content. Physical distance has also changed the way students are assessed, so institutions have widely adopted the continuous assessment format. Consequently, to elaborate assignments was an important activity for students, especially for students taking courses in the engineering area since the evaluation format in this field usually is carried out through exams. Besides, faculty had to be creative to overcome the unavailability of physical facilities to teach classes that needed laboratory equipment. Many of them managed to reinvent themselves through simulators, videos of how the experiments worked, encouraging students to go deeper into research through scientific papers and, in some cases, even continuing with the experiments and reporting to students through pictures that students should be watching in person. Several professors adopted another activity that was not usual in the F2F environment, recording classes. The sharing of this content with students was well accepted, mainly because it facilitates autonomous study, both in terms of being available for students to see as often as they want that class and at the time that is most convenient for them.

IT Platforms dimension encompasses the main tools currently used in the remote educational environment, responding to RQ2. Regarding this, there were variations in the approach taken by the institutions. While some made more extensive use of the LMS already adopted in the pre-pandemic period and guided all professors to use the same tool, others preferred to present a diversity of tools to faculty and leave them in charge of choosing which best suited their teaching approach. Professors broadly adopted tools such as Zoom, Blackboard, and Microsoft Teams for the transmission of synchronous classes, these tools allow the creation of dynamics similar to the face-to-face classes; for instance, within the same live transmission, students can be divided into small groups to facilitate the discussion of specific topics, allowing teachers to have access to all groups. Besides, students made broader use of file management systems, both for simultaneous editing of files and sharing of files for the development of the assignments. Communication platforms were extensively used during this period, and students usually use to discuss topics related to their assignments. Some teachers have created specific groups on these platforms to communicate with students, mainly if students want to ask questions about a specific topic that was not clear during the remote class. However, the most common means of communication for these purposes remains email.

To answer the RQ3, the Actors dimension emerged from the data collected. Considering the physical distance required by the COVID-19 pandemic, faculty and students became more isolated in this period, with feelings like anxiety, confinement, and demotivation, so the support from a psychologist is essential to maintain the healthy mind. The support provided by the institution at this time is crucial for the smooth running of the process, be it in terms of faculty

training, or ensuring that students and teachers can participate in remote classes or even financial flexibility because many students and their families had their income compromised due to the pandemic. In turn, the family has a supportive role, and in the case of international students, roommates also play this function.

Regarding the perceptions that faculty and students have in a remote educational environment, a conceptual conflict arose at first due to the definition of the teaching and learning approach adopted. According to Dharmawansa et al. (2013), synchronous e-learning is provided in real-time. The classes are scheduled and conducted in virtual classrooms with live transmissions, and the use of online chats increases the interactions between students and teachers. Then, the educational approach adopted by institutions during the pandemic fits with this definition. Besides, at the dimension *Perceptions*, it is possible to identify negative and positive insights regarding the change from F2F classes to a remote educational environment.

Concerning negative perceptions, the findings of this research include loss of body language and lack of interaction in remote classes combined with the lack of discipline and distraction due to stay at home. These findings are in accordance with the disadvantages related by Choudhury and Pattnaik (2020), however, regarding the feedback, most students are satisfied with the professors' response time, and they even have other channels of communication with teachers, such as groups on communication platforms, LMS forums, and chats that started to be used more often. Another negative perception that is in accordance with the literature is that students and teachers affirm that remote teaching does not replace classroom teaching, especially when considering the classes that require laboratory equipment (Keith & Simmers, 2013). Finally, due to the sudden change in the teaching format, the lack of training of faculty stood out as a disadvantage of remote teaching associated with the pandemic context, and according to Crook (2016) and Lytras et al. (2018), training faculty to work in a smart educational environment is essential to maximize students' learning capacity.

Considering the positive perceptions of the remote educational environment highlighted previously, the increase in learning opportunities, more flexibility considering the location and time, and a convenient educational approach, agree with the advantages presented by Arkorful and Abaidoo (2015). However, it was observed that the remote educational environment did not eliminate barriers related to students' shyness. Many of them felt uncomfortable answering questions during remote classes. In addition to the literature's advantages, it was observed that the fact that students and faculty already had previous contact with most of the tools adopted and that students are part of a generation of technological natives greatly facilitated the process of transition to a remote educational environment. Besides, students had the perception that the synchronous class format conveys greater confidence than the asynchronous format since they had the opportunity to ask questions live with the faculty and the commitment to attend classes according to the scheduled, so it is reliable. However, the main advantage of adopting a remote educational approach during the pandemic was the possibility of maintaining academic activities, thus minimizing the losses that would be caused in the event of total suspension of classes. Therefore, these findings concerning interviewees perceptions of conceptual conflict, disadvantages, and advantages of a remote educational environment respond to RQ4.

Some of the critical challenges to introduce ICT on education suggested by Toro and Joshi (2012) were overcome due to the pandemic context. To guarantee the continues of academic activities was necessary to inform about the tools available in the market, increasing the awareness. The stakeholders' dedication to making a reality of the remote educational environment in institutions that were not expecting this adaptation demands increased

commitment to ICT implementation and adoption. The wide use of free platforms or more extensive use of tools that already exist in the institutions helped to minimize the high costs of infrastructure. Regarding the course development and delivery, due to the lack of time to plan this shift from F2F to remote environment appropriately, a trial and error approach was adopted. However, since this pandemic context still is surrounded by uncertainties, higher education institutions are developing a proper pedagogical plan considering this new reality with online and presential classes, and according to McKenzie et al. (2013), this integration between F2F and EL remains a challenge. Another advantage of this experience was the acceleration of the ICT introduction in higher education institutions.

Regarding the lessons learned with this unexpected experience, the remote educational environment presented the potential to increase the learning opportunities, through more flexibility considering time and place, the increase of e-learning reliability among students as observed by Garrison and Vaughan (2008), and faculty and students proved that it is not so complicated the adaptation to new platforms and pedagogical approaches. Also, the presence of family and psychologists was fundamental to face the isolation period mentally healthy. Since this pandemic context is uncertain, as mentioned previously, it is necessary that institutions invest in faculty training, and focus on the platform's usage with most suitable pedagogic methods to increase the interaction during classes in a remote educational environment, that was perception referred by many interviewees. Table 15 clarifies the RQ5.

Lessons learned	Improvements
Increase of learning opportunities	Faculty training
More flexibility considering time and place	
Easiness of adaptation to new platforms	Interaction during remote classes
Increase of e-learning acceptability	
Psychological support to face the isolation period	

Table 15 - Lessons learned and Improvements

7   Conclusion and future research

The COVID-19 pandemic changed several aspects of the daily routine, including the way of education delivery in higher education institutions. The traditional F2F approach does not respect the required physical distancing recommended by WHO and several health institutions around the world. To enable the academic year's continuation and avoid the full cancelation of the classes, many higher education institutions adopted a remote educational approach that can be defined as synchronous e-learning. The objectives of this research were to understand how this shift from a presential to an online environment happened, regarding the activities performed, actors involved, tools used, and professors' and students' perceptions. Also, answering the question if the teaching and learning approach adopted by institutions is encompassed by smart education.

During this period, faculty and students transformed their houses into classrooms and daily, discovered tools, and learned other dynamics to overcome challenges such as lack of interaction, loss of body language, or even the distraction, inherent in a remote educational environment. The institution plays an essential role currently, ensuring that faculty and students have the minimum conditions to attend online classes, for instance, providing tools access. In this pandemic context, psychologists and family are fundamental to support the psychological struggles triggered due to isolation. However, this extraordinary situation stimulated the extensive use of ICTs in higher education institutions, including organizations that provided only presential education so far.

This research was developed through a qualitative methodology and, despite the sample diversity, was not considered the distinction between fields and academic degrees of the interviewees. Another limitation of this research is geographical as faculty and students interviewed were from higher education institutions from Brazil and Portugal. Further research studying the impact of the COVID-19 pandemic in higher-education institutions from other geographies is also needed.

Furthermore, a quantitative study is recommended to measure the impact of the main dimensions highlighted in this research.

The transformation of F2F classes into online classes was quite successful. Considering the smart education definitions previously mentioned in the literature review, the educational approach adopted by higher educational institutions was an adaptation from presential classes (Zhu et al., 2016), that took place outside traditional F2F approach environments (Bajaj & Sharma, 2018), through the usage of smart technologies (Kim & Kim, 2013). We conclude that the remote educational approach adopted by higher education institutions was an example of smart education during the COVID-19 pandemic.

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APPENDIX A: Professors script

Informações sociodemográficas

Nacionalidade:

Idade:

Gênero:

Tempo de Ensino:

Instituição:

Departamento:

Unidades Curriculares em andamento lecionadas através de plataformas digitais:

Dimensão - Ensino

1. Como você está ministrando suas aulas?
    a. Transmissão ao vivo? Vídeos gravados?
    b. Quais plataformas você está usando?
    c. O que você gosta / não gosta em cada um? Porquê?
    d. Quais são as vantagens e limitações de cada um?
2. Como o conteúdo está sendo disponibilizado aos alunos?
    a. Quais plataformas você está usando?
    b. O que você gosta / não gosta em cada um? Porquê?
    c. Quais as vantagens e limitações de cada um?
3. O que você está fazendo para manter os alunos interessados em suas aulas?
    a. Quais ferramentas você está usando?
    b. O que você gosta / não gosta em cada um? Porquê?
    c. Quais as vantagens e limitações de cada um?
4. Você está ministrando algum curso com aulas de laboratório?
    a. Levando em consideração o cenário da educação à distância, como tem sido a experiência com esse tipo de curso?
5. Como você vê a maneira de ensinar depois da pandemia?
    a. Você acredita em uma maneira híbrida de ensinar (abordagem de aprendizado misto)?

Dimensão - Comunicação

6. Além das aulas, como funciona a comunicação com os alunos?
    a. Quais canais de comunicação você está usando?
    b. Há alguma preocupação com a privacidade?
    c. O que você gosta / não gosta em cada um? Porquê?
    d. Quais as vantagens e limitações de cada um?
7. Como você está lidando com questões emocionais de seus alunos que o momento exige?
    a. Existe alguma orientação da instituição?

Dimensão - Aprendizagem

8. Quais são os aspectos diferentes entre a educação presencial e a educação à distância?
   a. O que você gosta / não gosta em cada um? Porquê?
   b. Quais as vantagens e limitações de cada um?

Dimensão - Resultados

9. Em relação ao processo de avaliação, como está indo?
   a. Quais plataformas você está usando?
   b. O que você gosta / não gosta em cada um? Porquê?
   c. Quais as vantagens e limitações de cada um?
   d. Quais são as suas principais preocupações em relação à avaliação remota?
   e. O que você está fazendo para superar essas preocupações?

10. O que você acha dessa mudança entre a educação presencial para a educação à distância?
    a. Que vantagens e desvantagens você vê?
    b. Você acredita que os resultados de um formato de ensino conseguem sobrepor o outro? Por quê?

11. Você deseja adicionar algo que não foi coberto por esta entrevista?

APPENDIX B: Students script

Dados sociodemográficos

Nacionalidade:

País de residência:

Idade:

Gênero:

Estudante de mobilidade?

Ciclo de ensino:

Curso:

Ano do curso:

Dimensão - Ensino

1. Você pode me explicar como está participando de suas aulas?
    a. Transmissão ao vivo? Vídeos gravados?
    b. Quais plataformas estão sendo utilizadas?
    c. O que você gosta / não gosta em cada um? Porquê?
    d. Quais as limitações de cada um?
2. Como o conteúdo está sendo disponibilizado pelos professores?
    a. Quais plataformas estão sendo utilizadas?
    b. O que você gosta / não gosta em cada um? Porquê?
    c. Quais as limitações de cada um?

Dimensão - Comunicação

3. Além das aulas, como você está se comunicando com os professores?
    a. Quais canais de comunicação estão sendo utilizados?
    b. Há alguma preocupação com a privacidade?
    c. O que você gosta / não gosta em cada um? Porquê?
    d. Quais as limitações de cada um?
4. Como você interage com seus colegas para realizar trabalhos em grupo?
    a. Quais plataformas estão sendo utilizadas?
    b. O que você gosta / não gosta em cada um? Porquê?
    c. Quais as limitações de cada um?
5. Você interage com seus colegas fora das aulas e / ou tarefas em grupo? Como e porquê?
    a. Durante esse período de educação à distância, você já quis estudar junto com outros colegas?
    b. Porquê? Por que não?
    c. Quais plataformas você está usando?
    d. O que você gosta / não gosta em cada um? Porquê?
    e. Quais as limitações de cada um?

Dimensão - Aprendizagem

6. Do seu ponto de vista, que aspetos são diferentes entre a educação presencial e a educação à distância?
    a. O que você gosta / não gosta em cada um? Porquê?
    b. Quais são as vantagens e limitações de cada um?
7. Você está fazendo algum curso com aulas de laboratório?
    a. Considerando o cenário da educação remota, como tem sido a experiência com esse tipo de curso?
8. Quais foram as habilidades mais importantes que o ajudaram a melhorar seu processo de aprendizagem, considerando a realidade da educação à distância? Porquê?
    a. Considerando os aspetos emocionais, como você está lidando com esse período de isolamento para continuar com suas atividades acadêmicas?
    b. Existe algum apoio da comunidade acadêmica?
    c. Como você está se motivando?

Dimensão - Resultados

9. Em relação ao processo de avaliação, como está indo?
    a. Quais plataformas estão sendo utilizadas?
    b. O que você gosta / não gosta em cada um? Porquê?
    c. Quais as limitações de cada um?
10. Quais são as vantagens e desvantagens dessa mudança entre a educação presencial e a educação à distância?
    a. Você acredita que os resultados de um formato de ensino conseguem sobrepor o outro? Porquê?
11. Como você acredita que o sistema educacional irá funcionar pós pandemia?

12. Você deseja adicionar algo que não foi coberto por esta entrevista?

APPENDIX C: Inform consent

CONSENTIMENTO INFORMADO

Estamos a solicitar a sua participação para um estudo de um projeto estabelecido entre a Faculdade de Engenharia da Universidade do Porto e INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência.

Este estudo tem como objetivo avaliar a experiência em um ambiente educacional remoto.

Estas entrevistas serão gravadas para possibilitar a sua transcrição e análise aprofundada. Só iniciaremos a gravação após a sua concordância, expressa através da assinatura deste consentimento informado.

A informação recolhida é estritamente confidencial e será apenas utilizada no âmbito deste estudo. Os resultados serão reportados de forma agregada, sem identificar individualmente os entrevistados. A informação poderá ser utilizada para relatórios, apresentações ou artigos científicos, mas o seu nome não será utilizado sem o seu consentimento explícito por escrito.

A sua participação no estudo é voluntária, pelo que poderá interromper a qualquer momento. Nesse caso toda a informação recolhida até o momento será inutilizada.

Para qualquer esclarecimento adicional, poderá contactar o Dr. Jorge Teixeira (jorge.grenha@fe.up.pt), Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, s/n 4200-465, Porto, telefone 225083437.

A investigadora:

Nome: _____

Assinatura: _____ Data: ____/____/_____

O participante:

Declaro ter lido e compreendido este documento, bem como as informações verbais fornecidas e aceito participar nesta investigação. Permito a utilização dos dados que forneço de forma voluntária, confiando em que apenas serão utilizados para investigação e com garantias de confidencialidade e anonimato que me são dadas pela investigadora. Autorizo a comunicação de dados de forma anônima a outras identidades que estabeleçam parceria com a Faculdade de Engenharia da Universidade do Porto para fins académicos e de investigação científica.

Nome: _____

Assinatura: _____ Data: ____/____/_____

ESTE DOCUMENTO É FEITO EM DUPLICADO: UM PARA O PARTICIPANTE E OUTRO PARA A INVESTIGADORA

APPENDIX D: Communication and Evaluation dimensions

Communication	Faculty *n=10*	Students *n=20*
Asynchronous		
Email	8	17
Forum	4	10
SMS	0	1
Social Network	0	2
Voice messages	0	1
Synchronous		
Call	1	8
Instant Mensseger	4	19
Online chat	3	8
Remote conference	2	8

Table 16 – Communication

Evaluation	Faculty *n=10*	Students *n=20*
Assignments	7	19
Continuous evaluation	2	1
Oral evaluation	4	1
Performance comparison	1	0
Presential exams	2	4
Remote exams	8	15
Seminars	4	6

Table 17 - Evaluation

APPENDIX Ε: Content, Pedagogical Aspects and Type of class dimensions

Content	Faculty n=10	Students n=20
Data from previous lab tests	0	1
Images	1	3
Manuals	0	2
Media	10	19
Papers	3	2
Proposed exercises	1	0
Slides	2	4
Solved exercises	1	0
Support texts	2	0
Tasks - Homework	0	1
Technical Standarts	0	2
Videos in other platforms	4	6

Table 18 - Content

Pedagogical aspects	Faculty n=10	Students n=20
Active Methodology	6	2
Class or Meeting dynamics	9	17
Content adaptation	7	4
Formative evaluation	4	1
Outcomes	2	2
Pedagogical support	5	0
Teaching through practical projects	1	0

Table 19 - Pedagogical Aspects

Type of class	Faculty n=10	Students n=20
Practical classes	8	14
Theoretical classes	3	3

Table 20 - Type of Class