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Factors that negatively influence students' transition from the traditional classroom to emergency remote education (ERT)

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ABSTRACT

Universities worldwide had to adopt Emergency Remote Teaching (ERT) because of the COVID-19 pandemic. This abrupt change forced students used to face-to-face classes to adapt to a new reality. However, this transition is different for each student because of personal realities. For example, the student's generation, emotional state, and some factors (e.g., tech skills, technological infrastructure, place of study, and perspectives regarding this change) may influence the feelings of optimism and awareness of learning. This work describes a quantitative study conducted before the first ERT academic semester starts with 1011 undergraduate students measuring those factors through questionnaires. In addition, to test whether the measuring factors are consistent with our understanding, the confirmatory factor analysis (CFA) and the statistical reliability analyses were performed. From the results, we identified differences between the participants' age generations. The mean scores for the Z generation were lower than other generations concerning the measuring factors and feelings. Plus, it was found that students' emotional states negatively influence their feelings about ERT. Also, the measuring factors influence optimism and awareness of learning. Therefore, we suggest that institutions around the globe should offer innovative distance learning strategies to train the students for this paradigm shift, identify the students' needs for the Internet and devices, and provide psychologists to aid the student's emotional state. Thus, helping a better and faster transition and adaptation of students to the change of educational methodology to improve students' experience in distance education.

1. Introduction

When 2020 started, most of the world's citizens did not imagine the changes in their lifestyles to come. A new virus detected, named SARS CoV-2, spread globally, and a pandemic began. It was necessary to reduce people's concentration in any place, e.g. parks, shopping, streets, and education institutes such as universities. In a matter of days, "quarantine" and "lockdown" were words that we had to get used to. The spread of the Covid-19 pandemic drastically disrupted all aspects of human life, including education. An unrestrained race to adapt the academic environment to this new reality began. After all, how to attend and preserve the health of the academic community? In this sense, through virtual meetings, professors, employers, and managers exchanged experiences and defined methodologies and practices that allow the continuity of education. From the meetings, the implementation of Emergency Remote Teaching (ERT) has become a reality. According to Green et al. [1], for the higher education sector, this pandemic can be a watershed. It brought radical changes in the university workflow and the day-to-day of the people who work and study in those institutes.

In many education institutes worldwide, teaching and learning have moved to the online system [2–4]. According to UNESCO, in April 2020, schools and Higher Education Institutions (HEIs) were closed in 185 countries, affecting 1,542,412,000 students, which constitutes 89.4% of the total enrolled students [5]. According to Aristovnik et al. [6] and Osman [7], closing education institutes (schools and universities) proved to be an efficient way to minimize the virus's spread since it reduced physical contact. Therefore, some strategies to assist and continue teaching were applied, e.g., the application of e-learning platforms which allowed interaction between teachers and students and, in some cases, national television programs or social media platforms were used to support them [24]. However, many challenges arose for students, teachers, and their families even with the previously mentioned strategies. The main challenge was the shift from face-to-face

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education to homeschooling.

This way, through technology, education institutes at all levels developed alternatives to delivery modes to migrate the traditional classes to remote learning [4,8–10]. Distance education or remote education system is a computer-based method in which the interaction between students and education professionals is provided at a distance and from a given centre [11]. This kind of education can be defined as "formal institution-based education, where the learning group is geographically separated, and interactive telecommunications systems are used to connect students, resources and instructors" [12]. Another feature of this education is that the students can also be separated by time; that is, they can learn at their own pace, according to their schedules. This feature is called asynchronous distance learning, and the opposite (simultaneous study) is called synchronous distance learning [13]. However, as many institutes worldwide did not have a fully functioning distance education system, many did not have adequate time to adapt or create systems for this teaching methodology. For this reason, according to Toquero [8], the application of distance learning that education institutes are implementing is named emergency remote teaching, known by the acronym ERT.

However, many institutes realised that it was not enough to authorise classes to be held remotely through the Internet. It was noticed that many variables must be taken into account, whether by the professor, student or institute. For example, professors noticed that it is not enough to use the classes given in the traditional modality and give them in the same way in the remote modality; it is necessary to adapt them. Students understood that they needed to organise themselves to carry out the assigned activities in many ways. Moreover, the institutes recognised that it is necessary to make investments so that the academic community is not too negatively affected in this transition of the educational paradigm. This investment can be made through the training of professors and students, as not all of them are digitally experts [14], and given that many students do not have technological resources (financial assistance is required to purchase equipment and internet plans). These are just a few challenges that the academic community needs to overcome to implement remote learning that is less harmful to all parties involved. In fact, some authors believe that this is an opportunity to build quality digital approaches to teaching in HEIs [15,16]. However, how identify the challenges to implementing distance education with acceptable quality?

The answer to this question is not trivial, mainly because the pandemic has exposed the weaknesses of the current higher education system and the need for more significant support and training for students and educators in digital technology to adapt to the rapid changes in the world's educational climate [17]. However, Williamson et al. [18] and Tzifopoulos [16] have identified some challenges in implementing distance learning when there is a shift in the educational paradigm. For example, Williamson et al. mentions that when analysing published articles and special issues, four significant challenges must be considered: The political economy of pandemic pedagogy, Digital inequalities during the pandemic, Spaces and hierarchies in times of pandemic (re-locating the digital pedagogy), and Emergency educational technology experimentation. Tzifopoulos in his theoretical work mentions that the challenges in changing teaching methodology are related to making this change in a forced and emergency way and in preparing students and teachers for this reality. In another work, Nambiar [19] identified that a significant challenge for remote teaching is to make the teaching quality similar to that provided by traditional teaching. Thus, to measure the quality of teaching, the authors measured Indian students' level of satisfaction by how the content was being taught. The results indicated significant differences in student satisfaction levels when online classes were compared with traditional learning. Students who took the traditional course were more satisfied with it than their online colleagues. Also, aspects such as technical issues, lack of structure, turbulence in the flow of classes, problems in clarifying doubts, and lack of interest and motivation to attend classes highlighted the low motivation in the online approach. He and Xiao [20] used the quantitative and qualitative data from a Chinese university survey and analysed some factors commonly used in academic research to measure the effectiveness of ERT, with perceptions of both students and teachers. The authors used the factors previously investigated in the study developed by Noesgaard and Ørngreen [21] who categorised 32 factors into individual (subject), contextual scaffolding (context + object) and e-Learning solution and process (artefact). From the results, He and Xiao mention that the main issues faced by students were: teachers not being familiar or skilful with the online teaching tools, easy getting distracted in homeschooling by other family members, and network congestion or disconnection.

It is possible to perceive that the challenges of changing the educational methodology are many and global. Each challenge can present several factors that can negatively influence the students' transition; for example, the challenge of digital inequities needs to consider students' digital skills, quality of internet access, and equipment used, among other factors [18]. Manca and Delfino [22] measures the adaptation of Italian school students in the interplay between continuity and change in school teaching and learning practices caused by the pandemic. They used the school management system data and questionnaires applied to students, teachers and parents. An interesting result found in this study is that a solid pre-existing digital competence level and collaboration within the school community were the most important factors for non-traumatic transition to distance learning.

Of course, other challenges and factors can be identified. For example, one factor that we can take into account is the age generation of students, given that some generations are more optimistic [23] and used to technology than others, thus presenting different characteristics between themselves that can impact (positively or negatively) the student's transition of teaching methodologies. The previously factor is considered easy to measure and obtain because it is factual information. However, it is possible to consider other not easy factors, such as a person's emotional state. This feature can be measured following theories and questions related to this matter. From the answers provided by the participant and the theory applied, it is possible to measure the person's emotional state at that moment. In this way, it is possible to apply this strategy before and after a task to verify if this task affected the person's emotional state. Moreover, in the situation of changing the educational methodology, which requires an adaptation to a new reality, the emotional state of a person is a factor to be considered because this feature can easily influence the acceptance of new technologies [24] and specific situations [25]. Plus, a person's emotional state can affect the most diverse daily activities, including tasks that require memory [26], the linguistic processing in the phrases [27] and have an impact on the low-level mechanisms underlying chronometric mental tasks [28]. Besides, some studies have shown that the person's emotional state can influence their performance in the activity being performed [29]. Thus, we perceive that it is vital to measure the participant's emotional state because that can describe what many students worldwide are going through at the beginning of a distinct academic semester. With this data is expected to find an association between the student's emotional state and his perception of factors that may influence his adaptation and acceptance of ERT. In addition, at the end of the semester, it is possible to measure the emotional state of the students again and identify whether there were positive or negative influences.

Therefore, the transition of educational methodology should not be implemented indiscriminately and imposingly; it is vital to consider the reality of the academic community. The fundamental issue is that not all students have the same emotional, social and familial conditions to take online courses. Thus, to identify additional factors and understand the effects of this sudden change of learning paradigm in the daily lives of students, this study describes an investigation carried out with undergraduate students about ERT. For this, at the beginning of the academic year of 2020, we sent a questionnaire to the students' institutional email to measure some factors that, according to our academic experience, we

consider vital to the students' transition to this new educational reality. Those factors identify students' age generation and measure their emotional state, technological and familial infrastructure, personal digital skills, and perspectives regarding ERT. The perspective factor depicts how students believe that remote teaching will be concerning their professors and their intentions to improve their technological infrastructure. Moreover, to verify whether these factors negatively influence the student's transition, two feelings about ERT were measured: the level of optimism and awareness of learning.

The feeling of optimism is a positive state about future events, and its level may reflect the better or worse quality of life [30]. According to Carver et al. [31], "optimism is an individual difference variable that reflects the extent to which people hold favourable general expectations for their future. Higher levels of optimism were prospectively related to better subjective well-being in times of adversity or difficulty (i.e., controlling past well-being)." Although optimism can be considered a personality trait, in our study, it was assumed to be a feeling at the moment and not a personality trait. Thus, it was unnecessary to apply strategy or theory to identify the participant's optimism trait. The feeling of optimism is a feeling that can constantly change; they are fleeting and based on the environment [32]. Another feeling that we believe reflects a state of future events is learning awareness. Students must feel that they will learn at least as much as before a significant change in how academic content will be taught. In this sense, we believe that the feeling of optimism and learning awareness can be affected by several factors, such as the person's emotional state and familial, social and technological structure, especially in a homeschooling environment. Those levels are essential because changing learning patterns can affect student growth and transition to other learning stages [33].

This study embraces the social-ecological perspective based on Bronfenbrenner's system theory [34], which emphasises that the development of the human being is based on the interaction of this individual with the environment in which s/he is. Considering that the modification of the teaching paradigm provokes a complete transformation in the student's environment (from the university environment to the home environment), which may affect their development, this perspective is valid. Following a theoretical approach similar to Manca and Delfino [22], where the authors also aim to transition from onsite schooling to distance schooling, we focus on the most inferior layer (microsystem) of the multilevel ecological model identified by Carpenter et al. [35]. The microsystem, unlike the others, refers to the closest factors that affect the development of the individual, such as educational institution, family, neighbours, peers, among others. Moreover, we used the instances of a pragmatic study [36], given that the data collection desires to understand the current reality of the academic students and find solutions for this context.

As the characteristics of university students are very heterogeneous with students of different ages, social classes and family support, many factors can impact/influence positively or negatively the change in the teaching modality. In this sense, we believe that in the society in which we live, the young generations are more habituated to technology and online education than the older ones. Because of that, this can be a factor that influences feelings (optimism and learning awareness) and the measuring factors evaluated in this study. In addition, as the change in teaching methodology requires an acceptance of new technologies by the students, the emotional state at the beginning of this shift can affect/influence positively or negatively the feelings towards this transition. Finally, we consider that having a suitable environment for homeschooling with good technological resources, digital skills, a place of study, and positive perspectives about ERT are essential factors that positively influence feelings about ERT, consequently providing a better adaptation and progress in remote learning. Given the above, we have formulated three main research questions:

1. Are feelings of optimism, learning awareness and measuring factors (internet infrastructure, digital skills, place of study and perspective on ERT) influenced by the intrinsic characteristics of each age generation?
2. Does the student's emotional state at the beginning of the remote educational semester influence their feelings of optimism and learning awareness regarding the transition of the teaching paradigm?
3. Are the student's Internet infrastructure, digital skills, place of study and perspective on ERT factors influencing students' optimism and learning awareness about ERT?

We believe that many factors not addressed in this study can influence students' transition when there is a change in the teaching methodology. However, the answers to the questions formulated in this research will evidence if the factors selected according to our academic experience positively or negatively influence students' transition from traditional classrooms to ERT. Thus, education institutes can implement the same procedures described in this document to understand better their students' technological, social, and familial conditions. Consequently, personalized actions can be carried out to obtain a healthier transition and adaptation of students in implementing a teaching methodology unfamiliar to them.

2. Research methods

2.1. Research model and procedures

To answer our research questions, we conducted a quantitative study where a questionnaire was made available with questions categorized by factors (more details in Section 2.3.1) to identify its influence on university students' feelings concerning the sudden change in their educational methodology. In this sense, we devised a within-subjects design study in which the questionnaire used was developed on the Google forms platform.

2.2. Research context and sample

The university (the centre of this study) provides quality public education in 32 undergraduate courses with nearly 12,000 students. Every year about 2500 students of different social classes enrol at the university. However, most of them live in the middle and poor social class. In addition, specialization postgraduate, master and doctoral courses are offered in the most different areas of knowledge. Before the pandemic, most of the courses were offered only in the face-to-face modality. For this reason, it is possible to suppose that most students had no previous experience with ERT. However, the university has a perspective/desire to increase the number of available courses in the distance modality in the following years.

Due to the 2020 pandemic, in March of the same year, before starting face-to-face classes, the university's board decided to close all the institution's environments, such as classrooms, laboratories, libraries, and living areas, to follow government guidelines about the social isolation. In addition, the university changed the way professors' classes should be given from traditional classrooms to ERT. The university provided online classes to teach professors and students how to use Google tools for education. Also, money support was provided for low-income students to acquire the Internet and tablet. However, it was not possible to assist several students due to a lack of investment.

Until the university's board decided on this change, the university's academic calendar suffered delays. For this reason, the start of virtual classes happened on September 8th, 2020. So, an invitation was sent to the students' institutional email on September 9th. More than nine (9) thousand emails were sent with the expectation of having the most significant number of participants to represent the undergraduate student population. From the emails, a convenience sample of 1011 undergraduate students accepted the invitation to participate.

As the sudden change in the learning methodology affected all

students, regardless of age, gender, course or place where they live, no filter was used to select the participants. We expected to reach different students, whether in terms of social class, age, gender, study area, and personal digital skills. With that, it is sought to identify if some factor could influence the student's transition to this unusual learning methodology to them. It is essential to mention that written consent was obtained as the first part of the study. Until September 29th of the 2020 academic year, the survey was available for responses.

2.3. Survey design

2.3.1. Measuring factors

The sudden change of teaching modality (from face-to-face to virtual) is not trivial, has many challenges and requires taking into account several factors, whether to the teachers or students side. In this sense, our goal is to identify factors that can negatively influence the students' transition. Thus, we developed a questionnaire to measure factors that we believe, regarding our academic experience of more than ten years, are vital in this process: the student's technological infrastructure, digital skills, place of study, and perspectives regarding ERT.

From the factors mentioned, the technological infrastructure (TI) is an evident component that must be taken into account when the task will be performed exclusively through technology and the Internet. This factor becomes even more critical when the population is considered lower middle class and poor. After all, it is a challenge to implement distance learning for students who do not have a computer or high-speed Internet. For this reason, it is essential to check each student's TI situation to examine if this factor can influence the feelings of optimism and awareness of learning in ERT. In this scenario where instructors and students must use online tools, we think that the lack of personal digital skills and previous experience in them can negatively influence the transition of students to ERT. It makes sense if the students are not used to technology and the Internet and are enrolled in courses that do not frequently use computers and Internet-based systems, as in social courses. Another factor that we consider vital for the transition of the teaching paradigm is the student's place of study. Having a suitable environment for studying is essential for any student and directly influences their learning [37]. However, with homeschooling, each student has his particular place of study, and this identification is necessary to verify if it negatively influences the transition. The last measurement factor is the perspectives on the ERT. This element will give us an idea of how the students expect distance learning to work, whether they think the learning will be good, neutral or bad. We expect to associate this perspective with optimism and awareness of learning. For example, students with a good perspective on ERT may be the most optimistic.

The questionnaire applied to the participants had seven (7) sections. After the student confirmed the research consent, the first section briefly introduces the study and demographic questions such as age, gender, the enrolled course, academic year, and study area were asked to collect the background information for participants' segmentation. The second section assesses the participant's current emotional state. For this, it was used a self-report survey named Positive and Negative Affect Schedule (PANAS) [38] that consists of two 10-item scales (each item is rated on a 5-point scale of 1 (not at all) to 5 (very much)) to measure both positive and negative affect (details in Section 2.3.2). After this section, the survey had the core 18 questions split into five measuring factors. The third section had seven questions measuring the student's technological infrastructure (TI). In the fourth and fifth sections, three questions are related to the student's digital skills (SS) and the student's place of study (PS), respectively. Then, five questions were made to identify the student's perspectives concerning ERT (PE). Finally, the last survey section presents two questions to measure students' feelings concerning ERT. In this section, each feeling has one five Likert scale question, in which the participant must inform the level of optimism and learning awareness regarding ERT.

Three professors with expertise in university education assessed the questionnaire by reviewing and adjusting each question's scale. Besides, unclear content, question order, rephrasing, and rewording were adjusted. This study's measuring factors and feelings questions are summarized in Appendix C.

2.3.2. Emotional state

In our study, participants' current emotional state was measured to find evidence that emotional state correlates with students' level of optimism and learning awareness. The PANAS questionnaire was applied, in which the scores can range from 10-to 50 for both the Positive and Negative Affect. The lower scores represent lower levels of Positive/Negative Affect, and higher scores represent higher levels of Positive/Negative Affect. After the participants pointed out their emotional state for the Affects, we calculated the positive and negative levels following the guidelines described in [38]. We adopted the values above and equal to 29 and 14 for high levels of positive and negative Affects, respectively. Values below 29 and 14 were considered low for positive and negative Affect, respectively.

2.4. Validity test and data analysis

For the statistical analysis, we used IBM SPSS packages and Microsoft Excel. Following the same statistical procedure described in the work of Tang et al. [39], we applied the confirmatory factor analysis (CFA) [40] to validate the measuring factors. We applied Cronbach's alpha [41], composite reliability (CR) [42], and average variance extracted (AVE) [43] to test the reliability and validity of our data. The value of Cronbach's alpha higher than 0.45 can be considered a sufficient level to consider the data with satisfactory reliability as mentioned in [44]. The acceptable value of CR was 0.7 following the work of Taber [44] and Bacon et al. [45], and adequate is the value higher than 0.6 [43]. Also, the AVE value usually is 0.5, but we also accepted 0.4 if the CR values is higher than 0.6 as mentioned in [43]. Plus, the Heterotrait-monotrait (HTMT) [46] ratio of the correlations was calculated to determine the model's discriminant validity.

At the beginning of the data analysis, two professors scored each question option based on the benefits for the student in the measuring factor. For example, a participant with unlimited internet will have one more point in the TI factor than a participant who does not (Appendix C). This score was necessary to measure the level that the participant has in each measuring factor. Thus, it was possible to create a variable named factor score to classify each participant's level of TI, SS, PS and PE. Therefore, participants with higher scores may have better technological infrastructures, personal digital skills, places of study, and higher perspectives about ERT. Goodman and Kruskal's gamma [47] and Spearman rank-order [48] correlation coefficient were applied to measure the strength and direction of association that exists between the factor score with each question. Those tests were applied because the data did not deviate from a normal distribution regarding the Shapiro-Wilk [49] normality test ($p = 0.000$). To identify the acceptable strength of association, we referred to the values suggested by Cohen [50], Dancey and Reidy [51], i.e. r value ranging from 0.10 to 0.39 is considered a weak association, from 0.4 to 0.69 moderate, from 0.7 to 0.99 strong, and r equal to 1 is the perfect association. Finally, the differences in students' generation and feelings (optimism and learning awareness) amid the four measuring factors were compared by applying the Multivariate Analysis of Variance (MANOVA) [52]. To identify which pairs of means were significantly different and investigate the differences between multiple groups, Fisher's Least Significant Difference (LSD) post hoc tests were implemented [53]. In the tests, it was considered 5% of statistical significance, i.e. p values of $<= 0.05$. Fig. A.1 in Appendix A illustrates the research methodology with the survey sections available to the participant and the statistical tests used for the statistical analysis.

3. Results

3.1. Demographic data

A total of 1011 participants answered the survey, which means 11.23% of the undergraduate students of the university centre of this study. Of these, 621 are female (21.4% with an average age 23.96 years old, $SD = 6.36$), 383 are male (37.9% with an average age 24.63 years old, $SD = 6.97$) and 7 participants preferred not to inform (0.7% with an average age 21.86 years old, $SD = 2.79$). Also, 290 (28.7%) students study in one course of the humanities faculty representing the faculty with most students participating. In addition, students enrolled in the second year of the course and newcomers participated the most, with 261 (25.8%) and 249 (24.6%) participants, respectively. Appendix D shows our data distribution based on the participants' answers.

3.2. Validity test of the measuring factors

First, we removed the data of five participants who skipped some information. Next, we performed the CFA to validate the factors. The factor loadings ranged from 0.52 to 0.77 for technological infrastructure, 0.39 to 0.78 for students' digital skills, 0.52 to 0.78 for the place of study and 0.78 to 0.86 for perspectives about ERT (results in detail see Appendix E). Although the factor loading value of item SS1 is less than the suggested value, we opted to maintain the item because this question has information about participant disabilities, which can be an essential factor for students' digital skills. The overall reliability found by Cronbach's was 0.756, and the value of the TI factor was over 0.7, displaying satisfaction reliability, and the SS, PS and PE were almost all over 0.4. Plus, CR values ranged from 0.707 to 0.920. The AVE values ranged from 0.422 to 0.710, which the values for the PE factor were higher than 0.5, and the others were higher than 0.4. The HTMT criterion measured in this study was from 0.189 to 0.845 (smaller than the $HTMT_{0.85}$ criterion [54]). The results indicate that there is discriminant validity between all construct measures Appendix F shows the results found by the HTMT).

Finally, regarding Goodman and Kruskal's gamma, 2 comparisons are considered weak, 6 are moderate, and 10 have strong associations. Spearman rank-order correlation coefficient identified 4 comparisons in which the association is considered weak, 7 is moderate, and 7 is a strong association. All associations presented statistical significance $p = 0.000$ (details of the results into Appendix G).

3.3. Age generation

In this study, only a single participant had the age to be categorized as Baby boomers generation (born between 1946–1964), 43 students had the age of X generation (1965–1980), 353 could be considered Millennials (1981–1996), and 609 had the age of Z generation (1997–2010). The results of differences between the age generation for each measuring factor and students' feelings (optimism and learning awareness) (MANOVA) are summarized in Table 1.

As only one participant is in the baby boomers generation, we chose not to consider the data from this single participant in this analysis. From the other generations, it is possible to note that the mean scores for the X generation were higher than the other two (Millennial and Z) in the factors of TI and SS. Millennials' mean score was higher in the place of study factor; meanwhile, the Z generation scored higher in the perspectives concerning ERT. Statistical differences were found only between the generations in the place of study factor ($F = 3.119$, $p = 0.045$). Moreover, it is possible to note that the X generation had a higher mean for optimism and learning awareness. Also, there was found statistical differences between the age generations in both feelings (optimism $F = 5.904$, $p = 0.003$; learning awareness $F = 15.107$, $p = 0.000$).

Table 2 summarizes the results of LSD test and the corresponding interpretation of the measuring factors and students' feelings. The analysis shows a significant difference between generation X and Z ($p = 0.05$) in the student's digital skills factor. In the PS factor the significant difference was found between the Millennial generation and Z ($p = 0.014 < 0.05$). Concerning students feelings, it was found significant differences between generation X and Z ($p = 0.006 < 0.05$), and Millennial and Z ($p = 0.014 < 0.05$) in the optimism feeling. In the learning awareness, it was found statistical differences between X and Millennial ($p = 0.004 < 0.05$), X and Z ($p = 0.000$), and Millennial and Z ($p = 0.000$) generations. The interpretation is given in the last column of Table 2. We had to disregard the only baby boomers generation data because post hoc tests are not performed in groups with less than two cases

3.4. Emotional state

In this study, 820 (81.1%) of the participants' emotional state before the beginning of the ERT semester was measured with low positive feelings (affects) and 741 (73.3%) with high negative feelings. Meanwhile, 191 (18.9%) participants presented high positive feelings and 270 (26.7%) had low negative feelings (details in Table B in Appendix B).

Before the ERT semester, the student's optimism and learning awareness levels were taken into account and analyzed with the emotional state affects. In Table 3, it is possible to see that statistical differences were found between the levels of optimism in the negative affects ($F = 4.192$, $p = 0.006$) and in the learning awareness in both affects (positive $F = 5,213$, $p = 0,001$ and negative $F = 5,329$, $p = 0,001$).

Following the same procedure mentioned in the previous section, Table 4 summarizes the results of LSD post hoc tests and the corresponding interpretation regarding the emotional state affects. The analysis shows a significant difference between the participants not optimistic (NO) and those more or less (ML) optimistic ($p = 0.007 < 0.05$), and between the participants classified as ML and those

Table 1
Summary of the participant's age generation differences about the measuring factors and feelings.

Measuring factors	Age generation						
	Baby boomers	X	Millennial	Z			
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	*F*	*p*	Partial eta squared
Techonological Insfrastructure	16 (0)	13.32 (5.30)	13.09 (4.41)	12.81 (4.33)	0.619	0.539	0.001
Digital Skills	7 (0)	5.60 (1.63)	5.26 (1.65)	5.12 (1.47)	2.453	0.087	0.005
Place of Study	4 (0)	2.18 (1.54)	2.22 (1.42)	1.99 (1.33)	3.119	**0.045***	0.006
Perspective ERT	8 (0)	6.18 (1.85)	6.16 (2.28)	6.22 (2.08)	0.095	0.909	0.000
Feelings							
Optimism	4 (0)	2.86 (0.70)	2.65 (0.82)	2.53 (0.71)	5.904	**0.003***	0.012
Learning awareness	4 (0)	2.32 (1.28)	1.83 (1.12)	1.57 (0.98)	15.107	**0.000****	0.029

*$p < 0.05$; **$p = 0.000$.

Table 2
Mean differences between generations and the corresponding interpretation concerning the measuring factors and feelings.

Measuring factors	Mean difference between **age generations**			Interpretation
	X and Millennial	X and Z	Millennial and Z	
Technological Infrastructure	0.232	0.509	− 0.277	
Digital Skills	0.344	**0.479***	0.135	X >Z
Place of Study	− 0.037	0.187	**0.225***	Millennial >Z
Perspective ERT	0.217	− 0.040	− 0.062	
Feelings				
Optimism	0.203	**0.326***	**0.123***	X >Z; Millennial >Z
Learning awareness	**0.489***	**0.754****	**0.264****	X >Millennial; X >Z; Millennial >Z

*$p < 0.05$; **$p = 0.000$.

Table 3
Summary of the participant's feelings (optimism and learning awareness) differences about the emotional state affects.

Emotional state	Optimism						
	I do not know	Not optimistic	More or less	Very optimistic			
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	*F*	*p*	Partial ETA square
Positive Affects	20.30 (8.18)	20.80 (8.09)	21.33 (7.93)	22.07 (8.18)	1.080	0.357	0.003
Negative Affects	20.19 (8.89)	22.22 (9.51)	20.48 (8.87)	19.64 (8.82)	4.192	**0.006***	0.012
	Learning awareness						
Emotional state	I do not know	No	Maybe	Yes			
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	*F*	*p*	Partial ETA square
Positive Affects	24.16 (9.05)	20.52 (7.89)	22.08 (7.84)	21.97 (8.41)	5.213	**0.001***	0.015
Negative Affects	19.05 (8.84)	22.02 (9.34)	19.56 (8.67)	19.95 (9.00)	5.329	**0.001***	0.016

*$p < 0.05$.

Table 4
Mean differences between the participants' optimism level (Idk = I do not know, NO = Not Optimistic, MO = More or Less, VO = Very Optimistic), and learning awareness with the interpretation regarding the participants' emotional state.

Emotional state	Mean differences between **optimism**						Interpretation
	Idk and NO	Idk and ML	Idk and VO	NO and ML	NO and VO	ML and VO	
Positive Affects	− 0.500	− 1.030	− 1.780	− 0.530	− 1.27	− 0.740	
Negative Affects	− 2.040	− 0.300	0.540	**1.740***	2.580	**0.840***	NO >ML; ML >VO
Emotional state	Mean differences between **learning Awareness**						Interpretation
	Yes and No	Yes and Maybe	Yes and Idk	No and Maybe	No and Idk	Maybe and Idk	
Positive Affects	1.450	− 0.120	− 2.190	− **1.560***	− **3.64***	− 2.070	Maybe >No; Idk >No Idk >Maybe
Negative Affects	− **2.070***	0.390	0.900	**2.460***	**2.960***	− 0.510	No >Yes; No >Maybe; No >Idk

*$p < 0.05$.

very optimistic (VO) ($p = 0.003 < 0.05$) for the negative emotional state affects. The interpretation column of the optimism table indicates that the participants' higher mean score was from those who were not optimistic.

Regarding learning awareness, the analysis demonstrates differences between the participants with the feeling that they will not learn (No) and those that said Maybe ($p = 0.020 < 0.05$) and "I do not know" (Idk) ($p = 0.001 < 0.05$) for the positive emotional affects. The Idk feeling obtained the higher mean. Differences were found for negative affects between participants who felt they would learn (Yes) and those who said No ($p = 0.039 < 0.05$). Also, there were differences between participants who said No from those who believe they Maybe learn ($p = 0.020 < 0.05$) and those that pointed out Idk ($p = 0.001 < 0.05$). In the interpretation column, it is possible to note that the Maybe learning awareness option had the higher mean to the positive affects; meanwhile, the negative affects were the No option.

3.5. Feeling of optimism

From the participants, 27 informed that they did not know (Idk) how to measure their optimism about ERT; most participants (495) felt not optimistic (NO), 345 more or less optimistic (ML), and 139 very optimistic (VO). Table 5 shows the statistical differences (MANOVA) between the level of optimism in all measuring factors with $p = 0.000$.

Table 6 summarizes the results of LSD post hoc tests, which the analysis shows that, regarding the TI factor, the participants that pointed out their level of optimism as Idk had significant differences from the participants that informed being ML ($p = 0.007 < 0.05$) and VO ($p = 0.000$). The participants with NO optimism had differences from the participants with ML ($p = 0.000$) and VO ($p = 0.000$) optimism. The ML optimistic participants had differences from the VO ($p = 0.000$). Regarding the SS factor, the participants with Idk optimism had differences from the ML and VO optimism, and those with NO optimism had

Table 5
Summary of the participant's feeling of optimism differences about the measuring factors.

Measuring factors	Optimism						
	I do not know	Not optimistic	More or less	Very optimistic			
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	*F*	*p*	Partial Eta Squared
Techonological Insfrastructure	11.33 (4.64)	11.89 (4.15)	13.60 (4.20)	15.28 (4.46)	28.403	**0.000***	0.078
Digital Skills	4.66 (1.81)	4.46 (1.36)	5.65 (1.25)	6.76 (1.11)	133.206	**0.000***	0.285
Place of Study	2.18 (1.59)	1.58 (1.23)	2.42 (1.32)	3.00 (1.23)	56.842	**0.000***	0.145
Perspective ERT	4.77 (2.30)	6.09 (2.08)	6.45 (2.11)	6.26 (2.28)	6.129	**0.000***	0.018

*$p = 0.000$

Table 6
The mean differences between the participants' optimism levels (Idk = I do not know, NO = Not Optimistic, MO = More or Less, VO = Very Optimistic) and the interpretation regarding the four measuring factors.

Measuring factors	Mean difference between **optimism**						Interpretation
	Idk and NO	Idk and ML	Idk and VO	NO and ML	NO and VO	ML and VO	
Techonological Insfrastructure	− 0.567	− **2.2754***	–	–	–	–	ML >Idk; VO >Idk; ML >NO; VO >NO; VO >ML
			3.954 **	**1.709** **	**3.388** **	**1.679** **	
Digital Skills	0.204	–	–	–	–	–	ML >Idk; VO >Idk; ML >NO; VO >NO; VO >ML
		0.988 **	**2.059** **	**1.192** **	**2.300** **	**1.107** **	
Place of Study	**0.593****	-0.240	–	–	–	–	Idk >NO; VO >Idk; ML >NO; VO >NO; VO >ML
			0.814 **	**0.836** **	**1.410** **	**0.573** **	
Perspective ERT	− **1.313***	–	–	− **0.364***	− 0.175	0.188	NO >Idk; ML >Idk; VO >Idk; ML >NO
		1.677 **	**1.488** **				

*$p < 0.05$; **$p <= 0.001$

differences from the ML and VO (all $p = 0.000$) optimism. The participants with ML optimism had differences from the VO ($p = 0.000$). The PS factor presented differences in the participants with Idk optimism from the NO and VO optimism, those with NO optimism from the ML and VO, and participants with ML optimism from the VO (all $p = 0.000$). In the last factor (perspective), those with Idk optimism had differences from the others optimism classifications (NO: $p = 0.002 < 0.05$; ML: $p = 0.000$; VO: $p = 0.001$) and those with NO optimism from the ML ($p = 0.015 < 0.05$).

The interpretation of each measuring factor regarding the optimism classification is given in the last column of Table 6, where it is indicated that the higher mean score was obtained by the participants classified as very optimistic in the TI, SS and PS factors. PE factor had a higher mean score by the participants classified as more or less optimistic.

3.6. Feeling of learning awareness

From the participants' data, most participants (674) reported feeling that they would not learn (No) in the ERT modality as in the traditional classroom, 57 reported that they did not know (Idk), 179 said that they Maybe would learn, and 96 said that they would learn (Yes). In Table 7, it is possible to notice that we found statistical differences in three measuring factors (TI, SS, PS) concerning the learning awareness in the studied population. However, no statistical differences were found in the measuring factor of perspectives about ERT.

Table 8 summarizes the results of LSD post hoc tests and the corresponding interpretation of the measuring factors. Regarding the TI factor, the participants that pointed out the learning awareness as Idk had significant differences to the participants that informed Maybe ($p = 0.002 < 0.05$) and Yes ($p = 0.002 < 0.05$). Also, it was found differences with the learning awareness as Maybe with No and Yes (both with $p = 0.000$). Concerning the SS factor, it was found statistical differences between all comparisons: Idk and NO ($p = 0.005 < 0.05$), Idk and Maybe ($p = 0.005 < 0.05$), Idk and Yes ($p = 0.000$), Maybe and No ($p = 0.000$), Maybe and Yes ($p = 0.000$), and No and Yes ($p = 0.000$). From the PS factor, it was found differences between all comparisons: Idk and NO ($p = 0.021 < 0.05$), Idk and Maybe ($p = 0.042 < 0.05$), Idk and Yes ($p = 0.000$), Maybe and No ($p = 0.000$), Maybe and Yes ($p = 0.005 < 0.05$), and No and Yes ($p = 0.000$). Regarding the factor of perspective about ERT, no differences were found.

The interpretation in the last column shows that, although in TI factor is not possible to determine which learning awareness level

Table 7
Summary of the participant's learning awareness differences about the measuring factors.

Measuring factors	Learning awareness						
	I do not know	No	Maybe	Yes			
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	*F*	*p*	Partial eta squared
Techonological Insfrastructure	12.28 (3.61)	12.40 (4.17)	14.30 (4.64)	14.56 (4.97)	14.408	**0.000***	0.041
Digital Skills	5.33 (1.48)	4.78 (1.44)	5.93 (1.38)	6.60 (1.22)	67.257	**0.000***	0.168
Place of Study	2.21 (1.23)	1.79 (1.30)	2.61 (1.34)	3.08 (1.23)	39.743	**0.000***	0.106
Perspective ERT	6.07 (1.99)	6.22 (2.11)	6.30 (2.16)	5.95 (2.45)	0.638	0.591	0.002

*$p = 0.000$.

Table 8
The mean differences between the participants' learning awareness in ERT (Idk = I do not know) and the interpretation regarding the four measuring factors.

Measuring factors	Mean difference between **learning awareness**						Interpretation
	Idk and No	Idk and Maybe	Idk and Yes	Maybe and No	Maybe and Yes	No and Yes	
Techonological Insfrastructure	− 0.119	− **2.021**∗	− **2.281**∗	**1.901****	− 0.260	− **2.161**∗∗	Maybe >Idk; Yes >Idk; Maybe >No; Yes >No
Digital Skills	**0.548***	− **0.605**∗	− **1.270**∗∗	**1.153****	− **0.665**∗∗	− **1.819**∗∗	Idk >No; Maybe >Idk; Yes >Idk; Maybe >No; Yes >Maybe; Yes >No
Place of Study	**0.415***	− **0.404**∗	− **0.872**∗∗	**0.819****	− **0.468**∗	− **1.288**∗∗	Idk >No; Maybe >Idk; Yes >Idk; Maybe >No; Yes >Maybe; Yes >No
Perspective ERT	− 0.155	− 0.231	0.111	0.076	0.343	0.267	

*p <0.05; **p <= 0.001.

obtained the highest mean, taking a deep look at our data, we noted that the participants with the awareness that they would learn had the highest mean. On the other hand, regarding the SS and PS factors, it is clear that the higher mean score was obtained by the participants who feel that they would learn in ERT like in the classroom.

4. Discussion

4.1. Measuring factors

Our results suggest that the factor loading for TI, SS and PS factors is generally acceptable and for PE is generally high. The internal consistency of data (how closely related the set of items are as a group) suggests that generally, it presents an acceptable internal consistency (reliability). The convergent and discriminant validity of the data was higher than 0.4 for all the factors, meaning that we can accept the convergent validity of our data. Plus, we adopted a recent model for determining the discriminant validity based on the HTMT criterion. The results have shown a discriminant validity between all constructs measured based on this criterion. Furthermore, our results pointed out that the score created for each measuring factor can be generally accepted by the level of strength and association between this score with each factor item.

4.2. Age generation

Our study sought to obtain diversification among participants by sending an invitation email to all university students with no filter, creating a scenario representing most HEIs. Diversification can bring many opportunities as well as challenges [55]. For example, different points of view, solutions and approaches to a given problem can be raised, as well as challenges in accepting different cultures and choices. The diversification delivers students with different financial, social, and experiences. We believe that some characteristics are built on the generation in which a person is born and grows. Although we had only one participant in the older generation, the number of participants belonging to other generations allows us to represent the average age that exists in several higher institutions around the world [56].

Thus, considering the participant's generation, our results showed a significant difference between the age generation of the participants with the place of study and feelings (optimism and learning awareness). The higher averages presented by the adult generations about this factor can be explained by the fact that they probably have greater purchasing power [57], infrastructure and place of study than the younger generation. In fact, we believe that older participants are more likely to have financial independence already; meanwhile, young people depend on their parents.

The result about the older generation being more optimistic than the young is in partial concordance with the work of Monaco and Martin [23], which mentions that Millennials are confident and highly optimistic. The authors make a definition that fits Millennials' education situation: "They have big dreams and expectations with an unclear path on how to reach the level of success they are so confident they will attain."

Interestingly, although the new technologies are a natural environment for the Z generation [58] and the mean obtained concerning the perspective about ERT was the highest, this generation had the lowest mean about the learning awareness. The characteristics of Generation Z can explain this behaviour, which has low confidence in their digital skills [59,60] and prefers practice over theory [61] (this practice is impaired in the case of distance learning). Besides, Hutchins [62] researched the motivation and use of technology by students at a university. They found evidence that Generation X shows significant differences and higher scores than Millennials in using technology. Furthermore, in the work of Zomer et al. [63], where a study was carried out with students of the administration course, it was noticed that Generation X has a more committed and engaged profile in the classroom than the other generations. Also, according to Wlodkowski and Ginsberg [64], adults want their world to make sense, find meaning and be more effective in what they value, which fuels the motivation to learn. Therefore, these findings corroborate the results obtained in our study, as the adult generations had higher means in the measured feelings than the younger generation. Furthermore, by associating that engagement, motivation and use of technology are essential for remote learning, the higher averages of optimism and learning awareness for older generations may make sense.

Specific social characteristics and the computer used by the student can explain the differences found in the digital skills factor between X and Z [65]. However, more research to investigate this behaviour is necessary.

4.3. Emotional state

The participants' emotional state just before the start of the academic semester shows that their positive affect levels were low, and the negative ones were very high. It means that the participants' emotional state was at a level not healthy, with higher levels of negative feelings in the majority of the participants. Our results suggest that a person's negative affects correlate with s/he level of optimism. This result is different from the study of Marshall et al. [66], where optimism correlates with positive affects. However, it is possible to deduce that the reality in which the participants had endured in 2020, the negative feelings may have influenced the interviewees' significant lack of optimism. A more in-depth analysis shows that a person with the negative feelings more highlighted than the positive ones was less optimistic about ERT. In this sense, our results were congruent with the work of Karalis and Raikou [67].

Moreover, even though positive affects promote a flexible and responsive approach to situations that encourage new learning and increase motivation [68], it was possible to see in our study that the learning awareness was not positive in those participants with high positive affects. However, the feeling was not negative either; instead, the participant with positive affects pointed out that they did not know if they would learn in remote learning. Different happened with the

negative affects; in these, the learning awareness was that they would not learn in remote education. Therefore, we found evidence that depending on students' emotional state, their feelings about the transition of teaching modality are different.

4.4. Students' feelings (optimism and learning awareness)

4.4.1. Optimism

Our results show that participants with better technological infrastructure, higher personal digital skills, and a better study place showed higher levels of optimism. Meanwhile, participants with a moderate level of optimism showed higher scores in their perspectives on ERT than the other optimism levels. The thorough research on factors that could influence optimism' levels did not reveal other studies that have measured similar factors to those discussed in this work that could corroborate our results. However, the level of optimism is a factor to be considered among the students, mainly because there is evidence that optimism is an indicator of better physical health [31].

4.4.2. Learning awareness

Our results show that a person's learning awareness depends on how s/he classifies the technological infrastructure, personal digital skill, and place of study. The participants with the learning awareness equal to Yes obtained a higher mean in TI, SS and PS factors. This result is congruent with the findings in Van Loon et al. [69], Lee and Rha [70], which shows that a digital learning task that combined autonomy support and structure had a positive influence on both intrinsic motivations, learning outcomes and satisfaction in students. However, it was impossible to find a correlation between learning awareness and the perspective on ERT. This result can be motivated by the questions made, which were related to perspectives on buying a new device or improving their place of study and about professors.

Although we did careful research to find studies that related the level of optimism and learning awareness with the change in the teaching modality, we did not find any work that supported the behaviours seen in this study. Thus, due to the scarcity of literature on this subject, it is necessary to carry out more studies to confirm the behaviours found.

5. Conclusion

In conclusion, this work showed some students' behaviours that we were foreseeing and others did not. For example, we believed that generations that grew up with more accessible computers and the Internet would be more favourable and receptive to this transition. However, we found that young students had the lowest learning awareness. Although distance learning techniques have been improved since their creation [71], we believe that the sudden change in teaching methodologies has influenced the young generation, which needs to feel prepared for this change. Thus, more comprehensive dissemination of remote study benefits is necessary, including in laboratory classes [72]. Plus, for the most current generation, it is essential to offer a package of procedures with training, flexible work or social team activities so that they feel healthy and confident [60]. In this sense, answering our first research question, the participants' optimism, learning awareness, and place of study differ from generation. Thus, the education institutes should identify the characteristics of each age generation to improve the students' optimism and learning awareness in a personalised way. Also, institutes must identify students' infrastructure for distance learning to aid those who need assistance. Plus, we consider an intelligent approach to offer innovative distance learning strategies and follow the students throughout the semester to identify difficulties and improve their distance education transition, experience and adaption.

It is evident that the sudden change in teaching methodology frightened students and filled them with negative affects. This influence is not good since students with negative moods may find it difficult to concentrate on the task at hand, and their motivation and willingness to stay in class may suffer [73]. In this sense, answering our second research question, our study showed that the emotional state reflected in the students' optimism and awareness of learning. Therefore, we suggest that education institutes make available psychologists' services to measure and control the student's emotional state level or adopt social and emotional learning (SEL) programs. Those kinds of programs are associated with positive outcomes [74]. Thus, enabling a better transition and adaptation of students to this change in the educational methodology.

In light of our results, we can answer our last research question, inferring that we found evidence that the measuring factors affected students' optimism level and learning awareness. Thus, we encourage the education institutes to identify the student needs for better Internet infrastructure, devices and technical difficulties. Additionally, we found evidence that the level of knowledge in digital technology was a factor that influenced students. For this reason, we advise the education institutes to provide training activities for the environment to be used in remote education before the beginning of the semester. In this way, the students would feel more prepared, aiding in the transition to distance education. Marshall et al. [75] suggest to academic institutes to incorporate digital learning days into future school calendars and put clear plans in place for future emergencies.

We understand that it is not correct to say that just implementing an e-learning system or making video calls changes the traditional educational methodology to distance learning. This process demands a more complex analysis taking into account some factors. Because of that, any transition of teaching methodology requires at least studies to investigate the difficulties and needs of professors and students. It is so true that the answers to the questions made in this study exposed the difficulties and frustrations that students suffer because of this abrupt transition. For this reason, education institutes should develop projects aimed at approaching the factors raised in this study to improve the levels of optimism and learning awareness of any student. Therefore, making the transition of learning methodology less harmful for the students' community. Also, we know that it is challenging to implement inclusive education in this process. Therefore, education institutes that have had or intend to migrate to remote education should review research that addresses this topic. Thus, trying to make the transition of people with disabilities more comfortable, hence, allowing an inclusive education that benefits everyone without distinction.

Finally, even though HEIs worldwide have to quickly adapt to remote education because of the pandemic of COVID-19, the learning that professors and students are having will be of great value when we return to face-to-face classes. For example, teachers already believe that their skills in using technology to prepare lessons, receive and provide answers, and communicate with students have improved [76]. Plus, we believe that some practices acquired at this time will be used and adapted for the classroom. This work could identify factors influencing university students' feelings when staring at the eminent academic semester that would start in a modality unfamiliar to them. In this way, we hope to give the academic institutes a treasure map pointing at which factors they must maintain continuous monitoring to help students feel prepared, optimistic and aligned with distance learning without feeling that their learning is being harmed. Besides, we emphasize that the measuring factors should be diagnosed before and during the academic semester to assist the students' transition and adaptation to distance learning.

5.1. Limitations and future research

This study has some limitations regarding the population focus of this research and literature review. The lack of older generation participants implied us not considering one participant's data. In addition, the subjects in this study belong to a small regional university, where part of its students has few conditions for ERT (whether financial or family). Thus, for example, some students only had a cell phone and

limited data for Internet use as technological equipment for their studies. Although this feature may have limited our number of participants and some results, we think this is still widely applicable to measure the students' infrastructure in any worldwide academic institute.

Another limitation is that we did not find another method to measure the participants' tech resources and emotional state levels in a pandemic moment than through self-questions. Consequently, it makes the user inform the measuring factors according to s/he perception of this factor. It means that what the user informs may not reflect the actual situation. For example, the perception that a given technological infrastructure is sufficient for ERT may differ among users, or else the perception of one user for a given level of digital skills may be different for another. Moreover, the participant's emotional state may be more affected by the pandemic moment than the change in educational methodology and vice versa. At the moment that we are living is difficult to make this distinction.

After a long search, no studies were found to provide a protocol for measuring and evaluating the factors measured in this study, such as the quality of students' place of study for distance learning. Thus, this study can be considered a first step to improving how to measure the factors used and, in this way, represent the reality of students regardless of geographic location.

Further investigation can be conducted to measure other factors that can hinder the transition and adaptation of students to distance education, such as lifestyle, identification with technology, environment, and family support. Besides, other students' features can be considered in the analysis, such as the participant's area of study, year of study (newcomers vs senior students) or even their experience of success or failure in their course of study. Furthermore, another future work can compare the measuring factors with students from HEIs that present better or worse conditions for remote study, thus checking if there is a generalization of the same results obtained. Finally, the implementation of the guidelines suggested in this study can be applied in a real scenario of the educational paradigm shift to verify if there is a better transition and improvement in students' emotional state, optimism and learning awareness.

CRediT authorship contribution statement

Raul Benites Paradeda: Conceptualization, Methodology, Validation, Data curation, Formal analysis, Investigation. **Heide Vanessa Souza Santos:** Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Research flow

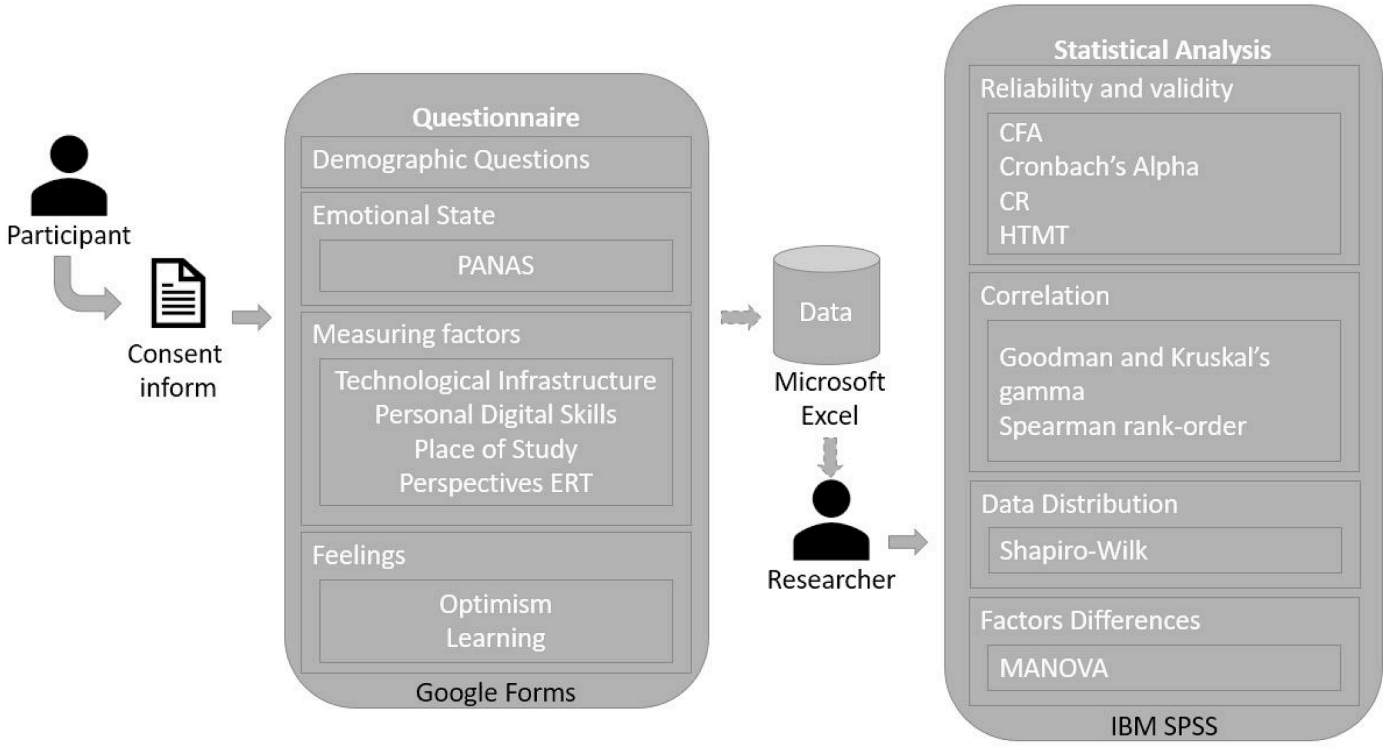

Fig. A1. Sections presented to the participant and the statistical tests used for data analysis.

Appendix B. Descriptive analysis of the participants' emotional state

	Affects	High positive	Low positive	High negative	Low negative
Gender	Male	79 (20.6%)	304 (79.4%)	258 (67.4%)	125 (32.6%)
	Female	111 (17.9%)	510 (82.1%)	478 (77%)	143 (23%)
	Not informed	1 (14.3%)	6 (85.7%)	5 (71.4%)	2 (28.6%)
Total	Number (%)	191 (18.9%)	820 (81.1%)	741 (73.3%)	270 (26.7%)

Appendix C. Questions and option scores used in the study

Technological Infrastructure (TI)

TI1 Do you have Internet access at home (yes=1, no=0)?
TI2 Is your Internet unlimited (yes=1, no=0, I do not know=0)?
TI3 Do you believe that your Internet will be enough for remote teaching (yes=2, no=0, maybe=1, I do not know=0)?
TI4 How do you rate your Internet access (Likert scale 1 (very bad) to 5 (very good))?
TI5 Which device will you access the classes (cellphone=1, notebook/PC=2, tablet=1, none=0)?
TI6 Do you think your cell phone is capable of supporting ERT programs (Likert scale 1 (not at all) to 5 (yes, absolutely))?
TI7 Do you think your device is capable of supporting ERT programs (Likert scale 1 (not at all) to 5 (yes, absolutely))?

Digital Skills (SS)

SS1 Do you have any disabilities that make it difficult to access the Internet or digital technologies (yes=0, no=1)?
SS2 How do you rate your skills in the use of digital tools (Likert scale 1 (I have no skills) to 5 (excellent skills))?
SS3 Do you believe that you are prepared to take classes and study at a distance (yes=2, no=0, maybe=1, I don't know=0)?

Place of Study (PS)

PS1 Do you believe you have an adequate place for education (yes=2, no=0, more or less=1, I do not know=0)?
PS2 Are the devices used for the classes personal or shareable (I share with others=0, just for my personal use=1)?
PS3 Do you think that domestic activities will have an impact on ERT activities (positive impact=2, no impact=1, negative impact=0)?

Perspectives ERT (PE)

PE1 Do you believe that your professors are prepared to teach at a distance (yes=2, no=0, maybe=1, I do not know=0)?
PE2 Do you believe that the professors' material will be adapted for ERT (yes=2, no=0, maybe=1, I do not know=0)?
PE3 Do you intend to subscribe to a better Internet if yours does not support ERT (yes=0, no=2, maybe=1, I do not know=0)?
PE4 Do you intend to purchase a new cell phone if yours does not support ERT (yes=0, no=2, maybe=1, I do not know=0)?
PE5 Do you intend to buy a new computer/notebook /tablet if your device does not support ERT (yes=0, no=2, maybe=1, I do not know=0)?

Feelings (FE)

FE1 What is your level of optimism about ERT (very optimistic, more or less optimistic, not very optimistic, I don't know)?
FE2 Do you believe that you will learn in ERT as in traditional classroom (yes, no, maybe, I do not know)?

Appendix D. Participants' descriptive analysis with their characteristics, study area and enrolled year

	Variables	Students	Mean/SD age
Total	Number	1011	24.24 (6.58)
Gender	Male	383 (37.9%)	24.63 (6.97)
	Female	621 (61.4%)	23.96 (6.36)
	Not informed	7 (0.7%)	21.86 (2.79)
Study area	Exact and Earth Sciences	154 (15.2%)	
	Biological Sciences	29 (2.9%)	
	Health Sciences	101 (10.0%)	
	Linguistics, Letters and Arts	165 (16.3%)	
	Applied Social Sciences	269 (26.6%)	
	Humanities	290 (28.7%)	
	Not informed	3 (0.3%)	
Enrolled year	I do not know	17 (1.7%)	
	First year	125 (12.4%)	
	Second year	261 (25.8%)	
	Third year	173 (17.1%)	
	Fourth year	105 (10.4%)	
	More tha five years	26 (2.6%)	
	Freshman	249 (24.6%)	
	Different years	55 (5.4%)	

Appendix E. Confirmatory factor analysis, the corresponding factor loadings and reliabilities

Factors/Questions	Mean	SD	Factor loadings	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Techonological Insfrastructure				**0.732**	**0.833**	**0.422**
TI1	0.931	0.252	0.520			
TI2	0.571	0.495	0.525			
TI3	0.530	0.499	0.575			
TI4	3.280	1.070	0.776			
TI5	2.020	0.947	0.672			
TI6	2.760	1.343	0.680			
TI7	2.840	1.677	0.750			

(*continued on next page*)

(*continued*)

Digital Skills				**0.409**	**0.707**	**0.466**
SS1	0.943	0.231	0.392			
SS2	3.440	1.030	0.794			
SS3	0.813	0.794	0.783			
Place of Study				**0.478**	**0.737**	**0.490**
PS1	0.920	0.777	0.788			
PS2	0.578	0.494	0.529			
PS3	0.588	0.666	0.754			
Perspective ERT				**0.393**	**0.920**	**0.710**
PE1	1.066	0.749	0.860			
PE2	1.235	0.772	0.859			
PE3	1.153	0.831	0.784			
PE4	1.450	0.778	0.864			
PE5	1.301	0.843	0.845			

Appendix F. HTMT between each measuring factor

Measurement factors	TI	SS	PS	PE
Technological Infrastructure	–			
Digital Skills	0.829	–		
Place of Study	0.687	0.845	–	
Perspectives ERT	0.402	0.463	0.189	–

Appendix G. Statistical analysis to measure the strength of association

	Factor score				
Factors/Questions	Mean	Sd	Goodman and Kruskal's gamma		Spearman's
Techonological Insfrastructure	12.938	4.402	G	*p*	*r*
TI1			0.860	0.000	0.366
TI2			0.552	0.000	0.449
TI3			0.612	0.000	0.504
TI4			0.730	0.000	0.730
TI5			0.684	0.000	0.677
TI6			0.690	0.000	0.729
TI7			0.796	0.000	0.843
Digital Skills	5.194	1.549			
SS1			0.660	0.000	0.236
SS2			0.917	0.000	0.841
SS3			0.880	0.000	0.770
Place of Study	2.087	1.379			
PS1			0.918	0.000	0.807
PS2			0.712	0.000	0.528
PS3			0.884	0.000	0.742
Perspective ERT	6.573	2.230			
PE1			0.337	0.000	0.304
PE2			0.355	0.000	0.314
PE3			0.694	0.000	0.630
PE4			0.804	0.000	0.664
PE5			0.781	0.000	0.677

References

[1] W. Green, V. Anderson, K. Tait, L. T. Tran, Precarity, fear and hope: reflecting and imagining in higher education during a global pandemic, 2020.

[2] Jena PK. Impact of COVID-19 on higher education in India. Int J Adv Educ Res (IJAER) 2020;5:77–81.

[3] Eder R. The remoteness of remote learning: a policy lesson from COVID19. J Interdiscip Stud Educ 2020;9(1):168–71.

[4] Mohmmed AO, Khidhir BA, Nazeer A, Vijayan VJ. Emergency remote teaching during coronavirus pandemic: the current trend and future directive at middle east college Oman. Innov Infrastruct Solut 2020;5(3):1–11.

[5] Marinoni G, Van't Land H, Jensen T. The impact of COVID-19 on higher education around the world. IAU Global Survey Report. 2020.

[6] Aristovnik A, Keržič D, Ravšelj D, Tomaževič N, Umek L. Impacts of the COVID-19 pandemic on life of higher education students: a global perspective. Sustainability 2020;12(20):8438.

[7] Osman ME. Global impact of COVID-19 on education systems: the emergency remote teaching at sultan Qaboos university. J Educ Teach 2020;46(4):463–71.

[8] Toquero CM. Emergency remote education experiment amid COVID-19pandemic in learning institutions in the Philippines. Int J Educ Res Innov 2020:162–76.

[9] Karakaya K. Design considerations in emergency remote teaching during the COVID-19 pandemic: a human-centered approach. Educ Technol Res Dev 2021;69 (1):295–9.

[10] Hodges C, Moore S, Lockee B, Trust T, Bond A, et al. The difference between emergency remote teaching and online learning. Educ Rev 2020;27:1–12.

[11] Hebebci MT, Bertiz Y, Alan S. Investigation of views of students and teachers on distance education practices during the coronavirus (COVID-19) pandemic. Int J Technol Educ Sci (IJTES) 2020;4(4):267–82.

[12] Simonson M, Zvacek SM, Smaldino S. Teaching and learning at a distance: foundations of distance education. 7th ed. IAP; 2019.

[13] Kaplan AM, Haenlein M. Higher education and the digital revolution: about moocs, spocs, social media, and the cookie monster. Bus Horiz 2016;59(4):441–50.

[14] Beckman K, Apps T, Bennett S, Lockyer L. Conceptualising technology practice in education using Bourdieu's sociology. Learn Media Technol 2018;43(2):197–210.

[15] Zawacki-Richter O. The current state and impact of COVID-19 on digital higher education in Germany. Hum Behav Emerg Technol 2021;3(1):218–26.

[16] Tzifopoulos M. In the shadow of coronavirus: distance education and digital literacy skills in Greece. Int J Soc Sci Technol 2020;5(2):1–14.

[17] Rashid S, Yadav SS. Impact of COVID-19 pandemic on higher education and research. Indian J Hum Dev 2020;14(2):340–3.

[18] Williamson B, Eynon R, Potter J. Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency.

Learn Media Technol 2020;45(2):107–14. https://doi.org/10.1080/17439884.2020.1761641.
[19] Nambiar D. The impact of online learning during COVID-19: students' and teachers' perspective. Int J Indian Psychol 2020;8(2):783–93.
[20] He W, Xiao J. The emergency online classes during COVID-19pandemic: a Chinese university case study. Asian J Distance Educ 2020;15(2):21–36.
[21] Noesgaard SS, Ørngreen R. The effectiveness of e-learning: an explorative and integrative review of the definitions, methodologies and factors that promote e-learning effectiveness. Electron J e-Learn 2015;13(4):277–89.
[22] Manca S, Delfino M. Adapting educational practices in emergency remote education: continuity and change from a student perspective. Br J Educ Technol 2021;52(4):1394–413.
[23] Monaco M, Martin M. The millennial student: a new generation of learners. Athl Train Educ J 2007;2(2):42–6.
[24] Saadé RG, Kira D. The emotional state of technology acceptance. Issues Informing Sci Inf Technol 2006;3.
[25] Na K, Garrett RK, Slater MD. Rumor acceptance during public health crises: testing the emotional congruence hypothesis. J Health Commun 2018;23(8):791–9.
[26] Figueira JSB, David IdPA, Lobo I, Pacheco LB, Pereira MG, de Oliveira L, et al. Effects of load and emotional state on eeg alpha-band power and inter-site synchrony during a visual working memory task. Cogn Affect Behav Neurosci 2020;20(5):1122–32.
[27] Goertz R, Vissers C, Verhees M, Chwilla D. Effects of emotional state on processing conceptual mismatches: erps in a picture-sentence matching task. J Behav Brain Sci 2017;7(12):557–84.
[28] Maire H, Brochard R, Kop J-L, Dioux V, Zagar D. Effect of emotions in a lexical decision task: adiffusion model analysis. Swiss J Psychol 2017;76(2):71.
[29] Khosravi P, Parker AJ, Shuback AT, Adleman NE. Attention control ability, mood state, and emotional regulation ability partially affect executive control of attention on task-irrelevant emotional stimuli. Acta Psychol 2020;210:103169.
[30] Segerstrom SC, Carver CS, Scheier MF. Optimism. The happy mind: cognitive contributions to well-being. Springer; 2017. p. 195–212.
[31] Carver CS, Scheier MF, Segerstrom SC. Optimism. Clin Psychol Rev 2010;30(7):879–89.
[32] Løvoll HS, Sæther K-W, Graves M. Feeling at home in the wilderness: environmental conditions, well-being and aesthetic experience. Front Psychol 2020;11:402.
[33] Gaunkar NP, Mina M. Developing self-awareness in learning practices: designing and implementing a survival tool for freshmen in engineering. 2018 ASEE annual conference & exposition. 2018.
[34] Bronfenbrenner U. The ecology of human development: experiments by nature and design. Harvard University Press; 1979.
[35] Carpenter JP, Krutka DG, Trust T. Continuity and change in educators' professional learning networks. J Educ Change 2022;23:85–113. https://doi.org/10.1007/s10833-020-09411-1.
[36] Saunders M, Lewis P, Thornhill A. Research methods for business students. Pearson Education; 2009.
[37] Acharya BR. Factors affecting difficulties in learning mathematics by mathematics learners. Int J Elem Educ 2017;6(2):8–15.
[38] Crawford J, Henry J. The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. Br J Clin Psychol 2004;43(3):245–65.
[39] Tang YM, Chen PC, Law KM, Wu C, Lau YY, Guan J, et al. Comparative analysis of student's live online learning readiness during the coronavirus (COVID-19) pandemic in the higher education sector. Comput Educ 2021;168:104211. https://doi.org/10.1016/j.compedu.2021.104211.
[40] Jöreskog KG. A general approach to confirmatory maximum likelihood factor analysis. Psychometrika 1969;34(2):183–202.
[41] Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951;16(3):297–334.
[42] Cho E. Making reliability reliable: a systematic approach to reliability coefficients. Organ Res Methods 2016;19(4):651–82.
[43] Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res 1981;18(1):39–50.
[44] Taber KS. The use of Cronbach's alpha when developing and reporting research instruments in science education. Res Sci Educ 2018;48(6):1273–96.
[45] Bacon DR, Sauer PL, Young M. Composite reliability in structural equations modeling. Educ Psychol Meas 1995;55(3):394–406.
[46] Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J Acad Mark Sci 2015;43(1):115–35.
[47] Goodman LA, Kruskal WH. Measures of association for cross classifications. Springer; 1979. p. 2–34.
[48] Spearman C. The proof and measurement of association between two things. Int J Epidemiol 2010;39(5):1137–50.
[49] Shapiro SS, Wilk MB. An analysis of variance test for normality (complete samples). Biometrika 1965;52(3/4):591–611.
[50] Cohen J. Statistical power analysis for the behavioral sciences. Academic Press; 2013.
[51] Dancey CP, Reidy J. Statistics without maths for psychology. Pearson Education; 2007.
[52] Warne RT. A primer on multivariate analysis of variance (MANOVA) for behavioral scientists. Pract Assess Res Eval 2014;19:1–10. https://doi.org/10.7275/sm63-7h70.
[53] Williams LJ, Abdi H. Fisher's least significant difference (LSD) test. Encycl Res Des 2010;218:840–53.
[54] Kline RB. Principles and practice of structural equation modeling. Guilford Publications; 2015.
[55] Gao X. On the construction of university culture under the background of value diversification. International conference on arts, design and contemporary education (ICADCE). 2015.
[56] OECD.Stat Profile of graduates and new entrants: graduation average age, 2021, Organisation for Economic Co-operation and Development.https://stats.oecd.org/index.aspx?queryid=79474.
[57] W. Fengler, The silver economy is coming of age: a look at the growing spending power of seniors, 2021, https://www.brookings.edu/blog/future-development/2021/01/14/the-silver-economy-is-coming-of-age-a-look-at-the-growing-spending-power-of-seniors/.
[58] Dolot A, et al. The characteristics of generation Z. E-Mentor 2018;74(2):44–50.
[59] CWJobs, High hopes gen Z will close the digital skills gap - but young people are in a confidence crisis, 2021, https://www.fenews.co.uk/press-releases/78898-high-hopes-gen-z-will-close-the-digital-skills-gap-but-young-people-are-in-a-confidence-crisis.
[60] O. Hughes, Sorry, gen Z isn't going to solve your tech skills crisis, 2021, https://www.zdnet.com/article/businesses-think-gen-z-can-solve-the-digital-skills-shortage-young-people-arent-so-sure/.
[61] Stjepić A-M, Vukšić M, Suša Vugec D. Digital literacy of the generation Z students and their attitudes and beliefs towards ICT knowledge and skills. Int J Vallis Aurea 2019;5(1):17–29.
[62] Hutchins L. Generation X and generation Y: an exploration of student motivation to learn and technology use. East Tennessee State University; 2021. Ph.D. thesis.
[63] Zomer LB, Santos AR, de Oliveira Costa KC. O perfil de alunos do curso de administração: um estudo com base nas gerações x, yez. Rev Gestão Univ Am Latina-GUAL 2018:198–221.
[64] Wlodkowski RJ, Ginsberg MB. Enhancing adult motivation to learn: a comprehensive guide for teaching all adults. John Wiley & Sons; 2017.
[65] Kassim ES, Hairuddin H, Chowdhury MHM, Al-Din ZHM, Azhar NSN. Digital competencies among generation Z: comparison between. Int J Adv Sci Technol 2020:559–71.
[66] Marshall G, Wortman C, Kusulas JW, Hervig L, Vickers R. Distinguishing optimism from pessimism: relations to fundamental dimensions of mood and personality. J Personal Social Psychol 1992;62:1067–74.
[67] Karalis T, Raïkou N. Teaching at the times of COVID-19: inferences and implications for higher education pedagogy. Int J Acad Res Bus Soc Sci 2020;10(5):479–93.
[68] Isen AM. Some perspectives on positive feelings and emotions: Positive affect facilitates thinking and problem solving. Feelings and emotions: the amsterdam symposium, Jun, 2001, Amsterdam, Netherlands. Cambridge University Press; 2004.
[69] Van Loon A-M, Ros A, Martens R. Motivated learning with digital learning tasks: what about autonomy and structure? Educ Technol Res Dev 2012;60(6):1015–32.
[70] Lee H-J, Rha I. Influence of structure and interaction on student achievement and satisfaction in web-based distance learning. J Educ Technol Soc 2009;12(4):372–82.
[71] Moore MG. Handbook of distance education. Routledge; 2013.
[72] Brinson JR. Learning outcome achievement in non-traditional (virtual and remote) versus traditional (hands-on) laboratories: a review of the empirical research. Comput Educ 2015;87:218–37.
[73] Pekrun R, Linnenbrink-Garcia L. Introduction to emotions in education. Routledge; 2014.
[74] Jones SM, Bouffard SM. Social and emotional learning in schools: from programs to strategies and commentaries. Social Policy Rep 2012;26(4):1–33.
[75] Marshall DT, Shannon DM, Love SM. How teachers experienced the COVID-19 transition to remote instruction. Phi Delta Kappan 2020;102(3):46–50.
[76] Beardsley M, Albó L, Aragón P, Hernández-Leo D. Emergency education effects on teacher abilities and motivation to use digital technologies. Br J Educ Technol 2021;52(4):1455–77.