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FAMILIES IN THE DIGITAL DIVIDE: IMPACT ON ONLINE LEARNING OF SPANISH UNIVERSITIES

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ABSTRACT

The forced transition to online learning during the pandemic was a significant challenge for universities, evidencing important barriers such as socioeconomic and sociocultural inequalities in the student body. The physical learning environment, especially the home, plays a crucial role in supporting or limiting online learning activities. The first-generation digital divide persists as worldwide problem, related with the lack of technologies and infrastructures in family nuclei that are socially, economically, and culturally disadvantaged. The aim of the study was to better understand the resources and infrastructures available to university students within the family nucleus and to analyze the relationship between the type of family and the possible barriers derived for the development of online learning. The sample is 670 university students in the area of education from two Spanish universities (University of Lleida and the University of Cordoba). The results revealed that there is still a divide related with the access to technological resources among families of university students, although it is not as deep as in other stages of education. Despite the fact that families of university students have more resources, inequalities persist, damaging the academic development of some students. From the sample, 35.3% of the families have doubts about their solvency to provide individual electronic devices to each member of the family. Despite most students considering that their devices are adequate, a fourth of the population faces difficulties in accessing appropriate devices. In conclusion, despite the fact that the families of university students have more technological resources, inequalities persist that affect the academic development of some. A significant percentage of families doubt their ability to provide adequate electronic devices to all their members.

KEYWORDS: Digital Divide, Family, Type of Family, University Education, Online Teaching, Online Learning, Pandemic, Digital Barriers.

1. INTRODUCTION

The family nucleus is the primary and essential social network in any stage of life, not only as a resource, but as a shelter in the life of humans (Rodríguez, 2012). Thus, the influences received within the family are decisive for the good life development of individuals.

During emergencies, such as the past pandemic, family resources must become accustomed to different demands, in this case imposed by the confinement during the pandemic, which forced digital inclusion, which placed stress on the daily life of families (Cobos et al. 2022; Ramos-Pla et al., 2023).

Among other things, the face-to-face academic activities were transferred from school environments (del Arco et al., 2021), to family environments, mostly mediated by digital devices. This forced a necessary technological adaptation to provide an answer to the new reality (Dhawan et al., 2020; Hodges et al., 2020) that was designed in terms of remote work, online teaching, socialization through networks, etc.

After the analysis of the events during de pandemic and taking into account the scientific literature published so far, it is necessary to analyse the digital divide of university students taking into account the type of family to which they belong. In this sense, many questions were posed that became objects of study: Were the technological infrastructures at home enough for closing the digital divide? Were the competences acquired the correct ones? Were the characteristics of the family nucleus determinant factors for the forced technological adaptation during the emergency? What type of equipment and how were they used during the emergency? Is the digitalization of the home here to stay? Or was it only a reaction against the situation that arose?

These and other matters must be studied to better understand, among other things, the technological advancements in the family environment, because, beyond their presence and use, an ethical discussion is also necessary (Balladares, 2017) on the changes that ICT provoked and are provoking at home, at education institutions, among the youth and children, and society in general, by studying the values and counter-values that could have different effects on the action of individuals and society at large.

1.1. Equipment And the Use of Information and Communication Technologies at Homes in Spain

On November 28th, 2023, the results from the poll on equipment and Information and Communication Technologies at Home (TIC-H) were published, a study conducted by the National Statistics Institute (INE) of Spain since 2002, which converged with the Eurostat methodology starting in 2006. This poll is used to compile information on the technological equipment found at home (television, telephone, radio, computer equipment), and the use of computers, the internet, and electronic commerce. In 2005 and 2006, it was published every semester, but in 2007, it returned to an annual publication. The size of the sample was composed of more than 23000 homes, with a fourth renewed every year. The interviews to collect data are conducted in the second quarter of the year, via the telephone or a personal visit. To attain a greater comparability with the data published by Eurostat, the results published in the last few years refer to homes inhabited by at least one person aged between 16 and 74 years old, and people in the same age group. The 10-15 years old group was differentiated in order to analyze the use of technology of children.

The data from 2023 show that 96.4% of the Spanish homes had access to broadband Internet, fixed and/or mobile (as compared to 96.1% in 2022). Also, 83.1% accesses the internet with a fixed broadband (optical fiber, cable, ADSL, etc.), and 13.4% through a mobile connection (3G, 4G, or 5G).

Mobile phones are present in 99.5% of the homes with at least one member aged 16 to 74 years old. Landlines are found in 57.5% of homes, 5.0 points lower than in 2022. In addition, 99.9% of homes have some type of telephone (landline or mobile), and 57.1% have both. Additionally, 0.4% only has a landline, and 42.4% exclusively utilizes the mobile phone. Lastly, 82.6% of homes has some type of computer (desktop, laptop, tablet…), 0.3 points less than in 2022.

In summary, figure 1 shows the changes in the last 10 years, indicating that ownership of broadband internet and some type of computer at home have increased. This increase was more evident during the pandemic (2020-2022), while a decrease is observed in the ownership of a landline telephone. In this regard, it should be noted that in 2023 the end of the pandemic emergency was declared, although COVID-19 is still present in a more normalized form (WHO, 2023).

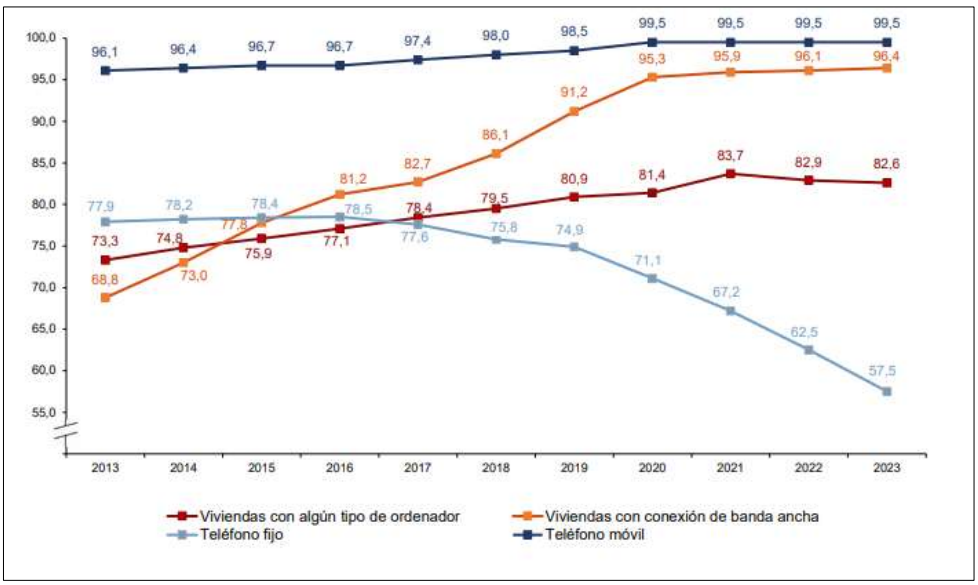

Figure I: Changes in ICT Equipment at Home: 2013-2023.

In this figure you can see the number of homes that have some type of computer, landline, connection and Internet with broadband and/or mobile phone (the latter stands out). Extracted from the National Statistics Institute of Spain (2023).

After the analysis of the type of family, according to the classification of the TIC-H2023 poll, figure II shows that:

1. There are significant differences between the type of family and the existence of a broadband internet connection, with only a slightly higher margin in families of cohabiting couples with children.
2. Equality of all types of families and cell phone ownership as a technological tool
3. The single-person household is the one that preferably uses the internet connection only through mobile broadband.
4. Couples with children living together at home stand out slightly above other types of families in terms of having a fixed broadband internet connection of any type and a greater variety of electronic devices: desktop computers, laptops, tablet computers, followed by single-parent families.

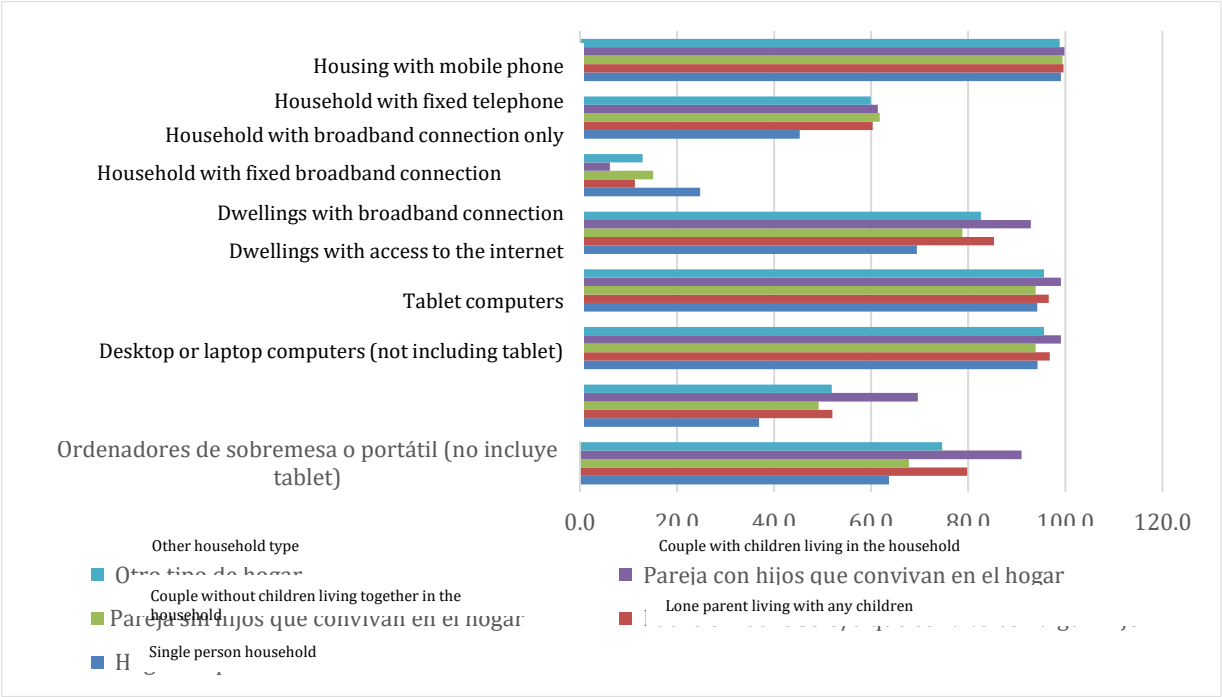

Figure II: ICT Equipment According to Type of Household ICT-H.2023.

The image shows that access to mobile phones and the internet is very high in all types of households, especially in homes with internet and broadband connections, where the values are around 100%. On the other hand, the availability of computers and tablets is more unequal, being higher in households with couples with children and lower in single-person households. Adapted from the National Statistics Institute (2023).

The single-person household obtained a lower percentage (69.8%) as compared to couples with children living together, which represented 94.1%, in having any type of computer device (computer). The single-parent families were 85.6%, and the couples without children living together, 74.5%.

1.2. Digital Divide and Homes That Facilitate Online Academic Activities

The digital divide refers to inequalities in access and use of information and communication technologies (ICTs) between individuals, regions, and countries (Martínez López, 2020; Mendoza-Ruano & Caldera-Serrano, 2014). It is a multidimensional concept encompassing barriers such as lack of skills, infrastructure, and economic resources (Martínez López, 2020). The first-level digital divide specifically focuses on physical access to ICTs (Pandolfi, 2024).

The availability of technologies devices and internet connectivity is one of the greatest challenges to address the learning problem. The literature that analyzed the needs and challenges of internet connections among students supported the argument of this study (Aboagye et al., 2021; Chase et al., 2018; Chung et al., 2020; Lorenzo, 2017). However, some people have other points of view about the internet connection. For example, a study showed that the use of the internet at a university was not affected by an inefficient internet connection (Apuke & Iyendo, 2018), while another study also indicated that improving the internet connection was crucial for online learning, especially in rural areas (Ahmed et al., 2017).

On the other hand, Hossain and Rahman (2017) affirmed that students must improve their use of the internet, and universities should provide internet connections and an adequate environment. Tarimo and Kavishe (2017) discovered that 82% of students used the internet for academic purposes. However, another study found negative results on the attitude towards the use of online learning management systems (Serhan, 2020). With these ideas and information, accessing the internet is a difficulty and a challenge for students, professors, and the institution as well.

The availability of learning resources is an additional subject related with the present study. For example, a study conducted in a country in Southern Asia found that the individuals polled had computers at home and at university. In another study, the students possessed a great variety of smartphones of different brands (Essel et al., 2018). This is feasible, given the demand in the mobile phone market, and the very competitive prices for consumers. According to many studies, (Apuke & Ivendo, 2018; Muthuprasad et al., 2021), smartphones are an important point of access to the internet and online learning. However, Gezgin (2017) did not find significant differences in the appearance of nomophobia among university students and the duration of ownership of a smartphone. Another study (Romero-Rodríguez et al., 2021) found that mobile devices for learning improved the perceived productivity of the students.

Lastly, authors such as Ovalles (2014), Pascuas-Rengifo et al. (2020) and Zhang et al. (2021) affirmed that a constant connectivity enables students to access online education resources from anywhere. Also, the fast availability of education resources facilitates, according to Demuyakor (2020), Shamir-Inbal & Blau (2021), Salas-Pilco et al. (2022), an improved collaboration, flexibility of learning, the availability of the richness of multimedia resources, and online learning platforms, the development of technological skills, and improves the technological infrastructure as well.

The emergency situation that forced the world's population to confinement was the ideal moment to propose this study, as the resources available at home had to be mandatorily mobilized, on some occasions, with limited possibilities to resort to extra resources. After the pandemic, the mobilization of all of these resources resulted in hyper-connected homes. At the homes of university students, this was not an exception, and it is interesting to compare the impact of the creation of technological spaces appropriate for academic aspects on these family nuclei, and to discover what possible barriers could appear that make equal conditions impossible, to guarantee access to technologies and their use. Therefore, the research questions posed are the following: Did the university students have enough resources and infrastructures to follow the online classes in moments of emergency? Can the first-level digital divide be discussed when analyzing the university students' families?

2. METHOD

2.1. Design And Methodology

To provide an answer to the research questions, the following objectives were defined, and a quantitative methodology with a descriptive approach was utilized. A non-experimental, descriptive design

2.2. Objectives

- To identify the resources and infrastructures available to university students in their family homes.
- To analyze the relationship between family type and potential barriers to the development of online learning.
- To discover the resources and infrastructures available to university students at the family home.
- To analyze the relationship between the type of family and the possible barriers derived, for the development of online learning.
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A non-experimental, descriptive design was utilized, through the application of a quantitative methodology.

2.3. Sample

University students enrolled in the 2021-2022 academic year participated in the study. They were enrolled in the Education degree at the University of Cordoba and the University of Lleida. A convenience sampling technique was utilized. The questionnaire in virtual format was sent to the students with the collaboration of professors from both universities (University of Cordoba and University of Lleida) The responses from a total of 670 participants were collected. Most of the participants were women: almost 80% (534). Their ages ranged from 17 to 55 years old (median of 22), with an evident and logical concentration of younger students: almost 90% were aged between 17 and 28 years old, with 5% older than 32. The mean age was almost 23 years old (95%CI: 22.5-23.3), with standard deviation of ±5.1 years.

Most of the students were enrolled in a bachelor's degree in the area of education (65.1%), while the remaining students (34.9%) were Master's students in the same area of knowledge.

Almost 69% of the sample (461 students) lived in an urban environment. About 29.3% (196 subjects) lived in a rural area, and 13 cases (1.9%) simultaneously lived in both contexts.

Cohabiting during the confinement was very varied, with the most frequent response being: with parents and siblings (more than 51%). Thus, the number of people who lived in the same house (during the confinement) varied between 1 (1.8%; 12 cases) and 11 (0.1%; only 1 case), with a median of 4 people. In about 10% of the homes of those polled, there were 5 people or more.

Figure III below shows the most frequent family configurations. In this study, the following are considered:

- Family without children. (47 =7.0%)
- Nuclear family (two-parent). The nuclear family is what we know as the family composed by a father, a mother (two adults as a couple) and their children. (478 = 71.3%)
- Single parent family. A single-parent family consists of only one parent taking care of the family unit. (24 = 3.6%)
- Composite family, characterized by being made up of several nuclear families. It is usually the result of the breakup of the initial couple. Other couples are formed and the children have the family of the father and his new partner and the mother and her new partner, and may end up having step-siblings. (76 = 11.36%)
- Extended family, characterized by the fact that the raising of children is the responsibility of different relatives or several family members (parents, cousins, grandparents, etc.) live in the same house. (7 = 1.0%)
- Others: when it does not fit any of the previously established criteria (38=5.7%).

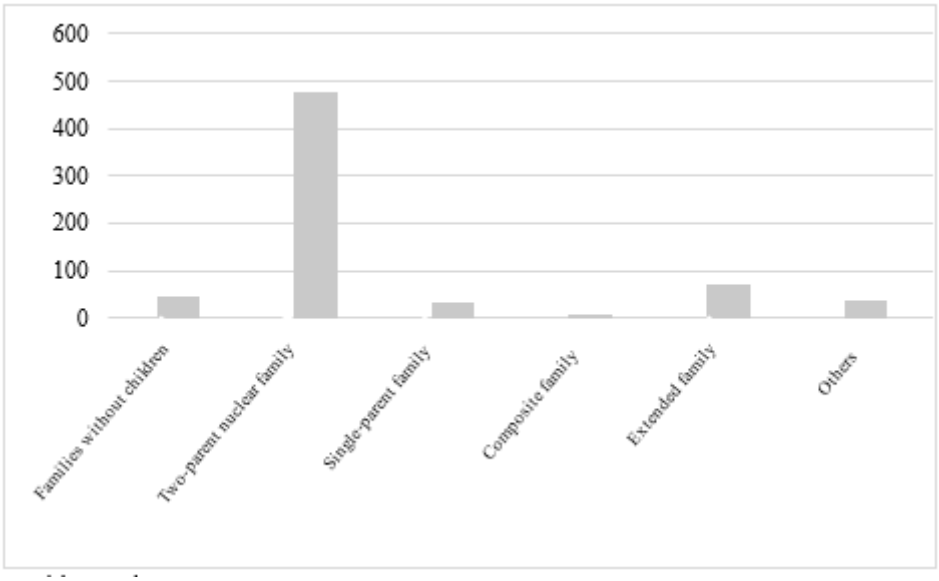

Figure III: Family Nuclei Participating in the Sample.

The graph shows that two-parent nuclear families are by far the most represented in the sample. The rest of the types of families (without children, single-parent, compound, extended and others) have a clearly lower participation and quite unequal among them. Own elaboration.

2.4. Instrument

An ad-hoc questionnaire was created composed of different sections. The aim of the questionnaire was to understand the situation during the training received by university students during the health crisis, to be able to analyze and provide a diagnosis of the situation, to understand the technological infrastructures available, and to what degree the family nucleus variable, its conditions, and structure, affected the ability of university students to follow the online classes during the emergency.

The present article will focus on the section: Barriers related with the characteristics of homes: Infrastructure and Resources, composed of:

- 2 dichotomous questions (yes/no):
  - I have my own equipment/device (PC, laptop, Tablet…) to be able to follow the online classes synchronously and perform my tasks.
  - I share my work equipment/device (PC, laptop, tablet…) with other members in my family.
- 5 Likert questions with 5 response options (from 1=complete disagreement, to 5=complete agreement):
  - The family has economic resources to pay for a broadband internet connection.
  - The family has economic resources so that each person can have his or her own equipment/device.
  - I have a sufficiently stable connection that "works" for correctly following my synchronous online classes with the programs used for it (Cisco Webex, Blackboard, Teams, Zoom...).
  - The device/equipment that I use to receive online courses through the programs used for this (Cisco, Blackboard, Temas, zoom...) is sufficiently "powerful" for following the classes correctly.
  - I have adequate audiovisual means (Webcam, speakers, microphone, headphones…) to follow the synchronous online classes.

The unidimensionality of the set of items that shape this section was verified with the Principal Components method from an Exploratory Factor Analysis, excluding the first two items given their dichotomous nature, and because there a clear majority of informants who gave the same answers. The results obtained indicate that these items had very high factorial loads (>0.70) in the same section, which together explained almost 60% of the empirical variability. Also, the reliability indices of these items were estimated, which was found to be >0.80 in all of them. This result, together with the above, indicates a high degree of reliability (EFA – Explained variance: 59.8% // KMO=0.79 // Bartlett: P-Value<.000001), with a Cronbach's Alpha reliability =0.83 for the entire section (table I)

Table I: Psychometric Properties: Validity and Reliability. Unidimensionality. Barriers Related to

Infrastructure and Resources. N=670. AFE – Variance Explained: 59.8% // KMO=0.79 // Bartlett: P-Value<.000001.

Items	Factorial Analysis		Reliability of the item
	Communality	*Factorial Load*	
3. The family has economic resources to pay for a broadband internet connection	0.64	0.80	0.78
4. The family has economic resources so that each person can have his or her own equipment/device	0.55	0.74	0.81
5. I have a stable connection for correctly following the online classes	0.65	0.81	0.78
6. The device used for the online courses is sufficiently powerful	0.64	0.80	0.78
7. I have adequate audiovisual means to follow the synchronous online classes	0.52	0.72	0.81

The raw score for this dimension was constructed using the common point accumulation method. According to this, the expected range of values was between 5 and 25 points, which it almost completely encompassed, given that the empirical range was: 6-25 (with a median of 21 points), and an evident asymmetry that concentrated most cases to the right side (high values) of the distribution (figure IV), as expected after examining the response to the items. With a mean value of 20.4 points (out of 25), it can be concluded that in general, the group of participants did not have problems that would imply a barrier to the infrastructures and resources to manage online learning.

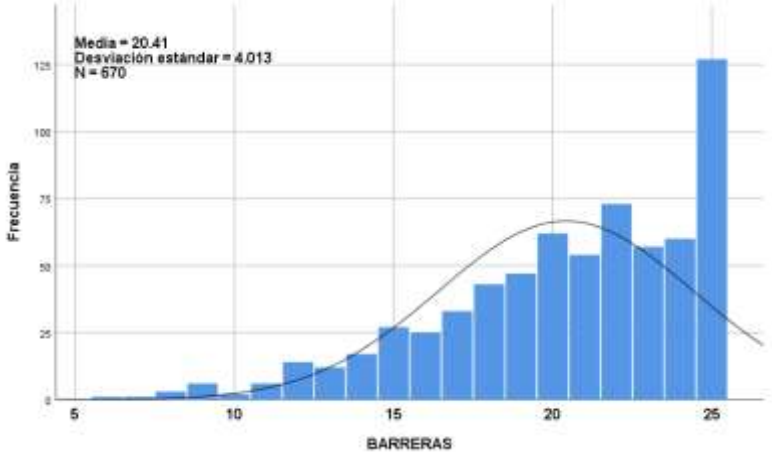

Figure IV: Barriers Related to Infrastructure and Resources. Total Raw Score. - N=670 Participants. Reliability: Cronbach's Alpha=0.83.

2.5. Data Analysis

The statistical analysis was performed with the computer program IBM-SPSS Statistics version 25.

The statistical techniques and tests utilized were:

- A description of the qualitative variables with frequencies and percentages. To cross-reference these variables, a contingency table was used.
- The quantitative variables were explored to verify their fit or not, to a normal Gaussian distribution. For this, the following were used: (a) normal Q-Q graphics, (b) asymmetry and kurtosis indices, and (c) the goodness-of-fit Kolmogorov-Smirnov test to verify normality, in which only a severe deviation ($p<.01$) indicates that the variable is not distributed normally.
- The quantitative variables were described through the commonly-used tools of (a) centrality: mean and median; and (b) variability: observed range, standard deviation, and interquartile range (P75 and P25).
- The reliability of the questionnaires was assessed through Cronbach's Alpha Coefficient of internal consistency. A value higher than 0.60 indicated an acceptable reliability, while a value higher than 0.80 indicated a good or very good (>0.90) reliability.
- To compare the significance of the means from the same sample of subjects (repeated measures / related samples), repeated measures one-way ANOVAs were used.
- To compare the means of groups composed by different subjects (independent between them), the student's t test and a one-way

ANOVA were used, when the variables were normal and their respective alternative were non-parametric (Mann-Whitney and Kruskal-Wallis) when they were not normally distributed.

In all of these inferential tests, a significance of $p<0.05$ (normal 5% CI) and a high significance when $p<0.01$ (1% CI) were considered. The high N could be the reason for high significances that are not confirmed because the effect size (R2) is small or very small (<2%).

3. RESULTS

3.1. Technological Resources in Families of University Students Descriptive Results on Technological Resources

Having technological resources or not at home can help university students follow the online classes. It is important to know if there was a barrier related with the digital infrastructure and tools, and to what measure it was related with economic resources in the family nucleus.

According to the results shown in table II:

- Almost all of the participants indicated having their own computer device / equipment to be able to take the classes online and perform their tasks (96.4% (646 cases).
- A high majority, 82.2% (551), indicated that they did not share their computer device / equipment with other members of the family.
- With respect to the 5 Likert items, it was observed (table 1) that the responses were concentrated in the high values (4-5) towards agreement, with percentages from 64.6% to 83.8%, so that the mean values came close or were higher than 4 points (out of maximum of 5). Thus, it can be concluded that in general, there were almost no barriers, given that they had access to resources, being able to pay for the connections and equipment, and to have powerful and adequate means for their purposes.

Table II: Descriptive Analysis. Barriers Related with Infrastructures and Resources. N=670.

Items	% response for each option					Media	Standard Deviation
	1 (Disagreement.)	2	3	4	5 (Agreement)		
3. The family has economic resources to pay for a broadband internet connection	1.8	3.0	11.5	26.9	56.9	4.34	0.92
4. The family has economic resources so that each person can have his or her own equipment/device	3.9	11.8	19.7	24.6	40.0	3.85	1.18
5. I have a stable connection for correctly following the online classes	3.4	8.2	17.8	33.1	37.5	3.93	1.09
6. The device used for the online courses is sufficiently powerful	2.4	7.0	17.2	32.2	41.2	4.03	1.04
7. I have adequate audiovisual means to follow the synchronous online classes	1.6	4.9	11.5	29.1	52.8	4.27	0.96

Next, the unidimensionality of the set of items was verified through the Principal Component method of the Exploratory Factor Analysis. The result obtained excluded the first two questions, which is logical, given the high concentration of participants on the same answer (as previously stated). At the same time, the other 5 items (the Likert-type questions) provided results (table II) that validated their belonging to the same dimension. These items had very high factorial loads (>0.70) in a single dimension, which as a set explained almost 60% of the empirical variability. This allows us to conclude that these 5 items shape the Barriers dimension related with infrastructures and resources, which can be represented as a single raw score. In addition, the reliability of the items was estimated, which were found to be high (around 0.80 for all of them), which allows us to add a high degree of confidence in these responses to the above.

Table II: Psychometric Properties: Validity and Reliability. Unidimensionality. Barriers Related to Infrastructure and Resources. N=670. AFE – Variance Explained: 59.8% // KMO=0.79 // Bartlett: P-Value<.000001.

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The raw score for this dimension was constructed using the common point accumulation method. According to this, the expected range of values was between 5 and 25 points, which it almost completely encompassed, given that the empirical range was: 6-25 (with a median of 21 points), and an evident asymmetry that concentrated most cases to the right side (high values) of the distribution (figure IV), as expected after examining the response to the items. With a mean value of 20.4 points (out of 25), it can be concluded that in general, the group of participants did not have problems that would imply a barrier to the infrastructures and resources to manage online learning.

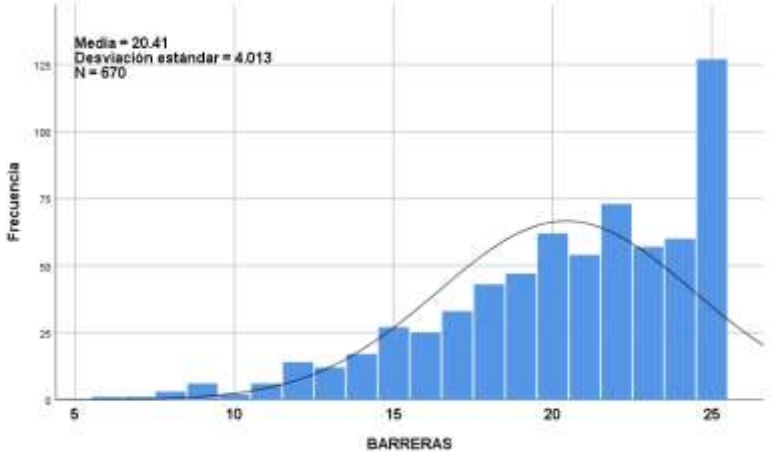

Figure IV: Barriers Related to Infrastructure and Resources. Total Raw Score. - N=670 Participants. Reliability: Cronbach's Alpha=0.83.

Next, the mean, standardized values of these dimensions were compared, as a function of the characteristics of the participants in the sample, namely Gender and Age.

With respect to gender, a significance was observed ($p<0.05$ at least), but the effect size was very low (1.5%), so that the significance was associated to a high N and not to a true difference. Thus, as function of the results, it can be concluded that there was no differential effect of gender on the scores found in that dimension.

As a function of age, 3 groups were created for the comparison, with cutoff thresholds of 23 and 30 years old. In this case, a statistical significance was not found ($p>0.05$) and the effect size was small or null, so that no statistical evidence of a differential effect was found of age in the dimension analyzed.

3.2. Barriers In the Family Nucleus for the University Students

It is important to know if barriers were detected in the clearly hyper-connected homes analyzed, which impeded the university students from normally following the online classes.

For this, the dimension analyzed until now was broadened with the following items:

- I have my own equipment/device (PC, laptop, Tablet…) to be able to follow the online classes synchronously and perform my tasks,
- I share my work equipment/device (PC, laptop, tablet…) with other members in my family,
- My family has economic resources to pay for a broadband internet connection,
- The family has economic resources so that each person can have his or her own equipment/device (PC, laptop, tablet…),
- I have a sufficiently stable connection that "works" for correctly following my synchronous online classes with the programs used for it (Cisco Webex, Blackboard, Teams, Zoom...)
- The device/equipment that I use to receive online courses through programs used for this (Cisco, Blackboard, Temas, zoom...) is sufficiently "powerful" for following the classes correctly, and
- I have adequate audiovisual means (Webcam,

speakers, microphone, headphones…) to follow the synchronous online classes.

The first item mentioned had a dichotomous answer, and those that answered "At home we have two computers (a laptop and a desktop) that are used depending on who needs it" were grouped as a NO answer. In total, 649 (96.9%) answered "yes", while 21 (3.1%) answered no. The "yes" answers were higher than that found in the NIE TIC-H.2023 report, which indicated a value of 82.6%. The family of university students had a higher percentage of technological resources and infrastructures.

The second item (I share my work equipment/device (PC, laptop, tablet…) with other members of my family) was also a dichotomous variable of Yes and No. A total of 551 (82.2%) participants answered No, and 117 (17.5%) answered Yes. This indicates that a high number of families of university students had their own electronic devices, and did not share them with the rest of the family.

In item 3 (My family has economic resources to pay for a broadband internet connection), 83.7% (561) said to be in agreement or completely in agreement with this statement, so that most did not have economic resources problems to be able to provide a broadband connection of the family unit.

In the fourth item (The family has economic resources so that each person can have his or her own equipment/device (PC, laptop, tablet…), 64.6% (433) were in agreement or completely in agreement, while 35.3% had doubts about the economic solvency in the family unit to provide each member of the family with an electronic device.

With respect to the availability of a sufficiently stable connection for correctly following the synchronous online classes with the programs utilized for this (Cisco Webex, Blackboard, Teams, zoom…) (item 5), 70.5% (473) indicated being in agreement and completely in agreement with this statement, indicating that they had a stable connection.

In item 6, 73.4% indicated that the device/equipment they used for the synchronous online classes through the programs used for this (Cisco, Blackboard, Temas, zoom…) was sufficiently "powerful" for correctly following the classes.

And lastly, in item 7, 81.9% had adequate audiovisual means (webcam, speakers, microphone, headphones…) to correctly follow the synchronous online classes.

Overall, the results indicate that most participants had adequate technological resources and infrastructure, suggesting that major barriers related to digital access were uncommon in the sample.

3.3. Type Of Family and Barriers Related with the Digital Infrastructures and Resources

Only two of the seven items analyzed were significant when cross-referencing them with the variable Type of Family:

- The first item (I have my own equipment/device (PC, laptop, Tablet…) to be able to follow the online classes synchronously and perform my tasks) was highly significant (p-value below 0.001). Thus, significant differences were found between the group of people who had their own equipment, and the type of family they had. A relationship was found between the type of family and having one's own device. The families without children, composite or single-parent families, did not ensure equipment/device (PC, laptop, tablet…) so that the university student could follow the synchronous online classes and perform the tasks assigned.
- The third item (My family has economic resources to pay for a broadband internet connection) was significant (p-value=0.021). Therefore, significant differences were found between the economic resources and the type of family they had. Thus, the two-parent nuclear family had sufficient resources to pay for a broadband internet connection, and on the other extreme, we find families without children, composite, or other types of families that coincided in not having enough resources for each member to have his or her own device/equipment (PC, laptop, tablet…).

In summary, after analyzing the family nucleus of university students, the type of family had a certain impact on the possible technological barriers that may arise in terms of having resources and infrastructure to continue their online classes.

4. DISCUSSION

During the pandemic, the forced transition to online learning was an important challenge for universities (Gunawardena & Dhanapala, 2022), and soon after, important barriers were observed, as well as socioeconomic and sociocultural inequalities, which had an effect on the participation of the students in a highly technical educational context.

The physical learning environment, in particular the home, plays a crucial role when supporting or limiting the online learning activities. Many studies have analyzed accessibility in online education, as a function of the family nucleus of university students (Gu, 2021; Reddy, José, Vaidehi, 2020), and there is a broad consensus when affirming that the first level or

first generation digital divide, that is, the one related with the lack of communication and information technologies and tools in some segments of the population, are still a global problem, which is directly related with family nuclei that are socially, economically, and culturally disadvantaged. Thus, an unequal infrastructure and access to the internet create obstacles to online learning (Satrianingrum & Prasetyo, 2020; Iskandar, Sunaryanto & Haryono, 2023), and these are also detected in Higher Education.

The results of the present study reveal the existence of a divide on the access to technological resources among families of university students. However, this divide is not as deep as that found in families of students in other stages of education, as the families of university students have a higher percentage of technological resources and infrastructures.

This suggests a higher capacity to adapt to online learning and digital demands, and it is also true that in this context, inequalities also appear, hindering the academic development of some students, in a learning context where access to digital technologies is crucial for their future success and professional perspectives.

Many studies sustain that categorical inequalities in society result in an unequal distribution of resources, which at the same time leads to an unequal distribution of technological resources and internet access (Van Dijk, 2005). Variables such as gender, age, economic resources, or ethnical aspects were factors that had an effect, but authors such as Scheerder et al (2019) mention that the characteristics of the family are also important factors. Van Deursen and Helsper, (2015), point out that not living alone or being in a relationship improved the possibilities of interacting with the internet. Also, the composition of the home is important, stating that the presence of children had a positive effect on access to the internet and having diverse digital resources (Deursen & Dijk, 2018).

The present study points out that in general, these families did not have economic problems for providing broadband connections to the family, which provides a stable connection. However, a critical perspective arises when analyzing the relationship between the economic resources and the ownership of individual devices. Approximately 35.3% of the families had doubts about their economic solvency for providing each member of the family unit with an electronic device.

Although most of the university students polled believed that their devices were sufficiently "powerful", and that they had adequate audiovisual means for online education, a quarter of the population still has difficulties in accessing adequate devices.

Being aware that the study has some limitations, such as the size of the sample, we believe that it opens a door to new research on how to address inequalities in ICT access and use, and points us in future directions, such as expanding research towards the second-level digital divide (cases in which, despite having access to technology, it is not used) or third-level (which would be determined by the quality and type of use) (Cabero-Almenara and Ruiz-Palmero, 2017).

The analysis of the relationship between the type of family and ownership of devices reveals significant disparities. Families without children, or composite or single-parent families, tended not to ensure equipment/devices for the university student in the family, which could negatively affect his or her participation in online education.

5. CONCLUSIONS

In conclusion, these results underline the importance of addressing inequalities in the access to technological resources to guarantee equal online education.

Families as learning environments, play a crucial role, and it is observed that the first-generation digital divide persists, affecting families that are socially, economically, and culturally disadvantaged.

This is the first study in which the digital divide of university students is analysed taking into account the type of family to which they belong. The research reveals that although the families of university students had, in general, a greater access to technological resources, inequalities still exist. The ability to adapt to online education and the digital demands could be conditioned by underlying inequalities, affecting the academic development of some students.

It is essential to consider strategies and policies that ease access to quality devices and connections, especially for the families that face economic limitations. Equality in digital education is a key component to ensure effective and accessible learning for all.

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REFERENCES

Apuke, O. D. y Iyendo, T. O. (2018). University students' usage of the internet resources for research and learning: Forms of access and perceptions of utility. *Heliyon*, Vol. 4, N. 12, e01052.

Asio, J. M., Gadia, E. D., Abarintos, E. C., Paguio, D. P. y Balce, M. (2021). Internet connection and learning device availability of college students: Basis for institutionalizing flexible learning in the new normal. *Studies in Humanities and Education,* Vol. 2, N. 1, pp. 56–69.

Balladares, J. (2017). Una ética digital para las nuevas generaciones digitales. Revista PUCE, N. 104, pp. 543–563.

Cabero-Almenara, J. y Ruiz-Palmero, J. (2017). Las tecnologías de la información y comunicación para la inclusión: Reformulando la brecha digital. *IJERI. International Journal of Educational Research and Innovation*, N. 9, pp. 16–30.

Cobos, D., López, E., Martín, A. H., Molina, L. y Jaén, A. (2022). Educar para transformar. *Innovación pedagógica, calidad y TIC en contextos formativos.* Madrid: Dykinson.

del Arco, I., Flores-Alarcia, Ò. y Ramos-Pla, A. (2021). Structural model to determine the factors that affect the quality of emergency teaching according to the perception of first-year students. *Sustainability,* Vol. 13, Art. 2945.

Demuyakor, J. (2020). Coronavirus (COVID-19) and online learning in higher institutions of education: A survey of the perceptions of Ghanaian international students in China. *Online Journal of Communication and Media Technologies*, Vol. 10, N. 3, e202018.

Deursen, A. J. van y Dijk, J. A. van (2018). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society*, Vol. 21, pp. 354–375.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, Vol. 49, pp. 5–22.

Essel, H. B., Nunoo, F. K. N., Tachie-Menson, A. y Amankwa, J. O. (2018). Higher education students' ownership and usage of smartphones and tablets: The case of KNUST. *International Journal of Educational Technology*, Vol. 5, N. 1, pp. 20–28.

Gezgin, D. M. (2017). Exploring the influence of the patterns of mobile internet use on university students' nomophobia levels. *European Journal of Education Studies*, Vol. 3, N. 6, pp. 29–53.

Gu, J. (2021). Condiciones familiares y accesibilidad de la educación en línea: La brecha digital y los factores mediadores. *Sustainability*, Vol. 13, N.º 15, Art. 8590.

Gunawardena, M. y Dhanapala, K. V. (2022). Barriers to removing barriers of online learning. *Communications of the Association for Information Systems*, Vol. 52, Art. 17.

Hodges, C., Moore, S., Lockee, B., Trust, T. y Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educational Review*, Vol. 27, pp. 1–7.

Hossain, M. A. y Rahman, M. H. (2017). Comparative study of internet usage among university students: A study of the University of Dhaka. *European Scientific Journal*, Vol. 13, N. 34, pp. 134–.

Iskandar, R., Sunaryanto, S. y Haryono, A. (2023). Online learning: A challenge for parents. *International Journal of Education and Literature*, Vol. 2, N. 11, pp. 1–11.

Luque, A. (2012). La educación inclusiva y el mundo digital: Nuevos retos en la sociedad del conocimiento. *Etic@net,* Vol. 2, N.º 12, pp. 202–215.

Martínez López, O. (2020). Brecha digital educativa: Cuando el territorio es importante. *Sociedad e Infancias*, Vol. 4, pp. 267–270.

Mendoza-Ruano, J. y Caldera-Serrano, J. (2014). Umbrales para la determinación de la brecha digital: Comparativa entre regiones desarrolladas. *Transinformação*, Vol. 26, N.º 2, pp. 125–132.

Muthuprasad, T., Aiswarya, S., Aditya, K. S. y Jha, G. K. (2021). Students' perception and preference for online education in India during COVID-19 pandemic. *Social Sciences & Humanities Open*, Vol. 3, N.º 1, pp. 1–

11.
Ovalles, L. C. (2014). Conectivismo: ¿Un nuevo paradigma en la educación actual? Mundo FESC, Vol. 4, N.º 7, pp. 72–79.
Pandolfi, J. (2024). Brechas de acceso digital: Cambio histórico y ciclo vital. *Revista de Ciencias Sociales*, Vol. 37, N.º 54, e205.
Pascuas-Rengifo, Y. S., García-Quintero, J. A. y Mercado-Varela, M. A. (2020). Dispositivos móviles en la educación: Tendencias e impacto para la innovación. *Revista Politécnica*, Vol. 16, N.º 31, pp. 97–109.
Ramos-Pla, A., Sampedro, B., del Arco, I., Marín, V. y Flores-Alarcia, Ò. (2023). Barreras formativas, personales y ambientales de la enseñanza en línea. *Educar*, Vol. 59, N.º 2, pp. 457–471.
Reddy, B., José, S. y Vaidehi, R. (2020). De acceso e inclusión: Brecha digital en la educación en línea. *Economía. Semanario Político,* Vol. 55, pp. 23–26.
Romero-Rodríguez, J. M., Aznar Díaz, I., Hinojo-Lucena, F. J. y Gómez-García, G. (2021). Uso de los dispositivos móviles en educación superior: Relación con el rendimiento académico y la autorregulación del aprendizaje. *Revista Complutense de Educación*, Vol. 32, N.º 3, pp. 327–335.
Salas-Pilco, S. Z., Yang, Y. y Zhang, Z. (2022). Student engagement in online learning in Latin American higher education during the COVID-19 pandemic: A systematic review. *British Journal of Educational Technology*, Vol. 53, pp. 593–619.
Serhan, D. (2020). Transitioning from face-to-face to remote learning: Students' attitudes and perceptions of using Zoom during COVID-19 pandemic. *International Journal of Technology in Education and Science*, Vol. 4, N. 4, pp. 335–342.
Shamir-Inbal, T. y Blau, I. (2021). Facilitating emergency remote K-12 teaching in computing-enhanced virtual learning environments during COVID-19 pandemic. *Journal of Educational Computing Research,* Vol. 59, N.º 7, pp. 1243–1271.
Tarimo, R. y Kavishe, G. (2017). Internet access and usage by secondary school students in Morogoro Municipality, Tanzania. *International Journal of Education and Development using Information and Communication Technology*, Vol. 13, N.º 2, pp. 56–69.
Van Deursen, A. J. A. M. y Helsper, E. J. (2015). A nuanced understanding of internet use and non-use among the elderly. European Journal of Communication, Vol. 30, N.º 2, pp. 171–187.
Van Dijk, J. (2005). *The deepening divide*. Londres: SAGE.
Zhang, X., Lo, P., So, S., Chiu, D. K. W., Leung, T. N., Ho, K. K. W. y Stark, A. (2021). Medical students' attitudes and perceptions towards the effectiveness of mobile learning. *Journal of Librarianship and Information Science,* Vol. 53, N.º 1, pp. 116–129.