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Students' E-Learning Domestic Space in Higher Education in the New Normal

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Abstract: The objective of this study is two-fold. Firstly, to analyse and discover the ability of HE students to use the physical home context for e-learning via ICT during the new normal; and secondly, to ascertain the underlying patterns of the adequacy of such domestic spaces. The authors offer a multidisciplinary approach combining pedagogic, architectural backgrounds with considerable experience in didactics, organization management of education, and ICT applied to education. A qualitative, arts-based research methodology that analyses photographs was used. A total of 220 domestic work environment photographs sent by higher education students were analysed. Results and conclusions show that students are able to attend virtual classrooms in a domestic atmosphere. Bedrooms and studies are usually the most-used spaces. Laptops and smartphones are the most frequent central hubs of student learning sessions. Students use other training resources (desktop computers, tablets, etc.) to supplement the most common digital devices. An intense relationship is observed between Space (bedroom and other rooms) and the Sofa and Beds variables, while a moderate one is observed between Age and Care items. The relationship between other variables is weak or non-existent.

Keywords: higher education; digital technologies; online learning; distributed learning environments; media in education; domestic space

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1. Introduction

The evolution of the Information and Communication Technologies (ICT) impacted on methods and techniques used in the higher education (HE) teaching [1]. Some of these strategies are supported on the Internet, as synchronous or asynchronous communication. Synchronous means use real-time connections for direct interactions with other members such as students, teachers, or other professionals. Examples of synchronous means are the phone, chat, or web-conference. Asynchronous means allow a delay between participant interactions. Examples of asynchronous means are mail, a forum, or social media. In these cases, the utterers could be connected at different times, and they do not need real-time connections. At this moment, there is a clear growth of synchronous means related to immediacy and mass media, and some chat tools are very popular, especially WhatsApp [2]. Transferring this tendency to HE didactics, web-conference tools are also becoming more and more popular, for different reasons. One of them was the confinement during the COVID-19 pandemic. Nevertheless, there is no doubt that university responses to this problem would not have been the same two decades earlier. Most persons were caught off guard in terms of reinventing their living space and converting home into a new classroom. Many activities, jobs, and businesses were converted to telecommuting. Thus, HE students and teachers faced an important challenge of using home space and their own technological resources. Students were forced to carve an area within the home for e-learning. This

situation resembles what was already pointed out at the creation of learning environments, understood as symbolic inhabited spaces where people protect themselves, train, evolve, and manufacture their identity [3]. Living in society is akin to living in relationship spaces, and their analysis can throw more light on human life than the one obtained either through individual consideration, or through the diverse positions assigned to it by science and metaphysics [4].

Generally speaking, actions taken by students also converge when they take on different challenges to facilitate ubiquitous learning [5,6]. Domestic life accompanies each person throughout his or her journey, and forms his or her inner construct and understanding of private relationships. People's aspirations about their home space may be conditioned by images they receive through the media, social media, or their digital device screens. The visibility of intimate environments generated a very direct perception of reality because domestic spaces were highly exposed. It is during this time, more than ever before, that students learned about the private environments of their peers and teachers, and possibly expanded their understanding of the lives of such people.

Web-conferences, web meetings, and web tutorials open your own home to partners, colleagues, and students. Living in this reality demands a previously non-existent domestic and pedagogical framework. Many meetings, classrooms, tutorials, conferences, etc., changed to virtual environments, both in face-to-face education and in distance education. People's daily lives, and that of students in particular, changed dramatically. Movement restrictions, social distancing, and forced migration of work and learning spaces into the domestic sphere meant a radical transformation. This led to changes not only in habitat management, but also in public areas for interaction and coexistence. Private spaces were made public. The possible difficulties generated by these new physical variables were appeased by using ICT. Therefore, formal and informal meetings today do not take place exclusively within a conventional physical framework, but are often reduced to virtual meetings, where multiple screens are the protagonists.

1.1. New Learning Spaces and ICT

The diverse digital communication platforms and multiple learning environments were already typical in the various forms of distance education, and accelerated the construction of the usual teaching–learning structures during confinement. This unexpected situation forced many HE institutions into a largely unplanned distance education process [7,8]; organizational factors contribute to the successful implementation of emergency remote teaching, and individual factors are also relevant. Moreover, the resultant crisis requires utilisation, not only of new methodologies and resources, but also of the characteristics of a new workplace, which is probably less suitable for training HE students than physical classrooms [9].

Digital tools were already generating greater citizenry participation, and of HE students both inside and outside the classroom. Nevertheless, training with digital resources and innovative methodologies still needs continued and systematic support, in order to expand the arising educational changes in the home environment. The Sustainable Development Goals (SDG) themselves include digital competence as a key aspect in the 2030 Agenda. In addition, the implementation of digital transformation plans at the meso-level will ensure the sustainability of organizations and jobs in the new normal [10]. Digital devices, the Internet, and e-learning platforms are essential to the learning, communication, and expression of university students. All of this not only meant a change in the way we perceive and use our homes, but also new mental and relational constructions between the home environment and that of the classroom group.

The regulatory principles of distance education include student responsibility for self-study through the use of digital tools, self-assessment, and hetero-evaluation (primarily a teacher competence), opportunities for interaction, collaborative work, and diversification of learning tools [11,12]. This transformation led to a rapid and unavoidable transition

from face-to-face to e-learning, or to hybrid modalities in HE students and, in general, profoundly transformed everyday life [13,14].

The outstanding role played by the home and digitalization during teleworking and live virtual activities confers greater significance on intimate space and items owned for personal learning. However, the individual and group domains are mixed in virtual classes, due to constant sharing of the physical environment. This situation leads to peculiar interactions where home and academic life develop from multiple foci. All HE students were subjected to intensive use and overexposure to ICT during these activities. Nonetheless, the use of digital tools can improve academic learning, through increased student involvement in their education [15,16]. Moreover, students that use mobile devices and digital tools for learning gain higher levels of digital literacy and training than those who use traditional resources [17].

The way students face classes in this new reality generates multiple micro-situations and narratives that embody a new image of the classroom and the learning process. The threshold of the physical classroom was definitively crossed, and the private and public lives of students and teachers are now intertwined. The virtual class contains personal elements at home that are displayed on computer screens. Hence, students lose home privacy during training when they share their surrounding space through webcams with other users.

Digital learning environments in the domestic context can be termed as local cosmologies, and interpreted as systems that represent and redefine personal and collective identities [18]. Now, more than ever, students reinvented their academic space within their homes, which can be analysed through the specific weight of the items therein. Exposure through digital devices reveals the most intimate home environment, which can be equated to that of television, defined as a medium that is not only optical or acoustic, but also tactile, i.e., equipped with a texture that confers new meaning to reading screen content [19].

The unavoidable use of ICT as a means of meeting educational needs and shortfalls in face-to-face teaching is an atypical reality, from which we could draw ideas to implement new educational methodologies. In fact, changes in teaching methodologies are transforming dominant models through new knowledge access mechanisms that develop globalised learning and social relations [20,21]. Academic activities carried out beyond specific spaces preconceived for that purpose can generate new links with knowledge. In this regard, ICT resources are an essential component for accessing information and learning [22]. Governments now support the improvement of digital literacy and high digital skills in student training, so that citizens can achieve greater economic, environmental, and social development [23].

Digital tools managed to dilute boundaries between the domestic and academic spheres. The construction of communities that process and share information through the Internet is a reality, which, in turn, boosts the development of a network-based university education [24]. Moreover, digital screens can provide equal access to education, and generate a more inclusive, democratic, and fair reality. Hence, teachers should use methodological strategies that offer new opportunities to generate and share learning, and reinforce students' interest in improving performance and make a positive impact [25]. The inclusion of ICT resources in the classroom generally improves student engagement, motivation, and attention, and, furthermore, enhances the development of ubiquitous learning.

HE is now characterized by the juxtaposition of learning spaces, which combine face-to-face and remote modalities. The interaction of local household cosmologies generates a common topology, pedagogical dynamics in which personal items build a joint virtual–educational environment. This collective scenario neutralises the relationship between space and the educational intention because screens homogenise all such projections against the one backdrop. In the physical classroom, teaching is usually conducted through a single-focal point, wherein eyes are directed towards the teacher, a screen, or the blackboard. However, the virtual classroom represents a multi-focal and flexible pedagogical space

where attendees participate sequentially, and perform autonomous inquiry using digital tools and more innovative practices.

1.2. Current Study

Several studies have already been carried out on ICT e-learning in HE students from different countries during this exceptional COVID-19 period [26,27]. However, this is a singular article starting from a different point of view; a multidisciplinary approach combining pedagogic, architectural backgrounds. To date, there is only one exploratory study about this topic with preliminary results [28]. Living in this new COVID-19 pandemic reality demanded a previously non-existent domestic and pedagogical framework.

The objective of this study is two-fold: firstly, to analyse and discover the ability of HE students to appropriate to their physical home context for training–learning via ICT, and, secondly, to ascertain the underlying patterns of the adequacy of such domestic spaces. The study was guided by the following research questions (RQs):

RQ1: What are the elements found in the physical learning space of HE students in their homes?
RQ2: Which rooms are used by students for e-learning?
RQ3: What are the features of the rooms based on the academic components they contain?
RQ4: What are the spatial relationships between the home and the digital screens used?
RQ5: What are the screen backgrounds used by students during online training connections?
RQ6: What is the relationship between the analysed variables?

2. Materials and Methods

This study involved analysis of photographs, and essentially followed a qualitative methodology framed within Arts-Based Research (ABR). ABR is quite useful as a data collection and analysis technique in education since it facilitates research into the context surrounding student practices [29]. This type of research avails of tools to analyse the situation under study, and offers a scientific and intuitive view of reality. The value of studying photographs in the present research through ABR lies in the possibility of collecting and capturing evidence of home use by HE students during e-learning.

2.1. Sample and Data Collection

This research was carried out at the Higher Technical School of Architecture, Universidad Politécnica de Madrid (Spain). The University offers undergraduate, master's, and PhD studies in architecture through specialised departments, which, similar to its staff members, enjoy a certain level of autonomy. The Foundations of Architecture, where this research was carried out, is a five year degree program. The fieldwork study was performed with the participation of 31 third year students (20 females and 11 males), 6 fourth year students (2 females and 4 males), and 23 fifth year students (16 females and 7 males).

To facilitate information collection for the study, one teaching staff member and author of this article sent emails to students from the Foundations of Architecture degree program at the Universidad Politécnica de Madrid (UPM), and published this call for participation on Instagram. Emails requested photographs from the aforementioned HE students, asking them to send photographs of themselves taken in the domestic learning environment, which they had shared on their digital screens; students sent their photographs. A stratified sample was used, inviting students from the five undergraduate courses. Participation was voluntary, and, perhaps due to their lack of maturity and commitment, the first and second year students did not send any photographs; this was the reason for not including them. However, voluntary participation is preferable to compulsory participation. The absence of associations between the student's levels and other variables does not allow the idea that the participation of first and second level students would change the results obtained.

In qualitative research, the sample is traditionally justified on the saturation point [30]. We analysed the occurrence of new subcodes in groups of six environments during the analysis while controlling internal consistency with Cronbach's alpha (Figure 1) [31]. It is

observed how, starting from the 42 photographs analysed, having reached 68 subcodes out of a total of 73, a consistency higher than 0.80 is achieved and maintained from that point on. This point could be considered the saturation point; starting from this point, further analysis are confirmatory.

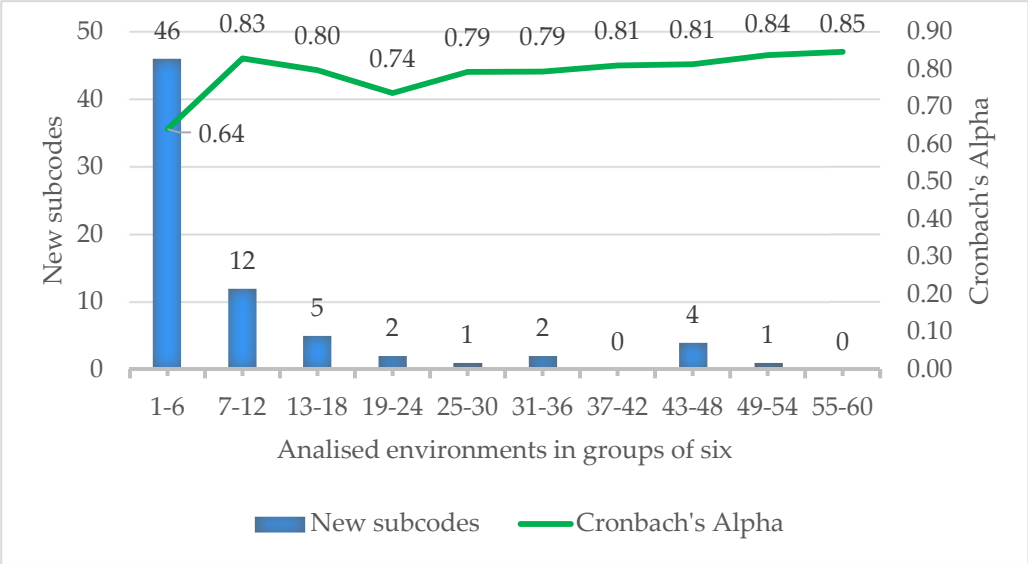

Figure 1. Analysis of new subcodes and Cronbach's alpha during coding new environments. Note. This is a dual scale graph. The blue bars indicate the new subcodes registered during the analysis of environments grouped six by six (left scale), while the green line reflects the evolution of internal consistency through Cronbach's alpha (right scale).

HE students that collaborated in this research provided a set of photographs that reflected their domestic learning environment. To visualize the entire room on a 360° basis, each student sent 4 photographs, one of each wall, or 2 × 180° panoramic photographs. A total of 50 students sent 4 photographs, and 10 students sent 2 photographs × 180°. The study sample consisted of 220 photographs provided by 60 students.

2.2. Data Analysis

The information collected was subject to content analysis using the AQUAD (version 7), and Excel (for performance of content and contingency analysis). The analysis categories were linked to the respective research questions [32]. The different categories were extracted by an inductive process from the photographic content analysed, and the absolute frequency of coding was computed to detect preponderance or absence. Code frequency is commonly used in content analysis [33], and can be completed with other calculations or analysis strategies.

The following content analysis order was used to construct the analysis categories: detailed identification of the items that make up the new academic spaces of HE students at home; determination of the physical variables that influence digital device screen location inside the home; and characterization of the rooms at home. Information was analysed from an individual and group perspective, for which researchers met from time to time to discuss coding. In the final stage, the researchers shared and discussed all results, and reached agreement whenever slight discrepancies occurred. Credibility of results was strengthened by maintaining balanced independence among researchers [34].

Excel was also used to study any possible associations between variables to ascertain their relationships. Cross-checks were performed not only between the profile variables (gender and age), the identified content analysis element categories, and use of HE students in the domestic sphere for e-learning with ICT, but also between the content variables themselves. To this end, a contingency analysis was applied, to obtain own statistics.

Values from the contingency tables were used to calculate the expected ones, chi-square (χ^2), *p*-value, and Cramér's V, which determines the intensity of association between the different variables (for a 95% confidence level, $\alpha = 0.05$). The independent variables were grouped into balanced dichotomous categories whenever there were three or more categories, to perform analyses, gain robustness, and, thus, strengthen contrast and concentrate values. The following Cramér's V values were used to interpret the degree of association between variables [35]: 0–0.19 (very low); 0.20–0.39 (low); 0.40–0.69 (moderate); 0.70–0.89 (high); 0.90–1 (very high).

3. Results

The results of this study are grouped in sub-sections, to match the study objectives and research questions.

3.1. Everyday Household Items Used by Students (RQ1)

The analysis provides codes and subcodes categorising the elements used by students for e-learning, and to establish order relations that define the patterns that shape these local cosmologies (Table 1). The five standard elements found in all home study environments are doors, windows, radiators, ceiling lamps, and cell phones. Less common elements (≤5%) include floor-to-ceiling carpentry, sofa beds, low tables, side tables, dining tables, bookcase cum TV cabinet, clocks, and baby cots.

Table 1. Elements used by students for learning in the domestic scenario.

Category		n	%
Code	**Sub-Code**		
Architectural elements	Interior door	60	100.00
	Exterior door	3	5.00
	Window	60	100.00
Thermal comfort	Radiator	60	100.00
	Air conditioning	7	11.67
Illumination	Window curtain	25	41.67
	Window roller blind	24	40.00
	Ceiling lamp	60	100.00
	Floor lamp	8	13.33
	Bedside table lamp	12	20.00
	Adjustable lamp	49	81.67
Sofas/Beds	Sofa	6	10.00
	Sofa-bed	3	5.00
	Bed	29	48.33
Tables	Desk table	43	71.67
	Integrated table and bed	12	20.00
	Table and shelf (study cabinet)	13	21.67
	Adjustable low table	3	5.00
	Dining Table	2	3.33
	Coffee table	3	5.00
Seating	Chair	15	25.00
	Wheelchair	34	56.67
	Ergonomic office chair	13	21.67

Table 1. *Cont.*

Category		n	%
Code	**Sub-Code**		
Storage	Bookshelf-library	33	55.00
	Shelf	31	51.67
	Living room furniture	3	5.00
	Sideboard-comfortable	4	6.67
	Cabinet	14	23.33
	Wardrobe	33	55.00
Technological devices	Mobile	60	100.00
	Desktop computer	5	8.33
	Laptop	59	98.33
	Display screen (dual screen)	29	48.33
	Tablet	18	30.00
	Printer	16	26.67
	Scanner	15	25.00
	Telephone	4	6.67
Work accessories	Desktop organizer/Pen holder	43	71.67
	Filing cabinet	20	33.33
	Case	44	73.33
	Bookstore (more than 10 books approx.)	48	80.00
	Calendar	24	40.00
Decorative elements	Wall decoration (photo, painting...)	51	85.00
	Plant	15	25.00
	Mirror	15	25.00
	Wall clock (time control)	3	5.00
Leisure	TV	7	11.67
	Stereo	15	25.00
	Musical instrument	7	11.67
	Sports equipment	11	18.33
	Gymnastics equipment (exercise bike, elliptical...)	4	6.67
Care	Children's equipment (playground, cot...)	1	1.67
	Pet	6	10.00

Note. Every code identifies a type of element that is described by several elements identified by a subcode. The percentages are calculated with respect to all 60 environments analysed.

Among the variety of items found in the rooms at home, those worth highlighting are laptops (98%); decorative wall paintings (85%); books (80%); desk tables (72%); office chairs (57%); and wall shelves (55%). The presence of the laptop against the desktop computer (8%) is striking.

The usual work accessories are books (80%), pencil cases (73%), pencil containers (72%), and calendars (40%). The home environment of these students also contains leisure and personal care items, such as floor exercise machines (18%), televisions (12%), pets (10%), and baby cots (2%). Some have built-in tables and beds (20%), indicating that the bedroom is dual purpose: rest and work; and ergonomic chairs (22%), designed to spend hours in front of computer screens, revealing that the activities require many hours.

3.2. Rooms Used to Study in the Domestic Scenario and Their Transformation (RQ2, RQ3)

The analysis shows a variety of rooms that HE students use to interact with digital screens in their home learning sessions. Room characteristics were extracted from the data, and help us identify their type from the items they contain. The results further indicate whether the initial purpose is domestic or academic use. HE students use the following rooms to connect digitally for training:

Bedroom (59%), of which 61% have an average area of between 10 and 15 m^2;
Study (25%), of which 53% have an average area of between 10 and 15 m^2;
Living room (6%), of which 50% have an average area of between 15 and 20 m^2;
Kitchen (2%), very rarely.

Analytical sub-atlases specific to each environment were developed, based on the graphic representation of the four domestic spaces, to depict the different academic items found there. Various items are found to be used purely for academic purposes within homes. This is the case of desk lamps, desk tables, shelf–table units, ergonomic chairs, bookshelves, cell phones, laptops, additional screens, printers, scanner, desktops, books, pencil cases, pencil containers, calendars, and filing cabinets. The room with the most items related to academic tasks is the study (64%), which is followed by the bedroom (52%), and the rooms with the least transformation possibility are the living room (33%) and the kitchen (31%), since they have few items destined for work. As well, the academic items used by students, for example in bedrooms and studios at home, could be compared (Figure 2).

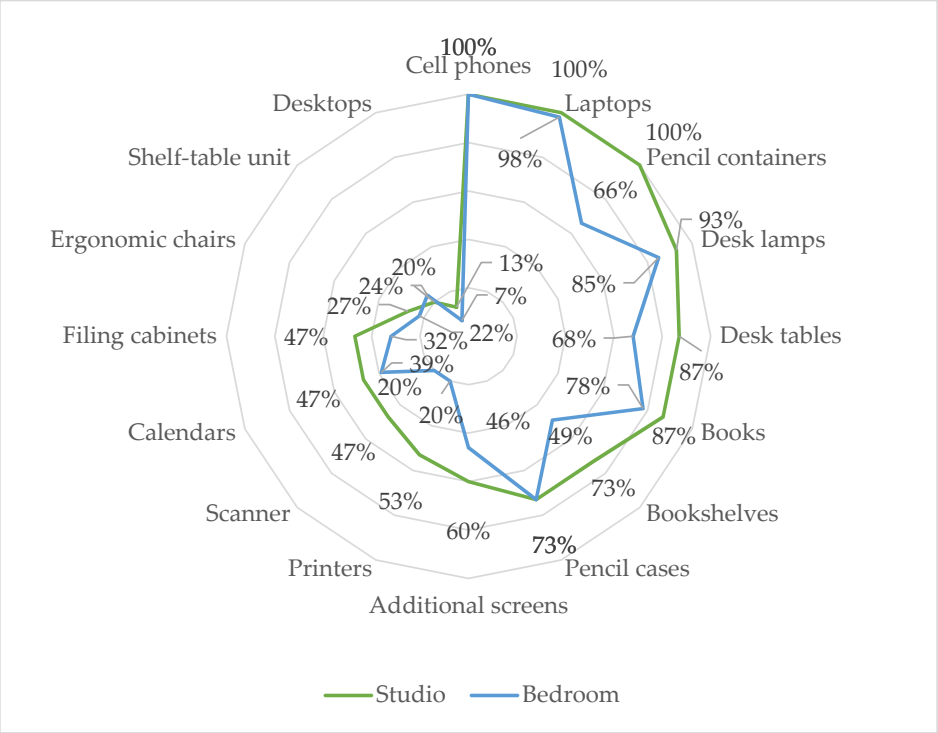

Figure 2. Academic items used by students in bedrooms and studios at home. Note. The percentages are calculated with respect to all 60 environments analysed.

3.3. Spatial Relationship of Digital Screens in the Home and Backgrounds Seen during Connections (RQ4, RQ5)

Results are depicted as drawings of the room types used by students. They show the spatial relationships between the essential architectural elements (such as windows and doors), the digital device screens used, and the screen backgrounds used during online learning connections.

The position of the digital device with integrated camera (broadcast source) is either located on one side, in front of, or behind the door; while the position of the device, with respect to the natural light source, windows, is either at the side (laterally), behind, in front, or in the zenith position (Figure 3).

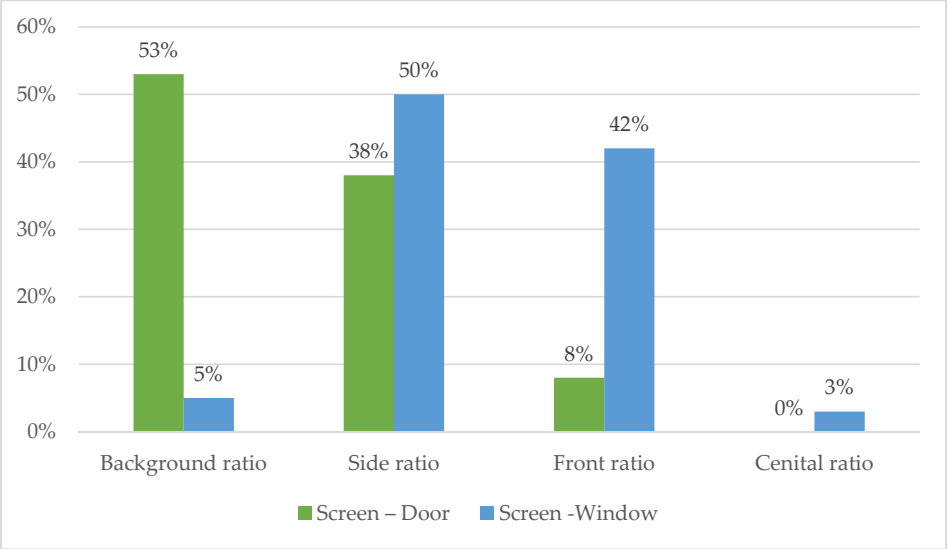

Figure 3. Relationship between the architectural elements and the broadcasting source (screen). Note. The percentages are calculated with respect to all 60 environments analysed.

The broadcasting device of most students is placed behind the door (53%), although a sizeable number also place it laterally (38%). With respect to the window, the device is mostly placed laterally (50%), although a sizeable number also place the device in front of the window (42%). Placement in a location at the back (5%) and in the zenith position (3%) occurs rarely.

The backgrounds exhibited by students in their online connections with camera have two variables. The first is related to the colour of the background wall (white or other colours). The second relates to items that are viewed as a backdrop, which can be: neutral or empty; have minimum décor; or display a number of items, thereby providing a wealth of information about users. The physical background shared in digital connections is mainly white (52%), but in other cases, it contains other colours or prints (48%). The elements found in most rooms comprise a complex backdrop of items (43%), but other environments show an empty or neutral background (40%). Some backgrounds (17%) have decorative elements.

3.4. Associations between Variables (RQ6)

The relationships between the different variables were analysed, and, depending on the Cramér's V results obtained, the interactions are presented as high (0.70–0.89), moderate (0.40–0.69), or low (0.20–0.39).

The highest association is seen between the variables Content, Space (bedroom and others), and Sofas and beds (sofa, sofa bed, bed) which give a $\chi^2 = 29.1275$ and $p = 0$, with a Cramér's V = 0.87551. On the other hand, one moderate and two low associations are also detected. A moderate association is seen between the profile variable Age (<23 years and >22 years) and presence of Personal care items (Cramér's V = 0.41667), while two low associations with values 0.34331 and 0.32604 respectively, are observed in the profile variables. These low relationships are seen between variables Age and Access to room (lateral, in front, or behind), and between Gender (female and male) and Storage unit (wall shelves, shelves, bookcase cum TV cabinet, sideboard or chest of drawers, closet, built-in closet).

Moderate association in the content variables is seen between Space (bedroom and others) and Tables (desk table, built-in table and bed, shelf–table unit, low table, side table, dining table), and between Sofas and beds (sofa, sofa bed, bed) and presence of Storage units (wall shelf, shelf, bookcase cum TV cabinet, sideboard or chest of drawers, closet, built-in closet). Another moderate association is seen between Access to room (lateral and others) and the presence of Tables (desk table, built-in table and bed, shelf–table unit, low table, side table, dining table), Sofas and beds (sofa, sofa bed, bed), and the Light source (in relation to screen position: lateral, frontal, back, and zenith). Colour (white and others) is associated with the type of workspace (bedroom, study, living room, kitchen), with Tables (desk table, built-in table and bed, shelf–table unit, low table, side table, dining table), and with the presence of care items (baby cots, pets). There is some association between Area (up to 10 m^2 and > 10 m^2) and the presence of Personal care items (baby cots, pets) (Table 2).

Table 2. Moderate associations between content variables.

Variable 1	Variable 2	χ^2	*p*-Value	Cramér's V
Space	Tables	22.34925	0.00045	0.54228
Sofas and beds	Natural light source	12.73325	0.00525	0.46067
Colour	Space	11.32152	0.01011	0.43439
Access	Sofas and beds	7.10983	0.02858	0.43255
Colour	Tables	13.57603	0.01854	0.42265
Colour	Personal care items	1.21528	0.27029	0.41667
Area	Personal care items	1.21528	0.27029	0.41667
Access	Tables	13.08293	0.02261	0.41490
Space	Storage	20.21256	0.00114	0.41388

Legend. Chi-square (χ^2), *p*-value, and Cramér's V, which determines the intensity of association between the different variables (for a 95% confidence level, $\alpha = 0.05$).

A low association is seen between the Natural light source (lateral and others) and the presence of Tables (desk table, built-in table and bed, shelf–table unit, low table, side table, dining table). The Background (neutral–empty and other) is associated with the Natural light source (lateral, frontal, back, zenith), and with presence of Sofas and beds (sofa, sofa bed, bed). Colour (white and others) is associated with three variables: Leisure facilities (music equipment, floor exercise machines, television, musical instrument, fitness equipment); relationship with Access to room (lateral, frontal, back); and with the presence of Sofas and beds (sofa, sofa bed, bed). Lastly, also notable is the presence of three other associations between Access to room (lateral and others) and Space (bedroom, studio, living room, kitchen), the estimated Area (5–10 m^2, 10–15 m^2, 15–20 m^2, >20 m^2), and Storage unit (wall shelf, shelf, bookcase cum TV cabinet, sideboard or chest of drawers, closet, built-in closet) (Table 3).

Table 3. Low associations between content variables.

Variable 1	Variable 2	χ^2	*p*-Value	Cramér's V
Light	Tables	11.35117	0.04485	0.38647
Background	Natural light source	8.75000	0.03281	0.38188
Colour	Sofas and beds	4.20323	0.12226	0.33258
Access to room	Storage	11.89883	0.03620	0.31755
Background	Sofas and beds	3.78320	0.15083	0.31553
Access to room	Tables	5.91830	0.11565	0.31407
Colour	Access to room	5.87029	0.05312	0.31279
Colour	Leisure facilities	4.13049	0.38863	0.30639
Access to room	Space	6.36878	0.09498	0.30381

Legend. Chi-square (χ^2), *p*-value, and Cramér's V, which determines the intensity of association between the different variables (for a 95% confidence level, $\alpha = 0.05$).

As the first whole example of analysis, we present the gender analysis (Table 4). This variable does not show relationships with any other except the Storage Units (Library shelf,

Shelf, Living room furniture, Chest of drawers, Wardrobe cabinet). In this case, we find a low association, with a *p*-value of 0.02805 and Cramer's V of 0.32604. In other cases, *p*-values are greater than 0.05000, and Cramer's V is less than 0.30000.

Table 4. Associations between student's gender and other variables.

Variable	χ^2	*p*-Value	Cramér's V
Workspace type	2.48570	0.47788	0.20354
Area	0.63020	0.88949	0.10249
Screen and physical background colour	0.36915	0.54347	0.07844
Screen and physical background object	1.38296	0.50083	0.15182
Screen and room access	2.26272	0.32259	0.19420
Screen and light access	3.70335	0.29533	0.24844
Doors and windows	1.12513	0.56975	0.09564
Heating and air conditioning	1.86942	0.17154	0.16704
Curtains and blinds	1.70273	0.19193	0.18641
Types of lamps	2.43628	0.48692	0.13743
Types of sofas and beds	0.62030	0.73334	0.12776
Types of tables	5.24766	0.38641	0.26277
Types of chairs	0.59538	0.74253	0.09799
Storage units	12.54352	0.02805	0.32604
ICT devices	6.50161	0.48254	0.17765
Desktop items	1.35840	0.85139	0.08711
Decorative elements	4.27119	0.23363	0.22549
Leisure equipment	2.22711	0.69407	0.22498
Children's equipment and pet	0.02431	0.87611	0.05893

Legend. Chi-square (χ^2), *p*-value, and Cramér's V, which determines the intensity of association between the different variables (for a 95% confidence level, $\alpha = 0.05$).

The second example is about the students' level (Table 5). Only a low significant relationship is found between the Screen and room access, and the level of students with a *p*-value of 0.02914 and Cramer's V of 0.34331. According to only the Cramer's V, we also found a moderate relationship with Care items (0.41667). In other cases, there are no associations. There were no answers from students of level 1 and 2. However, no data suggests that the results would change, at least in the descriptive and qualitative dimension.

Table 5. Associations between student's level and other variables.

Variable	χ^2	*p*-Value	Cramér's V
Workspace type	3.15635	0.36814	0.22936
Area	4.78357	0.18835	0.28236
Screen and physical background colour	0.61477	0.43300	0.10122
Screen and physical background object	3.03671	0.21907	0.22497
Screen and room access	7.07163	0.02914	0.34331
Screen and light access	0.30701	0.95871	0.07153
Doors and windows	3.12541	0.20957	0.15940
Heating and air conditioning	0.00174	0.96671	0.00510
Curtains and blinds	0.18133	0.67023	0.06083
Types of lamps	2.24272	0.52358	0.13185
Types of sofas and beds	1.70155	0.42708	0.21161
Types of tables	8.47126	0.13211	0.33386
Types of chairs	1.29231	0.52406	0.14437
Storage units	6.14879	0.29201	0.22827
ICT devices	4.99258	0.66087	0.15568
Desktop items	3.05387	0.54885	0.13062
Decorative elements	1.44968	0.69393	0.13137
Leisure equipment	5.85107	0.21055	0.36466
Children's equipment and pet	1.21528	0.27029	0.41667

Legend. Chi-square (χ^2), *p*-value, and Cramér's V, which determines the intensity of association between the different variables (for a 95% confidence level, $\alpha = 0.05$).

4. Discussion

This study shows that the elements surrounding HE students in the physical space at home during ICT-mediated e-learning can be grouped into different types. In this sense, many household items are detected in spaces used for academic purposes. Among digital devices, worth mentioning are laptops and cell phones, whose proportion is higher than any other item, allowing for greater flexibility, and showing complementarity between the different devices, clearly reflected by the presence of multiple screens. The desktop seems to be a technological device that supplements the two most commonly used devices (cell phone and laptop). This preponderance of mobile devices in education reinforces the characterisation already seen among citizens. Moreover, the main advantages of digital mobile devices lie in the possibilities they offer for communication, interactions, ubiquitous learning, and information management in general [36,37].

The new HE context forced a reversal of the classic classroom structures, and conferred relevance to homes and digital devices. A possible adaptation of items present in the respective rooms to a pedagogical environment is also seen, based on the symbolic and functional distribution of items within the environments analysed. More than ever, students use household items for their educational purposes. This implies a topological, rather than a distributive, spatial organization.

The most frequently observed scenarios are bedroom, study, living room, and kitchen; nevertheless the most common is the bedroom and, due to its functionality, the study is the room with the highest possibility for affinity to e-learning space and use of ICT. This reaffirms the suitability of this domestic space for training HE students. The daily life of university students is marked to a great extent by the relationship between the home items and possibility to alter the use of space, i.e., space-reconfiguring possibilities. Some studies report that spatial changes and the emotional state of HE students do not affect their academic performance, but they do affect the incorporation of innovative tools, such as ICT, used for learning [38].

At home, students often place the digital device cameras to face the access door; but its position with respect to the window is mainly lateral or at the back of the device, to avoid light reflection during sessions. Insofar as the items identified in the spaces analysed are concerned, the environment is intentionally customized by students, to reflect a generally neutral environment during learning sessions. In general, students avoid transmitting excessive private information.

This new pedagogical reality within the domestic scenario, and its relationship with the home elements, characterise the configuration of new classrooms, highlighted by the atypical use of home space and interaction through digital screens. The effort put in by HE students to resolve online learning requirements embodies the educational response to connect to innovative tendencies, and to ensure continuity of training, despite the prevailing deficiencies in knowledge, pedagogical techniques, and resources [39]. Moreover, an essential function of education is to promote student use of digital technology, to benefit from the changing environment [40].

This study shows that the space in which we live can be used to a new hybrid domestic–academic reality. However, this appropriation for virtual education is a besieged reality, in which screens and hyper-connectivity have also become the main protagonists. The virtual means confirms the great versatility offered by homes for space use, as well as the need to create versatile spaces for the different activities carried out in the home. Therefore, digital infrastructure, fast Internet connection, and institutional and educational support are the essential requisites at all educational levels [28,41].

Of the associations detected between the variables analysed, worth highlighting is the interaction between the variables Space and Tables, which can be considered as a confirmatory relationship, because the type of room somehow determines the furniture in it. The study shows that students have a good knowledge of space, which helps them to transform the physical environment easily and in a particular way [42]. In other cases, and in line with our expectations, a moderate association is seen between the variable Age and

the presence of Personal care items. Some moderate associations are seen in Access to the room (lateral and other), presence of several types of Tables, sofas (among other items), and the Natural light source (in relation to location of the digital device). The latter association shows that there is complementarity between the Natural light source and Access to the room. On the other hand, the position of the Natural light source is related to the presence of Tables, which is consistent with the technical recommendations regarding light source and work area. In fact, daylight is an essential element in studying [43].

Room colour is associated with the presence of Personal care items, tables, and room type. This association attributes white colour to rooms other than bedrooms, such as the living room or the study, which is somewhat confirmatory, because users often prefer warmer colours in intimate spaces. On the other hand, it should be noted that Space is associated with the presence of Storage furniture and Tables, which is likewise coherent. Moreover, it should be noted that daily home activities such as sitting, watching TV, or working on the computer are common routines and users appropriate space and furniture to avoid body stress [44].

Lastly, this research detects weak associations between the profile variables Gender and Age, as well as between Storage furniture and room access variables. One study finds differences in time spent on household activities by gender [45], which may explain differences in the spatial organization of environments, since cultural issues and habits rooted in society can influence.

5. Conclusions

The most common items seen in virtual classes are parts and elements of their homes, and laptops and cell phones are the most used devices, indicating that students are prepared to easily move their workspace. Four scenarios in student homes were identified for training (bedroom, study, living room, and kitchen), highlighting the occurrence of the bedrooms and the functionality of the study for attendance to e-learning sessions and use of ICT.

Students intentionally customize the environment to reflect a generally neutral environment during learning sessions, avoiding transmitting too many private data. The digital device cameras often face the access door, at a mainly lateral or back position with respect to the window, to avoid light reflection during sessions. The screen backgrounds used by students during online training connections confirm the great versatility offered by homes for space use, and attendance for the different activities carried out in the home. The absence of clear patterns reflects the great versatility of homes and uses. Most frequent associations are only confirming logical relationships.

6. Limitations and Prospects

It should be noted that this study was carried out on a small sample within the context of the Foundations of Architecture HE degree program, and hence, one would expect the participating students to not only have a sound awareness of the importance of spatial order, but also better strategies, as compared to other students, when transforming home space into an academic environment. Moreover, the user profile in this study is more concerned about design, and, hence, conclusions drawn may not be directly transferable to other profiles.

On the other hand, a bigger sample would help ascertain whether the moderately stable associations observed between the analysed variables are reaffirmed or increase. New studies are needed to confirm the low intensity associations between the different profile variables.

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