Bachelor's thesis

Facility layout:

Exploring interactions between environment and student performance

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Abstract

The influence that an environment can have on an individual's performance and the influence that an individual can have on their environment are important factors to be considered to maximize performance and achieve optimum results. To reach this conclusion and further develop research on the topic, this research paper analyses previous knowledge and studies a specific case by means of a survey. The case is whether the change of environment that university students underwent from attending face-to-face classes to taking them from home affected their performance. The conditions of the environment, such as noise, freedom of movement, routine, company, facility layout and workspace satisfaction can affect a student's performance including productivity, creativity and academic results, so they should be taken more into account in daily lives to maximize potential by adapting the environment.

| Environment | Performance | Student | Interactions | Creativity | Workspace |

Resumen

Diseño de las instalaciones: explorando interacciones entre el entorno y el rendimiento de los estudiantes.

Este trabajo de investigación consta de un estudio de como un espacio y ambiente puede afectar el rendimiento de un estudiante, incluyendo la productividad, la concentración, la creatividad y los resultados académicos y recíprocamente ver como un estudiante puede influir en su espacio o entorno. Así pues, el objetivo es ver como estos dos factores interactúan y cuáles son las consecuencias de ello.

También se estudian las consecuencias que la pandemia del Covid-19 ha tenido en el rendimiento de los estudiantes analizando dos espacios distintos: clases presenciales en la universidad (antes del Covid-19) y clases desde casa (durante el Covid-19). Se estudian varios factores de los dos espacios, entre ellos, por ejemplo, su disposición, los recursos que proporcionan, los colores, la libertad de movimiento, el uso compartido o individual del espacio, el ruido o la satisfacción del usuario.

Este estudio se ha llevado a cabo por varias etapas. Primero, realizando un estudio de lo que se ha dicho hasta la fecha sobre el tema. Segundo, realizando un estudio específico de la diferencia entre las clases online y las clases presenciales debido a las medidas tomadas para reducir la expansión del Covid-19. Finalmente, haciendo una encuesta a estudiantes de la cual se han obtenido resultados que han sido analizados y discutidos. El trabajo finaliza con algunas limitaciones encontradas, temas para futura investigación y conclusiones.

| Entorno | Rendimiento | Estudiante | Interacciones | Creatividad | Lugar de trabajo |

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I. INTRODUCTION

Facility layout is key to achieving effectiveness and efficiency. It is defined as the arrangement of different aspects of a space so as to achieve best results. It considers available space, objectives, equipment, and convenience of users.

Facility layout is part of the Operations Management aspect of business and can be studied in the Operations department of a company, or it can also be integrated within other company departments due to its interrelation with all of the firm's activities. The study of the operations' aspect of business is the central bone of every company because it helps production flow smoothly and be achieved at an optimum cost, therefore making it efficient. However, it can also be seen in a wider context as a part of daily life.

Facility layout studies a space and looks at how objects and equipment can be physically allocated to get an as efficient design of the available square meters as possible in order to get the maximum performance out of users. It can also be used to study a space and then relate it to the effects it has on people, referring to performance which is defined as "how well a person, machine, etc. does a piece of work or an activity" (Cambridge English Dictionary, 2020).

Although performance is a broad concept, this thesis studies performance related to how well an undergraduate student can take classes, study and get good grades specifically in relation to productivity, concentration and creativity in their field in a specific space. At the same time, the effect that a space can have on student performance has been investigated, while also considering the effect that students can have on space and their environment.

Space can affect a person's performance but also attitude, emotions, and many other aspects of a person's wellbeing. That is why it is so crucial to keep the effects that an environment and its disposition can have at the front of our mind to achieve greater efficiency in whatever we are doing, whether it is working, studying or sleeping.

Similar to the mutual effects that the environment and an individual can have on each other, we could relate it to this part of the poem "No man is an island" by John Donne (Donne, 2020):

> No man is an island entire of itself; every man
>
> is a piece of the continent, a part of the main; […]

Of particular interest in this thesis is the space in which students study and attend classes. Since the beginning of their learning process, they have always been in a different environment from home (i.e. at a nursery, school, high school, university, college). This influences their state of mind. When the Covid-19 pandemic struck early in 2020 and social distancing was required, students had to start learning and taking classes from home. It is important to think about the space where this work took place and the possible subsequent effects on the learning process.

II. OBJECTIVES

The aim of this project is to study the influence that an environment and physical space can have on a student's performance, specifically productivity, creativity, concentration and grades since these are the characteristics thought to be needed to achieve good academic results when studying that can be affected by an environment. Therefore, this thesis studies how the student's environment and space can affect their performance and how the student, at the same time, can affect the environment and their space. Consequently, the aim is to study a bidirectional relationship between two variables: student performance and environment.

The specific objectives of this thesis are related to the relationship between student performance and the environment. They are to evaluate the impact that the Covid-19 pandemic has had on student's university classes and methods of studying. This is comparing and contrasting classes at university (face-to-face) with classes from home (online). Hence, seeing how these two different spaces affect undergraduate student's performance by looking at the two different locations and analysing the effects that they have on performance by means of a survey. This provides insights into what effects the change of space (university classroom vs home desk) has had on undergraduates' performance.

Based on some initial research, the premise of this dissertation is that there are interactions between the environment and student performance. The environment can affect the outcome (student performance) by making students more or less productive depending on the space, the disposition of fixtures and fittings, colours, background noise and light affecting their overall performance. At the same time, the students can influence their environment and their own space and consequently their performance, by organizing it in their own personal way.
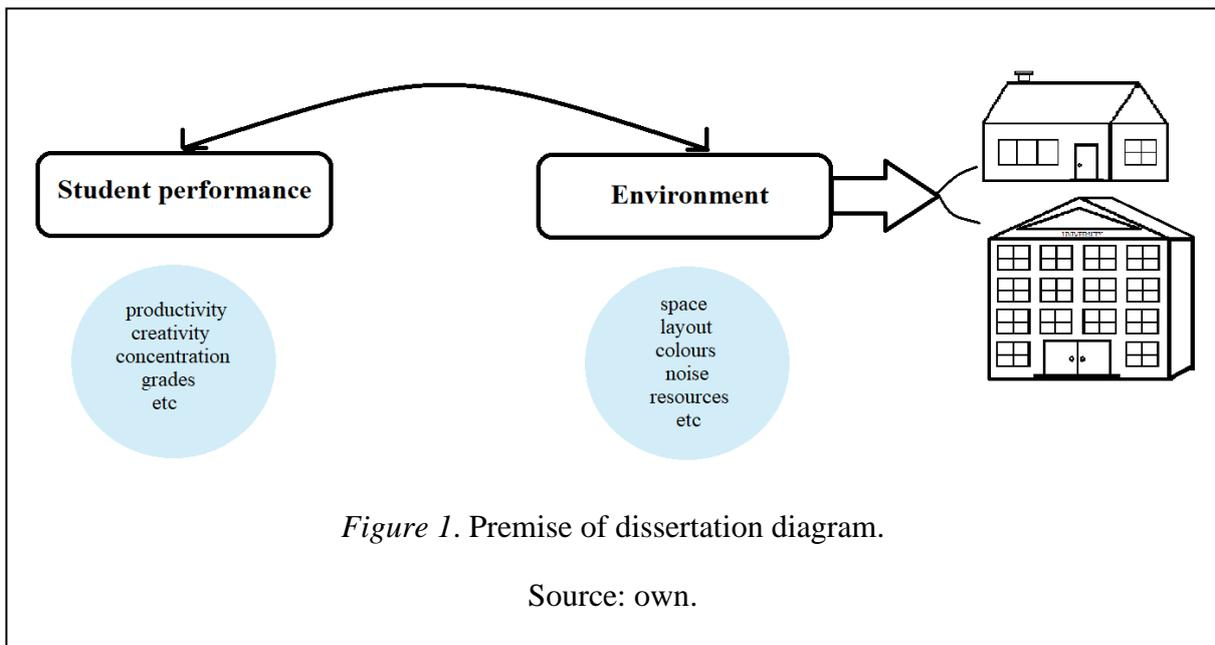
Figure 1. Premise of dissertation diagram.

Source: own.

III. METHODOLOGY

To see the influence that an environment and physical space can have on a student's performance, an analysis on what has been said on the topic up to date has been performed, followed by a survey. To finalise, the results are analysed, and some conclusions are reached.

The initial premise states that there are bidirectional interactions between the environment and student performance. Consequently, firstly, in the background research section, information is analysed to see what has been said on the topic in articles, books and websites.

Secondly, a section is dedicated to mentioning the possible effects that the change of the study environment due to the Coronavirus pandemic could have on students. Changing the environment in which they take classes from the university to their homes may affect grades, creativity and feelings, and overall performance.

Thirdly, a section is dedicated to analysing the results of the survey that was sent out to undergraduate students. The survey evaluated students' knowledge and opinions on the mutual effect of environment and individuals and assessed the effects of the change of their study environment on their feelings and performance (concentration, productivity, distractions, academic results, well-being).

For this third part, a set of questions was created based on qualitative aspects, as opposed to quantitative, with the aim of reaching the most students possible, with a desired response of around 100 people. The questions are based on research performed previous to the survey.

The desired sample size of 100 comes from a rounded 95% confidence interval and a 10% margin of error which according to Conroy (Conroy, 2018) is acceptable for an exploratory study for a large population size (in this case it is 6,700 - the number of students at the Faculty of Economics and Business of the University of Barcelona studying degrees as of the academic year 2018-2019 (AQU (Agència per a la Qualitat del Sistema Universitari de Catalunya), 2020)).

As previously mentioned, the questionnaire is qualitative and a combination of two approaches to a qualitative questionnaire: constructivist and trusting constructivist. According to Romm (Romm, 2013), a constructivist approach implies that questionnaires create a social constructed knowledge from the interaction between researchers and participants based on the participants' interpretation that offer researchers some information that can have multiple interpretations. A trusting constructivist approach means that questionnaires are constructed by researchers bearing in mind that they can be a tool to form people and consider that it is important to listen to the participants.

Therefore, the aim of the survey was to make students think about the mutual influences that student performance and environment have on each other. The majority of questions required

an answer based on a 1 to 5 Likert scale, ranging from totally disagree to totally agree. The advantage of this is that people always have the possibility to express their position or extreme position while also being allowed to take a neutral position. Furthermore, it is easy to analyse the results by entering the data into graphs and results can be seen clearly for example in figure 6, figure 7, figure 8 and figure 9. The survey also included an open space for participants to add their description of an ideal workspace. The influence that the environment can have on individuals is a topic which is not considered much but it is significant since it can be very influential on the achieved results.

The survey was created using the Google service Google Forms. It was used to do the questionnaire and share it through social media to friends and fellow students. The questionnaire was available for students to answer for a period of two weeks, after which it was closed, and no more answers were accepted. This was done in this manner to give respondents enough time to answer it and think about it without being pressured to do so. An online survey is a good way to reach people in different spaces, and even more useful in the moment the research was carried out when it was recommended to keep social distances and avoid getting together with other people, especially in a closed space to answer the questionnaire. There was also a risk that people would ignore the questionnaire and not answer it which is why a brief introduction was added before the survey so that people knew what it was about.

After the two weeks, the results of the survey were analysed and linked to theories mentioned in the background research, discussed, and finally conclusions were drawn.

To end, the theoretical findings are related with the practical ones from the questionnaire by discussing them and finally end with some conclusions.

This previously mentioned process has been the one followed to develop this research project in order to get the most correct information possible regarding the topic of interactions between environment and student performance.

IV. BACKGROUND

4.1 Summary table 1

For a summary of the background section, see table 1 below.

Table 1: background summary table		Source: own
Relationship between an individual and their surroundings		Bidirectional relationship.
Behavioural science	It studies the relevance of thinking about human behaviour when designing and building environments. Designers and architects must consider human needs in their jobs due to the relationship between humans and environments, therefore use the knowledge of behavioural science.	
Environmental psychology	Within the behavioural sciences, it studies the interrelationships between a person's behaviours and experiences with their physical built environment.	
Misfit between person and environment theories	Person-environment theory states that stress arises from a misfit between the person and their environment.	Yerkes-Dodson law defends that a certain level of misfit between a person and the environment is beneficial for performance.
Yin and yang	Nature and nurture are part of each other, in the same way environment and individuals are.	
Creativity	Ability to come up with new, surprising and valuable ideas or artefacts. A person's creativity can be stimulated or hampered by an environment.	
Creativity requirements	Certain environmental conditions, a place and a time, a stimulating environment and a talented individual with domain expertise.	
Stages of creativity	Authors state four, five or six. Some are more connected with environment than others. Models that try to explain creativity that do not include spatial categories have less power than models that do include such categories.	
Factors that can influence creativity	Culture, structures (economic, social, political), design of work settings, arrangement of communications, authority within the organization, degree of centralization of decision-making and style of supervision and evaluation. Enhance creativity: motivation, flexibility, originality, wide interests. Obstacles to creativity: strict adherence to rules, strong hierarchies.	
Power distance	The higher the value for Hofstede's power distance, the lower creativity is.	
Group discussions and brainstorming do not enhance creativity	Members copy each other's ideas or responses. Group brainstorming results in less ideas than the members brainstorming alone due to individuals being reluctant to express unusual ideas, a dominant individual talking most of the time, hostile group climate or not wanting to share the benefits of an idea. However, with the right combination of personalities, diversity and resources, creativity can rise.	
Perception	The way an individual interprets and organizes information.	
Approaches to perception	Conventional atomistic approach: The person receives a stimulus from the external environment through the nervous system and interprets it with past experiences to gather information about the environment.	Holistic approach: The person receives properties of the environment as meaningful interconnected entities, which lead to possibilities for action that differ according to previous knowledge, experience and capabilities of the person.

Variables that can influence perceptions	Gender, ethnicity, socioeconomic level, family background, education, status in the community and relational roles.	
Colours	They influence the way people perceive something: some colours create a sense of peace or calm while others are depressing. These effects result in some colours being good for creativity and productivity and others not.	
Personalize according to preferences	People personalize their environments according to their preferences. When productivity falls behind, they alter some aspects of their workspace or move to a new one.	

4.2 Interactions between environment and individuals

Humans have many needs, and these are in a constant state of change. This can make them complicated to study, but it is vital that most importantly designers take them into account when planning peoples environments for two reasons. Firstly, people are in constant contact with their surroundings and secondly, there is a mutual relationship between people and their surroundings. Consequently, the design of the environment can be very significant.

Behavioural science studies the importance of baring in mind human behaviour when designing built environments (Mersal Mahmoud, 2018). A key field within behavioural sciences that studies the interrelationships between a person's behaviours and experiences with their physical built environment is environmental psychology and is essential to this study (Ackerman, 2010; Mersal Mahmoud, 2018). Some key aspects that are changing the framework of environmental psychology are the concepts of preference which refers to liking an alternative more than another, cognition which is the mental process of learning and understanding by thinking, gaining experience and problem-solving, place attachment which is related to the emotional bond between person and place and ICT[1] which are communication technologies such as the internet, phones, computers and tablets (Mersal Mahmoud, 2018).

Architecture and architects must use the information and knowledge provided by behavioural scientists to create spaces that are adapted to humans needs.

Consequently, it is paramount to state that the relationship between an individual and their surrounding is bidirectional and the effect that each can have on the other are reciprocal (Mersal Mahmoud, 2018; Sameroff, 2010). The interaction of individuals with the environment and the space also depends on their perceptions of it, on the security and safety it provides them and how it influences their well-being (Mersal Mahmoud, 2018).

Humans give meaning to spaces with their behaviour, activities and culture. These spaces can also influence the behaviour that an individual exhibits in a specific environment as well as the relationships with others and their actions within the environment (Mersal Mahmoud, 2018).

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[1] ICT is the abbreviation for Information and Communication Technology.

For example, in the education field, the environments in which children learn have rules which guide them in acting appropriately and gaining recognition (Meusburger, 2009).

In environmental psychology we find the person-environment theory which states that stress arises from a misfit between the person and their environment. This framework consists of:

- the <u>objective person</u> referring to the attributes that exist,
- the <u>subjective person</u> referring to the persons' perception of their own attributes like, for example, the self-concept,
- the <u>objective environment</u> referring to the situations that exist independent of the persons perceptions, and
- the <u>subjective environment</u> which refers to the situations encountered and perceived by the person.

The relationships between these four concepts are imperfect due to perceptual distortions and processing capacities which are limited for humans because they can only handle a limited amount of information and organizational structures that limit the access people have to objective information. These distinctions form four types of correspondence between person and environment (Edwards et al., 1998):

- objective P-E[2] fit: objective person and objective environment
- subjective P-E fit: subjective person and subjective environment
- contact with reality: the degree to which the subjective environment corresponds to the objective environment
- accuracy of self-assessment: degree of match between objective and subjective person.

Another important set of relationships in the person-environment theory is firstly, the fit between the demands of the environment and the abilities of the person and secondly, the fit between the needs of the person and the supplies in the environment that fit the needs (Edwards et al., 1998).

This P-E theory is based on the fact that environmental structure is understood to be critical to human cognition and vice versa (Sameroff, 2010).

Contrary to the person-environment theory which considers the misfit between a person and the environment a negative result, the Yerkes-Dodson law defends that a certain level of misfit is beneficial for performance.

According to the Yerkes-Dodson law (Yerkes & Dodson, 1908) there is an empirical relationship between pressure and performance. This law was developed by the two psychologists that give the name to the stated law in 1908, and it states that performance

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[2] P-E: person environment.

increases with arousal, up to a certain point where arousal levels become too high and performance decreases. This is illustrated graphically in Figure 2 (Diamond et al., 2007) with a bell-shaped curve which increases and then decreases with higher levels of arousal.

As it can be seen in Figure 2, different tasks require different levels of arousal for performance to reach its maximum: simple tasks may be performed better with more arousal due to an increase in motivation whereas difficult, complex or unfamiliar tasks demanding high intellect may require less arousal to facilitate concentration (Yerkes & Dodson, 1908).

Figure 2. Yerkes–Dodson law (Yerkes & Dodson, 1908).

Source: (Diamond et al., 2007).
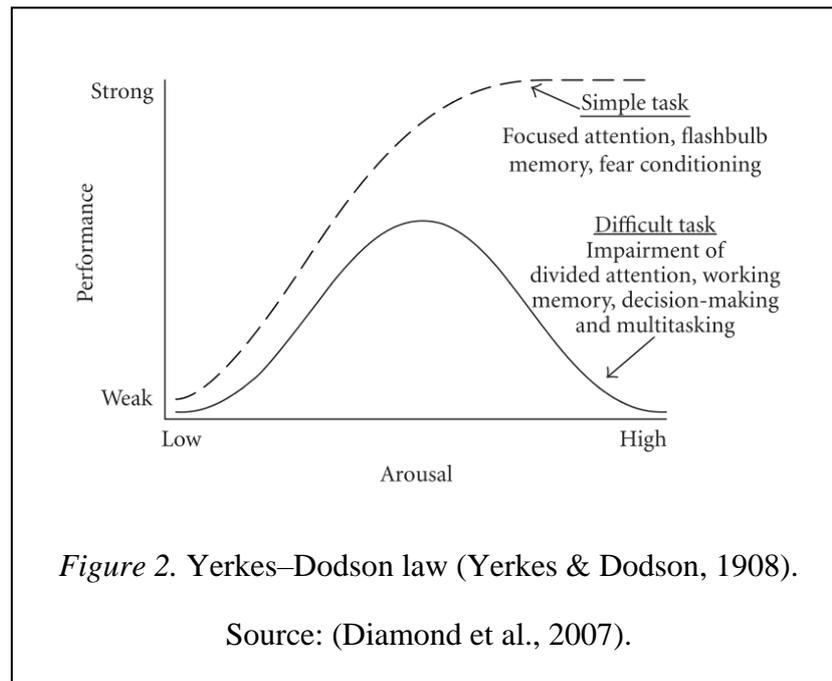
As seen, many authors have defended that human-environmental relations are marked by their mutual causality. Here is what Neves-Graça (Neves-Graça, 2007) said:
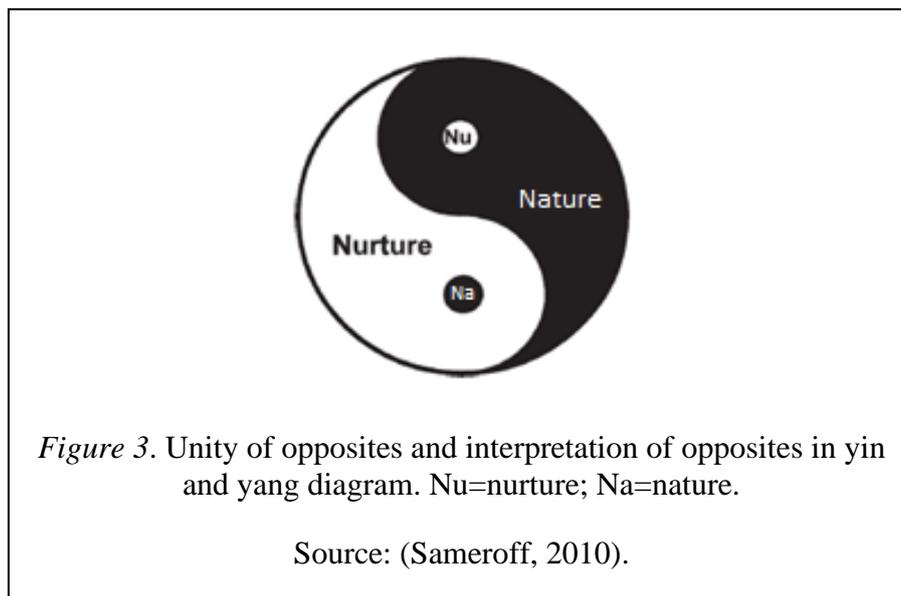
> human-environmental relations are recursively linked, … such that knowledge, forms of knowing, and experiences of past human-environmental practices are constantly being re-embedded in new contexts that *are* themselves simultaneously sociocultural, historical and ecological. Hence, the ontological condition of human-environmental relations is irreducibly interactive and dynamic.

A person is part of the environment and adapts to it while also actively adjusting it and shaping it according to their capabilities, resources and position in the environment (Meusburger, 2009). To study the role of environments, it can be helpful to follow Neisser's 1987 distinction between perceptual-visual processes which refer to the objective intake of existing information, therefore seeing, and perceptual-cognitive processes which refer to the subjective intake subject to beliefs of the world, therefore thinking and categorizing (Meusburger, 2009).

Despite the influence that an environment can have on individuals, it is necessary to also say that place dependence varies depending on needs whether solitude, security, or distraction. This variation could differ from one profession to another, from one discipline to another or from

one stage of the creative process (mentioned in section 4.1) to another (Meusburger, 2009). There is a general agreement among researchers that human cognition is physically and socially situated (Malinin, 2016).

A further concept linked to the relationship between people and environment is nature and nurture, which Sameroff says "each can explain the influences of the other because in the end neither can exist without the other" (Sameroff, 2010). The debate between these two concepts relies on whether human behaviour is determined by the environment or not. Nature and nurture form part of each other since "there is a unity of opposites in that development will not occur without both, and there is an interpenetration of opposites in that one's nature changes one's nurture and conversely one's nurture changes one's nature" (Sameroff, 2010). These concepts are related to the Ancient Chinese concept of yin and yang which is represented in Figure 3.

Figure 3. Unity of opposites and interpretation of opposites in yin and yang diagram. Nu=nurture; Na=nature.

Source: (Sameroff, 2010).

This idea relates to the importance of developmental context and the inability to separate individuals from context, which is the initial premise, with a context being able to both foster and inhibit development:

> On the nature side, whatever measure of individual differences has been discovered, two children with the same characteristics can have quite different outcomes and two children with different characteristics can have the same outcome. On the nurture side, whatever measure of the social environmental has been discovered, two children with the same experiences can have different outcomes and two children with quite different experiences can have the same outcome (Sameroff, 2010).

Facility layout aims to provide an optimum space to organize equipment, facilitate and reduce movement of both people and objects, promote safety and facilitate change to increase performance. It ensures that environments meet people's requirements. This is done by training, creating awareness, encouragement, motivation and optimum use of resources (Juneja, 2020).

4.3 Creativity and environments

Creativity is one of the aspects of performance studied in the thesis which can be influenced by environment. The effect of an environment on a human and their processes cannot be predicted although it is clear that they can be key to a person's creativity or capacities which can be stimulated or hampered by an environment (Meusburger, 2009).

The definition of creativity according to Boden is: "creativity is the ability to come up with ideas or artefacts that are new, surprising and valuable" (Boden, 2007).

Creativity was thought to be a gift some people innately had but researchers realized that it was not. It was not until the late twentieth century when interest in studying the impact of spaces on creativity started to rise and although it still remains largely uninvestigated (Malinin, 2016), some research has recently been carried out.

It was found that creativity requires certain environmental conditions and time (Malinin, 2016; Meusburger, 2009). Before a creative process can occur, a stimulating environment and a talented individual must come together and interact in a place (Sternberg & Lubart, 1991). Also, some studies say that creative people have more awareness and are more sensitive to environmental stimuli than less creative people (Malinin, 2016; Meusburger, 2009). Malinin says that "stories abound about how creative people feel their physical environments become part of their creative process", by referring to Kipling and Kant (Malinin, 2016). It is also necessary for a person to have domain expertise within a field to be creative (Malinin, 2016).

Many researchers defend that creativity is a lengthy process that involves stages (Funke, 2000; Malinin, 2016; Meusburger, 2009; Runco, 1993). Most have established that a creative process has four stages, but others have stated more than four, for example five or six. According to Funke (Funke, 2000) there are five stages in a creative process which are preparation, incubation, insight, evaluation and lastly elaboration and verification. Of these, the first stage and the last two are thought to be more connected with environments and spaces than the others although the other two, insight and incubation, might turn out to be more influenced by the environment in the future with further studies and more research (Meusburger, 2009).

Since the early 1980s, more and more authors have tried to explain creativity by introducing multidimensional models and asking themselves "how personal traits, group characteristics, work environments, organizational structures, cultures, and political conditions interact and how they thereby foster or inhibit creativity" (Meusburger, 2009). There is plentiful factual evidence on the close relationship between social environment and creativity and that single models that ignore spatial contexts have less power to explain creativity than some that include spatial categories (Meusburger, 2009).

Spatial categories and environment are two concepts that are sometimes used synonymously but they have different meanings. Spatial categories "have the capacity to facilitate or impede interactions" and "comprise institutions, infrastructure, resources, job opportunities, challenges, and risks" (Meusburger, 2009) while environment "refers to both subjectively perceived and objective, relatively stable qualities of an individual's or group's physical and social surroundings" (Clitheroe et al., 1998) and it is centred around an actor or system.

Some other aspects that can affect creativity are culture, social and economic structures, attitude of supervisors, political systems and academic evaluation systems. If the ruling classes of a country or region are reluctant to change and are rigid, defensive and pessimistic, creativity will be reduced. However, if an environment recognizes and fosters creative ideas and the system is open-minded and optimistic, people will be more creative (Meusburger, 2009).

Personality also influences creativity, with motivation, mental energy, ideational fluency, adaptive flexibility, originality, curiosity, self-confidence and wide-ranging interests among others enhancing creativity with these traits being learned or developed (Meusburger, 2009).

Other aspects that are significant in influencing creative processes are the design of work settings, the arrangement of formal communications, authority within the organization, the degree of centralization or decentralization of decision-making, the competence of supervisors and the style of supervision and evaluation, the degree of autonomy and the availability of resources among others. A strict adherence to rules, strong hierarchies and supervisors that are incompetent are obstacles to creativity (Meusburger, 2009).

Creativity can also be damaged when a same space is used all the time. Mobility is needed to stimulate creativity by changing the work environment or culture. Malinin stated: "creative work demands quiet and privacy, but also needs movement and a sense of change" which is especially necessary when frustration arises (Malinin, 2016).

Another commonly argued topic is related to group discussions and their influence on creativity. Some studies have supported that group discussions lead to group members copying each other's responses, decreasing creativity and resulting in a lower number of different responses by the group as a whole in comparison to the number of the ideas collected by individuals working on their own (Andre et al., 1979). Similarly, brainstorming performed in groups generates fewer ideas than individuals brainstorming alone and their ideas being put together rafter (Andre et al., 1979; Kohn & Smith, 2011). Some reasons for brainstorming blocking creativity can be individuals being reluctant to express unusual ideas due to fear of how they will be received by the group, because of a dominant individual leading the discussion and talking most of the time and others cannot express their ideas, antipathy between group members, fear of losing status, lack of support, hostile group climate or not wanting to share the benefits of an idea with others and being somehow selfish (Andre et al., 1979; Meusburger, 2009). Performance is not enhanced by hearing other's ideas either.

Individuals cannot be forced to participate in group discussions (Meusburger, 2009). Kurtzberg and Amabile say that most brainstorming groups have participants who have no knowledge of other's strengths and weaknesses but with the right combination of personalities, diversity and resources a problem can be effectively solved by the group (Kurtzberg & Amabile, 2001). Shalley found that "the highest levels of creativity occurred when individuals had a creativity goal while working alone and expecting to be evaluated" (Shalley, 1995). However, other authors have found that surveillance has a very negative effect (Meusburger, 2009). Forgays and Forgays found that more creative people respond more positively to solitude than not so creative people (Forgays & Forgays, 1992), while other authors found the contrary (Meusburger, 2009). Again, we can see how controversial this topic is.

In conclusion, the studies carried out have not come up with any clear evidence of how spatial configurations support creativity. As a general conclusion, spaces that are perceived as inspirational have generally proven to increase their creativity (Dul et al., 2011; Dul & Ceylan, 2011; McCoy & Evans, 2002). However, preferences for an inspirational space differ between individuals. Scientists have recognized that creativity is a multifaceted and complex event that has to be studied from the perspective of more than one approach (Malinin, 2016).

4.3.1 Creativity and power distance

As mentioned above, some features that can affect creative processes are authority within the organization and the degree of centralization or decentralization of decision-making. The stricter the adherence to rules is and the stronger the hierarchies are, creativity is more restricted.

For this reason, creativity could be related to the power distance variable of Hofstede's country comparisons (Hofstede Insights, 2020). Power distance is defined as "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally" (Hofstede Insights, 2020).

A list of the ten most creative countries in the world has been compiled by the Martin Prosperity Institute according to the Global Creativity Index 2015 which presents a model of economic development defined as the 3Ts: Talent, Technology and Tolerance. One-hundred and thirty-nine worldwide nations have been assessed on each of these pillars and received an overall score putting them into a ranking (Florida et al., 2015). The top ten countries are in Figure 4.

Rank	Country	Technology	Talent	Tolerance	Global Creativity Index
1	Australia	7	1	4	0.970
2	United States	4	3	11	0.950
3	New Zealand	7	8	3	0.949
4	Canada	13	14	1	0.920
5	Denmark	10	6	13	0.917
5	Finland	5	3	20	0.917
7	Sweden	11	8	10	0.915
8	Iceland	26	2	2	0.913
9	Singapore	7	5	23	0.896
10	Netherlands	20	11	6	0.889

Figure 4. Ranking of the top 10 most creative economic performers.

Source: (Florida et al., 2015)

To relate this with Hofstede's power distance dimension, the countries were entered into Hofstede's website country comparison search to see their power distance qualification which can be seen below, with the full graphs for the ten countries in Appendix 1.

In the order for the most creative countries, the respective power distances are as follows:

Australia 38
United States 40
New Zealand 22
Canada 39
Denmark 18
Finland 33
Sweden 31
Iceland 30
Singapore 76
Netherlands 38

They can be seen in the below Figure 5.

Figure 5: Power distance

Source: own.
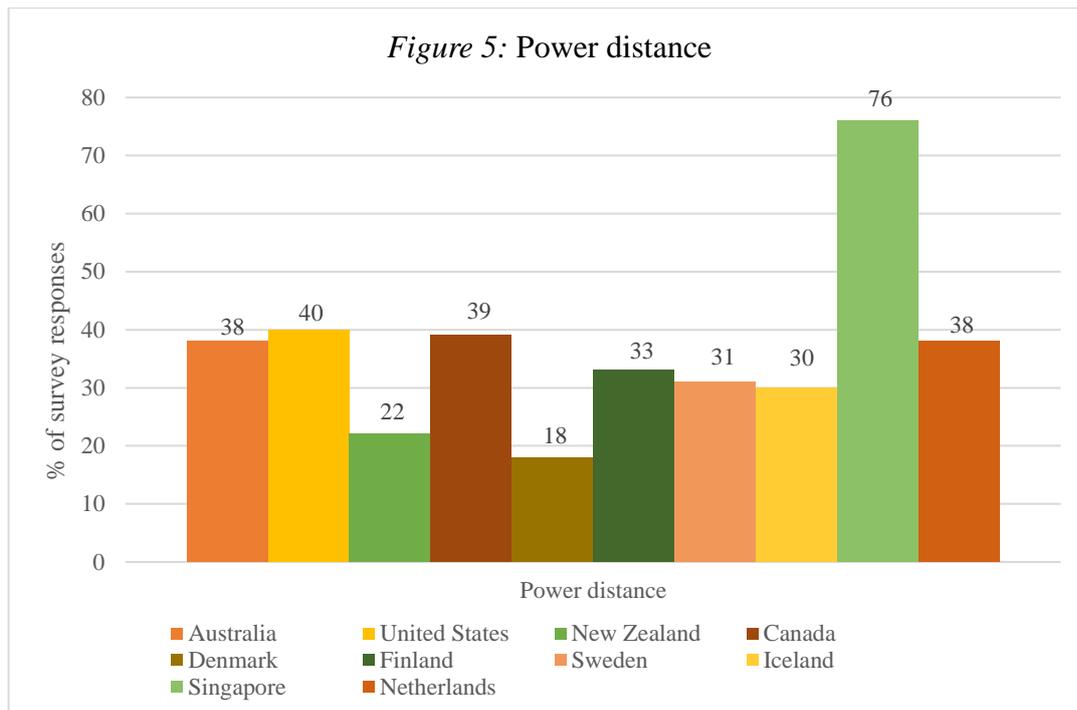
All of the countries except Singapore which is in 9th position out of the world's 10 most creative countries have scores of 40 or less for power distance which relate to how well individuals accept inequalities and this classification in society and their attitude towards it.

As 9 out of the 10 countries in the list have a below 50 power distance, it can be said that the degree of formality within the structural organization is low and hierarchies are not very strong. There is more accessibility for lower levels such as employees or students to higher levels such as managers or teachers, for example. Communication is informal and decision-making is decentralized, which enhance creativity. Singapore needs further investigation to determine what other variables make it an anomaly within the list.

In general, it is seen that a lower power distance positively influences creativity.

4.4 Perception of the environment

As concluded previously, spaces are perceived differently by different people, having different effects on them.

"Perception is man's primary form of cognitive contact with the world around him" (Efron, 1969). A person's primary source of information is their environment and information can come from simply being aware of one's surroundings, without requiring further thought.

Perception is different from vision because vision is the ability of seeing something while perception includes "the organization, identification and interpretation of sensory information" (Diffsense, 2020). Therefore, perception involves a person's senses, including sight.

According to cognitive psychology, the act of seeing is not merely a passive record of the external physical environment; it also involves active processing and analysis. The sensory input coming from the external environment undergoes a series of modifications before an object can be perceived: the input is transformed, reduced, processed, stored, retrieved and then used (Mastandrea, 2020).

There are two approaches to perception which are the atomistic view and the holistic view (Meusburger, 2009).

The conventional atomistic approach assumes that the person receives a stimulus from the external environment through the nervous system by having a receptor in their body activated. It is then interpreted by the individual with their past experiences to gather information about the environment. Each person interprets the unconnected stimuli to construct something relevant about the environment (Meusburger, 2009).

The holistic approach which changed the way of considering the process of perception is defended, among others, by Gibson. It says that stimuli is "what an organism is responding to, and not by what excites all the little receptors" (Meusburger, 2009). It defends that "properties of the environment are perceived not as distinct points but rather as meaningful entities", therefore everything is interconnected (Meusburger, 2009).

Gibson also refers to affordances. These are possibilities for action that we get from the world through our perceptions (Mastandrea, 2020). What is stressed by Gibson is that perception of an object and of the characteristics of it such as colour, shape or location, suggest to the perceiver what he can do with it, leading to actions (Heft, 1988). "Affordances are perceived in a direct, immediate way with no mediation by sensory processing" (Mastandrea, 2020).

Another aspect that can influence the perception that a person has according to Gibson is their previous knowledge, experience and capabilities because due to these, the same signal from the environment can differ in the way it is perceived between individuals (Meusburger, 2009).

Some other variables that can influence perceptions are gender, ethnicity, socioeconomic level, family background, education, status in the community and relational roles.

In conclusion, perception is very personal, and the same thing can mean different things to each person who experiences it. It is crucial to take all the aforementioned variables into account.

4.4.1 Colours

A key variable in perception is colour. Colours play an important role in people's minds and should be taken into account when designing any space or product. Colours have psychological effects on people and influence the way reality is perceived (Velarde, 2017).

Some examples of the effect colours can have according to Velarde are (Velarde, 2017):

- black can be heavy and depressing,
- white generally gives a sense of peace, freshness, cleanliness and calm but too much can be overwhelming,
- red is associated with power and passion and good for detail-oriented tasks but it can also mean danger and does not help in creative thinking,
- yellow can signify health but also depression so effects produced depend on the tone,
- blue can provide a calming effect and is good for creative thinking, but depending on the tone it can have a meaning of sadness, coldness and lack of emotion, and
- green is the colour of nature and is associated to ecology and 'green' values.

People prefer spaces with natural light and views of nature but when it comes to colours, opinions differ enormously. Some people prefer warm colours and highly complex visual materials while others prefer cool colours and low visually complex materials (Malinin, 2016). If permitted people personalize their environments according to their preferences. Creative people personalize their workspaces with their objects and develop routines to get them into a creative mood which suits them and start their creative process. It is common that when their productivity falls behind, they alter some aspects of their workspace or move to a new one (Malinin, 2016). However, when designers create spaces for specific uses, the effects of colours should be taken into account.

After this background analysis, the premise that there are bidirectional interactions between the environment and student performance has been confirmed.

V. CASE STUDY

In this section, some preliminary background research on environments at university campuses is done, and it is followed up with a more specific research study regarding the specific case of the effects that the Covid-19 pandemic has had on the end of the academic year 2019-2020 and the beginning of the 2020-2021 one. There was a reduction in the number of face-to-face classes as they were replaced by online ones for the students in order to comply with government and educational body requirements which recommended social distancing where possible to help reduce the spread of the Coronavirus.

5.1 Background on university campus environments

When a campus is designed, it should provide an attractive and versatile range of accommodations and facilities, which can be a struggle to achieve successfully (Jansz et al., 2020). Design of university campuses is usually based on general assumptions and not on specific evidence because studies related to the environment are not specifically applicable to a university campus environment. University campuses need to be consciously designed and built because they are not only a place to locate university buildings but also a place where the behaviour of the people who work, teach or study there can be inspired or constrained (Jansz et al., 2020) and affect their outcome.

According to Jansz et al. there are three types of campuses (Jansz et al., 2020):

- science parks for R&D activities,
- innovation campuses where the main characteristic is to stimulate cooperation and interaction between actors, and
- facility campuses which attract campus users by providing a shared use of specialist facilities.

Some predominant factors in the success of campuses are place dependency, geographic and cognitive proximity, resources, transitional spaces, shared facilities, synergies, events, networks, interactions, comfort, experience and trust. These critical success factors put together in a correct way and with the correct balance increase the chances of campus users meeting each other and sharing useful information leading to an increased knowledge sharing, affect their state of mind and increase innovation (Jansz et al., 2020).

When it comes to analysing student well-being, educational environment is paramount. "School environment refers to the set of relationships that occur among members of a school community that are determined by structural, personal, and functional factors of the educational institution, which provide distinctiveness to schools" (Tapia-Fonllem et al., 2020). The instrument used to measure the relationship of educational environment and well-being and the variables

themselves is based on three dimensions: physical, social and academic (Kutsyuruba et al., 2015). These three "dimensions of the school climate" refer to the following:

a) Physical: school facilities, their quality and condition and their relationship with students.
b) Academic: teachers' personal skills and characteristics.
c) Social: relationships between members of the school community and the quality of these.

The two variables, educational environment and student well-being, were found to have a significant and strong correlation (Tapia-Fonllem et al., 2020).

5.2 University of Barcelona

The University of Barcelona (UB) is a public Catalan university with more than 570 years of history and is one of the leading universities in Catalunya, Spain and Europe as a higher level face-to-face educational institution. Its mission is to offer a high quality higher education to students with the transfer of knowledge through study, teaching and research with the values of freedom, democracy, justice, equality and solidarity (Universitat de Barcelona, 2020c).

It has sixteen faculties, all located around the city of Barcelona. The Faculty of Economics and Business is located on the *Avinguda Diagonal* in Barcelona, and it is part of the *Campus Diagonal* which includes other faculties such as the faculties of physics, chemistry, biology, and law. The Faculty of Economics and Business emerged in 2008 from the merge of two faculties: the Faculty of Economic and Business Sciences and the University School of Business Studies. It is composed of two buildings: *Avinguda Diagonal, 690* and *Avinguda Diagonal, 696* (Universitat de Barcelona, 2020a).

The Faculty of Economic and Business Sciences was designed by the two architects Francisco Javier Carvajal and Rafael Castro who won a competition in 1954 to design the campus. Their project situated the lecture rooms and the conference hall on the ground floor and the common spaces and offices on the higher floors with a glass façade oriented to the south (López Íñigo et al., 2019).

This layout remains mainly the same as can be seen in Appendix 2 with the two maps of the buildings that make up the faculty. Both buildings' layouts is similar: they have the cafeteria in the centre with lecture rooms surrounding it, the conference hall (Aula Magna), the library and a copy centre on the ground floor, and all of the offices and some more lecture rooms on the floors above.

This layout is conservative and could maybe be studied in order to enhance performance of its regular users.

5.3 Coronavirus impact on university lectures and students

On March the 14th, 2020, the state of emergency was declared in Spain due to the Covid-19 pandemic. Some measures were put in place to stop the spread of the virus, among which was the suspension of all face-to-face educational activity including primary and secondary schools as well as universities (Agencia Estatal Boletín Oficial del Estado, 2020a; Universitat de Barcelona, 2020b). This was initially only for fifteen days but it was extended until the 20th of June, resulting in a total of 98 days (Las Provincias, 2020), with most of the second semester of the academic year 2019-2020 being online.

For the academic year 2020-2021, the situation seemed to have improved a bit and classes for the degree level at the Faculty of Economics and Business of the University of Barcelona were scheduled to have a mixed teaching system. This implied half of the students attending lectures one week and the other half the next, while the others followed the lectures through an online steaming service (Blackboard Collaborate). Subsequently, the state of emergency was declared again in Spain on the 25th of October, 2020 due to the worsening situation in Spain and the spread of the coronavirus (Agencia Estatal Boletín Oficial del Estado, 2020b). As a result, classes changed to being online again now for all students (Universitat de Barcelona, 2020e). This situation was prolonged up until the Christmas holidays. It still remains to be seen how the second semester of the academic year 2020-2021 will function.

The impact of the coronavirus pandemic on students will have other effects apart from physical health ones like, for example, mental health problems such as anxiety, insomnia, fear, depression, loss of concentration or a decrease in academic performance (Pastor Jimeno, 2020). These psychological effects come from the impacts that the coronavirus pandemic have on people, both directly and indirectly and the uncertainty that comes with it. These effects can cause shock, confusion, disorganization and stress (Pastor Jimeno, 2020) and can have a high emotional impact and change people's behaviour as well as altering their development.

Specifically in relation to this section, the uncertainty for students can have a negative impact on their academic performance.

To reduce students' anxiety, it is necessary to get correct scientific information from trusted sources and follow the safety instructions given by health institutions and governments (Nadeak et al., 2020). Anxiety is fear or worry in certain situations that are very threatening and can be caused by uncertainty (Nadeak et al., 2020). Symptoms can be both physical and mental:

> Physical symptoms include cold fingers, faster heartbeat, cold sweats, headache, decreased appetite, sleeplessness, chest tightness while mental symptoms are fear of feeling overwritten by danger, unable to concentrate attention, not peace, want to run from reality (Nadeak et al., 2020).

The next section analyses the results of the survey set out to students to see the differences there may be between taking classes from home or attending the university face-to-face.

5.4 Summary table 2

For a summary of the key results from the survey, see table 2 below.

Table 2: survey results summary table	Source: own
Sample size and implications	50 university students (76% female, 24% male). Conclusions can be drawn but they are not fully representative of the whole population.
Survey format	1 to 5 Likert scale questions and one open-ended question. Blocks: -demographics & consent, -statements about environment, individuals and performance, -assertions regarding student's own environment and performance, and -statements about students' opinions before and after taking online classes and ideal space.
Environment and individuals have a bidirectional relationship	Respondents agree that environment and individuals have a bidirectional relationship, with one environment fostering someone's development but inhibiting another's, and that architects take into account the environment when designing spaces. There is consensus that a pleasant environment increases productivity.
Workspace conditions	-A small majority of respondents do not share their workspace with others but think that people are more creative when not alone. Related to this, a large majority think that brainstorming in groups causes more creativity to the participants. -General agreement that a quiet environment is better for performance while studying, although not everyone actually has a quiet environment. -Colour in the workspace is an unclear topic and there is no clear majority whether warm colours or cool colours enhance performance more. -Freedom of movement is important to increase productivity, and most students are able to move freely in their workspace. -The layout of objects in a workspace is relevant for performance. The layout of the workspace at home meets needs better than the university layout. -Whether physical or digital university resources helped more in the learning process, digital ones were slightly more helpful to the surveyed students.
Routine	A fixed routine is agreed to maintain and improve performance. Going to university makes it easier to follow a routine than taking classes from home.
Workspace pleasant vs as I like it	Ambiguity whether the workspace is just how each student likes it, however, most find their workspace pleasant and agree that it is clean and tidy.
Classes from home vs online	Students feel less productive taking classes from home than from university, although grades are higher studying from home.
Expectations vs reality	Respondents were at first enthusiastic with online classes but after experience, most prefer to take face-to-face classes.
Ideal workspace	Some common points for an ideal workspace are natural sunlight, clean and tidy, not too many objects (only the necessary ones), no distractions, comfortable seating and accessible space to eat or rest. Different opinions on noise or company.

VI. SURVEY

The survey was sent out to university students to assess their knowledge and opinions on the mutual effect of environment and student performance and the real effect that environment has had on their performance with relation to the change of their study environment due to the Covid-19 pandemic.

The desired sample size was of 100 and the achieved one has been 50. This amount of responses is considered adequate bearing in mind the time of the year when the survey was published, which coincided with Christmas holidays and a heavy workload for students studying for final exams. Conclusions can be drawn but they are not fully representative of the whole population since only half of the desired responses were achieved for undergraduate students at the Faculty of Economics and Business of the University of Barcelona with a 95% confidence interval and a 10% margin of error. However, the survey was sent out to mainly students of the International Business degree and for the year 2019 there are 344 enrolled. Consequently, almost 15% responded to the survey which is quite significant (Universitat de Barcelona, 2020d).

The survey can be seen fully in Appendix 3 with all the responses. It consisted of thirty-two questions. The great majority were statements with the possible answers being on a Likert scale of 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = indifferent, 4 = agree and 5 = strongly agree) but there was also one optional open-ended question at the end which received twenty-six answers (just over 50% of respondents).

The statements were divided into two main blocks. The first one concerned eleven statements about environment, individuals and performance and the second one consisted of sixteen assertions regarding the student's own environment and performance. To end the survey there were two statements about students' opinions before and after taking online classes and the open-ended question I previously mentioned about ideal workspaces.

At the beginning of the survey, there was a demographic question to get an idea of the gender of the respondents, and a consensual question to get the permission to use each person's responses for this research project. The gender turned out to be 24% male and 76% female, which is similar to the gender percentages that we find in the University of Barcelona in which there are more female students (around 60%) than male students. All fifty students gave consent for the use of their data anonymously for this research project so there are no restrictions on analysing the findings.

The results of the survey are analysed by sections, grouping questions from related topics together. The analysis could also be done by only relating specific questions from the first block with specific closely related ones from the second one, more or less relating the theoretical opinion with the real actions followed by students. With the method used, these relations are also taken into account.

6.1 Space consciousness

The first section of the survey is space consciousness which is closely related to the first question of the survey and the topic of this research project itself: *The relationship between the environment and individuals is bidirectional (environment affects individuals and individuals affect the environment)*. Most respondents agreed or strongly agreed with the statement (92%), coinciding with the findings of the theoretical research.

Whether students think that *Architects and designers take into account the environment when they design spaces for people*, the general opinion is that they do (70%).

Another strong common opinion is that *The same environment can foster one person's development while inhibiting another's* (86%). This is related to the first question since people are aware that the environment can have different effects on people.

There is also a strong belief that *A pleasant environment increases productivity* with 98% of surveyed students agreeing or strongly agreeing with the statement. Related to the previous question about a space fostering or inhibiting development, we must bear in mind that a pleasant environment for one person might not be pleasant for another.

Therefore, we can conclude that since a pleasant environment is different for everyone and when it is pleasant, it increases productivity, it is obvious that one specific space might be pleasant for someone, increasing their productivity, while being unpleasant for another and decreasing their productivity.

Studying in the same space may also be key. 68% of respondents *Since confinement, study in the same space every day* while 30% do not. This could affect their productivity and performance, by not being used and comfortable with different spaces all the time.

To conclude regarding space consciousness, in general students are aware of the impact that environment can have on performance and productivity.

6.2 Social attitudes

The preference to study alone or with someone else is as personal as the characteristics of a pleasant environment for each individual.

A small majority of respondents (62%) do not *share* their *workspace with others (friends, family, ...)* while 28% do. This may be due to personal preferences, but it may also be due to impositions for example having to share the space with others because there is not enough space at home. If it is due to personal preferences, it can be assumed to have a positive impact on performance whereas if due to space constraints it is more likely to lead to decreased performance.

When it comes to the statement *People are more creative when alone, as opposed to when they are with other people*, more respondents disagreed (60%) than agreed (16%), while the rest (24%) were indifferent. The more common opinion is that people are more creative when they are with other people.

For the statement *Brainstorming sessions in groups cause people to be more creative*, a big majority (88%) agreed or strongly agreed while a minority (10%) disagreed. This answer is in line with the previous one, with students thinking that creativity is enhanced when in groups, although the theoretical findings state the opposite.

6.3 Workspace conditions

This refers to specific environmental conditions such as noise, colours, the ability to move around and layout in the workspace.

6.3.1 Noise

Studying in a quiet environment (as opposed to one with background noise) is key to better performance was a statement that had a clear response: 94% agreed or strongly agreed, while only 2% (one person) disagreed. Therefore, the consensus is that a quiet environment improves performance.

In reality, for the statement *My workspace where I do my university work is usually quiet*, 68% agreed or strongly agreed which is less than for the previous statement, 14% disagreed or strongly disagreed and 18% are indifferent.

Therefore, only 68% of respondents do actually have quiet workspaces. Considering that 94% think that a quiet workspace improves performance, the students with this opinion but that do not actually have a quiet workspace might have a lower performance than what it would be in a quiet environment.

For instance, six respondents that do think that a quiet workspace improves performance do not have one, which could lead to, as said, a lower performance. For the one respondent that did not agree that a quiet workspace improves performance but that does have a quiet workspace, it could also lead to a lower performance because it does not suit their preferences.

6.3.2 Colour

Results of the survey show that the colour scheme of the workspace is perceived as having a less obvious impact on performance.

For the statement: *A space with warm colours (red, coral, orange, yellow, brown, cream, beige, …) enhances performance more than a space with cool colours (black, grey, white, green, blue, violet, …)*, 44% were indifferent, 38% think that a space with cool colours enhances

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performance more than a space with warm colours, while 18% think that a space with warm colours enhances performance more than a space with cool colours.

This unclear tendency can be seen in the related statement *My workspace has mostly warm colours (red, orange, yellow, beige, ...) rather than cool colours (black, white, blue, violet, ...)*. Although 56% of the respondents state that their workspace mostly has warm colours while 24% have cool colours, it is probably not due to the knowledge of the influence that these colours can have on performance but more due to design choices, imposition or personal preferences.

6.3.3 Freedom of movement

Similarly to noise, freedom of movement seems to be significant in affecting academic performance.

70% agreed or strongly agreed that *A space where you can move freely increases productivity as opposed to a space with restricted movement* while only 10% disagreed or strongly disagreed with it, with the other 20% being indifferent.

In practice 78% stated that *In my workspace, I can move about freely whenever I want*, which could lead to increased productivity. 14% disagreed or strongly disagreed, so if free movement increases productivity, they might see a decrease in their productivity due to restricted movement in their workspace.

6.3.4 Facility layout

The layout of the facilities could also be a key factor for performance.

Most respondents (86%) agree or strongly agree that *The location of the objects in a workspace and their arrangement is relevant for performance*, with 8% disagreeing and 6% being indifferent.

The following two questions relate to the layout of the two different spaces: university and home workspace.

No clear conclusion can be drawn from the responses to the statement *The layout of your university is meeting your needs as a university student* since 30% of respondents answered with indifference. However, more people disagree and strongly disagree (42%) than agree or strongly agree (28%) with the statement.

For the second question about layout: *The layout of your workspace at home meets its needs* there is a more positive response. 60% of respondents agree or strongly agree that it does meet their needs while only 26% disagree or strongly disagree and 14% are indifferent.

As we can see in the graph below (figure 6) combining the results for both layout statements, the layout of the workspace at home is perceived to meet students' needs better than the layout of the university.

Figure 6: Layout meeting needs
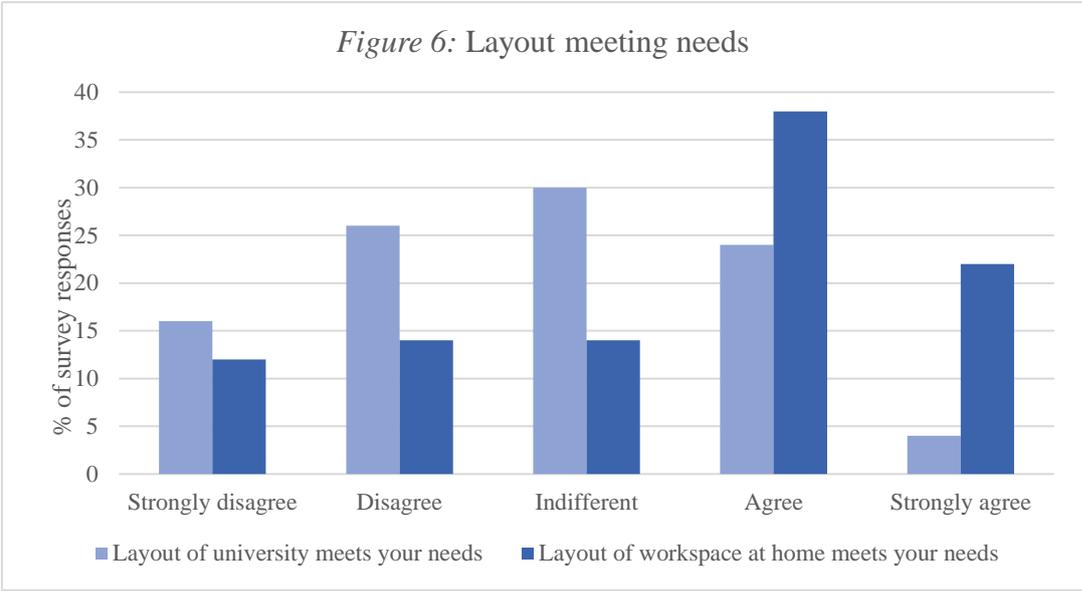
Source: own.

6.3.5 Resources

The following two questions are regarding the resources provided by the university in two different situations: attending face-to-face classes before the Covid-19 pandemic and studying from home during the pandemic.

For *The physical resources provided by your University (books, libraries, workspaces, …) helped you in your learning process when you took classes there*, there is more tendency towards disagreement. 52% of respondents disagree or strongly disagree, while 26% agree or strongly agree that the resources did help them in their learning process. 22% are indifferent.

For *The digital resources provided by your University now (online access to books, online streaming platform, …) help you in your learning process*, compared to the previous question there is a slight movement towards agreement. 40% disagree or strongly disagree and 34% agree or strongly agree. 26% are indifferent.

Therefore, as we can see in the graph below (figure 7) comparing the results, the digital resources provided by the university are perceived as helping respondent's learning process slightly more than the physical ones.

Figure 7: Resources
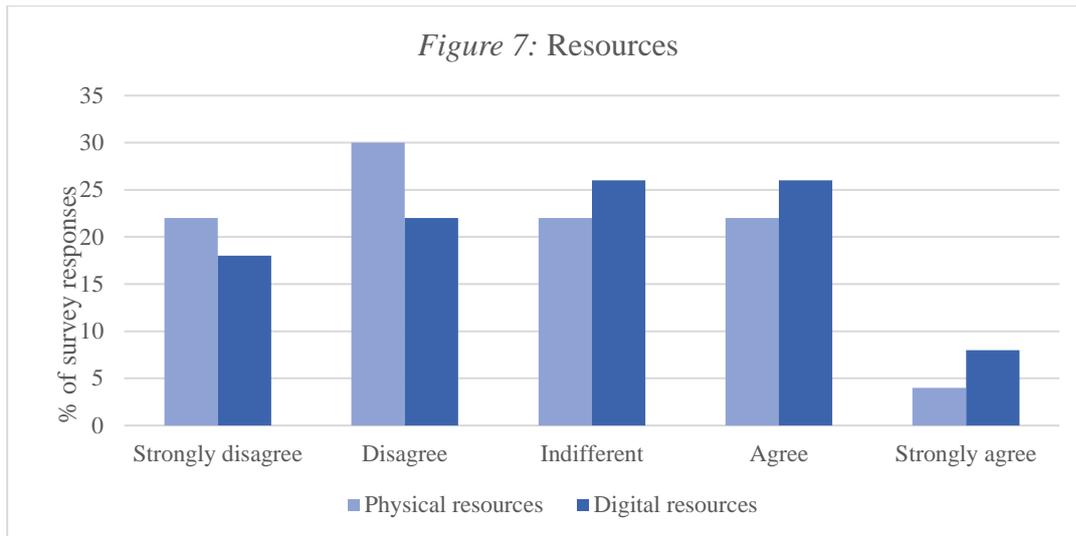
Source: own.

6.4 Routine

Other than the physical conditions of the workspace, another factor that could affect performance and increase productivity is having a fixed routine. There is a consensus on this as 84% of respondents agreed or strongly agreed that *A routine helps maintain and improve performance (waking up, having a shower, having breakfast or a coffee, doing exercise, studying, …)*, nobody disagreed and the rest (16%) were indifferent.

The following two declarations investigate two different scenarios: following a routine when physically attending university (before Covid-19) and following a routine when studying from home (during Covid-19).

The structure and rules of the university are helpful in maintaining a healthy routine has 52% of respondents disagreeing or strongly disagreeing and only 22% agreeing or strongly agreeing.

With regard to the other situation, *Since confinement and online classes, I find it easier to follow a routine*, the response is even worse. 60% disagree or strongly disagree and only 16% agree or strongly agree.

Therefore, there is a pretty clear agreement that studying from home makes it more difficult for students to follow a fixed routine than when going to university, as can be seen in figure 8.

Figure 8: Routine
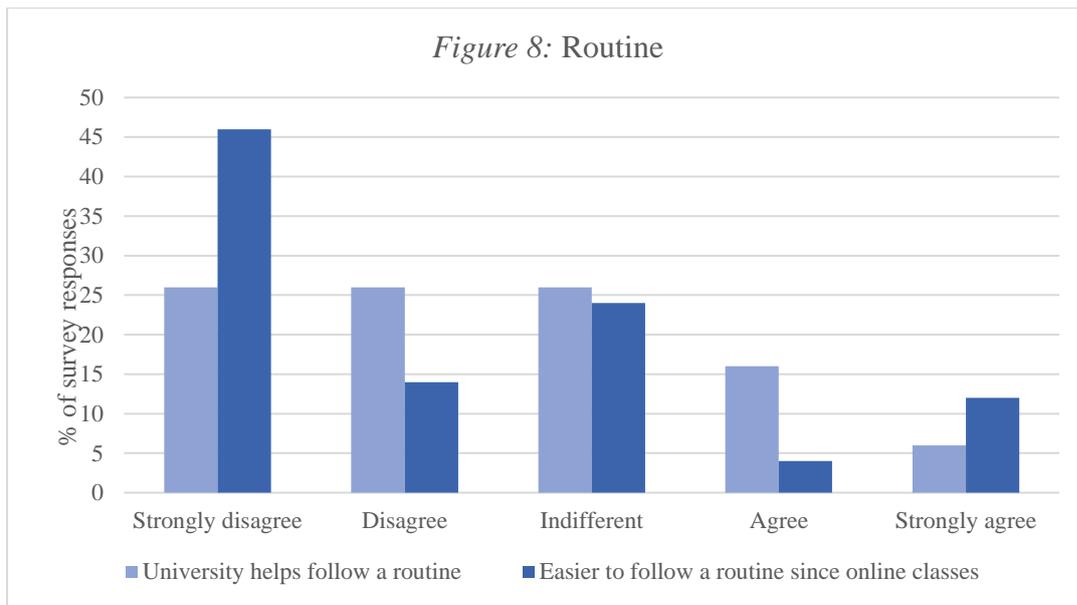
6.5 Workspace satisfaction

The statement *I have my workspace just how I like it* can be a key factor for performance. Answers are almost equally distributed among all options on the Likert scale. Probably the people that have selected 1, 2 or 3 have not got their optimal productivity due to not having their workspace just how they would like it which would mean a pleasant environment for them. Further investigation would be needed to see if this could be due to sharing a workspace, structural limitations of the space or some other factor(s).

The previous premise can be linked with *My workspace at home is pleasant*. This statement was agreed or strongly agreed with by 66% of respondents and disagreed or strongly disagreed with by 16%. Therefore, for the people that do not have a pleasant workspace, it may be that their productivity is not maximized.

My workspace is usually clean and tidy can be linked to it being a pleasant environment for many. 60% agree or strongly agree with the statement while 22% disagree or strongly disagree with it. We see that a smaller percentage of people (60% vs 66%) have a clean and tidy workspace than a pleasant one, meaning that maybe for the 6% difference, a clean and tidy environment is not necessarily pleasant and other aspects are more important to them.

6.6 Self-rated performance

When it comes to students self-rated performance, statements are related to productivity and grades.

For students opinions on what their performance is like from home compared to going to the university, 60% disagree or strongly disagree with the statement *In general, I feel like I am more productive taking classes from home than from the University* and only 22% agree or

strongly agree, concluding that the majority of students feel more productive going to university than from home, at least in the current situation.

However, when it comes to grades, the statement *My grades are, in general, higher now (taking classes from home) than before the confinement (taking classes at the University)* was agreed or strongly agreed with by 60% and disagreed or strongly disagreed with by 18%.

Therefore, the conclusions are contradictory. Students are more productive going to university, but grades are higher taking classes from home.

6.7 Student's opinion: online or face-to-face?

To conclude the survey there were two questions related to the experience of taking online classes vs face-to-face ones.

To the statement *Thinking back, when you were told that classes would be online and not at university, you felt enthusiastic*, 58% agreed or strongly agreed and were enthusiastic about taking classes online, while 32% were not and 10% were indifferent.

Then, for the second statement *Now, after your experience, you like taking classes from home*, 64% of students disagreed or strongly disagreed and a 22% minority agreed or strongly agreed, while 14% are indifferent.

Although when it was first proposed a large proportion of respondents felt enthusiastic about taking classes online, having actually experienced it most have decided they do not like it and prefer to go to university and take face-to-face classes. It can be seen in figure 9.

Figure 9: Opinion
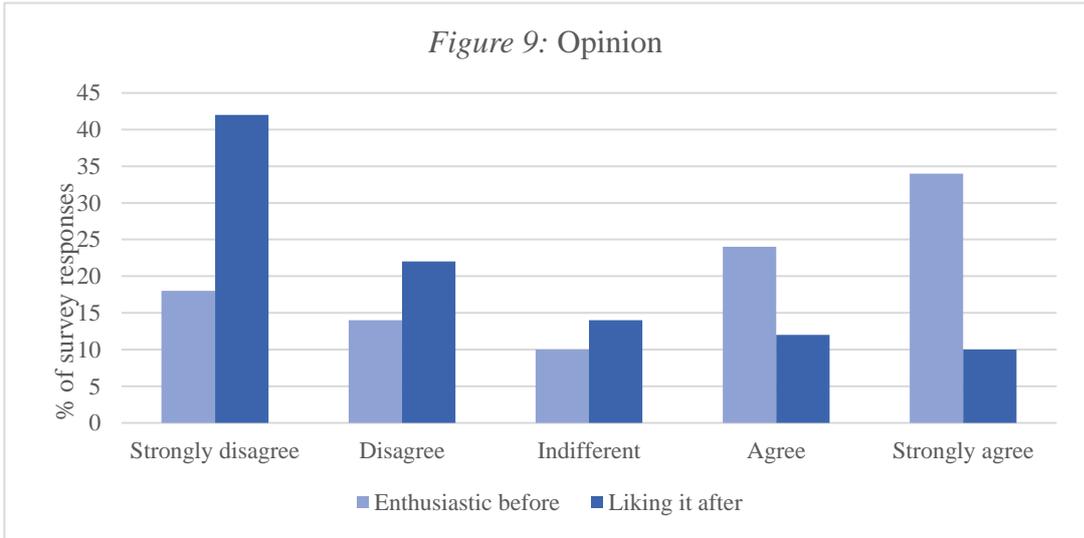
Source: own.

6.8 Open-ended question

For the question *Take a moment to imagine your ideal workspace. What would it be like? What would it provide you with to help you in the achievement of your goals? Would it have specific*

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objects, colours, noises, people, furniture, ...? some characteristics are repeated while others differ among students.

A clear common point that is repeated various times is natural sunlight. This seems to be a very relevant aspect for many, as well as having big windows and a tidy and clean workspace.

When it comes to noise, some prefer no noise at all and the space to be completely silent while others like to listen to relaxing music or be in the company of other people.

Another common point is not having a lot of objects in the workspace. Some refer to it as minimalism while others say that they just need a desk, a computer and their office supplies (for example pens, pencils, paper and highlighters), all organized in a way they can find what they need. Many highlight the need to get rid of distractions like any surplus objects, their telephone, their friends or even their bed. There are also others that think that objects and furniture are not important. However, a characteristic that was repeated many times was the importance of comfortable seating and a big enough desk to have the laptop and notes and space to be able to work comfortably.

When it comes to being alone or with others, there are several opinions. Some students need to be alone in a quiet space with no distractions at all while others prefer to be with a few friends working together. Others just need the environment such as a library to be productive and although not working with other people, value the feeling of others around doing the same thing: studying.

An additional aspect that some students mentioned was to have an accessible space to eat or chill out or be able to access the outdoors to have breaks. Some also commented on having plants or a view to green spaces.

With respect to colours, some mentioned light colours, others cool colours, others warm colours, and some were more specific by saying white or nude. The responses are as unclear as the answer to the Likert statements in the survey referring to colours.

An interesting aspect that was mentioned by one student was the importance of smell: having air freshener. This could be an aspect for further research.

For others, it is also important to have access to a drink, like water or tea.

It can be seen that for a workspace to be ideal, it is individual to a person because everyone has different needs, values and perception.

VII. DISCUSSION

The results of the survey have provided proof that some of the respondents do know more on the topic of how environment affects individuals and individuals affect the environment while others know less and are more unaware of the effects of this bidirectional relationship.

Most participants agree that the environment and individuals have a bidirectional relationship which coincides with the finding of the theoretical analysis in the background section. They also agree that architects and designers who build and design spaces for people consider the environment. This is important to bear in mind due to the importance and effects that an environment can have on a person as seen in the background analysis.

It was also clear for the students surveyed that environment can affect people differently, with one environment fostering one person's development while inhibiting another's. This is related to people's preferences. They also agree that a pleasant environment increases productivity and is very personal to the individual, meaning that what is pleasant for one person may not be pleasant for another. Therefore, there is apparent knowledge that the same environment can affect different people in different ways according to if it is pleasant to them or not.

The results of the survey in general show a variety of students' preferences for a pleasant space including noise, company, free movement and colours.

Most people agreed that quiet environments result in a better performance, although some of the surveyed student's workspaces are not particularly quiet. This might be because their workspace is shared or because their preferences are to work with music. Performance in quiet environments might not always be better if silence makes a person uncomfortable and they prefer to work with background music or noise.

An additional common opinion is that a space with free movement increases productivity and most students can move freely in their workspace. This is good and comes from the opinion that restricted movement can make people feel unhappy, leading to a decreased performance since their environment is not pleasant.

When it comes to following a routine, it is thought that a fixed routine helps performance. However, students find it difficult to follow a fixed routine going to university but even more so when studying from home. Having to go to university and taking classes means that there is a fixed timetable in which lectures take place, although when studying from home, lectures also take place in a fixed time frame, there are more distractions. In addition, when going to university there are probably people there that are expecting to meet friends, and therefore encourages students to go in order to socialize. This creates a routine in terms of travelling to get to university, attending lectures and possibly doing activities after which can be social or extracurricular activities (languages, sports or music).

The more common feeling towards productivity comparing face-to-face and online classes is that productivity is higher taking face-to-face classes at university than online ones, probably due to what is previously mentioned in relation to a routine. Within the routine of attending university, there is a time slot where students get home and do homework and study, however when they are at home most of the time they might feel like the only thing they are doing is study, so they are less motivated and more distracted.

When it comes to colours, the picture is less clear. The knowledge in this topic is not so extensive among the public, although, most respondents' workspaces have warm colours. However, warm colours like red do not help creative thinking and some yellow tones can have a negative effect while cool colours like white provide a sense of peace and calm which can help while studying and blue helps creative thinking. Having said this, most of the wall colours that people have in their homes are personal tastes or imposed and are not chosen thinking of the effects they can have on performance or emotions.

In the surveyed group, more people think that people are more creative when in a group as opposed to when alone, although most of them do not share their workspace with anyone. In line with this opinion, most of the respondents think that brainstorming sessions in groups make people more creative. However, this contradicts the theoretical analysis. Researchers (Andre et al., 1979; Kohn & Smith, 2011) have defended and provided proof that people who have done brainstorming sessions in groups and then alone are more creative when alone and come up with more ideas for various reasons, among which is that they are not scared of coming up with and presenting unusual ideas in front of others and being judged.

The location of objects in the workspace also seems to be significant for the performance of most respondents. As mentioned in the theoretical analysis (Kant, Kipling and Proust) creativity is related to physical environments and the location of objects within.

Related to this arrangement of objects in the workspace, the layout should meet the needs of its users, in this case students. The university's layout meets these needs for less than a quarter of the respondents while the home workspace's layout meets the needs for almost two thirds. This could lead to the university having to rethink its layout to better adapt to the users' needs.

As for the resources provided by the university, the digital ones have helped more in students learning processes than the physical ones. This may be due to the obvious reason that the digital resources are better than the physical ones or because students have more time to search for them themselves instead of waiting for teachers to provide them.

When it comes to students self-rated performance, they feel that productivity is higher when going to the university. This may be related to having a fixed routine. For the academic aspect of the survey, students have higher grades studying from home than going to university, which

may be due to the digital resources being better and students having more time to study by not having to commute which in some cases can take up to over two hours a day.

With regard to the statement about students having their workspace just how they like it responses are equally distributed, but with the open-ended question, things become clearer with respect to what is more valuable for them in their workspaces.

The ideal workspace goes one step further than a workspace that is just pleasant. A workspace with the combined characteristics mentioned in the final question should get maximum performance out of students including productivity, creativity and good grades. Since the characteristics define an ideal workspace which is better than a pleasant one, and a pleasant environment increases performance, a workspace with those characteristics should achieve maximum performance.

The most repeated answers to the ideal workspace question are a space with natural light and windows that is clean and tidy and for most surveyed students quiet with only the necessary objects (big enough desk, computer and office supplies) without any distractions (telephone, friends, bed, etc). Comfortable seating is also key. For what refers to colours and company, responses are ambiguous. Some interesting aspects mentioned by some students are having a space to chill out, eat or drink.

This aspect of having a space to chill out is related to taking breaks while studying or working from home. It has been proven necessary by various studies from for example the University of Illinois, the University of South Florida, University of California and Women's Hospital that to take breaks is necessary in order to not overlearn and to process the information while being productive (OnlineSchools.org, 2016). However, not just any type of break or not the same type of break will suit all students. In general, the break should meet some of the following characteristics for it to be effective, increase performance and quality learning (Knight Randolph, 2020; Lucidchart Content Team, 2020; OnlineSchools.org, 2016; Oxford Learning Centres Inc., 2016):

- not be longer than 10 or 15 minutes,
- get up and go to a different space while stretching the body,
- not looking at social media which can cause even more stress,
- maybe do some exercise, go for a walk or just breathe in some fresh air,
- have a nutritious snack and drink (not junk food),
- play some favourite music to increase energy levels,
- chat to friends,
- tidy or clean up a space,
- do some meditation,
- plan breaks without being too strict with timing and allowing for some flexibility.

The general conclusion from the final two Likert scaled questions of the survey is that most students do not like taking classes from home and would prefer to go to the university. This result is in harmony with some of the results of some questions while not with others.

There are two questions that indicate that students prefer to attend university classes. Firstly, they find it easier to follow a routine which leads to an increase in productivity. Secondly, because human beings need to socialize and be around others and going to university provides this (meeting friends, going to the cafeteria after class or studying together).

However, the results of some survey questions could lead us to think that students prefer online classes, although the majority do not. These are analysed in the following section.

7.1 Contradiction

The response to the last Likert scale question of the survey is clear with more than half not liking taking online classes and less than one quarter liking it, whilst the other quarter are indifferent. The general impression is that students prefer to go to university.

However, this result is inconsistent with some responses to some of the survey questions.

Firstly, the results showed that digital resources provided during the online class period helped the students learning process more than physical ones when they attended university. As already stated, probably due to the extra time that students have and the less direct relationship with teachers that forces them to be more self-sufficient in looking for more information. This less direct relationship between students and teachers is not preferred by most people, since interaction is lost and communicating to a screen is not the same as seeing someone in person while talking and moving around or reacting to the speaker.

Secondly, the layout of the workspace at home meets students' needs better than the layout of the university. This result is significant but it must be noted that previous to the pandemic, students already studied at home in their own workspace, therefore the only real differences are the place where they are taking classes and that they are spending more time in their workspace. It is quite obvious that taking face-to-face classes is better than watching a screen due to the reduced interaction, and although the university might not meet the students' needs better than their workspace, it still might meet them, just not in a better way than their comfortable home workspace with their objects and layout according to their personal preferences.

Thirdly, grades are higher when students are studying and taking exams from home. This could be due to the pressure that an in-class examination can cause to students. Generally, people are nervous, some are doing some last-minute revising, others are talking and all together it can create a stressful ambience for many. Another aspect is feeling watched by the teacher walking around the class which adds more pressure to the fact of having to achieve a good grade to pass. From home, students are on their own and, even though they know that they have to achieve a

good result to pass, they can create their own relaxed area maybe with background music or just with complete silence; they can choose. Other factors that can cause distractions in exam rooms include when someone asks the teacher a question or gets up to do so, or the teacher remarks the time left until the end of the examination.

All these factors seem to be counteracted by the social aspect (meeting friends, interacting with others or doing activities outside home) which is more important for students than the layout of the university, the resources or the grades.

However, it must be said that maybe with the improvement of the technology used to provide and participate in online classes, the results to the question could be different, by students preferring online classes. The situation in which online classes had to start being provided was sudden and nobody was fully prepared or equipped. This caused a steep learning curve for all, both teachers and students to adapt to the new conditions.

7.2 Limitations

This research project has been developed in a pandemic situation. It has not been possible to do any field research due to social distancing requirements and mobility limitations from national and international authorities to reduce spreading risks.

The survey has also been conducted in an exclusively online format. It was shared though social media (WhatsApp, Instagram) and email to some students. The desired response for the results to be representative was of 100 people and only 50 were collected. This implies that the results, the implications of these and the conclusions drawn cannot be considered to be fully and honestly representative of the whole student population, although they can be interpreted as estimations. In addition, it must be said that the survey was distributed mainly only to students of the International Business degree from the Faculty of Economics and Business of the University of Barcelona and not extended to other faculties, universities or countries.

For the theoretical and background research on the topic, no major limitations were found. A significant amount of information was found on the internet, in articles and in books about the topics of how performance, productivity, creativity and results can be influenced by an environment. However, there is not as much information on the second relationship which is how students affect their environment.

A small hurdle that came up was the restricted access to some resources such as articles and books. By being a member of the University of Barcelona, access is provided to more resources than those that can be found by an individual person alone on the internet that does not pertain to any group, association or institution. Even with this privilege, some articles were not accessible and may have been useful.

It is also fair to say that some of the articles on some topics are a bit dated and not very up to date with the current conditions. Also, the Covid-19 pandemic and its implications are a recent and still ongoing phenomenon which has had no other comparable occurrences in recent history. No known conclusive research has been done on the impacts that Covid-19 has had on students studying in the affected period.

7.3 Further research

After this research project, some aspects have been identified which could be followed up on so as to better understand the implications of the pandemic situation. The situation started in the month of March 2020 and continued up to January 2021 and might have continued for a longer period after the finalization of this research project, so it is necessary to understand the effect that online learning can have on students, on learning, on academic grades and on the future to better adapt it and hereby optimize the effects..

Due to globalization in general and the evolution of internet and related aspects such as artificial intelligence and online security, studying online and working from home are being made easier to do thanks to rapid improvements and research. Although in the current situation, these conditions have been imposed by force majeure (Covid-19 pandemic), in the future they could be put in place to better adapt to people's lives and desire for flexibility.

A topic mentioned by a student in the open-ended question was having air freshener in their workspace. In this research project nothing related to smell influencing performance has been studied but it could be interesting to see. Can an odour influence productivity? Can a nice odour, according to someone's preferences, increase their productivity, while a bad odour decrease it? It could be interesting to further research this.

Another idea for this project and the survey was to study the different workspaces people have by having them provide pictures of theirs. However, for privacy and ethical reasons this was not done and instead an open-ended question was added to the survey to get a similar result.

Further investigation could also be done regarding colours and the effects that these can have on performance, creativity, motivation or concentration, whether it is the colours of the walls or the colours of the surrounding objects, fixtures and fittings.

It would be interesting to read about any of these afore mentioned topics in the future or any other related ones that arise from the reading of this project that anyone can think of. It is clear that further research can be done on the topic and it can be significant.

VIII. CONCLUSIONS

Commonly, a space and a person are looked at individually, without thinking of any relationship between them. What we do not realize is to what extent a space can influence an individual and an individual can influence a space.

As a result of the Covid-19 pandemic, the environment and the conditions in which students follow their classes has completely changed, moving from a full-time face-to-face education to an online one, at the beginning fully online and then combined with face-to-face classes. This has been the specific scenario used to explore the interactions between environment and student's performance.

The initial premise was that there are interactions between the environment and student performance, with the environment affecting student performance and students influencing their environment.

As a result of the research performed, it has been found that the premise is true, that there are indeed interactions between environment and students and their performance. But how do they affect each other? The conditions of an environment can make students feel comfortable or uncomfortable depending on their preferences of space, fixtures and fittings disposition, colours, background noise and company. Students will then influence the environment in the way they use it and arrange it.

By means of a survey, it was shown that there are various factors that influence student's performance such as workspace conditions (noise, colours, freedom of movement, facility layout and resources) and the satisfaction with these, routine or attitude. Some are taken into account more while studying or taking classes like preferences for noise or company while others are hardly considered like colour.

Overall, in the last years there has been an increase in consciousness of the environments around us since they can highly influence the individuals within it, leading to a high importance of the facility layout of those spaces. Both companies and interior designers are taking them into account to better adapt spaces to users.

The general conclusion of this research project is that the initial premise that the environment can affect people and people can also affect their environment, being it a bidirectional relationship, has been confirmed.

The importance of understanding this is crucial for society to be more productive and people be motivated in doing whatever they do. People should understand their environment to get more knowledge on how it can affect them and modify it accordingly.

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X.   APPENDIX 1

Hofstede country comparison for the top 10 most creative economic performers.

* estimated

* estimated

* estimated
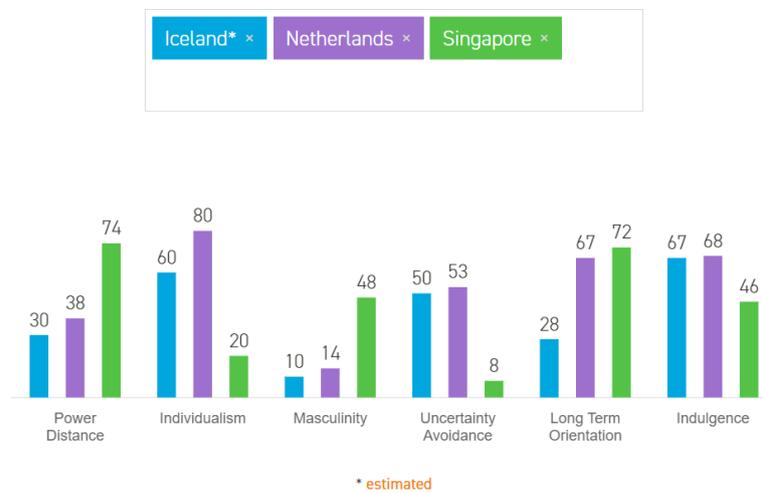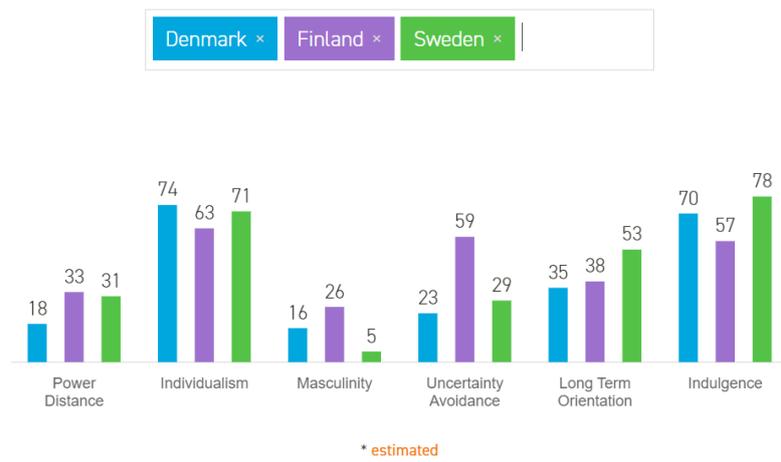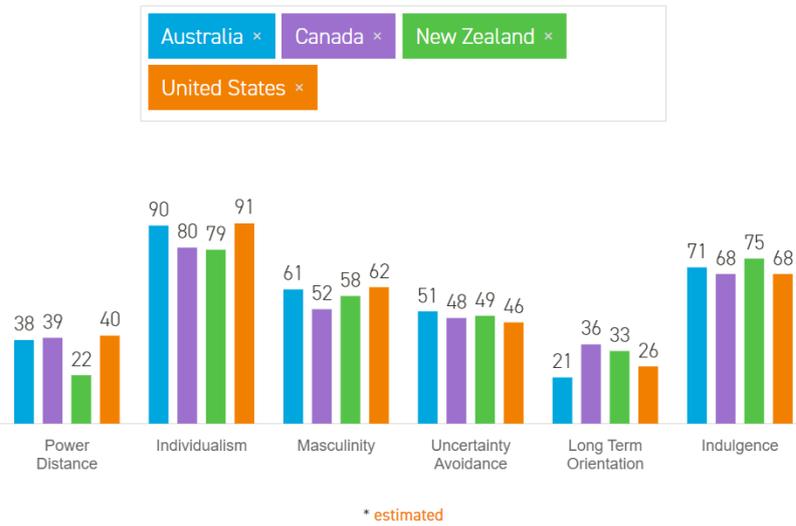
XI. APPENDIX 2

Maps of the ground floor of the two buildings of the Faculty of Economics and Business of the University of Barcelona.
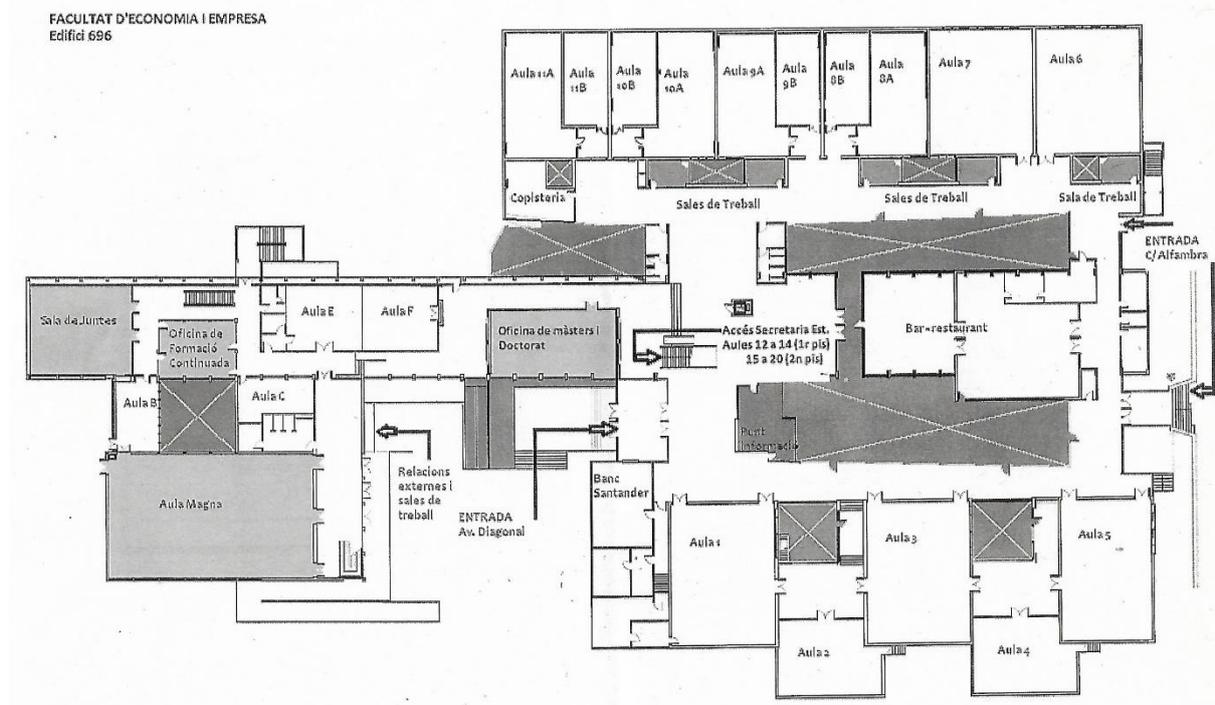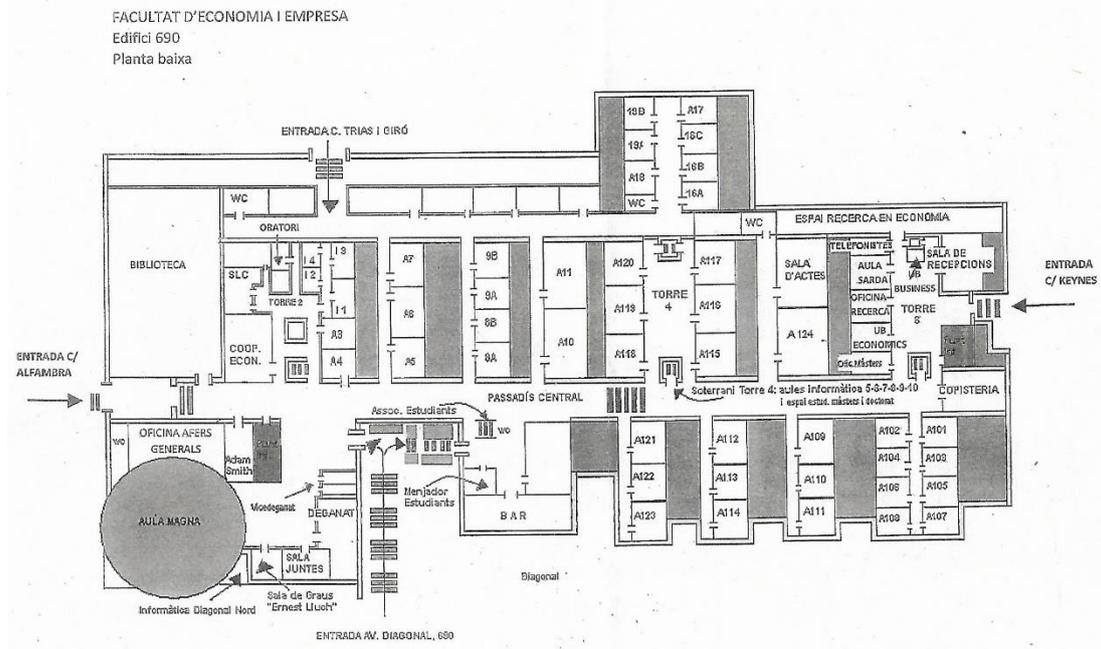
XII. APPENDIX 3

Complete survey performed and results.

Exploring interactions between environment and student performance

Hello student! Welcome to my questionnaire on 'Interactions between environment and student performance'. This survey is for my TFG and it is aimed at university degree students. It contains statements which you will be asked to rate on a scale of 1 to 5 depending on whether you agree or not with them. The statements concern topics related to the environment, spaces, individuals and performance.

The aim of my research is to study the impact that the environment and space can have on a student's performance and vice versa to see how important it may be to pay more attention to it. It is an anonymous survey and the information contained in it and obtained from it will only be treated for research directly related to my TFG.

I would be really grateful if you could take 5 minutes to answer it! Thank you.

Section 1

Do you consent your anonymous answers to be used in the research of this project? *

☐ I consent

☐ I do not consent

I consent — 50 (100 %)

I do not consent — 0 (0 %)
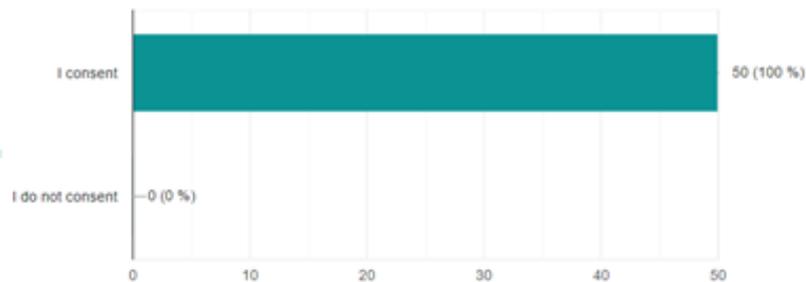
Gender

○ Male

○ Female

○ Other

● Male
● Female
● Other

76%

24%
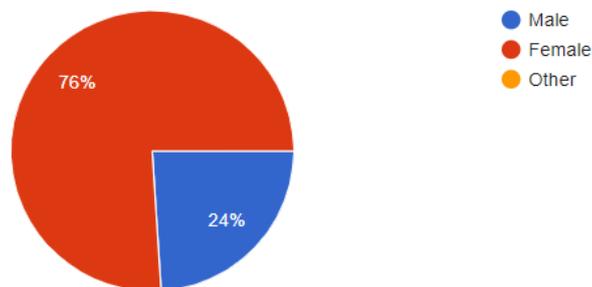
Section 2: Assumptions about environment, individuals and performance

On a scale of 1 to 5, where 1=strongly disagree, 2=disagree, 3=indifferent, 4=agree and 5=strongly agree, rate the following statements:

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The relationship between the environment and individuals is bidirectional (environment affects individuals and individuals affect the environment) *

Bar chart:
- 1: 1 (2 %)
- 2: 1 (2 %)
- 3: 2 (4 %)
- 4: 15 (30 %)
- 5: 31 (62 %)

Architects and designers take into account the environment when they design spaces for people *

Bar chart:
- 1: 0 (0 %)
- 2: 6 (12 %)
- 3: 9 (18 %)
- 4: 18 (36 %)
- 5: 17 (34 %)

The same environment can foster one person's development while inhibiting another's *

Bar chart:
- 1: 0 (0 %)
- 2: 2 (4 %)
- 3: 5 (10 %)
- 4: 19 (38 %)
- 5: 24 (48 %)

A pleasant environment increases productivity *

Bar chart:
- 1: 0 (0 %)
- 2: 0 (0 %)
- 3: 1 (2 %)
- 4: 10 (20 %)
- 5: 39 (78 %)
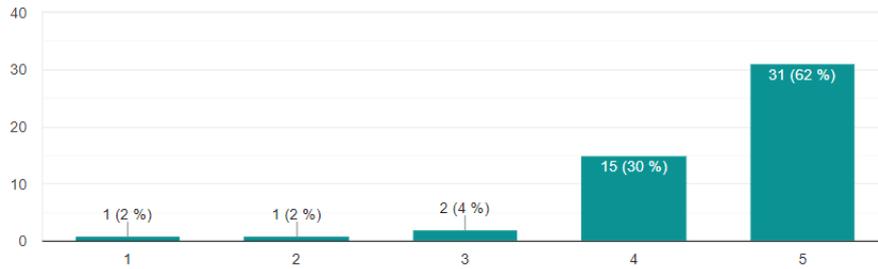
Studying in a quiet environment (as opposed to one with background noise) is key to better performance *

A space with warm colours (red, coral, orange, yellow, brown, cream, beige, ...) enhances performance more than a space with cool colours (black, grey, white, green, blue, violet, ...) *
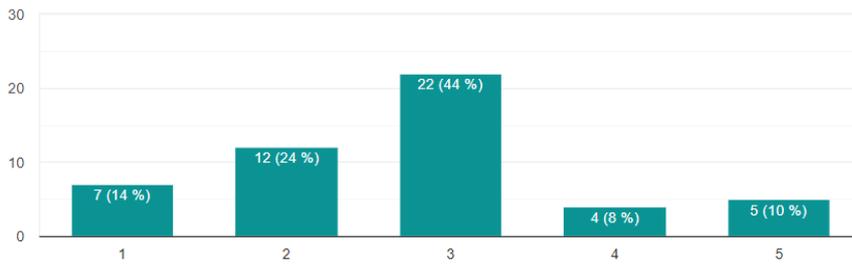
People are more creative when alone, as opposed to when they are with other people *
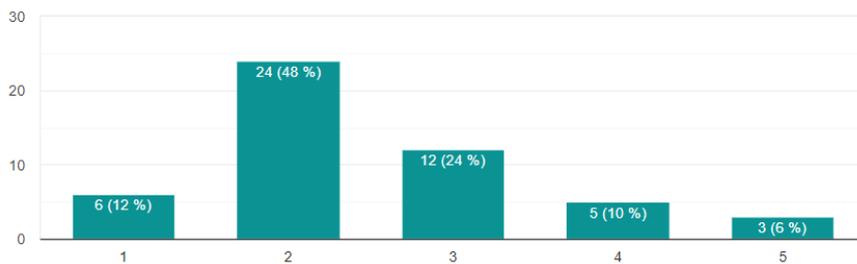
A space where you can move freely increases productivity as opposed to a space with restricted movement *

47
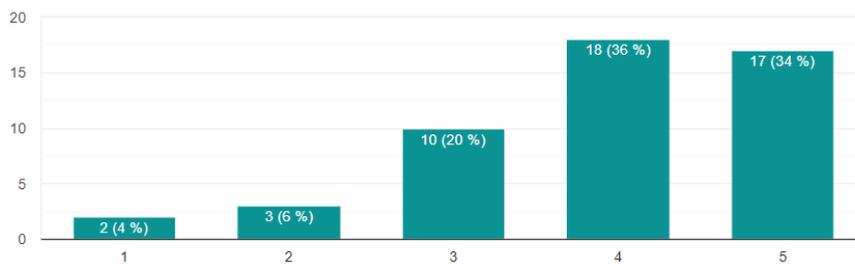
A routine helps maintain and improve performance (waking up, having a shower, having breakfast or a coffee, doing exercise, studying, ...) *
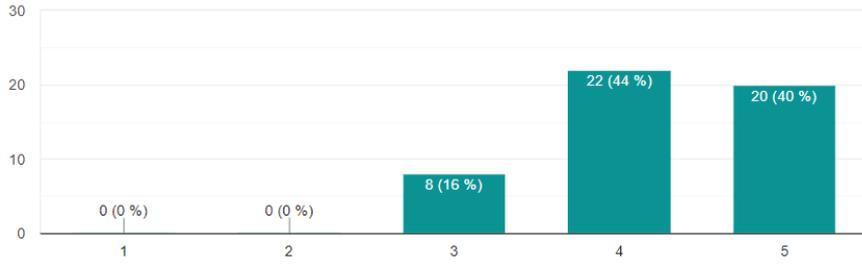
The location of the objects in a workspace and their arrangement is relevant for performance *
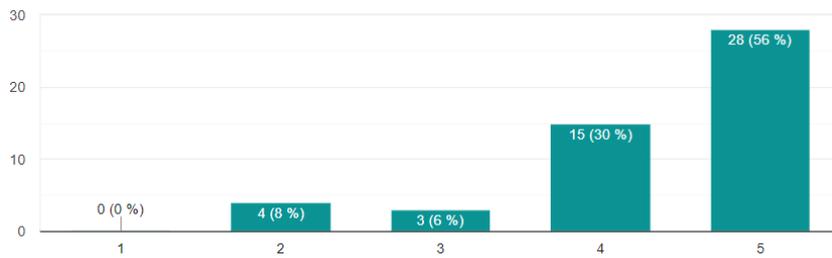
Brainstorming sessions in groups cause people to be more creative *
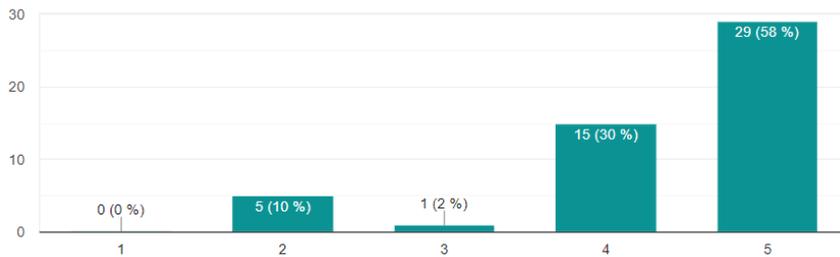
Section 3: Your environment and performance

On a scale of 1 to 5, where 1=strongly disagree, 2=disagree, 3=indifferent, 4=agree and 5=strongly agree, rate the following statements:

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In general, I feel like I am more productive taking classes from home than from the *
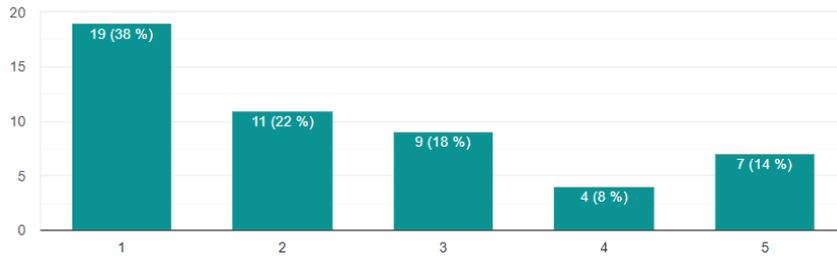
My grades are, in general, higher now (taking classes from home) than before the confinement * (taking classes at the University)
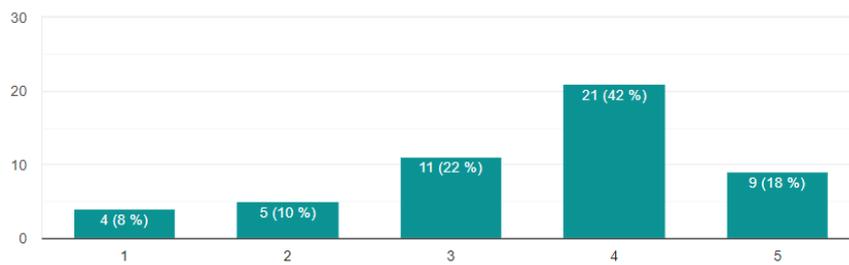
The layout of your university is meeting your needs as a university student *
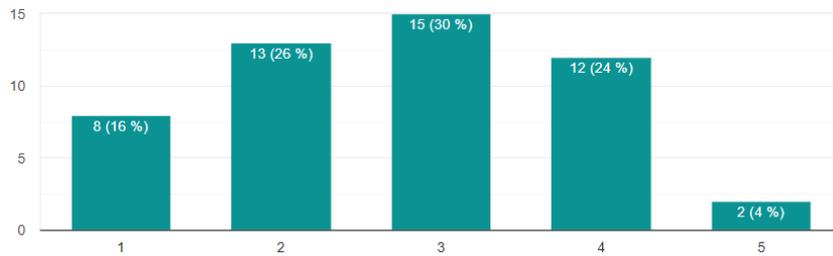
The physical resources provided by your University (books, libraries, workspaces, ...) helped you * in your learning process when you took classes there
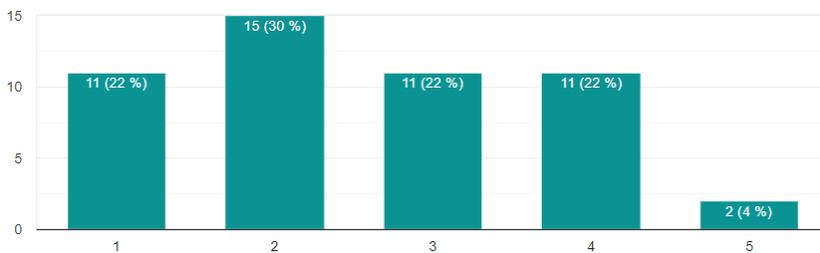
The layout of your workspace at home meets its needs *
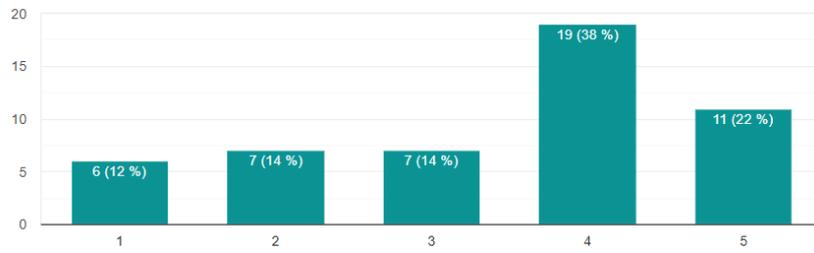
I have my workspace just how I like it *
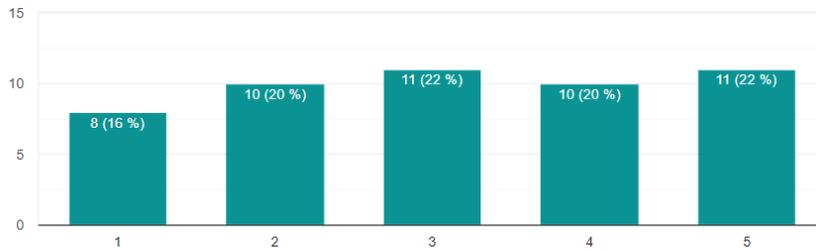
The digital resources provided by your University now (online access to books, online streaming *
platform, ...) help you in your learning process
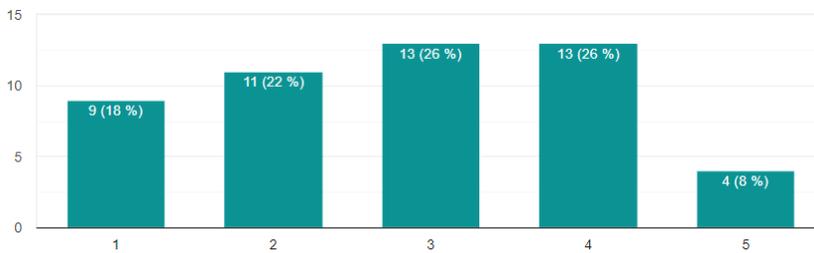
Since confinement, I study in the same space every day *
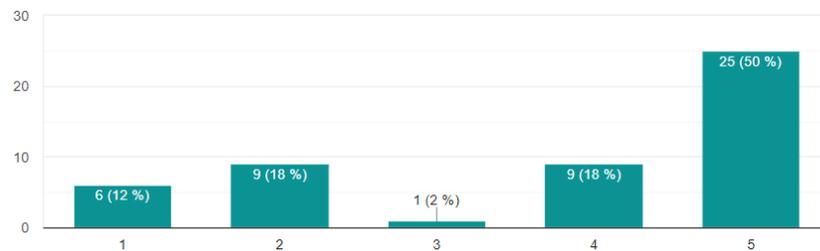
My workspace at home is pleasant *
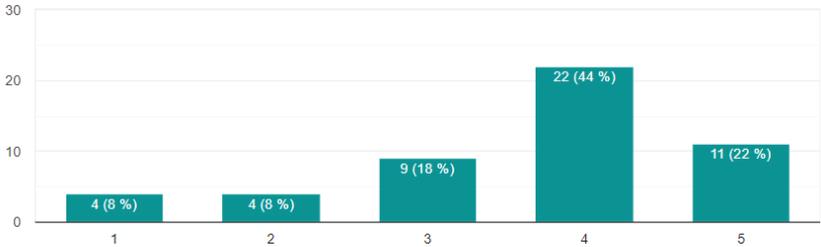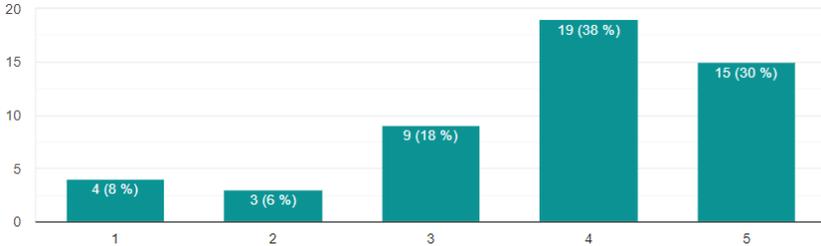

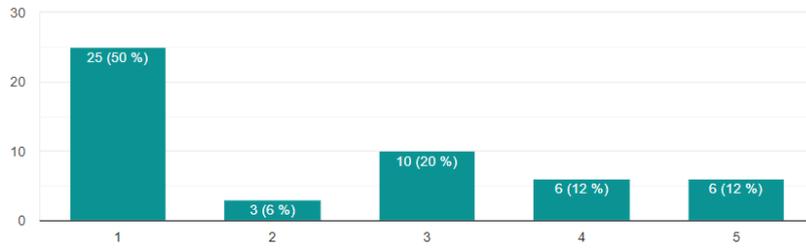The structure and rules of the university are helpful in maintaining a healthy routine *
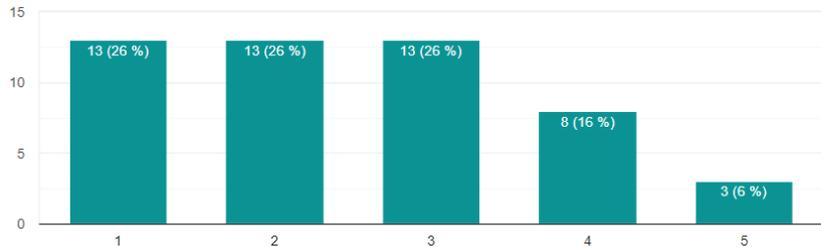
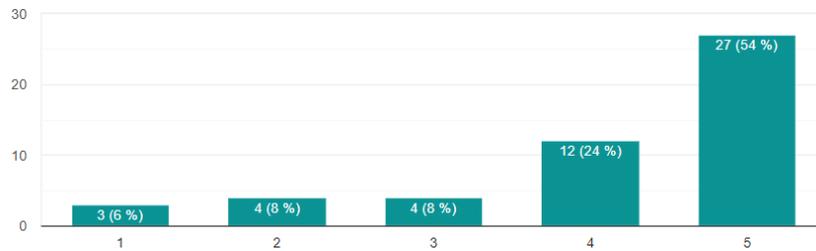Since confinement and online classes, I find it easier to follow a routine *
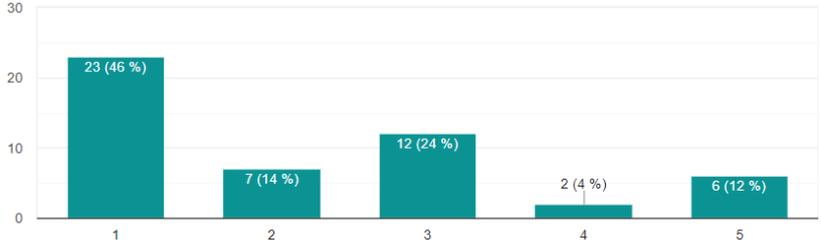
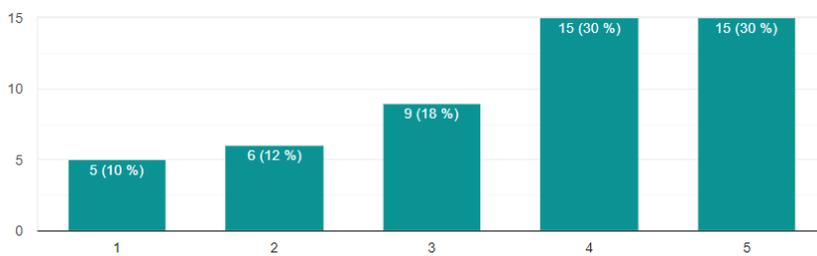My workspace where I do my university work is usually quiet *

My workspace has mostly warm colours (red, orange, yellow, beige, ...) rather than cool colours *
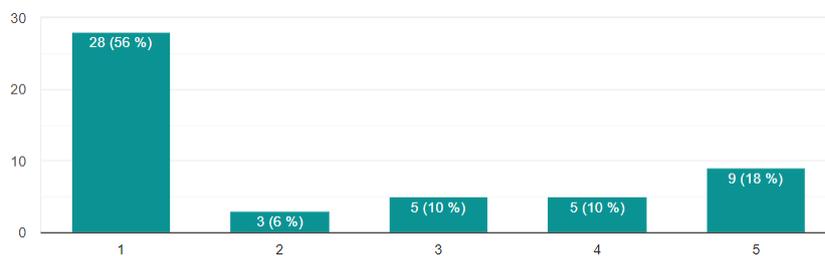(black, white, blue, violet, ...)

In my workspace, I can move about freely whenever I want *

My workspace is usually clean and tidy *

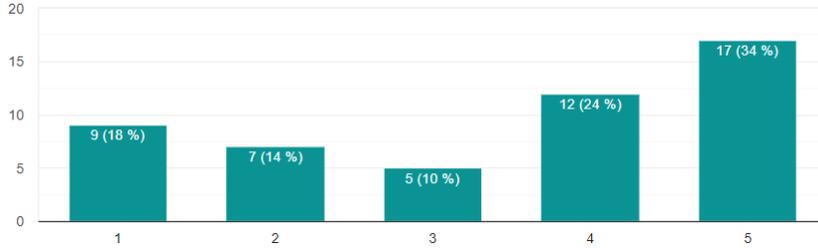

I share my workspace with others (friends, family, ...) *

Section 4: To finish …

On a scale of 1 to 5, where 1=strongly disagree, 2=disagree, 3=indifferent, 4=agree and 5=strongly agree, rate the following statements:
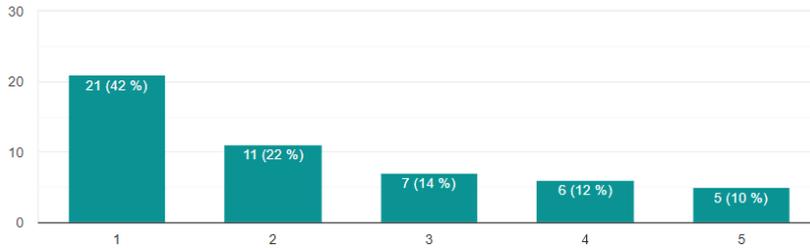
	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

Thinking back, when you were told that classes would be online and not at university, you felt enthusiastic *

Now, after your experience, you like taking classes from home *

Feel free to answer the following open question:

Take a moment to imagine your ideal workspace. What would it be like? What would it provide you with to help you in the achievement of your goals? Would it have specific objects, colours, noises, people, furniture, ...?

For me a perfect workspace is a tidy, clean one, without noises or distractions. It should also have abundant natural light, and I should have it organized in a way that makes sense to me, so that I know where I can find anything.

It would be somewhere not in my house. A private space where I could work with just my friends and talk outloud without being disrupted.

A typical class or library where everyone is being productive makes me want to be productive too. The furniture and objects would not be that relevant

alone with comfortable seating and warm lighting, assess to books and similar, and place to eat lunch, have snacks and have coffee

There would be a lot of sun light, not artificial light.

Cleanest and minimalist as possible

Big windows to have natural light most of the working hours, big brown tables, comfortable chairs and a chill out space with couple of sofas and coffee corner in an adjoining room

My ideal workspace is my bedroom. It is a quiet space. I need completely silence and be alone. Moreover, the colours are white and light brown.
The furniture is simple, just one desk and a computer. Online classes make me spend less time in transport and more autonomy to follow the lessons.

Firstly, a big table made out of wood
'color crema'
Not a lot of objects
Relaxed music without lyrics
Natural light if possible
Some plants
A yoga mat (to do a quick flow if I'm stressed)
A big water bottle, tea and coffee ☕
Big windows

My ideal workspace would be having a big table with all the things that i need on it. Furthermore the table should be located in a bright room with a view over a green quite area.

Very clean and tidy surrounding, no unnecessary objects or distracting things, enaught space for writing and working with PC, height adjustable desk, comfortable chair, natural lightning, clear structure for required tools

Minimalist furniture, cool colours, 0 noise, maximum 2 apart from me hard working people , relaxing rituals air freshener, some candles and green tea.

Nothing special, I just need my computer and a clean desktop with a comfortable chair.

My ideal workspace is very minimalistic may be with light colored walls and few furniture. It could be perfect if I could have a place where I can hear any noise from the street.
I think I only need a desk with my laptop, paper, office supplies like pens or highlighters and my class notes

A big desk where I have enough space for my laptop, notebooks, books, etc and better lighting

It would be quite, with an ergonomic chair, a big desk, relatively big but with easy access to whatever I might need, with a window (to work with natural light)....

My ideal workspace would connect the outside and inside, so that whenever you want you could take a break outside, it would be white with a lot of space and with comfortable furniture to relax but also a desk and chair to work

For college things I like to work surounded with people, like in a library. My ideal place is something similar to the library from the UPF called "Diposit de les Aigues". Big, plenty of light for study, and with sun light all day long. But the mask makes difficult to be there for a long time.

Big spacious desk, a printer, next to a window, good comfortable seat...

It would be a quiet place equipped with the things I need the most when working

I would like a workspace based on minimalism, now that I spend a lot of time in my room studying and working from home, I feel that there too much thing within so I get distracted easily. So a space with the minimum furniture and objects required would help me to concentrate and feel more calm. I'm a person who really belives in energies, and the energy it can make you feel a specific place is really important to me; my ideal workspace would be a space that could help me to stay in a state of mindfulness, with calid and nude colours, not need to be a noiseless space but with music tha helps to concentrate as well and finally I would like tha my workplace would have a wide space because I don't like the feeling to be "closed".

It has to be far way from technology so I don't get distracted.

Under my point of view, an ideal workspace must have a lot of daily light, since it is what I miss the most here in Barcelona. Moreover, it must be quiet and with the minimum amount of distractions (like phone, instagram, having friends around...) which can sometimes be more difficult if you are at home than at university. Finally, a space where you can move and don't feel trapped and that you have enough space to put all your staff like the computer, notes...

I would like to have a room just to do my homework and study sessions. I feel like having the bed next to my desk is really stressful because you never disconnect. When you go to bed you are still thinking about all the work you have to do because you have it in front of you.