UTM UNIVERSITI TEKNOLOGI MALAYSIA

IJBES

International Journal of Built Environment and Sustainability
Published by Penerbit UTM Press, Universiti Teknologi Malaysia
IJBES 9(3)/2022, 35-46

Impact of Physical Learning Environment on University Students' Academic Engagement in an Online Learning Setting during Covid-19: Evidence from a Sri Lankan University

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ABSTRACT

The restrictions imposed due to the outbreak of Coronavirus 2019 led to a paradigm shift in terms of the learning arrangements. In such a situation, since curfew was imposed in Sri Lanka, the universities commenced their all-academic activities using different virtual platforms such Zoom and MS Teams to continue teaching and learning process. Active student engagement is vital for the success of the process. However, evidence shows that the level of student engagement is low in academic activities in an online learning setting and the studies that explored the impact of the physical environment on this situation are rare. Therefore, this study aims to study the impact of ambient and spatial attributes in the physical environment on the level of students' academic engagement in an online learning setting. Data were collected from a purposive sample of 238 undergraduates of University of Sri Jayewardenepura, Sri Lanka and were analyzed using Structural Equation Modeling with AMOS. The model fit assessment, path coefficient estimation and hypotheses testing were done at the data analysis. The study finding empirically validate the impact of ambient and spatial attributes of the physical environment on student engagement in an online learning setting. Out of ambient attributes, noise and lighting level were recorded as the most influencing factor while size and shape of the study area were recorded as highly influencing factors out of spatial attributes. The impact of air quality, layout and pattern on student engagement was found insignificant. The study finding broadens the components taken as physical resources considered in the Engagement Theory and provide insights for students, university officials, housing developers and policy makers on the importance of the physical learning environment for the student academic engagement in an online leaning setting.

Article History

Received: *12 March 2022*
Received in revised form: *21 June 2022*
Accepted: *08 July 2022*
Published Online: *31 August 2022*

Keywords:

Engagement, Ambient attributes, Spatial attributes, Online learning, Covid-19

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DOI: 10.11113/ ijbes. v9. n3.953

1. Introduction

The outbreak of Coronavirus Disease 2019 (Covid-19) has created unexpected challenges worldwide. In order to control the spread of the outbreak of SARS-CoV-2 virus, governments around the world have taken a set of actions and introduced control strategies. As a result, indefinite lockdown of whole regions, closing borders, closing of businesses, except for essential services, and enforcing self-isolation and social distancing rules restricting close physical human contact were the main and immediate actions taken (Shine, 2020). These restrictions have led to a paradigm shift in terms of

flexible work arrangements (Lee and Lee, 2021) as well as in terms of teaching and learning arrangements (Khlaif *et al.*, 2021).

Among the countries in South Asia, Sri Lanka is one of the countries, which have been affected by the Covid-19 pandemic, and the government imposed a curfew to control the spreading coronavirus *(Fowsar et al.*, 2020). In such a situation, all the Sri Lankan universities commenced their all-academic works and administrative works using technological devices and applications such as Zoom, MS Teams, WhatsApp, Viber, Moodle Learning Systems, etc. for work from home. The establishment of online education strategies instead of the general traditional face-to-face academic model can be identified as a considerable structural change that happened recently in the higher education sector in Sri Lanka. This was a novel experience for most of the academics, administrative staff as well as students in Sri Lankan universities as for a long time, the face-to-face teaching and learning process has been practiced in Sri Lankan universities. Therefore, it is essential to study this new phenomenon to identify the challenges faced and to overcome them for better performance to reach ultimate expected course learning outcomes. Although previous scholars found that students' engagement is low in academic activities in an online learning setting (Priyadarshani and Jesuiya, 2021), studies which explored the impact of the physical environment on this situation are rare (Lansdale *et al.*, 2011; Lonka, 2012; Sjöblom *et al.*, 2016). Therefore, it is essential to study this new phenomenon to identify the physical environmental attributes that affect students' academic engagement to reach the ultimate expected course learning outcomes.

The scope of this paper includes studying the impact of physical environment on the students' academic engagement in an online learning setting. Even though this has been widely studied at the university premises, studies are rare in online setting context. Originality of the paper includes broadening the components taken as physical resources considered in the Engagement Theory. Since online learning and teaching process continues for more than two years in many countries including Sri Lanka since the emergence of the Coronavirus 2019, this study's findings will be useful for many parties.

2. Research Problem

Student involvement plays a very vital role in students learning and satisfaction in distance education (Martin and Bolliger, 2018). However, several researchers across the world have conducted researches recently on the impact of Covid-19 on the academic performance of students in universities as well as higher education institutions and found that students face various issues. Those are the absence of traditional classroom socialization, response time and lack of direct interaction with the teacher during the Covid-19 pandemic due to the online teaching and learning process (Gonzalez *et al.*, 2020; Adnan and Anwar, 2020). Accordingly, it is evident that student engagement is relatively low in an online learning setting (Priyadarshani and Jesuiya, 2021) and teachers continuously emphasize the low level of student engagement as a major challenge in the online teaching and learning process.

This significant phenomenon encouraged researchers to examine the factors affecting student engagement. Moreover, (Kahn, 1990) stipulates in the Engagement Theory (ET) that given the right conditions; individuals will be engaged in their in-role performances. This theory further explains that people require to have the availability of psychological, emotional and physical resources to be able to engage well in their role (Khan, 1992). At an instance where they feel sick and where they worry about other matters, that will lead them to have lack of resources to be present and engaged in the role properly (Khan, 1992). As discussed, with this shift toward online education, students join online lectures from various locations around the country instead of traditional lecture halls in the university. This situation has led students to shift to new conditions such as environmental, technological, and psychosocial aspects to take online classes and study (Realyvásquez-Vargas *et al.*, 2020). According to the above-mentioned research results, the safety, health, comfort, academic engagement and performance of students can be influenced by the new conditions (Califano *et al.*, 2017; Lee *et al.*, 2016). Simultaneously, exposure to diverse levels of noise (Nava *et al.*, 2015; Lee *et al.*, 2016), temperature (Califano *et al.*, 2017), and lighting level (Omidiandost *et al.* 2015; Nava *et al.*, 2015) are key *ambient attributes* in the physical environment may cause discomfort and distraction to them. Moreover, students have to interact with their new study stations (table/desk, chair, computer, mouse, electrical outlets) and other *spatial attributes* such as size, shape, design, layout or arrangement, etc. of the study area which, if not designed and arranged from an ergonomic approach, can lead to students' body segments to adopt uncomfortable or forced postures (Nava *et al.*, 2015) and that can lead to less engagement in online academic activities. Although Kahn (1990) argued meaningfulness, safety, and availability as the three predictors of engagement, where availability is defined as "possessing physical, emotional, and psychological resources for investing the self in role performances".

Scholars state that the physical environment must be able to facilitate the teaching and learning experience for better academic engagement (Bouslama and Kalota, 2013; Dittoe, 2002; Miller *et al.*, 2001). However, when reviewing the literature, it was found that most of the articles focus on the impact of psychological and emotional resources on engagement in the online learning context and most of the studies done focusing on physical resources also have explored the impact of technology apparatus and related things on students' engagement. Further when considering the empirical studies on physical environments done by Küller and Lindsten (1992); Winterbottom and Wilkins (2009), on the other hand, have traditionally concentrated on factors related to physical health or discomfort. Knowledge on how the physical environment, instance physical spaces, tools, and equipment, is related to psychological and pedagogical phenomena is still scarce (Lansdale *et al.*, 2011; Lonka, 2012; Sjöblom *et al.*, 2016).

In addition, the relatively few attempts that have been taken focusing on the influence of physical learning environment on student performance (Yang *et al.*, 2013; Kong and Jakubiec, 2019) have been done in the classroom context of which, the findings will not be applicable in the home environment in an online learning setting. Therefore, this study will generate new insights useful in an online learning setting. Further, scholars have recommended further research to study the impact of variables such as lighting, noise, and temperature levels as well as the desk/table and chair design where students take classes on student engagement (Realyvásquez-Vargas *et al.*, 2020). By considering all the evidence,

the author reached the research question as "what physical learning environment factors affect the level of their academic engagement of students in an online learning setting?". Accordingly, the objective of this study aims to study the impact of ambient and spatial attributes in the students online learning physical environment on the level of their academic engagement of students in an online learning setting.

3. Literature Review

3.1 Students' Academic Engagement

When considering the more traditional context, students can straightly enroll and interact with the conversations, producing a more private approach to the loop of feedback, sharing new ideas, contributing to the debate, discussing personal or other nonobjective viewpoints, etc. In contrast, during conducting online classes, instructors are unable to directly interact and engage with students as it is done previously in traditional physical classrooms. It means if someone has a question, it is harder for the learner to get answers promptly (Realyvásquez-Vargas *et al.*, 2020). Students' effort and their engagement has been considered as the main key determinants for successful educational outcomes (Hopland and Nyhus, 2016). The engagement was originally described by Kahn (1990) as a significant and unique motivational concept that harnesses an individual's whole self-concerning physical, cognitive, and emotional aspects to role performances. Physical engagement refers to the level of physical effort taken to complete a task while cognitive engagement refers to the behavior of an individual that is more attentive, vigilant, and focused, and emotional engagement relates to the level an individual being connected to people around them emotionally (Kahn, 1990). In an online learning situation, this can be the connection with teachers and classmates in the same academic batch.

3.2 Learning Environment

Learning environment refers to "the diverse physical locations, contexts, and cultures in which students learn" (Edglossary, 2013). Online learning environment is usually called a virtual environment where learning happens rather than a physical environment. As literature shows that the architecture of educational space has been considered as one of the influential factors in education (Gilavand, 2016). The physical characteristics and attributes have been mainly classified into three categories; ambient, spatial and technology-related. This research studies only the ambient and spatial attributes of the physical environment and reviewed literature of those are discussed further in the next sections. Technology-related attributes were not explored as the study done by Karunarathne et al. (2020) reveals that majority of students have compatible devices and with internet services. Further, a special programme was carried out by the university to ensure all students have accessibility to required devices and services.

3.2.1 Ambient Attributes

Ambient attributes include temperature, air quality, acoustics and lighting (Earthman, 2017; Shaughnessy *et al.*, 2006; Lackney, 2000). Room temperature is a range of temperatures that denotes comfortable habitation for humans (Helmenstine, 2020). WHO (2005) has mentioned that good air quality pertains to the degree to which the air is clear, clean and free from pollutants which are dust, smoke and smog, among other gaseous impurities in the air. Noise, in acoustics, is any undesired sound, either intrinsically objectionable one or one that interferes with other sounds that are being listened to (Britannica Dictionary, 2021). Lighting or illumination is the deliberate use of light to achieve practical or aesthetic effects. Lighting consists of the use of both artificial light sources such as lamps and light fixtures, as well as natural illumination by capturing daylight (Daltco, 2019).

3.2.2 Spatial Attributes

Spatial attributes and needs are often discussed at the classroom level in previous literature. Spatial attributes include size, shape, furniture, seating arrangement, color selection and nature accessibility (Safer et al., 2005; Papadatos, 1973). This paper has considered the size, shape, layout/ arrangement, colour selection, nature accessibility, pattern/ design and materials in terms of the study area, doors, windows, walls, floor, roof, ceiling and furniture as the spatial attributes. Furniture entails the functionality of chairs, comfort, ergonomics and study stations whilst the arrangements and boundaries of the space are defined as the layout. (Yang et al, 2013). Nature accessibility refers to how the student can see or access to the natural environment and whether natural lights and ventilation can be accessed or not.

4. Hypothetical Model Development

4.1 Impact of Ambient Attributes on Student Academic Engagement

The ambient attributes studied in this paper are temperature, acoustics, air quality and lighting. As scholars reveal in previous studies, adverse ambient conditions for instance the extreme temperatures, poor air quality and inadequate lighting undoubtedly have negative impacts on the involvement of the students (Morrow and Kanakri, 2018). Further, surveys and quantitative tests have found that temperature to be the vital influential ambient attribute which is indicating the student perceptions of study areas (Liu *et al.*, 2011) and they prefer slightly cool or slightly warm thermal conditions (Hwang *et al.*, 2006). When it comes to air quality which refers to the concentration of indoor pollutants, especially that of CO2 (Lee and Chang, 2000), scholars state that poor air quality has been correlated with low efficiency, high absence rate, unsatisfactory performance and failure (Shaughnessy *et al.*, 2006). Regarding acoustics, student perceptions are affected by internal environmental sounds as well as by external sources (Dockrell & Shield, 2006). Poor classroom acoustics can contribute to a negative learning environment for students, as excessive noise causes distraction and annoyance (Yang *et al.*, 2013). The perception of lighting is governed by light levels, the spatial distribution of light, glare and color rendering in a space. Poor lighting leads to a negative learning environment and it can result in headaches, eyestrain, and fatigue (Yang *et al.*, 2013) which makes students distracted and less engaged in academic activities. Accordingly, hypotheses relate to ambient attributes can be advanced as;

Hypotheses 1a, 1b, 1c and 1d: The ambient environment attributes; lighting (Hypothesis 1a), acoustic (Hypothesis 1b), temperature

(Hypothesis 1c) and air quality (Hypothesis 1d) affect student academic engagement.

4.2 Impact of Spatial Attributes on Student Academic Engagement

The spatial design of study areas, incorporating furniture, layout and visibility has also been a frequent topic of many studies. The spatial attributes investigated in this study are size, shape, layout/ arrangement, colour selection, nature accessibility, pattern/ design and materials in terms of the study area, doors, windows, walls, floor, roof, ceiling and furniture. When comparing ambient attributes with spatial attributes, spatial attributes are less standardized by industry codes, and few studies have studied on the impact of spatial design on student engagement and performance in the learning process. However, several significant consensuses have been achieved to showcase that those spatial attributes are important for a supportive learning environment that leads to a higher level of student engagement; size and shape (Roskos and Neuman, 2011), layout/ arrangement, pattern/ design (Guardino and Fullerton, 2010), colour, materials (Yang *et al.,* 2013) and nature accessibility (Gilavand, 2016). Accordingly, hypotheses relate to spatial attributes can be developed as;

Hypotheses 2a, 2b, 2c, 2d, 2e, 2f and 2g: The spatial environment attributes; size (Hypothesis 2a), shape (Hypothesis 2b), layout/ arrangement (Hypothesis 2c), colour selection (Hypothesis 2d), pattern/ design (Hypothesis 2e), materials (Hypothesis 2f) and nature accessibility (Hypothesis 2g) affect student academic engagement.

4.3 Control Variables

In addition to the hypothesized relationships, the effects of age and educational level are controlled for as they may affect academic engagement (Yang *et al.*, 2013) and only university undergraduates in ages between 20 to 25 were selected.

The above hypotheses are graphically depicted in the conceptual model shown in Figure1

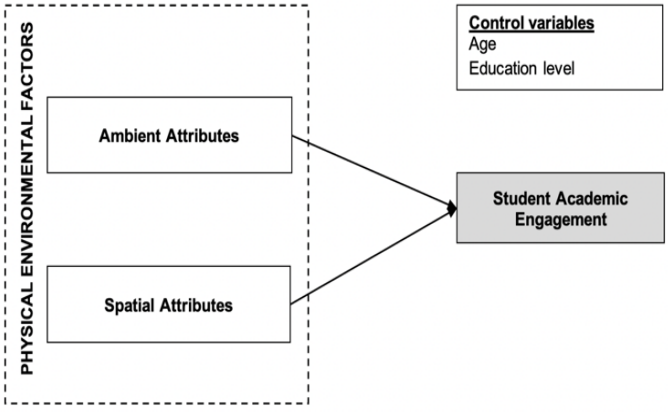

Figure 1 Conceptual model (Author using literature 2021)

5. Methodology

5.1 Participants and Procedures

This research study was carried out using a deductive approach under the positivistic research philosophy. The individual undergraduate who participated in online lectures regularly was selected as the unit of analysis. Data were collected from undergraduates of the Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Sri Lanka. As per the available statistics from University Grant Commission, Sri Lanka, the approximate number of total students enrolled in the Faculty of Management Studies and Commerce in all four academic batches is 4,700, yet the number of students participated in online lectures regularly during the Covid-19 period cannot be traced due to unavailability of reliable statistics. Accordingly, the sample frame cannot be defined. Hence the sample was derived from the purposive sampling which is a non-probability sampling technique and this quantitative cross-sectional study collected data from a purposive sample of 238 undergraduates which is an adequate amount (Kline, 2016; Hair et al., 2019), representing all four academic years of Faculty of Management Studies and Commerce, University of Sri Jayewardenepura, Sri Lanka using a structured questionnaire. The main reason for choosing university undergraduates is because, online teaching and learning were fully adopted nationwide by universities and as previous studies have found, the level of engagement of university students is relatively low than in other grades and categories. The survey instrument was pilot tested to ensure validity and reliability. In the main survey, the researcher administered the questionnaires online and 241 were received, however, only 238 (n=238) were usable for further analysis. The structural equation modeling (SEM) with AMOS was performed for the analysis of the collected data.

5.2 Measurements of Latent Variables

The measures used in operationalizing the constructs were obtained from previously used scales, questionnaires and items which are validated. Under engagement, perception on physical, emotional and cognitive engagements were measured using the scale used by Rich *et al*. (2010). To measure the physical aspect of engagement, items were drawn from Russell and Barrett's (1999) research on core affect and items used by Rich *et al*. (2010). Finally, for the cognitive aspect of engagement, items were drawn from Rothbard's (2001) measure of engagement. Each dimension consists of five question items. To measure the aspects of ambient attributes, items were extracted from the scale developed by Realyvásquez-Vargas *et al*. (2020). The aspects of ambient attributes were measured using a set of self-constructed survey items using literature. Each dimension consists of four to six question items. Items of all latent variables were measured on a five-point Likert Scale ranging from strongly agree to strongly disagree and the items are listed in Annexure 01.Demographic data and the subcategories were identified by the previous study done using university undergraduates in Sri Lanka (Karunarathne *et al.,* 2020). This included age, gender, academic year, department and usual study area used for online learning.

6. Data Analysis and Results

6.1 Profile of Respondents

This included gender, age and usual study area used for online learning. As shown in Table 1, when considering the gender, age, and the study place, the majority of the respondents are females, 23 years, and studying in their own bedrooms, respectively

Table 1 Profile of Respondents

Category	Categories	No of students	%
Gender	Male	93	39%
	Female	145	61%
	Total	238	100%
Age	20 years	4	2%
	21 years	22	9%
	22 years	62	26%
	23 years	91	38%
	24 years	47	20%
	25 years	12	5%
	Total	238	100%
Usual place used for online learning	Own bedroom	127	53%
	Bedroom shared with one sibling	36	15%
	Bedroom shared with more than one sibling	12	5%
	Study/ reading room	40	17%
	Dining area	4	2%
	Living area	15	6%
	Outside of the house	4	2%
	Total	238	100%

Source: Author (2021)

6.2 Construct Reliability and Convergent Validity Assessment

Before testing the measurement model, the data set was tested for common method bias, non-response bias, and multivariate assumptions, namely, normality, linearity, homoscedasticity and multicollinearity. Following the decision rules, the outcomes of these tests did not indicate any significant issue in the data set related to common method bias (Podsakoff *et al.*, 2003), non-response bias (Miller and Smith, 1983), normality (Kline, 1998), linearity, homoscedasticity (Saunders *et al.*, 2019) and multicollinearity (Sekaran and Bougie, 2016). Accordingly, the authors proceeded to test the measurement model.

Next, convergent validity and discriminant validity were tested through confirmatory factor analysis. According to the threshold value of 0.5 (Hair *et al.*, 2014), four items with component loadings less than 0.5 were eliminated. Those were AL4, AL9, AL10 and SN4, and their standard regression weights were 0.039, 0.018, 0.155 and 0.057, respectively. The model was retested for validity and reliability after refinements and the test results are given in Tables 2 and 3.

Table 2 Validity Testing for Variables

Dimension/ Variable	No of Items Remained	Standardized Factor Loading (Min-Max)	AVE	CR	Cronbach's Alpha
Lighting (AL)	7	0.459-0.885	0.502	0.813	0.759
Acoustic (AA)	5	0.571-0.908	0.456	0.802	0.789
Temperature (AT)	4	0.627-0.884	0.582	0.846	0.843
Air quality (AQ)	5	0.858-0.943	0.836	0.962	0.963
Size (SS)	6	0.674-0.806	0.581	0.892	0.892
Shape (SH)	7	0.730-0.996	0.791	0.963	0.969
Layout (SL)	5	0.890-0.938	0.749	0.936	0.931
Colour (SC)	4	0.835-0.963	0.804	0.942	0.942
Pattern (SP)	5	0.693-0.94	0.651	0.901	0.846
Material (SM)	4	0.853-0.991	0.852	0.958	0.951
Nature accessibility (SN)	4	0.469-0.948	0.698	0.897	0.819
Physical engagement (EP)	6	0.546-0.858	0.576	0.889	0.883
Emotional engagement (EE)	6	0.691-0.922	0.611	0.903	0.903
Cognitive engagement (EC)	6	0516-0.945	0.616	0.903	0.901

Source: Author (2021)

Table 3 Test Results of Discriminant Validity

Variable	AVE Vs. SMC													
	AL	AA	AT	AQ	SS	SH	SL	SC	SP	SM	SN	EP	EE	EC
AL	**0.502**													
AA	0.164	**0.456**												
AT	0.388	0.333	**0.582**											
AQ	0.272	0.131	0.526	**0.836**										
SS	0.323	0.165	0.235	0.065	**0.581**									
SH	0.466	0.159	0.462	0.233	0.465	**0.791**								
SL	0.278	0.135	0.247	0.090	0.761	0.526	**0.749**							
SC	0.378	0.109	0.385	0.175	0.452	0.811	0.486	**0.804**						
SP	0.277	0.090	0.331	0.118	0.540	0.661	0.654	0.774	**0.651**					
SM	0.223	0.125	0.463	0.270	0.205	0.658	0.293	0.774	0.562	**0.852**				
SN	0.408	0.226	0.317	0.128	0.409	0.759	0.485	0.629	0.523	0.388	**0.698**			
EP	0.042	0.270	0.248	0.200	0.001	0.093	0.011	0.049	0.037	0.130	0.156	**0.576**		
EE	0.008	0.181	0.093	0.003	0.072	0.064	0.121	0.052	0.074	0.075	0.128	0.374	**0.611**	
EC	0.015	0.251	0.007	0.000	0.011	0.004	0.040	0.002	0.014	0.006	0.047	0.422	0.590	**0.616**

Source: Author (2021)

The present study followed the guidelines of Hair *et al*. (2014) and Fornell and Larcker (1981) to assess scale reliability and validity. Accordingly, as shown in Tables II and III, all latent variables in the model of the current study are at a satisfactory level of convergent validity (AVE>0.5, Hair *et al*., 2011), Cronbach's alpha (α >0.7, Hair *et al*., 2011), composite reliability (CR>0.7, Hair *et al*., 2011) and discriminant validity (AVE for each construct is greater than the squared multiple correlations between constructs, Fornell & Larcker, 1981). The values of standardized factor loading that fall between 0.45 – 0.5 were also taken as valid as their rounded off value is 0.5, which complies with the threshold. The values of goodness of fit indices were; RMSEA=.078; CFI=.625; TLI=.632. RMSEA value should be close to 0 to be perfect fit. RMSEA value 0.78 can be considered as reasonable, as value that is less than 0.09 suggests a reasonable model–data fit (Browne & Cudeck, 1993; Hu & Bentler, 1999). A higher CFI and TLI values close to 1, indicate a better model fit (Hu & Bentler, 1999). Accordingly, values of the goodness of fit indices, the model fits the observed variables moderately, thus, proceeded to test hypotheses.

6.3 Structural Model

Once the measurement model was verified, three structural models were performed to test the developed hypotheses as well as the impact of the controlling variable on the dependent variable. According to the outputs of the first two models, the impacts of age and education level as control variables on engagement were found to be insignificant (age: p= .439 and education level: p= .315), and thus, this control variable was eliminated from the research model

at the data analysis level and was not considered in the other structural models. The third model was performed to test the other direct hypotheses (Hypotheses 1a to 2g) that relate to testing the impact of ambient and spatial attributes on student academic engagement.

Figure 2 shows the structural model and the standardized coefficients and the p-values for the direct paths are shown in Table 4

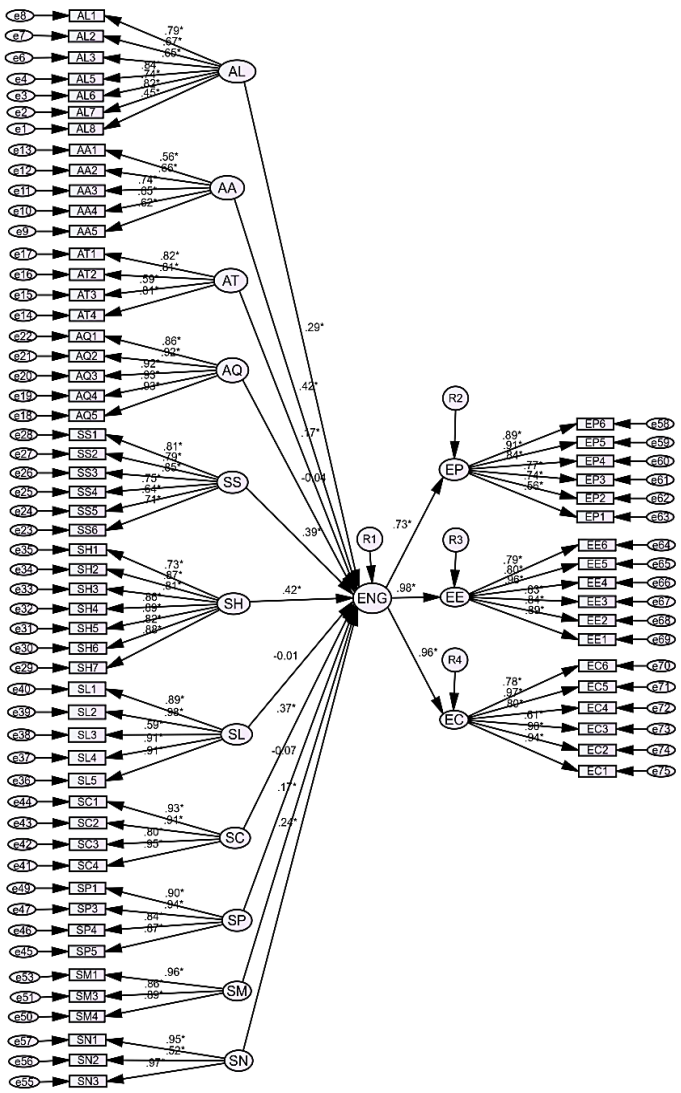

Figure 2 Conceptual Model (Source: Author 2021)
Source: Author (2021)

Table 4 Summary of Hypotheses Testing

Hypothesis	Path	Std. Coefficient	P-value	Hypothesis Result
H1a	Lighting → Engagement	0.29	0.000*	Supported
H1b	Acoustic → Engagement	0.42	0.000*	Supported
H1c	Temperature → Engagement	0.17	0.000*	Supported
H1d	Air quality → Engagement	0.04	0.142	Not supported
H2a	Size → Engagement	0.39	0.000*	Supported
H2b	Shape → Engagement	0.42	0.000*	Supported
H2c	Layout → Engagement	0.01	0.698	Not supported
H2d	Colour → Engagement	0.37	0.000*	Supported
H2e	Pattern → Engagement	0.06	0.087	Not supported
H2f	Material → Engagement	0.18	0.038*	Supported
H2g	Nature accessibility → Engagement	0.24	0.000*	Supported

Note: * Significant at level 0.05

The p-values recorded in the summary of hypotheses testing shown in table IV, reveal that all direct paths except H_{1d}, H_{2c} and H_{2e} are significant at the 05 percent level ($p<0.05$). Accordingly, all direct paths H_{1a} to H_{2g} except H_{1d}, H_{2c} and H_{2e} mentioned in table 4 were found to be statistically significant and were supported by the results of the analysis. This reveals that lighting, acoustics and temperature out of ambient attributes and size, shape, colour, material and nature accessibility out of spatial attributes of physical learning environments at homes affect students' academic engagement in an online learning setting.

7. Discussion

The objective of this study was to study the impact of ambient and spatial attributes in the students online learning physical environment on the level of their academic engagement in an online learning setting. As hypothesized, the findings suggest that adequate level of lighting, acoustic and temperature make a significant positive impact on student academic engagement. Consequently, when the illumination level in the study area is sufficient to see the around clearly, if it enables visual comfort to the student without causing any glare sensation from windows as well as from artificial lights, and if the lighting level can be controlled by the students, they tend to engage with academic activities enthusiastically and with high level of interest leading to improved emotional engagement. Further, when the study area is free from noise coming from external sources, enabling the student to concentrate more on the academic work, they engage more. This directly links to their cognitive engagement level that associates with their attention and concentration level on academic activities. Moreover, when the temperature level at the study area is bearable and if it allows students to take online classes comfortably and if the temperature level can be controlled by students, it affects them to engage more in academic activities in an online learning setting. These findings further supported the findings of the research work done by Realyvásquez-Vargas et al. (2020). The validated impact of adequate lighting level and visual comfort on engagement is consistent with the research work of Liu et al. (2011) and Yang et al. (2013). It proves that inadequate lighting undoubtedly can negatively impact the visibility and ultimately academic engagement of students (Morrow and Kanakri, 2018; Oselumese et al., 2016). As indicated by Singh et al. (2020), lighting levels from 250 to 500 lux are considered adequate for better academic engagement. This applies in an online learning setting also (Realyvásquez-Vargas et al., 2020) and it shows that the lighting level in the study area is significant for students' academic engagement.

The findings of the study done by Dockrell and Shield (2006) and Oselumese *et al*. (2016) are congruent with the current study's finding on the acoustic condition of the study area and its positive impact on students' engagement when the study areas are less noisy. The main reason is when the study areas are too much noisy, students face difficulties in concentrating and it leads to distractions (Yang *et al*., 2013). Braat-Eggen *et al*. (2017) in their study found that high level of noise as a factor that can distract students when they are engaged in cognitive tasks. This can directly influence the cognitive engagement level of students. Thus, a acoustic condition where internal and external noises from devices, people's talks, etc. are low, students can easily concentrate and engage with their academic work more effectively.

The positive impact of a tolerable temperature level on engagement was also found significant as per the perceptions of the respondents. The current study's findings coincide and prove the finding of research work done by Liu et al. (2011), Baarfi (2020), López-Chao et al. (2019) and Realyvásquez-Vargas et al. (2020). They also found that temperature is one of the most crucial ambient attributes in determining student perceptions of study areas. The desirability of the temperature level is decided when the environment is thermally neutral where it is not too cold or too hot. Further, when the level of temperature can be controlled by the students in their study area by turning on and off the fans, closing or opening windows, those also increases the perception of students on the temperature level. Accordingly, such supportive environment can lead to more effective student academic engagement.

The study findings further reveal that the impact of air quality on engagement was found insignificant. This contradicts the findings of the research work done by Shaughnessy et al. (2006) yet agrees

with the findings of the studies done by Hopland and Nyhus (2016) and Yang et al. (2013) where they have found that students have given low impact votes to air quality. Thus, students do not pay much attention to if they get natural lighting, if the air quality is appropriate and acceptable to take online classes and if they can control the air quality by opening a window or turning a fan or an A/C on when engaging in academic activities in an online learning setting.

When moving to the spatial attributes, the study findings reveal that size, shape, colour, material and nature accessibility make a significant positive impact on student academic engagement. The sufficiency of the sizes of the usual study area to reside, to keep furniture and also the size of the furniture and equipment; chair, table, computer, etc. is found significant for student engagement. Further, the shape of the study area, roof, doors, windows, and furniture was also found significant for students to comfortably engage in academic activities in an online learning setting. The colour and material of floor, walls, roof, ceiling and furniture also make an impact on the level of student engagement. As revealed by Greene, Bell, & Boyer (1983) and Plass, Heidig, Hayward, Homer, & Um (2014), warm colors such as yellow and orange, rather than using the cold colors such as gray which are used in materials can enhance students' learning and engagement. The findings of the positive impacts of size and shape on student engagement are congruent with the findings of the studies done by Roskos and Neuman (2011) and Yang et al. (2013). The findings of the impacts of colour selection, material and nature accessibility on engagement were also significant and those validate the findings of the studies carried out previously by Yang et al. (2013) and Gilavand (2016). As they revealed, desirable colors and materials of walls, floor, chairs, tables, etc. in students' study areas can elicit positive feedbacks and enhance learning desires. Similarly, Tanner and Kenneth (2000) also state that nature accessibility affects students' academic engagement.

On the other hand, the impact of layout and pattern on engagement were found as insignificant. Accordingly, it was evident that students do not pay much attention to the arrangement and pattern of doors, windows, furniture, fittings when engaging in academic activities in an online learning setting. This contradicts with the findings of the study done by Guardino and Fullerton (2010).

Overall, with the transformation of teaching and learning process to virtual platforms due to Covid 19 pandemic situation, different ambient and spatial attributes of the physical learning environment of the students' usual study place still affect the level of students' physical, emotional and cognitive engagement to the academic activities in an online learning setting.

8. Conclusion and Implications

The current study tested eleven hypotheses and found that when the ambient condition of the learning environment in terms of lighting, acoustic and temperature and spatial attributes in terms of size, shape, colour, material and nature accessibility are supportive and desirable, it can motivate students to engage more in academic work. In addition, although literature supports that air quality which is another ambient attribute and layout and pattern which are spatial attributes may also make an impact on engagement, the current study contradicts those findings and found that those factors do not significantly influence students' engagements. The main reason for this is, students not being concern about getting natural lighting, appropriateness of air quality, controlling air quality, as well as the layout arrangement and the pattern of doors, windows, furniture, fittings when engaging in academic activities in an online learning setting. Respondents do not consider these variables as influencing to their physical, emotional and cognitive engagement level in an online learning setting.

Accordingly, this study validated the impact of ambient and spatial attributes of the physical environment on the student engagement in an online learning setting and contribute to theory by broadening the components taken as physical resources considered in the Engagement Theory (1990) by including external environmental factors; ambient and spatial attributes as a key significant component in the availability antecedent. This study addresses the gap in empirical evidence on the impact of the physical environment on psychological and pedagogical phenomena in an online learning setting.

Based on the study findings, authors have suggested several implications for managers and other stakeholders. Those include, university guidelines given for students on online learning should include points on how to create a physical learning environment more desirable for a student to engage in academic work properly before starting lectures, selecting construction materials for walls that can absorb or eliminate external noises, the size and colour of the space can be made more desirable, adopting green building elements to improve the physical environmental conditions in terms of natural lighting and ventilation easily and conducting awareness programmes with the presence of experts on green elements would help to convince the residents of the importance of adopting these green elements to create a desirable learning environment. The findings of this study are also important for policymakers on the development and implementation of policies related to the education sector and institutions at regional, national as well as international levels.

9. Limitations and Further Research Directions

This study used non-probability sampling technique and the sample was selected from one faculty of a Sri Lankan university. This can affect the generalizability of the study findings. Future studies can carry out using probability sampling techniques to ensure high generalizability of findings. The current study examined only the impact of selected ambient and spatial attributes on students' academic engagement. However, due to the high complexity and heterogeneity of physical environments, there can be many other factors that can influence students' academic engagement. Subsequently, future studies may focus on examining those attributes such as privacy, safety, level of maintenance, etc. In addition, although the impacts of several attributes; air quality, layout and design/ pattern were found insignificant on engagement, future studies will be worthwhile to examine and validate these findings further. Moreover, this study examined the perceptions of students, yet the perceptions of academic staff also can add value to studying the situation of

student academic engagement. On the other hand, the academic staff also are engaging in work online distantly via technological platforms. Future studies may require examining their work engagement level and related areas as those would also generate new insights useful for various parties

Acknowledgments

This study was supported by the Centre for Real Estate Studies (CRES), Department of Estate Management and valuation, University of Sri Jayewardenepura, Sri Lanka.

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Appendix

Annexure 01: Operationalization of the variables

Attributes	Variables	Items
Ambient Attributes	**Lightening**	The level of lightening in my study area is sufficient.
		Only daylight is sufficient to illuminate my study area.
		The level of lighting in my study area allows me to see clearly what is around, as well as to concentrate when taking online classes.
		I can control the level of lighting in my study area when taking online classes (for example: opening/closing blinds, curtains; having a table lamp; dimmers within reach).
		The level of lighting (from lamps, computer screen) in my study area allows me to have visual comfort when taking online classes.
		The glare sensation caused by excessive light, bright reflections or contrast from the computer screen makes me uncomfortable when learning online.
		The glare sensation caused by excessive light, bright reflections or contrast from the windows makes me uncomfortable when learning online.
		The glare sensation caused by excessive light, bright reflections or contrast from artificial lights makes me uncomfortable when learning online.
	Acoustic/ Noise	My study area is free from noise.
		I have privacy in my study area when taking classes online.
		The noise level coming from devices in my study area allows me to concentrate, take the class, and clearly hear my teacher and classmates.
		The noise level coming from people's talks, external sources in my study area allows me to concentrate, take the class, and clearly hear my teacher and classmates.
		I can control the noise level in my study area (example: opening/ closing doors/ windows).
	Temperature	The internal temperature in my study area is bearable.
		The temperature in my study area allows me to be comfortable and concentrate when taking online classes.
		I use additional methods to control temperature (example: fans, A/C, etc.)
		I can control the temperature in my study area (for example: opening/closing windows, turning fan or A/C on/off) when taking online classes.
	Air Quality	The internal air quality in my study area is acceptable.
		I get natural ventilation to my study area.
		The air quality in my study area allows me to be comfortable and concentrate when taking online classes.
		The air quality in my study area is appropriate for taking the classes online.
		I can control the air quality in my study area (for example: opening/closing windows, turning fan or A/C on/off) when taking online classes.
Ambient Attributes	**Size**	My usual study area is spacious/ big enough to comfortably engage in online learning.
		My usual study area is spacious/ big enough to keep furniture and equipment used for online learning.
		The furniture I'm using (chair, table, etc.) are big enough to comfortably engage in online learning.
		The window(s) in my study area are large enough to comfortably engage in online learning.
		The door(s) in my study area are large enough to comfortably engage in online learning.
		The wall height is adequate to comfortably engage in online learning.
	Shape	The shape of floor in my study area is suitable to comfortably engage in online learning.
		The shape of roof/ ceiling in my study area is suitable to comfortably engage in online learning.

		The shape of walls in my study area is suitable to comfortably engage in online learning.
		The shape of windows in my study area is suitable to comfortably engage in online learning.
		The shape of doors in my study area is suitable to comfortably engage in online learning.
		The shape of furniture in my study area is suitable to comfortably engage in online learning.
		The overall shape of my study area is suitable to comfortably engage in online learning.
	Layout/ Arrangement	The arrangement of lighting fixtures in my study area is suitable to comfortably engage in online learning.
		The arrangement of windows in my study area is suitable to comfortably engage in online learning.
		The arrangement of doors in my study area is suitable to comfortably engage in online learning.
		The arrangement of furniture in my study area is suitable to comfortably engage in online learning.
		The overall layout/ arrangement of my study area is suitable to comfortably engage in online learning.
	Colour Selection	The floor colour in my study area is appropriate to comfortably engage in online learning.
		The wall colour in my study area is appropriate to comfortably engage in online learning.
		The roof/ ceiling colour in my study area is appropriate to comfortably engage in online learning.
		The furniture colour in my study area is appropriate to comfortably engage in online learning.
	Nature Accessibility	I can see natural environment through windows when siting in my study area.
		I can see natural environment through doors when siting in my study area.
		I can get natural lights to my study area.
		I can get natural ventilation to my study area.
	Pattern/ Design	The floor pattern/ design in my study area is appropriate to comfortably engage in online learning.
		The wall pattern/ design in my study area is appropriate to comfortably engage in online learning.
		The roof/ ceiling pattern/ design in my study area is appropriate to comfortably engage in online learning.
		The pattern/ design of furniture used in online learning is suitable and comfortable.
		The overall pattern/ design of my study area is appropriate to comfortably engage in online learning.
	Materials	The floor material in my study area is appropriate to comfortably engage in online learning.
		The wall material in my study area is appropriate to comfortably engage in online learning.
		The roof/ ceiling material in my study area is appropriate to comfortably engage in online learning.
		The material of furniture used in online learning is suitable and comfortable.
Student Engagement	**Physical Engagement**	I study with passion in online learning.
		I exert my full effort in online learning.
		I devote a lot of energy in online learning.
		I try my hardest to perform well in online learning.
		I strive as hard as I can to complete tasks in online learning.
		I exert a lot of energy on in online learning.
	Emotional Engagement	I am enthusiastic in online lectures.
		I feel energetic at online lectures.
		I am interested in online lectures.
		I am proud of engaging in online lectures.
		I feel positive about online lectures.
		I am excited about online lectures.
	Cognitive Engagement	At online lectures, my mind is focused on my studies.
		At online lectures, I pay a lot of attention to my studies.
		At online lectures, I focus a great deal of attention on my studies.
		At online lectures, I am absorbed by my studies.
		At online lectures, I concentrate on my studies.
		At online lectures, I devote a lot of attention to my studies.