The Impact of Physical, Mental, Social and Emotional Dimensions of Digital Learning Spaces on Student's Depth of Learning: The Quantification of an Extended Lefebvrian Model

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Abstract
Despite the widespread implementation of digital learning spaces (DLS) generally in Higher Education and for COVID-19 social distancing guidelines, a coherent and unified quantification of core aspects of the DLS on student learning has remained elusive. Therefore, this work extends the earlier work of Harkin and Nerantzi (2021), where we employed Lefebvre's (1991) Trialectic of Space to explain physical, mental, and social aspects of the DLS. In the present paper, we now quantify Lefebvre's original dimensions (physical, mental, social) and an Extended Lefebvrian Model (ELM; adding emotional experiences) on the depth of learning (DoL) of 188 university students at an undergraduate and postgraduate level. Results revealed that physical, mental, and social dimensions explained 42% of the variance in DoL, with emotion explaining an additional 6% which justifies its addition to our ELM (48%). Furthermore, postgraduate students experienced increased anxiety, held poorer mental representations of the DLS, and rated their DoL lower versus undergraduates. Using our findings as a guide, we highlight improvements to pedagogical practice within the DLS along physical, mental, social, and emotional dimensions to improve the experiences and learning of students in the DLS.

Keywords: Digital Learning Spaces, Lefebvre's Trialectic of Space, Depth of Learning, Physical Practices, Mental Representations, Social Representations, Emotional Experiences

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1. Introduction

Despite the widespread adoption of digital learning spaces (DLS) in response to the COVID-19 crisis (Carrillo & Flores, 2020; Harkin & Nerantzi, 2021; Nerantzi & Chatzidamianos, 2020) and generally within education over the last twenty years (Allen & Seaman, 2017), a coherent and unified quantification of key aspects of the DLS on student learning has remained elusive (see Martin, Sun, & Westine, 2020). We attribute this to the multifaceted nature of the DLS as observed across Higher Education (HE), a complexity reported in descriptive, qualitative and quantitative accounts (Henry, 2020). For example, Carillo and Flores (2020) identified that learning within the DLS is shaped by cognitive (e.g., the reflection of learners on content, action development), taught (e.g., learner as the focal point and tutor as the facilitator, appropriate use of technology), and social (e.g., belongingness, collaboration) dimensions. Nerantzi (2017) captured this complexity noting that learning in such environments benefits from facilitator support, activities, choice and a sense of community. Lastly, Henry (2020) reported that students described the DLS via themes of motivation, ability, personal circumstances, interactions, curriculum and environment.

Quantitative research reports a similarly complex pattern. For example, Gray and DiLoreto (2016) identified a relationship between structural and organizational elements of the online learning space and student outcomes. Specifically, user-friendliness, easy access to learning materials, clear schedule, and community strongly predicted student satisfaction and perceived student learning. Quantitative research often circumvents the inherent complexity of the DLS by focusing on isolated and different factors concerning student outcomes (Almendingen et al., 2021; Fawaz & Samaha, 2021). Almendingen et al. (2021) reported that 71% of students felt that it would be harder to achieve learning outcomes due to the unique demands of the DLS. In contrast, Paul and Jefferson (2019) reported no differences in student performance between online and face-to-face learning environments. In contrast, other researchers have commented on the positive relationship between the online community and academic performance (Crampton & Ragusa, 2015) or how it offers benefits via self-paced learning (Braet, 2009). A thought-provoking study by Spitzer and Musslick (2021) reported that students (K-12 level) mathematical problem-solving performance improved online during the COVID-19 lockdown of 2020 relative to the previous year (i.e., face-to-face) and that this improvement was more pronounced in low- versus high-achieving students.

Extent research also indicates that pre-existing and evolving student capacities are at play within the DLS. In their recent systematic review, Martin et al. (2020) identified a confluence of student characteristics that influenced how they use and produce the DLS: readiness for online learning (e.g., Buzdar, Ali, & Tariq, 2016), cognitive characteristics (e.g., see Broadbent, 2017), sense of community (e.g., Berry, 2017), and use of course technologies (e.g., Zawacki-Richter, Baecker, & Vogt, 2009). In line with this last point, the DLS places a necessary pressure on students to use numerous aspects of digital technology to navigate the online space successfully (e.g., MS-Teams, Moodle, mobile devices, personal computers; Kosari & Amoori, 2018). Much

like not having a key to a door, if students are not able to use digital technologies to access the DLS, then failure to attain learning-related goals, anxiety, avoidance and course drop-out is likely (Biasutti & El-Deghaidy, 2015; Carrillo & Flores, 2020; Cullen, Kullman, & Wild, 2013). Cheng and Xie (2021) identified the importance of personality characteristics in the academic outcomes and experiences of students learning in a DLS. They reported that academic procrastination occurs when students are low in conscientiousness, perceive course materials as unstimulating and irrelevant, and view technology and multimedia as unsupportive and distressing. Of interest and in contrast to previous research, they found that community factors such as engagement with tutors and peers did not predict academic performance. Lastly, Harkin and Nerantzi (2021) highlighted that several hidden factors influence the learning of students within the DLS, wherein: "The human aspect of student engagement is unknown and often hidden behind the veil of the computer screen in online sessions" (p. 30).

The previous research supports an assertion of Sangra, Vlachopolos and Cabrera (2012) as they noted that "the multiplicity of perspectives surrounding e-learning [i.e., within the DLS] causes confusion and, sometimes, even contradictions" (p. 146). As a solution, we follow the recommendation of Rossiter (2007) as they stated that there is a "pressing requirement to understand better the nature of e-learning [i.e., within the DLS], as an educational innovation, and to evolve contextually derived frameworks for change" (p. 93). Thus, as we acknowledge the multifaceted nature of DLSs and their reliance on numerous digital resources (Sangrà, et al., 2012), we apply the following definition to our conceptualisation of the DLS: "the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services, as well as remote exchange and collaboration" (Alonso, López, Manrique, & Viñes, 2005, p. 218).

When we consider the narrow focus on the DLS in the extent literature alongside the fact that few studies have examined the physical, mental, social, and emotional aspects in unison, we argue that this justifies the present extension of our previous work (Harkin & Nerantzi, 2021), where we provided a unique and unified tripartite explanation of the DLS (see Figure 1). Specifically, we conceptualised the DLS within a Lefebvrian (1991) construction of space comprising physical, mental and social elements, each with their unique demands and impacts on student experience and learning. We proposed that within the DLS, a bidirectional relationship exists between the learner and the digital space. One where the DLS affects the learner and simultaneously the capacities, perceptions and experiences of the learner shape the DLS (Harkin & Nerantzi, 2021). Thus, the present paper provides the next logical extension to this, one where we standardise the main elements of the DLS within a coherent and Extended Lefebvrian model (i.e., physical, mental, social, and emotional factors) and quantify their impact on student depth of learning (DoL). We use this to inform tailored interventions across these four dimensions to improve the experiences and learning of students in the DLS.

2. Lefebvrian Framework and the Digital Learning Space

We now outline the manner that we employ and extend Lefebvre's (1991) Trialectic of Space as a means to explain and quantify variance in the DoL of students learning within the DLS.

Previously, we used Lefebvre's (1991) Trialectic of Space to untangle and explain the multifaceted and complicated nature of the experiences and uses of the DLS (Harkin & Nerantzi, 2021). In its original conception, Lefebvre's Trialectic was a lens through which to understand physical, mental, and social aspects of human experience within a produced social space. Lefebvre saw space not as a passive container but as an active arena that interacts with and produces thought and behaviour: It is the 'production' of space rather than the space *per se* that is the fundamental object of interest. To this end, Lefebvre integrated physical, mental, and social space to unify the main elements of the produced space, which in spatial terms he referred to as 'Spatial Practice', 'Representations of Space' and 'Representational Space', respectively (Lefebvre, 1991, p. 40). It is important to note that in the Lefebvrian literature, it is common to see the terms associated with these three aspects of space used interchangeably (Buser, 2012; Harkin & Nerantzi, 2021; Harkin et al., 2021). Therefore, for simplicity, and due to the frequent use of digital technologies in the DLS and the numerous factors identified in the literature associated with the DLS (Carrillo & Flores, 2020; Henry, 2020; Nerantzi, 2017), we use the terms: "physical practices", "mental representations", and "social interactions".

Lefebvre's triad has proven a suitable lens to understand how people produce space across cultural geography (leisure/tourism, Bunce, 2008; urban policy planning, Carp, 2008; social production of harmful practice, Parkin & Coomber, 2011), virtual space (Kosari & Amoori, 2018), social networking sites (Harkin, et al., 2021) and recently by us to online teaching (Harkin & Nerantzi, 2021). Previously, we proposed that pre-existing physical (e.g., use of digital devices to access online materials), mental (e.g., how the online-teaching space shapes the thinking of the learner and vice-versa), and social (e.g., short-time period as a barrier to online learning communities) constructions and experiences of online spaces potentially contribute to the curriculum, student-tutor and student-student dialogue and community (Harkin & Nerantzi, 2021). In agreement with recent literature (e.g., Fawaz & Samaha, 2021) we identified that anxiety was a common and vital experience for students concerning the DLS. A finding that is in accord with the observation that students who complete online courses can experience higher levels of boredom, anxiety, anger, and less enjoyment in comparison to those who participated in face-to-face learning (Fauconnier & Turner, 2002; Stephan, Markus, & Gläser-Zikuda, 2019). However, positive emotions are also experienced, such as excitement over the flexibility (e.g., work at their own pace) that the DLS potentially provides students (Zembylas, Theodorou, & Pavlakis, 2008). Indeed, we propose that it is inevitable that physical, mental, and social interactions with the DLS evoke strong emotional responses in users.

Considering these points, we now explore and operationalise the main dimensions of Lefebvre's Trialectic (physical, mental, social), emotional experiences (Extended Lefebvrian Model; ELM) and DoL regarding students' experiences within the DLS.

2.1. Physical Practices within the Digital Learning Space

Lefebvre (1991) proposed that physical practices exist in people's habits, rituals, and patterns of movement that they adopt in space. We observe physical practices in daily routines, how they are "concretized over time" (Urry, 1995, p. 25) via repetition in the space they occur.

When applied to the DLS, physical practices refer to the manner that students access a range of digital devices in their personal life (e.g., personal computers, mobile phones, tablets), which online learning then necessarily requires them to use and correctly apply in sometimes novel online educational spaces (e.g., Moodle, forums, Microsoft Teams). This is consistent with the Student Digital Experiences Insight Survey, which highlighted the need to support students and their effective use of online technologies (Killen & Langer-Crame, 2020). The authors insightfully noted that students must have support beyond the level of allowing them to simply access materials. They need to see the benefits of engaging and using technology effectively to further their learning.

The ease of use and availability of digital devices allows students to access online educational spaces frequently, in any location, at any time, and even automatically. Through such frequent and consistent use, accessing online teaching spaces can become a habit (Lakhal, Khechine, & Mukamurera, 2021), especially when accessed under similar contexts and for similar purposes (Danner, Aarts, & de Vries, 2008). This demand for digital connectivity to constantly update or check (Robinson, 2018) can have positive and negative outcomes. For example, it provides students with the means to access online course materials whenever they need to and wherever they are (Killen & Langer-Crame, 2020). However, in contrast, the Student Digital Experiences Insight Survey (Killen & Langer-Crame, 2020) reported that while 54% of students enjoyed trying out new and innovative technologies, only 43% felt at ease using mainstream technologies. Thus, on a national level, approximately 50% and 85% of students were not entirely comfortable using online technologies and did not feel involved in the design of the DLS, respectively (Killen & Langer-Crame, 2020). This data is consistent with research that shows an external locus of control (i.e., a lack of control over the DLS) is associated with symptoms of depression and anxiety (Hovenkamp-Hermelink et al., 2019). However, the requirement to constantly access the DLS in combination with an inability to navigate the space optimally can evoke deep emotional responses in users: "An individual unable to manage their activities using a laptop or a smartphone, while at home, faces ever-increasing anxiety" (Kosari & Amoori, 2018, p. 182). Therefore, we operationalised physical representations of space as the convenience of digital devices to support student engagement in the DLS.

2.2. Mental Representations of the Digital Learning Space

Mental representations of space refer to the manner that people construct space via thought, ideation, planning and categorization (Carp, 2008), which in turn produces the conceived, represented, and constructed space (Lefebvre, 1991). Mental representations are not solely unitary experiences but rather an amalgamation of

multiple experiences with and within that space; i.e., a blended space (Fauconnier & Turner, 2002).

When applied to the DLS, mental representations exist in how the digital space shapes thinking and behaviours in physical space and vice versa. It evokes a bidirectional relationship between the user and the space: The user imposes meanings, interpretations and boundaries upon the space but is also subject to the influences of the space upon them. Mental representations of the DLS arise as the user attempts to impose an often abstract meaning, understanding and control of the space (Watkins, 2005).

When discrepancies exist between different user's mental representations of that space (e.g., how frequently to post questions on Microsoft Teams; expectations of interactions with tutors or peers), connection to that space, or the intended use of that space, then dissonance and anxiety within a user or conflict between users can arise (Galvez-Pol, Nadal, & Kilner, 2021). We propose that the strength of the mental representations that a user holds likely determines their connection to the DLS and influences their DoL. As noted by Turner (2014), for those spaces that dominate our thinking, we necessarily develop strong mental representations and connections to that space, in terms of a "mental web [that has] mental spaces and connections between them" (p. 5). This point has relevance to undergraduate students, as they were required to adjust their expectations based on previous experiences (i.e., mental representation) from face-to-face teaching to the DLS in response to the COVID-19 lockdown (Almendingen, et al., 2021). When these expectations are not satisfied, then it is likely that anxiety and avoidance will follow. Thus, in the present analysis, we operationalised mental representations in the following manner: the strength and extent that students connect to the DLS.

2.3. Social Interactions within the Digital Learning Space

Lefebvre (1991) proposed that space exists as a 'lived', produced and reproduced experience. It is the experience of this 'lived space' that evokes a sense of meaning and a strong sense of "in-the-moment awareness of being alive or fully present" (Carp, 2008, p. 135). As such, it is not experienced via purely physical properties, but rather a union of visual, verbal, and/or kinaesthetic symbolism, which we observe in pictures, writing, music, gestures, metaphors, signs or rapt attention (Carp, 2008), and potentially evokes memories and emotions, imposes social norms, and can create a strong sense of social belonging and community (Buser, 2012). The subtle, symbolic, often unwritten but understood by all coding of space not only influences people's reactions to that space but can create a sense of inclusion, belonging and empowerment for one individual/group and exclusion, alienation and disempowerment in another (Lindgren, 2010).

Previous literature identifies the importance of social belonging and community to learning within the DLS. For example, Almendingen et al. (2021) reported that students felt that online teaching and lack of social interaction led to poor learning outcomes, motivation, and well-being. Similarly, student engagement/learning motivation has key affective components of "feelings of identification or belonging,

and relationships with teachers and peers (for psychological engagement)" (Appleton, Christenson, & Furlong, 2008, p. 372). Furthermore, a review of conceptual and empirical pedagogical frameworks for fully online, blended, face-to-face and formal and informal settings showed that community is central in fostering effective learning supported by digital technology and highlighted the importance of facilitator support and activities (Nerantzi, 2017). As Nerantzi and Chatzidamianos (2020) noted, online teaching highlights the need and the pedagogical benefits of connection, togetherness, and distant socialising. Kosari and Amoori (2018) noted social interactions and the need to manage them with an online space: "It is increasingly related to the management of our emotions and relationships. […] which are hard to manage, and good skills are required to manage them." (p. 182). Thus, as identified previously in the discussion on physical practices and mental representations of space: Extended isolation and lack of community with peers and tutors are likely to create a sense of dissonance and anxiety in students within the DLS. To this extent, we operationalised social representations as students' sense of community in the DLS.

2.4. Emotional Experiences within the Digital Learning Space

In the discussion of physical, mental, and social representations of the DLS, online pedagogical space has the power to evoke deeply emotional experiences in students. As noted by Kosari and Amoori (2018) in their discussion of the interaction between physical and digital spaces: "The increasing interpenetration of real and [digital] … spaces intensifies the stresses day after day and more and more skills are needed to manage interactions *in* and *between* these spaces. An individual unable to manage their activities using a laptop or a smartphone, while at home, faces ever-increasing anxiety" (p. 182). Therefore, we operationalised emotional experiences as the perceived anxiety of students concerning the DLS.

2.5. Depth of Learning and the Digital Learning Space

We argue that the DLS as viewed through a Lefebvrian lens influences DoL in several ways (Almendingen, et al., 2021; Sapp & Simon, 2005). For example, Sapp and Simon (2005) noted that "online courses tend to leave students with higher instances of unfinished learning goals, a sense of decreased importance of teacher feedback, and a lack of engagement in the learning process" (p. 472). In contrast, the online DLS offers an advantage to those who prefer a deep sense of learning via the expression of personal autonomy and strategic (versus surface) learning (Entwistle, Meyer, & Tait, 1991). Furthermore, research indicates that when students perceive workloads as overwhelming and when assessments require the reproduction of facts versus the development of critical thought, then a surface approach to learning is more likely to follow (Entwistle, Tait, & McCune, 2000). Therefore, while the DLS offers students autonomy over their learning, it may also encourage superficially fact focused learning. An assertion of particular importance as the DLS invariably occurs within a short and intensive time frame. Thus, we propose that DoL is a sensitive enough construct to measure the impact of DLS upon it (Webb, 1997) and to differentiate between different study levels (i.e., undergraduate versus postgraduate). In Figure 1, we highlight the effects of physical, mental, and social dimensions on learning for those students in the DLS. To this end, we operationalised DoL as students' perceptions of their own DoL across physical, mental, and social domains.

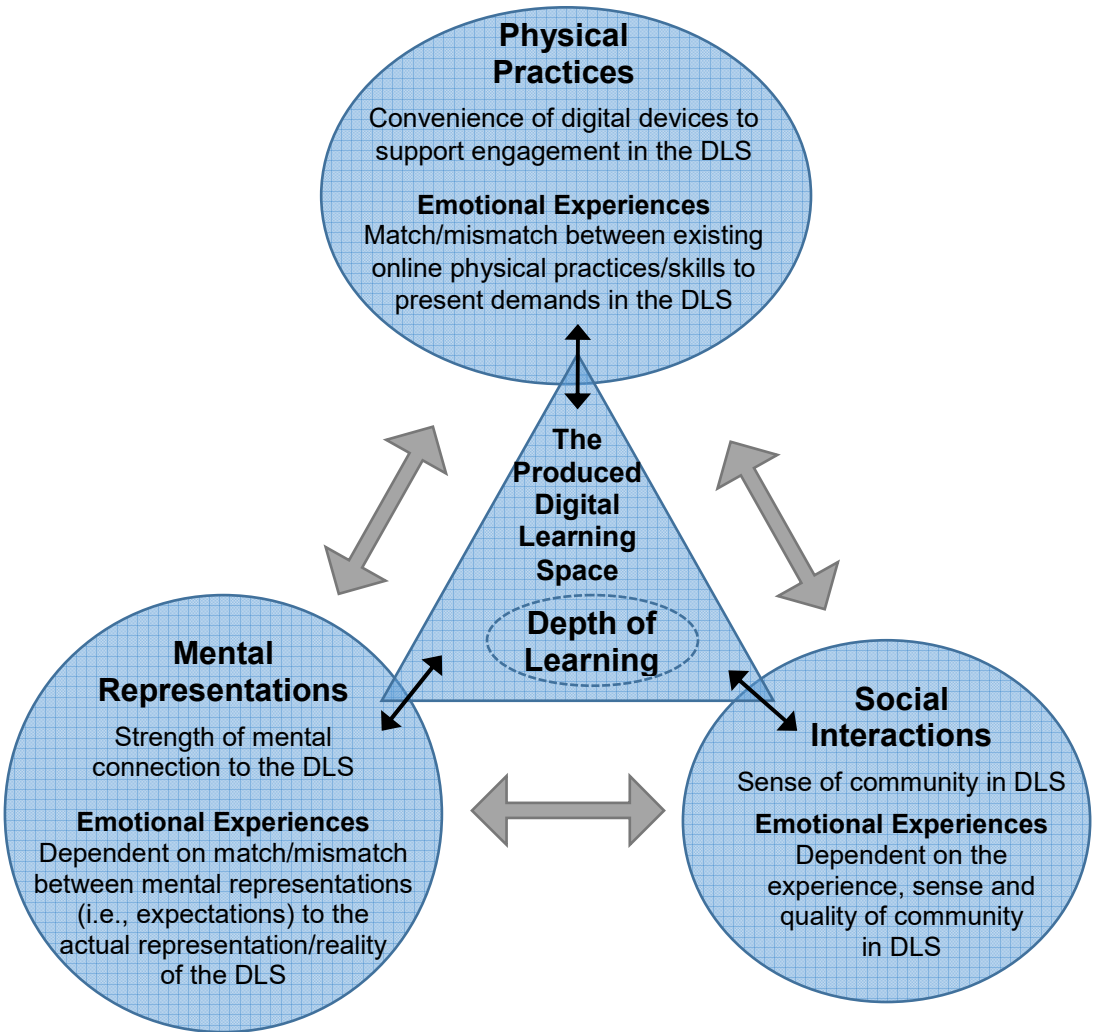

Figure 1. Our Extended Lefebvrian Model (ELM) version of Lefebvre's Trialectic of Space (1991) as applied to the DLS in terms of Physical, Mental, Social and Emotional Dimensions of Space. This model acknowledges: (a) the multifaceted nature of the production of the DLS, (b) the manner that each of the spatial triads (physical, mental, social) evokes emotional reactions in students, and (c) that these four dimensions likely contribute to the overall DoL of students within the DLS.

3. Research Questions and Hypotheses

As demonstrated above, the DLS is a complex pedagogical phenomenon with numerous impacts on students learning. As such, we devised three main research questions and hypotheses (null and alternate) as they apply to our original Lefebvrian understanding of the DLS (i.e., physical practices, mental representations, social interactions) and our Extended Lefebvrian Model (ELM; addition of emotional experiences) concerning the DoL of university students. We will also compare undergraduate to postgraduate students for each of the four dimensions of the ELM and DoL to examine if they differ in any meaningful ways.

Q1. Does the original conceptualisation of Lefebvre's Trialectic of Space (Harkin & Nerantzi, 2021) predict DoL in the DLS? We anticipate that the combination of physical practices, mental representations, and social representations of the DLS will explain variance in DoL.

$H_{0.1}$ When statistically controlling for both age and previous experience of the DLS, the interaction term for physical practices, mental representation, and social representation will not be statistically related to DoL.

$H_{A.1}$ Lefebvre's Trialectic of digital space has a positive relationship with students' perceived DoL after accounting for age and previous experience of DLS.

Q2. Does adding the dimension of emotional experiences improve the variance explained by Lefebvre's Trialectic of DLS on students' perceived DoL? We anticipate that the ELM with the addition of emotional experiences will increase the variance explained in students' DoL. In addition, given arguments centred on reduced enjoyment and increased anxiety in digital space (Rajabalee & Santally, 2021), we expect a significant negative relationship between emotional experiences and DoL.

$H_{0.2}$ The interaction term for physical practices, mental representations, social representations, and emotional experiences will not be statistically related to DoL.

$H_{A.2}$ The ELM with the addition of emotional experiences will significantly increase the variance explained in DoL.

Q3. Does study level (SL: undergraduate versus postgraduate) result in meaningful differences along each of the four dimensions (physical, mental, social, emotional) of the ELM and DoL?

$H_{0.3}$ There is no significant interaction between SL, ELM and DoL.

$H_{A.3}$ The interaction between SL, the four dimensions of the ELM and DoL will be statistically significant. If present, we will conduct post hoc comparisons (undergraduate versus postgraduate) for each of the four dimensions of the ELM and DoL.

4. Method

4.1. Participants

One hundred and eighty-eight (132 female, 55 males, 1 transgender) students participated in the study from 21 different Universities across the UK, with full demographic data presented in Table 1. Undergraduate psychology students represented 44% and postgraduate psychology students represented 56% of the total sample. Age range between 18 and 59 with seventy-five percent of the participants aged 30 or under. Ethnicity was 158 white Caucasian, 7 black or African, 8 Asian and 8 from multiple races. Seventy percent of participants had never been out of education, with 16% and 14% having an educational gap between 1-5 years and 5-10 years, respectively.

4.2. Learning Contexts

Online courses were delivered in a block teaching structure via a course management system (e.g., Moodle, Blackboard) with no face-to-face lectures or meetings. Course engagement and interactions between tutors and students and among students themselves occurred solely through asynchronous communication tools (e.g.,

discussion boards, emails, and Microsoft Teams chat box). Students engaged in a diverse range of learning activities and assessments; e.g., group projects, portfolios, written reports and essays and final year dissertations.

4.3. Procedure and Measures

For this study, we followed the human research ethical guidelines in the University to invite voluntary and anonymous participation from students who enrolled on courses or units delivered solely online. The questionnaire for this paper was designed, generated and implemented using Qualtrics software of the Qualtrics Research Suite (Qualtrics, 2020). Convenience sampling was employed with links to the Qualtrics online questionnaire and associated study information provided to participants who were engaged solely in digital learning over the period if the COVID-19 lockdown in 2021. Participants completed their questionnaire near the end of a semester or given unit.

The present ELM as applied to digital space (i.e., physical, mental, social, emotional) was measured via sixteen selected items based on previous research on a six-point scale (strongly agree to strongly disagree) (Harkin & Nerantzi, 2021). Example questions and associated Cronbach alphas for the main dimensions of our model were as follows. (a) *Physical practices* (e.g., "The convenience of digital devices (e.g., mobile phones) encouraged you to communicate with the tutors?"; $\alpha = 0.74$); (b) *Mental representations* (e.g., "How would you rate your perceived DoL from digital education?"; $\alpha = 0.72$); (c) *Social representations* (e.g., "You experienced a strong sense of community with other students?"; $\alpha = 0.74$); (d) *Emotional experiences* (e.g., "The fully online nature and demands of this unit caused you to experience anxiety?"; $\alpha = 0.71$); and (e) *Depth of learning* (i.e., "How would you rate your perceived depth of learning during online learning?"; $\alpha = 0.73$). The composite measure study alpha was 0.71. Consent form completion, demographic, age, level of study, use of digital devices, and previous experience with DLSs was also collected.

4.4. Data Analysis

Correlational analysis and a hierarchical regression model (HRM) were performed in this study. The correlation matrix comprised five variables (physical, mental, social, emotion, DoL), using Pearson's correlation coefficients for significance. We employed a theory-driven 3 Step HRM based on our conceptualisation of Lefebvre's Trialectic as applied to the DLS (i.e., Model 2: physical, mental and social; Harkin & Nerantzi, 2021) and our Extended Lefebvrian Model (i.e., Model 3: addition of emotional experiences) was employed. The aim was to determine if these individual variables and Models (2 and 3) explained a significant amount of variance in students' DoL (dependent variable) when other variables are controlled (i.e., Model 1: age and previous experience with DLS). Sequentially, in Model 1, we entered age and previous experience with ODE so that any predictive factors relating to DoL were not explained by age and experience with DLSs. In Model 2, we entered physical, mental, and social dimensions of Lefebvre's Trialectic to determine if they were significant predictors of students' DoL. In Model 3, we then included emotion with the previous three variables to see if it added to the predictive power of the ELM.

A 2 x 5 Mixed Model ANOVA was performed to examine differences between university students' study level (undergraduate vs. postgraduate) and mean scores across physical practices, mental representations, social representations, emotional experiences and DoL.

5. Results

5.1. Descriptive Data

In Tables 1 and 2 we provide descriptive data and response statistics for the regression analysis for the 188 participants, respectively.

Table 1: Demographic Data

Variables	Mean (SD) or Total (%)
Age	26.85 (8.58)
Gender	N (%)
Female	132 (70%)
Male	55 (29.4%)
Transgender	1 (0.5%)
Ethnicity	N (%)
White Caucasian	158 (84%)
African or Black	14 (7%)
Asian	8 (4%)
Multiple Races	8 (4%)
Level of Study	
Undergraduate	84 (45.4%)
Postgraduate	98 (51%)
Other	6 (3.25%)
Year of Study	
Year 1	(2.1%)
Year 2	(11.1%)
Year 3	(16.3%)
Year 4	(15.3%)
Year 5	(51.6%)
Other	(3.6%)
Education Continuity	
Continuous	132 (70%)
Out of education – 1 to 5 years	30 (16%)
Out of education – 5 to 10 years	26 (14%)

Table 2: Descriptive Statistics for the Regression Analysis

	Mean	Median	SD	Range	Valid data	Missing data
Control variables						
1. Age	26.85	23	8.58	41	186	2
2. Previous experience	2.35	2	1.56	4	159	30
Predictor variables						
1. Physical	2.27	2.5	0.73	2.5	174	15
2. Mental	3	3	0.95	4	175	14
3. Social	3.19	3.33	0.93	3.33	181	8
4. Emotion	3.1	3	1.08	3.36	183	6
Dependent variable						
1. Depth of Learning	3.15	3.33	1.01	3.67	180	9

5.2. Correlation Predictors: Physical, Mental, Social, Emotional, and Depth of Learning

Results from the correlation analysis are presented in Table 3. As DoL is the dependent variable of interest, we focus on key correlations in relation to DoL. Specifically, students who scored higher on physical practice (r = 0.47, p <0.001), mental representation (r = 0.59, p <0.001) and social representation (r = 0.31, p <0.001) had significantly higher levels of perceived DoL than students who scored lower on physical practices, mental representation, and social representation. Correlations to emotional experiences also proved illuminating and consistent with prior expectations. Specifically, students who scored higher on emotional experiences (i.e., greater anxiety) had significantly lower levels on physical practice (r = -0.23, p <0.01), mental representation (r = -0.39, p <0.01), social representation (r = -0.20, p <0.01) and perceived DoL (r = -0.51, p <0.001) than those students who scores low on emotional experiences.

Table 3: Correlations among Variables

	1	2	3	4	5
1. Physical	1				
2. Mental	.46**	1			
3. Social	.22**	.19*	1		
4. Emotional	-.23*	-.39*	-.20**	1	
5. Depth of Learning	.47**	.59**	.31**	-.51**	1

** p <.001. * p <.01

5.3. Hierarchical Regression Model: Extended Lefebvrian Model & Depth of Learning

Table 4 represents the results of the HRM. Model 1 investigated whether the control variables of age and previous experience with the DLS influenced students' DoL. The regression analysis revealed that the model explained 4% of the variance and was a significant predictor of students' perceived DoL, $F(2, 142) = 4.28$; $p = .016$). Specifically, age (β = -.030, p = .008) contributed significantly to the model whereas previous experience with DLS's did not (p > .05). Model 2 investigated whether physical, mental, and social dimensions of Lefebvre's Trialectic could significantly predict students' DoL. The results of the regression indicated that the model explained 42% of the variance and that the model was a significant predictor of perceived DoL, $F(3, 139) = 32.03$; p <.001). Specifically, the dimensions of Lefebvre's Trialectic in terms of physical practices (β =.264, p = .009), mental representation (β =. 501, p < .001) and social representation (β =.208, p = .005) contributed significantly to the model. Model 3 introduced emotional experiences to Lefebvre's Trialectic to investigate whether this dimension could significantly improve the predicted DoL shown in Model 2.

The result of this regression indicated a significantly improved model explaining a further 6% of the variance and showing that the addition of emotional experiences specifically and the ELM generally was a significant and improved predictor of students' perceived DoL, $F(1, 138) = 15.68$; p <.001). Students' emotional experiences (β =-.248, p <.001) contributed significantly to the model, which now explained 48% of the variance in students' DoL.

Table 4: Hierarchical Regression Model

Model and Predictor Variable	R^2	ΔR^2	ΔF	*df*	β	*t*	*p*	*SE*	*95% CI*
Model 1	.057	.044	4.28*	2,142					
1. Age					-.030	-2.685	.008	.011	-.053 - .008
2. Previous Experience					.006	.102	.919	.061	-.114 - 1.26
Model 2	.442	.422	32.03**	3,139					
1. Physical					.264	2.65	.009	.100	.067- .461
2. Mental					.501	6.44	<.001	.078	.347 - .654
3. Social					.208	2.85	.005	.073	.064 - .353
Model 3	.499	.477	15.675**	1,138					
1. Physical					.241	2.54	.012	.095	.053 - .428
2. Mental					.408	5.26	<.001	.078	.254 - .561
3. Social					.162	2.30	.023	.070	.023 - .302
4. Emotional					-.248	-3.96	<.001	.063	-.372 - .144

Note. ΔR^2 = change in R2; ΔF = change in F. *p < .05. **p < .01.
HRM includes age and previous experience with the DLS, the three single Lefebvre's Trialectic subcomponents (physical, mental, social), and the additional component of emotion to predict perceived DoL in the ELM.

5.4. Mixed Model ANOVA: Undergraduates versus Postgraduates

A 2 x 5 mixed ANOVA revealed a two-way interaction between study level (undergraduate vs. postgraduate) and response dimensions (physical practices, mental representations, social representations, emotional experiences, DoL) ($F(4, 672) = 5.64$, $p<.001$, $\eta^2=.032$). Consistent with our a-priori hypothesis ($H_{A.\ 3}$), we conducted post hoc-tests to compare undergraduates to postgraduates along these five dimensions (See Figure 2). Undergraduate students scored lower on emotional experiences (i.e., less anxiety) ($t(181) = 2.42$, $p = .017$, $d = 1.06$, 95% CI = [-.652, -.065) but higher on mental representation ($t(173) = 2.1$, $p = .038$, $d = .95$, 95% CI = [-017, 617]) and perceived DoL ($t(178) = 2.27$, $p = .025$, $d = .99$, 95% CI = [.043, 635]) compared to the postgraduate students. It is important to note that all effect sizes for these significant comparisons were large (i.e., d > 0.8; Sawilowsky, 2009). No other post hoc tests were significant (*all ps*. >.05).

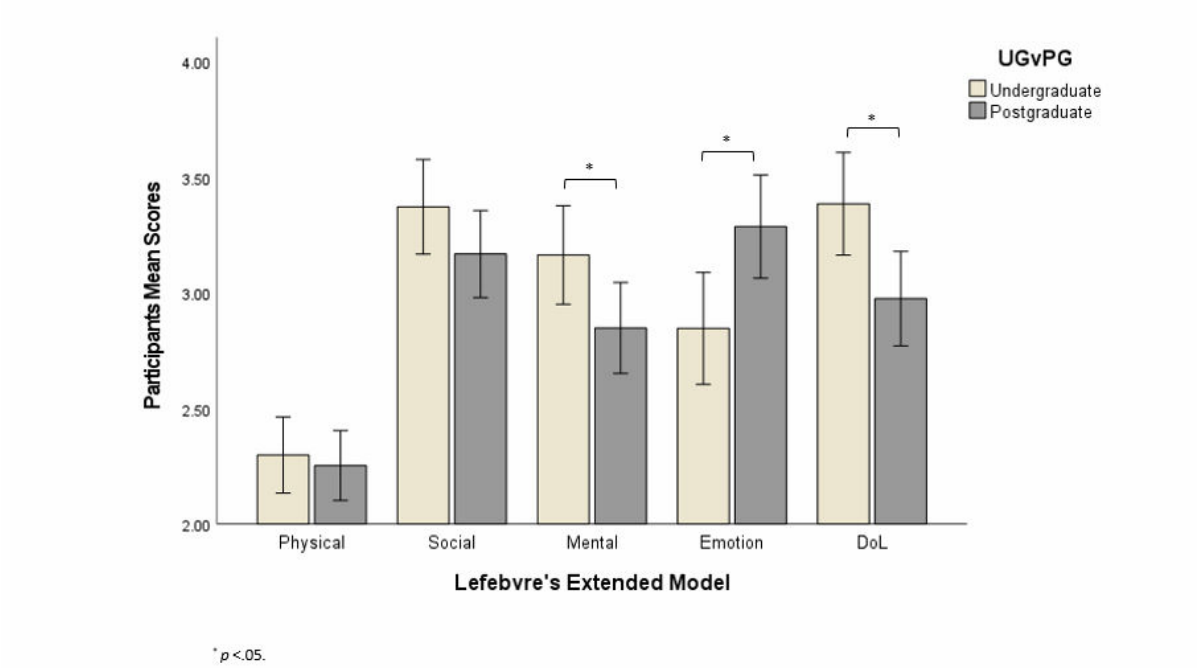

Figure 2. Comparison of Undergraduate to Postgraduate Students for the ELM and DoL. The 2 x 5 ANOVA comparing the simple main effects between Study Level (SL: Undergraduate versus Postgraduate) and mean scores for each of the four dimensions of the ELM (physical practices, mental representations, social representations, emotional experiences) and DoL.

6. Discussion

The findings from the current study showed that our novel ELM model, consisting of the physical, mental, social, and emotional dimensions, was a significant predictor of student's DoL in the DLS. Physical, mental, and social dimensions were positively associated with DoL, whereas emotional experiences (anxiety) were negatively associated with DoL. This inverse relationship reveals that as emotion (anxiety) increases, there is an associated decrease in DoL. Further supporting the destabilising effect of emotionality was the significant negative correlations between emotion (anxiety) and physical, mental, and social dimensions of the ELM.

An unexpected yet interesting finding was that postgraduate students held less robust mental representations of the DLS than undergraduate students. Specifically, postgraduate students experienced more negative emotional experiences (i.e., anxiety) than undergraduate students and scored significantly lower on mental representation and their perceived DoL compared to undergraduate students. A limitation of this finding is that we are not able to interview participants on why this happened, and as we suggest that future research interview undergraduate and postgraduates engaged in DLS to provide a fuller and more thorough explanation of such findings.

We now discuss the physical, mental, social and emotional components of our ELM with the intent to inform the pedagogic design of the DLS to the needs of students. Thus, we attempt to address a specific point raised by Cheng and Xie (2021) concerning the DLS: "Instructors should … be actively engaged in tailoring course

materials to students' needs and strategically designing and integrating technology and multimedia into courses to promote adaptive motivation and positive emotions" (p.9). In Figure 3, we summarise key intervention points across physical, mental, social, and emotional dimensions of the DLS and highlight the importance of communication between program and unit leads, personal tutors, digital and IT specialists, and university-wide practices to optimise student experience and learning.

6.1. Targeting Physical Practices in the Digital Learning Space

Within the DLS, students have use a range of digital tools to access the online space to assist their learning; e.g., Microsoft Teams (Calleja, 2021), Zoom Meetings (Goei et al., 2021), Padlet (Weaver et al., 2021), e-books (Hernández-Rodríguez et al., 2021). As noted by Huang, Halgevold and Lang (2021), the success of digital technologies in the DLS, in terms of student learning, is dependent on their intentional and purposeful integration into the DLS (see also Weaver et al., 2021). It is common to report the positive relationship between appropriate training in online digital tools and DoL (for review see Hrastinski, 2021). However, it is common to overlook the correct and appropriate use of digital tools in induction sessions for courses and units. For example, a national survey on students digital experiences revealed that 46% of students' did not enjoy trying out new and innovative technologies, only 43% felt comfortable using mainstream technologies, and only 17% felt involved in decisions about digital technologies in the DLS (Killen & Langer-Crame, 2020). This is consistent with our finding that students who score higher on physical practice had significantly higher levels of perceived DoL and vice-versa. This is important as it highlights the importance of students existing physical management of the online space and their subsequent DoL.

We propose that when a mismatch exists between the present capacities of the student and the demands of navigating the DLS, then students will likely experience a range of negative emotions (e.g., anxiety, fear) and associated behaviours (e.g., avoidance, lack of engagement, drop-out). As a solution, we propose that before launching online courses, induction sessions need to target the creation of strong and positive mental representations of the role of digital technology in their learning; e.g., socialising students in the effective use of online forums (Hara & Kling, 1999). Adopting this approach, as noted by Cheng and Xie (2021), will "help build up students' knowledge base and skills for using technology, and thus, may *increase their perceived* [mental representation of] *technology usability*" [italics added] (p. 11). We propose that this supports the interrelationship between physical, mental, social, and emotional dimensions that we highlighted in Figure 1 and investigated in our ELM.

6.2. Targeting Mental Representations of the Digital Learning Spaces

Mental representations (i.e., the experience of connection) explained the greatest variance in DoL in our ELM and had the strongest relationship to emotion and DoL. They manifest in students' unique expectations and demands of the DLS (Watkins, 2005). We propose that when students hold discrepant mental representations regarding the use of the DLS versus its actual presentation, then they would experience dissonance, anxiety and possible conflict with those (i.e., tutors, unit leads, etc) that implemented the space and other students within that space (Galvez-Pol, et al., 2021;

Hassel & Ridout, 2018; Smith & Wertlieb, 2005; Smith & Hopkins, 2005). For example, students often hold unrealistic expectations regarding tutor contact, availability, and nature of that contact time, size of classes, and general workload (Lowe & Cook, 2003; Smith & Hopkin, 2005).

Through the Lefebvrian lens, we suggest that some students potentially transfer pre-existing mental representations of educational spaces (e.g., secondary, university, pre-COVID lockdown) with an implicit expectation of face-to-face and directed learning (Luk, 2005). As noted by Nerantzi and Chatzidmianos (2020), who stated that "while the aim [of online teaching] is to be inclusive, inadvertently the design may create barriers for learning and is exclusive" (p. 487). Thus, as a solution, we propose the appropriate identification of barriers and management of expectations will likely reduce anxiety and improve DoL for some students. For example, in the first instance, we highlight the need to inform students of the intensive and autonomous nature of the DLS during induction. In addition to making them aware of the benefits that the DLS potentially provides, for example, learning at their own pace, development of self-management, peer-to-peer learning and collaborations.

Identifying students who continue to hold discrepant expectations and tailoring interventions to their needs may reduce anxiety and potential dropout (Appleton, et al., 2008). Further supporting this was our finding that postgraduates (versus undergraduates) had weaker mental connections to the DLS, more negative emotional experiences, and poorer DoL. Postgraduates may hold specific implicit discrepant expectations (e.g., pre-existing experiences of face-to-face teaching) regarding the DLS that require interventions specific to their needs. For example, as most of them likely had face-to-face delivery in their previous educational experiences, they then unknowingly carry this into the DLS which potentially increases the likelihood of feeling isolated and lonely. This is important as loneliness has established links to reduced learning ability and achievement (Nehring, 2021).

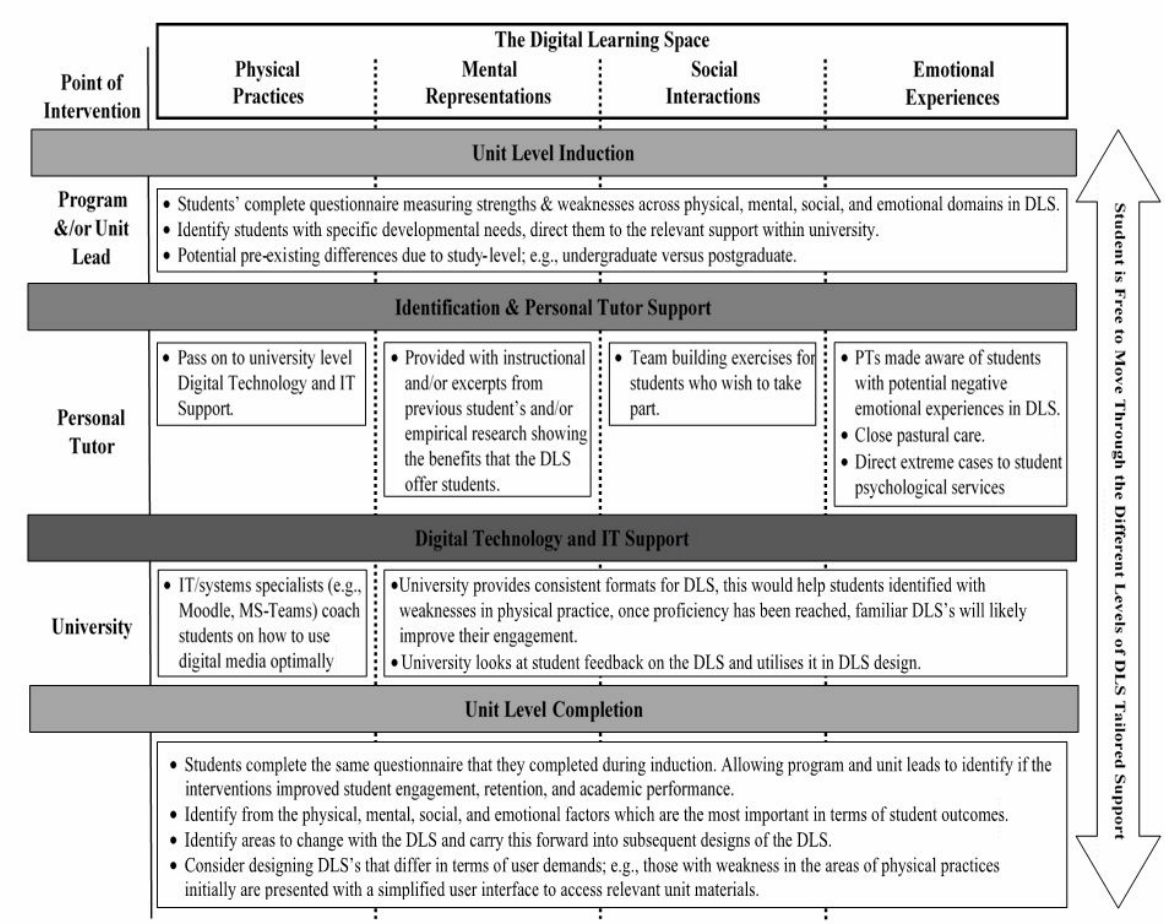

Figure 3. Key intervention points across physical, mental, social, and emotional dimensions of the DLS to improve student experience and learning. In addition, observe the importance of communication between program and unit leads, personal tutors, digital and IT specialists, and university wide practices.

6.3. Targeting Social Interactions in the Digital Learning Space

Extant research identifies social belongingness, presence, and community as central to effective online learning and teaching (for review see Carrillo & Flores, 2020; Hramiak, 2010). For example, Carrillo and Flores (2020) identified themes of belongingness (e.g., trusting relationships), cohesiveness (e.g., collaboration), and participation (e.g., prioritising social interaction over task completion) as key to establishing a sense of social community with the DLS. Evidence indicates that intensive and immersive experiences with the DLS can foster bonds between tutors and students and help develop a learning community (Male, et al., 2016). However, learning within the DLS can also be a lonely experience, where students lack any meaningful connection to the learning outcomes, other students, and tutor expectations (Nerantzi & Chatzidamianos, 2020).

In a similar manner to what we observed in the discussion of physical and mental representations of the DLS, we propose that issues arise for students when a mismatch exists between their expectations of space and the social reality of that space. Student engagement, learning and motivation include key affective components of "feelings of identification or belonging, and relationships with teachers and peers (for psychological engagement)" (Appleton, et al., 2008, p. 372). For educators, this

indicates the need to manage student expectations and to empower students to manage their expectations in a personal and optimal manner. For example, Portugali, Benenson and Omer (1997) proposed that to reduce dissonance in the perceived or actual use of a given space, there needs to be a change in either spatial location or the intended use of that space. This concurs with Truta, Parv and Topala (2018), as they noted the relationship between limited engagement and early dropout intentions on university courses. As educators, we want to stop students from leaving the online space (i.e., not attending, dropping out). Therefore, if we are unable to remove the online feature due to COVID related social distancing, or a course uses it as a primary means of delivery, then we must ensure that students can manage, create, and imbue a sense of personal value and community that is at an appropriate level to them (see Figure 3). Failure to address such issues in the DLS frustrates learners and reduces their chances of success (Hara & Kling, 1999).

7. Conclusion: the Pedagogical Significance of the Extended Lefebvrian Model

The present ELM provides a novel pedagogical approach and paradigm to connect physical, mental, social, and emotional experiences of students and their DoL. It is argued that within the DLS a bidirectional relationship always exists between the learner and the DLS: One where the DLS affects the learner, while simultaneously the capacities, perceptions and experiences of the learner shape the DLS (Harkin & Nerantzi, 2021). As such, we offer a solution to a plethora of excellent research which looks at the various components of the DLS from a descriptive (e.g., Carrillo & Flores, 2020; Nerantzi, 2017) or reductionist (e.g., Almendingen, et al., 2021; Spitzer & Musslick, 2021) perspective. Specifically, we found that physical, mental, and social dimensions were positively associated with the student's DoL, while emotional experiences (anxiety) were negatively associated with DoL. Further supporting the destabilising effect of emotionality was the significant negative correlations between emotion (anxiety) and physical, mental, and social dimensions of the ELM. In Figure 3, we advise future applied pedagogical practice to use these four areas to screen students early in the induction of a DLS program. After this, students with identified areas of development are tracked and directed towards an appropriate source of help (e.g., peer support, personal tutors, IT support) with specific interventions to each student identified across physical, mental, social, and emotional domains.

However, we are aware of the tension between a theoretical model and the realities of tutor workloads and university provision. Lastly, we reported that postgraduate students have more negative emotional experiences (i.e., anxiety) than undergraduate students and scored significantly lower on mental representation and their perceived DoL compared to undergraduate students. We propose further research to examine the differences between postgraduate and undergraduates in how they perceive the DLS and how this potentially relates to differences in the experience of anxiety between these groups. We hope that the educational field can use the present Lefebvrian model (Figure 1), approach to analysis and subsequent findings, and suggestions for interventions (Figure 3) to implement change in the DLS and potentially face-to-face settings in ways that were not previously apparent.

8. References

1. Allen, I. E., & Seaman, J. (2017), *Digital Compass Learning: Distance Education Enrollment Report 2017*. Babson survey research group.

2. Almendingen, K., Morseth, M. S., Gjølstad, E., Brevik, A., & Tørris, C. (2021), "Student's experiences with online teaching following COVID-19 lockdown: A mixed methods explorative study", *PLoS One*, Vol. 16, No. 8, e0250378. https://doi.org/10.1371/journal.pone.0250378

3. Alonso, F., López, G., Manrique, D., & Viñes, J. M. (2005), "An instructional model for web-based e-learning education with a blended learning process approach", *British Journal of Educational Technology*, Vol. 36, No. 2, pp. 217-235. https://doi.org/10.1111/j.1467-8535.2005.00454.x

4. Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008), "Student engagement with school: Critical conceptual and methodological issues of the construct", *Psychology in the Schools*, Vol. 45, No. 5, pp. 369-386. https://doi.org/10.1002/pits.20303

5. Berry, S. (2017), "Building community in online doctoral classrooms: Instructor practices that support community", *Online Learning*, Vol. 21, No. 2, n2. https://doi.org/10.24059/olj.v21i2.875

6. Biasutti, M., & El-Deghaidy, H. (2015), "Interdisciplinary project-based learning: an online wiki experience in teacher education", *Technology, Pedagogy and Education*, Vol. 24, No. 3, pp. 339-355. https://doi.org/10.1080/1475939X.2014.899510

7. Braet, D. (2009), *Principles for designing online self-paced corporate training*. Masters of Science Thesis, Iowa State University.

8. Broadbent, J. (2017), "Comparing online and blended learner's self-regulated learning strategies and academic performance", *The Internet and Higher Education,* Vol. 33, pp. 24-32. https://doi.org/10.1016/j.iheduc.2017.01.004

9. Bunce, M. (2008), "The 'leisuring' of rural landscapes in Barbados: New spatialities and the implications for sustainability in small island states", *Geoforum*, Vol. 39, No. 2, pp. 969-979. https://doi.org/10.1016/j.geoforum.2007.10.005

10. Buser, M. (2012), "The production of space in metropolitan regions: A Lefebvrian analysis of governance and spatial change", *Planning Theory*, Vol. 11, No. 3, pp. 279-298. https://doi.org/10.1177/1473095212439693

11. Buzdar, M. A., Ali, A., & Tariq, R. U. H. (2016), "Emotional Intelligence as a Determinant of Readiness for Online Learning", *International Review of Research in Open and Distributed Learning*, Vol. 17, No. 1, pp. 148-158. https://doi.org/10.19173/irrodl.v17i1.2149

12. Calleja, J. (2021), "Teachers' learning in extraordinary times: shifting to a digitally facilitated approach to lesson study", *International Journal for Lesson and Learning Studies*, Vol. 10 No. 2, pp. 118-137. https://doi.org/10.1108/IJLLS-09-2020-0058

13. Carp, J. (2008). "Ground-Truthing" Representations of Social Space: Using Lefebvre's Conceptual Triad", *Journal of Planning Education and Research*, Vol. 28, No. 2, pp. 129-142. https://doi.org/10.1177/0739456X08324685

14. Carrillo, C., & Flores, M. A. (2020), "COVID-19 and teacher education: a literature review of online teaching and learning practices", *European Journal of Teacher Education*, Vol. 43, No. 4, pp. 466-487. https://doi.org/10.1080/02619768.2020.1821184

15. Cheng, S.-L., & Xie, K. (2021), "Why college students procrastinate in online courses: A self-regulated learning perspective", *The Internet and Higher Education*, Vol. 50, 100807. https://doi.org/10.1016/j.iheduc.2021.100807

16. Crampton, A., & Ragusa, A. T. (2015), *Exploring the role of technology in fostering sense of belonging in students studying by distance*. Sydney: Office for Learning and Teaching, Department of Education and Training.

17. Cullen, R., Kullman, J., & Wild, C. (2013), "Online collaborative learning on an ESL teacher education programme", *ELT Journal*, Vol. 67, No. 4, pp. 425-434. https://doi.org/10.1093/elt/cct032

18. Danner, U. N., Aarts, H., & de Vries, N. K. (2008), "Habit vs. intention in the prediction of future behaviour: The role of frequency, context stability and mental accessibility of past behaviour", *British Journal of Social Psychology*, Vol. 47, pp. 245-265. https://doi.org/10.1348/014466607x230876

19. Entwistle, N., Tait, H., & McCune, V. (2000), "Patterns of response to an approaches to studying inventory across contrasting groups and contexts", *European Journal of Psychology of Education*, Vol. 15, No. 1, pp. 33-48. https://doi.org/10.1007/bf03173165

20. Entwistle, N. J., Meyer, J. H. F., & Tait, H. (1991), "Student failure: Disintegrated patterns of study strategies and perceptions of the learning environment", *Higher Education*, Vol. 21, No. 2, pp. 249-261. https://doi.org/10.1007/BF00137077

21. Fauconnier, G., & Turner, M. (2002), *The way we think: Conceptual blending and the mind's hidden complexities*. New York: Basic Books.

22. Fawaz, M., & Samaha, A. (2021), "E-learning: Depression, anxiety, and stress symptomatology among Lebanese university students during COVID-19 quarantine", *Nursing Forum*, Vol. 56. No. 1, pp. 52-57. https://doi.org/10.1111/nuf.12521

23. Galvez-Pol, A., Nadal, M., & Kilner, J. M. (2021), "Emotional representations of space vary as a function of peoples' affect and interoceptive sensibility", *Scientific Reports*, Vol. 11, No. 1, 16150. https://doi.org/10.1038/s41598-021-95081-9

24. Goei, S. L., van Joolingen, W. R., Goettsch, F., Khaled, A., Coenen, T., Veld, S. G. J. G., de Vries, S., & Schipper, T. M. (2021), "Online lesson study: virtual teaming in a new normal", *International Journal for Lesson & Learning Studies*, Vol. 10, No. 2, pp. 217-229. https://doi.org/10.1108/IJLLS-09-2020-0078

25. Gray, J. A., & DiLoreto, M. (2016), "The Effects of Student Engagement, Student Satisfaction, and Perceived Learning in Online Learning Environments", *International Journal of Educational Leadership Preparation*, Vol. 11, No. 1, 98-119.

26. Hara, N., & Kling, R. (1999). "Students' frustrations with a Web-based distance education course", *First Monday*, Vol. 4, No. 12. https://doi.org/10.5210/fm.v4i12.710

27. Harkin, B., & Nerantzi, C. (2021). "It helps if you think of yourself as a radio presenter! A Lefebvrian commentary on the concerns, conflicts and opportunities of online block teaching", *International Journal of Management and Applied Research*, Vol. 8, No. 1, pp. 18-35. https://doi.org/10.18646/2056.81.21-002

28. Harkin, B., Yates, A., Riach, M., Clowes, A., Cole, S., & Cummings, C. (2021), "I Want to See People's Reactions to the Selfies: A Lefebvrian Analysis of the Impact of Social Networking Sites on Physical, Mental, and Emotional Functioning", *Social Science Computer Review*, Vol. 40, No. 3, pp. 788-808. https://doi.org/10.1177/0894439321994222

29. Hassel, S., & Ridout, N. (2018), "An Investigation of First-Year Students' and Lecturers' Expectations of University Education", *Frontiers in Psychology*, Vol. 8, No. 2218. https://doi.org/10.3389/fpsyg.2017.02218

30. Henry, M. (2020), "Online Student Expectations: A Multifaceted, Student-centred Understanding of Online Education", *Student Success*, Vol. 11, No. 2, pp. 91-98. https://doi.org/10.5204/ssj.1678

31. Hernández-Rodríguez, O., González, G., & Villafañe-Cepeda, W. (2021), "Planning a research lesson online: pre-service teachers' documentation work", *International Journal for Lesson & Learning Studies*, Vol. 10, No. 2, pp. 168-186. https://doi.org/10.1108/IJLLS-09-2020-0068

32. Hovenkamp-Hermelink, J. H. M., Jeronimus, B. F., van der Veen, D. C., Spinhoven, P., Penninx, B. W. J. H., Schoevers, R. A., & Riese, H. (2019). "Differential associations of locus of control with anxiety, depression and life-events: A five-wave, nine-year study to test stability and change", *Journal of Affective Disorders*, Vol. 253, pp. 26-34. https://doi.org/10.1016/j.jad.2019.04.005

33. Hramiak, A. (2010), "Online learning community development with teachers as a means of enhancing initial teacher training", *Technology, Pedagogy and Education*, Vol. 19, No. 1, pp. 47-62. https://doi.org/10.1080/14759390903579265

34. Hrastinski, S. (2021), "Digital tools to support teacher professional development in lesson studies: a systematic literature review", *International Journal for Lesson & Learning Studies*, Vol. 10, No. 2, pp. 138-149. https://doi.org/10.1108/IJLLS-09-2020-0062

35. Huang, R., Helgevold, N., & Lang, J. (2021), "Digital technologies, online learning and lesson study", *International Journal for Lesson & Learning Studies*, Vol. 10, No. 2, pp. 105-117. https://doi.org/10.1108/IJLLS-03-2021-0018

36. Killen, C., & Langer-Crame, M. (2020). Student digital experience insights survey 2020: UK higher education findings. UK: JISC Data Analysis.

37. Kosari, M., & Amoori, A. (2018), "Thirdspace: The Trialectics of the Real, Virtual and Blended Spaces", *Journal of Cyberspace Studies*, Vol. 2, No. 2, pp. 163-185. https://doi.org/10.22059/jcss.2018.258274.1019

38. Lakhal, S., Khechine, H., & Mukamurera, J. (2021), "Explaining persistence in online courses in higher education: a difference-in-differences analysis", *International Journal of Educational Technology in Higher Education*, Vol. 18, No. 1, pp. 19. https://doi.org/10.1186/s41239-021-00251-4

39. Lefebvre, H. (1991), *The Production of Space* (D. Nicholson-Smith, Trans.): Wiley-Blackwell.

40. Lindgren, J. (2010), "Spaces of social inclusion and exclusion—A spatial approach to education restructuring", *Education Inquiry*, Vol. 1, No. 2, pp. 75-95. https://doi.org/10.3402/edui.v1i2.21934

41. Lowe, H., & Cook, A. (2003). Mind the Gap: Are students prepared for higher education? Journal of Further and Higher Education, 27(1), 53-76. https://doi.org/10.1080/03098770305629

42. Luk, H. S. (2005), "The gap between secondary school and university mathematics", *International Journal of Mathematical Education in Science and Technology*, Vol. 36, No. 2-3, pp 161-174. https://doi.org/10.1080/00207390412331316988

43. Martin, F., Sun, T., & Westine, C. D. (2020), "A systematic review of research on online teaching and learning from 2009 to 2018", *Computers & Education*, Vol. 159, 104009. https://doi.org/10.1016/j.compedu.2020.104009

44. Nehring, L. (2021), *Loneliness and learning: The impact of COVID-19 on adult learners.* iNSENDi - Shaping the Future of Online Education.

45. Nerantzi, C. (2017), *Towards a framework for cross-boundary collaborative open learning in cross-institutional academic development.* Edinburgh Napier

University. Retrieved from https://www.napier.ac.uk/~/media/worktribe/output-1025583/towards-a-framework-for-cross-boundary-collaborative-open-learning-for.pdf

46. Nerantzi, C., & Chatzidamianos, G. (2020), "Moving to Block Teaching during the COVID-19 Pandemic", *International Journal of Management and Applied Research*, Vol. 7, No. 4, pp. 482-495. https://doi.org/10.18646/2056.74.20-034

47. Parkin, S., & Coomber, R. (2011), "Public injecting drug use and the social production of harmful practice in high-rise tower blocks: a Lefebvrian analysis", *Health Place*, Vol. 17, No. 3, pp. 717-726. https://doi.org/10.1016/j.healthplace.2011.02.001

48. Paul, J., & Jefferson, F. (2019), "A Comparative Analysis of Student Performance in an Online vs. Face-to-Face Environmental Science Course From 2009 to 2016", *Frontiers in Computer Science*, 1. https://doi.org/10.3389/fcomp.2019.00007

49. Portugali, J., Benenson, I., & Omer, I. (1997), "Spatial cognitive dissonance and sociospatial emergence in a self-organizing city", *Environment and Planning B-Planning & Design*, Vol. 24, No. 2, pp. 263-285. https://doi.org/10.1068/b240263

50. Qualtrics. (2020). *Qualtrics XM*. Provo, Utah, USA.

51. Rajabalee, Y. B., & Santally, M. I. (2021), "Learner satisfaction, engagement and performances in an online module: Implications for institutional e-learning policy", *Education and Information Technologies*, Vol. 26, No. 3, pp. 2623-2656. https://doi.org/10.1007/s10639-020-10375-1

52. Robinson, L. (2018), "The identity curation game: digital inequality, identity work, and emotion management", *Information, Communication & Society*, Vol. 21, No. 5, pp. 661-680. https://doi.org/10.1080/1369118X.2017.1411521

53. Rossiter, D. (2007), "Whither e-learning? Conceptions of change and innovation in higher education", *Journal of Organisational Transformation & Social Change,* Vol. 4, No. 1, pp. 93-107. https://doi.org/10.1386/jots.4.1.93_1

54. Sangrà, A., Vlachopoulos, D., & Cabrera, N. (2012), "Building an inclusive definition of e-learning: An approach to the conceptual framework", *The International Review of Research in Open and Distributed Learning*, Vol. 13, No. 2, pp. 145-159. https://doi.org/10.19173/irrodl.v13i2.1161

55. Sapp, D. A., & Simon, J. (2005), "Comparing grades in online and face-to-face writing courses: Interpersonal accountability and institutional commitment", *Computers and Composition*, Vol. 22, No. 4, pp. 471-489. https://doi.org/10.1016/j.compcom.2005.08.005

56. Sawilowsky, S. S. (2009), "New Effect Size Rules of Thumb", *Journal of Modern Applied Statistical Methods*, Vol. 8, No. 2, Article 26. https://doi.org/10.22237/jmasm/1257035100

57. Smith, J. S., & Wertlieb, E. C. (2005), "Do First-Year College Students' Expectations Align with their First-Year Experiences?", *NASPA Journal*, Vol. 42, No. 2, pp. 153-174. https://doi.org/10.2202/1949-6605.1470

58. Smith, K., & Hopkins, C. (2005), "Great Expectations: Sixth-formers' perceptions of teaching and learning in degree-level English", *Arts and Humanities in Higher Education*, Vol. 4, No. 3, pp. 304-318. https://doi.org/10.1177/1474022205056173

59. Spitzer, M. W. H., & Musslick, S. (2021), "Academic performance of K-12 students in an online-learning environment for mathematics increased during the shutdown of schools in wake of the COVID-19 pandemic", *PLoS One*, Vol. 16, No. 8, e0255629. https://doi.org/10.1371/journal.pone.0255629

60. Stephan, M., Markus, S., & Gläser-Zikuda, M. (2019), "Students' Achievement Emotions and Online Learning in Teacher Education", *Frontiers in Education*, 4. https://doi.org/10.3389/feduc.2019.00109

61. Truta, C., Parv, L., & Topala, I. (2018), "Academic Engagement and Intention to Drop Out: Levers for Sustainability in Higher Education", *Sustainability*, Vol. 10, No. 12. https://doi.org/10.3390/su10124637

62. Turner, M. (2014), *The origin of ideas: Blending, creativity, and the human spark*. Oxford: Oxford University Press.

63. Urry, J. (1995). *Consuming Places*. London: Routledge.

64. Watkins, C. (2005), "Representations of Space, Spatial Practices and Spaces of Representation: An Application of Lefebvre's Spatial Triad", *Culture and Organization*, Vol. 11, No. 3, pp. 209-220. https://doi.org/10.1080/14759550500203318

65. Weaver, J. C., Matney, G., Goedde, A. M., Nadler, J. R., & Patterson, N. (2021). "Digital tools to promote remote lesson study", *International Journal for Lesson & Learning Studies*, Vol. 10, No. 2, pp. 187-201. https://doi.org/10.1108/IJLLS-09-2020-0072

66. Webb, N. (1997), *Criteria for Alignment of Expectations and Assessments in Mathematics and Science Education.* Washington, DC: Council of Chief State School Officers.

67. Zawacki-Richter, O., Baecker, E. M., & Vogt, S. (2009), "Review of distance education research (2000 to 2008): Analysis of research areas, methods, and authorship patterns", *The International Review of Research in Open and Distributed Learning*, Vol. 10, No. 6, pp. 21-50. https://doi.org/10.19173/irrodl.v10i6.741

68. Zembylas, M., Theodorou, M., & Pavlakis, A. (2008), "The role of emotions in the experience of online learning: challenges and opportunities", *Educational Media International*, Vol. 45, No. 2, pp. 107-117. https://doi.org/10.1080/09523980802107237