Which qualities should built environment possess to ensure satisfaction of higher-education students with remote education during pandemics?

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Abstract
The built environment may be considered a complex system comprising several parts (including people, organizations, and physical structures). Since the emergence of the COVID-19 virus in recent years, there has been an explosion in the usage of mobile learning applications for classroom instruction. Research on the diffusion of mobile learning is lacking. This study examines the perceptions and experiences of many aspects of online education from the viewpoint of Chinese HEIs and university students who shifted to online modes of instruction during the COVID-19 outbreak. This research aimed to determine whether or not college students were happy with the resources available to them, how their teachers communicated with them, how they were evaluated, and the conditions in which they studied at home. It also looked at the pros and cons of online learning from the students’ points of view. For this study, researchers opted for a cross-sectional survey using an online questionnaire. Information was gathered from 450 students from different Chinese tertiary institutions. To this end, we reflect on the experiences and perspectives of postgraduate students in urban design and discuss the results of an online survey conducted during the 2021–2022 academic year’s subject delivery period, which included activities such as assessment, feedback, field study visits, workshops, and the use of digital platforms. PLS-SEM, which stands for partial least square structural equation modeling, is used in order to evaluate the proposed model. Therefore, the findings show that the research model offered for this investigation could explain the diversity in the actual use of mobile learning systems. This would provide helpful insight into the effect of educational, environmental, and quality factors on the actual use of remote education systems. It was shown that quality concerns acted as a mediator between institutional policy, change management, and the implementation of mobile learning systems in actual classrooms. The findings also indicate that the level of pleasure students feel acts as a moderating factor between the degree to which the mobile learning system is used and its overall level of quality. According to the findings of these studies, academic institutions may enhance their use of mobile learning applications and get more benefits from these systems if they adhere to the suggestions stated in these studies.

Keywords Remote education · COVID-19 · Student satisfaction · Built environment · China · PLS-SEM

Introduction

As the COVID-19 pandemic grows further engrained in the everyday lives of billions of people throughout the globe, it has a tremendous influence on how activities involving human-to-human contact are carried out. Actions that formerly took little thinking must now be meticulously pre-planned because of the pandemic’s presence. Even higher education institutions (HEIs), or universities, have been swept up in this new social dynamic. They have had to quickly adjust to a far more complex setting than the classrooms they are used to (Navani et al. 2021). To stem the spread of the COVID-19 virus, the vast majority of educational institutions worldwide have been closed since about
March 2020. This has impacted over 90 percent of the total number of students worldwide. By the end of January 2020, all of China’s schools had been closed (Al Ghafri et al. 2020) and on January 29, the Chinese government. Because of the recent school closures, the Ministry of Education enacted an emergency policy known as “Suspending Classes Without Stopping Learning” to guarantee that students can continue their education from the comfort of their own homes utilizing the resources available on the internet. Chinese colleges began using online learning systems on January 29 and ended on April 3. Approximately 950,000 educators were responsible for instructing about 942,000 classes and 7,133,000 lectures utilizing various online platforms. College students have taken up 1.18 billion instances of these classes and lectures. The magnitude, breadth, and depth of China’s online education model are unsurpassed in the history of higher education worldwide. In addition, it has been a key experiment to support students in stopping learning so that more students would use them and fewer would drop out (Qin et al. 2023). The delivery of online courses has been made more accessible by several organizations, including these universities, which have established teaching and learning (TNL) departments in which instructors are trained to use online learning management systems like Blackboard. For online education to be successful, instructors needed clear instructions and thorough training (Zhu et al. 2022). All faculty and students had access to podcasts and tutorials, and online learning was well-supported. Some benefits and drawbacks came with this change for both children and teachers. Despite the widespread use of online learning, there is a lack of clarity on how students’ experiences may impact their happiness and continuation intention.

With the proliferation of mobile apps, online learning platforms have replaced conventional classrooms as the primary means through which higher education institutions (HEIs) may reach a wider audience and facilitate more significant levels of student engagement, collaboration, and personalization (Castillo-Manzano et al. 2021). On the other hand, the widespread pessimism and misconceptions about the efficacy of online education work to stymie the progress of individual students and whole educational institutions (Mallapati 2020). Recent research has also shown that students’ opinions and levels of satisfaction with remote online learning have little bearing on whether or not they plan to continue using it (Yang et al. 2022). The services and conveniences provided, in addition to the expertise and certifications of the instructors and the availability of support services and extracurricular activities, are all concrete aspects that contribute to student happiness in a conventional classroom environment (Alexander 2020). However, when used in an MCO setting, which might place teachers and students under great stress, remote online learning presents a unique set of difficulties. In light of this, HEIs know the critical necessity to overcome technical barriers during the pandemic (Liu et al. 2022a). It is especially important to have a strong foundation for online education and instruction. Since students are the end users, it is crucial to analyze what influences their level of contentment (Iqbal et al. 2021). It is important to understand how the present scenario may have affected students’ happiness with online learning, although many research has already explored this topic (Guo et al. 2022).

The I.T. resources and infrastructure in higher education may be roughly divided into asynchronous and synchronous (Kahraman et al. 2007). Asynchronous learning systems are based on types of communication that eliminate the need for users to communicate in real time with one another (Di Vaio and Varriale 2020). Well-established remote learning systems, such as Moodle and Blackboard, are designed to support stakeholder interactions based on a ‘request-response’ paradigm without time constraints. Conversely, video conferencing apps like Zoom and Skype are often used for synchronous online learning with real-time information exchange (Bayramova et al. 2021). Most universities and colleges that attempt to build virtual classrooms have relied heavily on these. However, a hybrid approach is required to successfully recreate face-to-face teaching in a digital setting (Kawaguchi 2019; Li, et al. 2022b).

The teaching methods and administrative backing needed to maintain meaningful student involvement are major challenges when shifting from face-to-face to online education delivery (Khanfar et al. 2021). Such concerns often stem from the nature of the subject matter being taught and the demographics of the intended student body. Training in advanced statistical methods, for instance, would need significantly different teaching styles and learning tools than medicine or other health-related courses with a practical component. What was simple to do face-to-face, such as doing practical demonstrations, becomes complex in an online setting, necessitating the development of expertise in the use of quickly developing learning tools not often used in the instruction of such tasks (Cerný et al. 2021).

Limited attention is being paid to sustainable learning, teaching, and education before and after pandemics, despite the fact that research is still being conducted to consider the need for a sustainability-focused approach that either reduces the risk of the pandemic or promotes flexibility in response to it. Planning’s role in pandemic management is
discussed, and the discrepancy between theory and reality is highlighted (Liu and Zhang 2020). According to the author, “those looking at the intersections of planning, design, and public health have focused less on infectious diseases and more on chronic disease, hazards and disasters, and the vulnerable” during the previous few decades (Li et al. 2023). The present epidemic brings back to the forefront the subject of how to design for infectious illnesses and offers critical challenges for further research and application (Yang et al. 2023). The debate, which results from the significance of planning, is as follows: education about the built environment has in the knowledge and practice of space design. The basis of this argument is that there is a need not only for the basic education and capacity development of built environment professionals (graduates or those still in training) but also for the built environment as a whole (Khan et al. 2021), but also for education that takes into consideration the possibility of pandemics or shocks in the future. The researchers’ previous knowledge and activity in the built environment cluster, in both their academic and professional capacities, is essential to the success of this study (Guo and Zhong 2022). As a result, some anecdotes may speak to or reflect the researchers’ ideologies and experiences with critical thinking in the service of ideation and argumentation (Dwivedi et al. 2020).

Considering all of these factors, this study’s overarching goal is to dissect students’ views towards mandatory distance learning during a worldwide crisis. Private higher education institutions (HEIs) need to assess students’ happiness with online knowledge and their continued use goals for online education, given the uncertain future of the global pandemic. The importance of the emerging pattern in online education and the uncertainty of the situation necessitates this. To be more specific, this study aims to determine which factors are most influential in determining the extent to which pleasure that students have with their experience of online learning and to investigate whether or not this level of satisfaction acts as a mediator in the correlations that exist between the primary factors and students’ desire to continue using the platform. This study also aims to fill in some gaps by investigating how gender and skill level moderate the relationship between students’ satisfaction and their determination to continue their education. Despite the difficulties we face, it is hoped that the findings of this study will be instrumental in developing methods that will help improve the efficiency of distance education. Conversely, creating a built environment with features intended to boost psychological well-being is unusual. When considering academic buildings, the built environment may be conceived of as having three dimensions: the interior environment, the semi-open space environment, and the outer perimeter environment, which considers both physical conditions and natural exposure (Li, et al. 2022a).

This research aims to examine, within the context of the pandemic, the extent to which students are satisfied with the different components of the architectural environment of academic buildings and how these assessments impact the predisposition for worry among students. A multifactor holistic model was devised because of the potential for interference from confounding factors in the study (Li et al. 2020). The findings of the study will be used to assist in relevant decision-making. The study will serve as a reference for the design and renovation of the architecture and environment of academic buildings. This will be done to reduce student anxiety and improve mental health through improvements to the built environment of academic buildings. This may be achieved by altering the architectural environment of educational institutions (Qazi et al. 2022).

The remaining portions of this report are organized as shown below. The literature reviews for this research are included in the “Literature reviews” section of the report. The “Hypothesis development” section discusses the theoretical framework and hypotheses that guided the study; the “Methodology” section describes the research strategy, variables, and statistical methods used; the “Results and analysis” section presents the data; the “Discussion of analysis” section offers an interpretation of the data; and the “Conclusion and policy suggestions” section provides a summary, recommendations, and caveats (Raza et al. 2020).

Literature reviews

“Learning that is mediated by the Internet” (Chen et al. 2022) is what is meant by “online learning,” while the term may have a variety of other connotations (Chien et al. 2021). Distance education includes a wide variety of technical applications and learning methods, and one subset of this is online learning, also known as e-learning, web-based training, virtual learning, net-based learning, and cyberlearning (Tang et al. 2022). When a class is held online, both the instructor and the students may take part in the lessons and assignments from anywhere they have an internet connection, whenever they choose (Deng et al. 2015). Learner agency and independence are emphasized as central to the online learning pedagogical paradigm (Zou 2021), regardless of whether the implementation is synchronous or asynchronous (Zhu 2017). Accordingly, online education aims to foster metacognition, reflection, and teamwork among students (Chau et al. 2021a). Several academics have cited the transitory nature of classroom conversations and the increased time for students to reflect before replying to questions as advantages of online learning (Shirish et al. 2021). However, issues with accessibility, technological know-how, equipment, and student focus may all compromise the efficacy of online education (Adarkwah 2021).
Blackboard and similar microblogging, multimedia-based platforms have reportedly grown in significance over the last several years in distance education classes (Patrascoiu et al. 2022). Asynchronous learning via microblogging is thought to improve education since it allows for greater customization and ongoing education even after courses have ended (Wong 2020). Video conferencing applications like Zoom, Blackboard Collaborate, and Trendify have made it feasible for distance learners to participate in live lectures. In the aftermath of COVID-19, it is more important than ever to conduct research using the synchronous mode of instruction, where sessions are scheduled at the original class period and held in real time ignoring geographic constraints (Sun et al. 2021). As the COVID-19 situation improves, more and more schools are adopting hybrid/blended/flipped classroom models, which integrate online and face-to-face instruction with problem-centered learning and the practice of tasks (Li et al. 2021; Khan et al. 2019; Sun et al. 2022).

Online education emphasizes technological elements, some of which may hinder or aid students’ education (Vasic et al. 2019). Attributes of online learning denote those aspects of the virtual classroom that allow for communication between the teacher and the student (Tang et al. 2022). These characteristics include adaptability, practicality, structure and organization, ease of use, and teacher caliber while using virtual classrooms (Purnawirawan et al. 2012). Previous studies on online learning have focused on some of these characteristics, but they only scratch the surface (Table 1) (Cao 2022). We deploy a questionnaire to gauge users’ impressions of interactive goods based on 26 criteria to counteract this shortcoming. These features are broken down into six categories: perception of the product, readability, familiarity, speed, effort, dependability, user control and confidence, stimulation, motivational quotient, and newness (Adarkwah 2021; Ali et al. 2022).

Table 1 The participants’ biographies, including their educational backgrounds

| Variables                     | Frequency | Percentage |
|-------------------------------|-----------|------------|
| Gender                        |           |            |
| Male                          | 267       | 59.33%     |
| Female                        | 183       | 40.67%     |
| Types of university           |           |            |
| Public                        | 310       | 68.88%     |
| Private                       | 140       | 31.12%     |
| Level of enrollment           |           |            |
| Undergraduate (e.g., B.A., BSc) | 215       | 47.78%     |
| Graduate (e.g., MA, M.Sc., BS Hons) | 90       | 20%        |
| Postgraduate (e.g., MPhil., PhD) | 145       | 32.22%     |
| Major disciplines             |           |            |
| Social science                | 93        | 20.67%     |
| Science                       | 67        | 14.87%     |
| Engineering and technology    | 150       | 33.35%     |
| Business/management/commerce  | 54        | 12%        |
| Arts and humanities           | 43        | 9.55%      |
| Agriculture                   | 23        | 5.11%      |
| Health and science            | 20        | 4.45%      |
| Arrangement for study         |           |            |
| Shared study room             | 280       | 62.22%     |
| Independent study room        | 170       | 37.78%     |

Motivation is something within you that makes you want to act or come closer to your objective (Li et al. 2021). Student motivation may be defined as strength, originality, and preparedness (Archambault et al. 2022). Studies have shown that students are less motivated to study when they feel alone or distant from other students in an online classroom (Zhang et al. 2020), which may lead to a higher dropout rate. According to Lau et al. (2021), students’ motivation plays a role in how happy they are with their online learning experience. A student’s level of motivation predicts how well they will do in an online learning environment.

An important part of online education that might affect quality is the institutional facilitation of students and teachers. It has been argued that organizational decisions impact teaching quality and that organizational policies are crucial in keeping educators’ content (Pu et al. 2022; Wang et al. 2021). When there is a crisis at a university, open lines of communication from the administration assist students and staff in remaining informed, motivated, and optimistic (Sahir et al. 2021). It has also been theorized in the literature that teachers in virtual classrooms rely on administrative backing and supplies to create learner-centric spaces. According to instructors, collaboration, training, and institutional support are crucial for successful teaching (Chao et al. 2021), according to instructors. However, it should be emphasized that occasionally the training supplied to the instructors is either not appropriate for the job at hand or is incompatible with the demands of the educators (Huang et al. 2021b). The cumulative effect of these problems might have an effect on how happy students are with their online education (Ahmed et al. 2020). The present COVID-19 epidemic is a problem that requires immediate attention the function of institutions takes on an even greater significance (Khan et al. 2018). The cumulative effect of these problems might affect how happy students are with their online education. In critical situations, such as the present COVID-19 outbreak, the function of institutions takes on an even greater significance (Al-Shammari et al. 2022).

Student satisfaction with an online course is better among those students who are familiar with the usage of relevant educational technology and tools (Patrascoiu et al. 2022). However, even students who consider themselves to
be “tech savvy” may at some point need assistance with a technical issue (Haji 2021). Online learning environments and experiences are influenced by student perceptions of aspects including usability, friendliness, safety, speed, and responsiveness (Solomon 2021). The current epidemic has also shown how important it is to have institutionalized help and direction during emergencies (Andersson et al. 1979). Students learning online have been said to have needed more explicit explanations and enforcing of ICT laws (Lange et al. 2020). Issues of inequity and inadequate aids have to be addressed on a systemic basis (Tsimisaraka et al. 2023). At the venue, both students and teachers had access to short-term loans and the internet University of West Indies in a timely manner, which has been praised in the literature (Caglar et al. 2021). It has been pointed out, meanwhile, that research institutions in poor nations may lack the resources of their more developed counterparts, making it harder for them to implement effective preparation, response, recovery, and mitigation programs (Lu 2018).

Hypothesis development

The term “top management support” (TMS) refers to the approval and backing from above that mobile learning systems get (Khoso et al. 2021; Chen and Bai 2022). Management at the university’s highest levels, including the president, vice president, faculty dean, department head, and mobile learning director, are considered “top management” in this study. According to Sun (2016), this is a major reason why mobile education systems have been so successful. When asked what variables contributed most to the success of mobile learning programs, 79% of respondents cited managerial support (Gluch et al. 2009; Kutieshat and Farmanesh 2022). With the backing of upper management, mobile learning initiatives will have access to more funds and tools, allowing for more efficient development and rollout (Weihong et al. 2021).

Having the backing of upper management is essential for mobile learning to succeed, according to many studies (Sulich and Soloduro-Pelc 2021; Ahmed et al. 2023). Also, research by Shi et al. (2013) found that having management buy-in improves quality of the system and the service. We have faith in the factors discussed here—including the backing of upper management—that will lead to an improvement in mobile learning’s system and service quality, which will increase happiness among users and more widespread adoption of the technology (Chen et al. 2022; Xiong et al. 2022a).

Hypothesis 1 (H1). The quality of the system will improve with the backing of upper management.

Hypothesis 2 (H2). The quality of services provided will improve with leadership’s backing.

Allocation of institutional values, resources, and objectives is known as institutional policy (Xu et al. 2021). Institutional policy is formalized and disseminated in writing, creating a canon to which all employees are legally bound (Khan et al. 2020). According to Qalati et al. (2021), e-learning policies need to address issues including how they will be funded, who will provide technical assistance, how they will be evaluated, what kind of infrastructure will be needed, and what the pedagogical objectives will be. Qalati et al. (2021) claimed that institutions may benefit from adopting mobile learning practices that are both accommodating and adaptable. It has also been noted that institutional policy is crucial to the effective implementation for portable instructional tools (Kutieshat and Farmanesh 2022). Furthermore, the research already done on e-learning suggests that the quality of the system and the service is directly influenced by institutional policy (Info n.d.). With the right institutional policies in place, we believe that m-learning systems and technological support will be able to evolve to better fulfill the needs of the people who use them. As a result, we should anticipate a rise in the quality of both systems and services (Xiong et al. 2022b).

Hypothesis 3 (H3). The quality of the system will be improved through institutional policy.

Hypothesis 4 (H4). The quality of services provided will improve as a result of institutional policy.

Online (synchronous or asynchronous) learning environments provided by learning systems allow for increased teacher-to-student communication, tracking of individual students’ progress, and the safe distribution of digital course materials (Zhang et al. 2020). Whether instructors and students are able to use the system to their advantage is often used as an indicator of how well e-learning is doing as a whole (Alsabawy et al. 2016). The quality of the website, technical tools, and infrastructure through which instructors and students access learning materials or resources of different courses has been shown to have a significant impact on their utilization of e-learning systems (Akram et al. 2021; Chao et al. 2021; Chandna, Saini, and Kumar 2021). Those who utilize the system more effectively report higher levels of learning satisfaction; this, in turn, may lead to more consistent system usage by students. Learning results and student satisfaction with online education have been shown to improve with higher quality of system (services, administration, and technology) (Liu et al. 2023a; Lau et al. 2021). Researchers in Thailand looked at postgraduates’ impressions of distance learning and reached the conclusion that eLearning system affects how happy and successful those learners feel. Akram et al. (2021) performed a National Survey of Pakistani Undergraduate Dentistry Students on Their
Perceptions of the Effectiveness Students’ Perceptions of the Value of Online Learning Were Most Affected by the Learning System and Service Quality During the COVID-19 Pandemic. Therefore, the achievement and satisfaction of college students enrolling in online courses during the COVID-19 epidemic may depend on the quality of the systems used to deliver those classes (S. Lu et al. 2023). As a result, we will assume that

Hypothesis 5 (H5). The satisfaction of students is influenced favorably by the quality of the system.

When discussing mobile education, service quality is defined as how well the services provided by the system live up to the standards of dependability, security, privacy, responsiveness, and assurance set by the students using the system. Previous research on I.S. success has shown that high-quality service increases student happiness (Huang et al. 2021a). The ISS model suggests that the quality of the service provided may influence how often it is used (Zheng et al. 2021). Student acceptance of mobile learning systems was shown to be positively correlated with service quality, according to research on I.S. success cited in Huang et al. (2021a). Ahmad et al. (2019) verified that improved service quality increases the value of these solutions. Therefore, we hypothesize that enhancing service delivery would lead to greater user satisfaction and increased adoption of mobile learning platforms (Liu et al. 2023b).

Hypothesis 6 (H6). Satisfaction among students will increase as a result of high-quality services.

As all teaching and learning took place in an online environment during the COVID-19 pandemic, we include the quality dimension, which measures several important aspects of the e-learning system, such as the quality of the system, the quality of the information, the quality of the service, the quality of the learner’s digital work, and the quality of their interactions with other learners. The D&M model, with its emphasis on user happiness and quality dimension, is often used for the purpose of determining the efficiency of information systems, especially online learning systems (Bates 2021). It is a framework the extent to which students feel they are supported by their instructors and the academic counseling service contributes to their level of perceived student satisfaction (Wang et al. 2022). An online learning system’s perceived value to students is the focus of Perceived Student Performance. Students’ perceptions of their own progress in light of the shift to an online learning environment are assessed (Dwivedi et al. 2020). There are three main components to the suggested model’s framework: Quality of Online Courses, Learner Experience, and Academic Success (Gao and Petrova 2022). It is reasonable to anticipate that improved levels of student contentment with the online education environment system will result in more student utilization of the system, which, in turn, will lead to improved levels of academic achievement. It is quite unlikely that someone can achieve success without making use of the system.

As a result, three different theories have been offered:

Hypothesis 7 (H7). Improved student satisfaction may be attributed to higher standards in online education.

Increased time spent in nature has been shown to improve physical health, mental health, and cognitive functioning; decreased time spent in nature has been shown to have the opposite effect on mental health outcomes; and those who lack access to green space and are otherwise physically unhealthy are more likely to experience mental health issues (Khan et al. 2018). More frequent use of green space and the availability of a view from a home’s windows were related with higher levels of self-worth, life satisfaction, and subjective well-being, as well as lower levels of sadness, anxiety, and loneliness during the COVID-19 pandemic (Zafar et al. 2021). It may be possible to lessen or even avoid the mental health risks associated with social isolation by maintaining contact with nature (blue-green space) (Zou et al. 2019; Zhou and Shimada 2020). According to campus-based research, students’ physical well-being is greatly improved by the presence of green spaces on campus. This is because plants have been shown to reduce students’ levels of stress and because being in nature has been shown to improve students’ ability to focus and learn (Kadlec et al. 2011). In conclusion, being outside in a natural setting has a profoundly positive effect on one’s mental health. We hypothesized that students who were dissatisfied with the constructed environment’s natural exposure component would also be more prone to worry.

Hypothesis 8 (H8). For a constructed setting to be suitable for distance learning, health and safety measures must be in place.

Methodology

According to Haji (2021), surveys are the most common form in information gathering for research on Chinese online educational platforms, so we found the best way to get a representative sample of perspectives, insights, and experiences of Chinese students from the East and West during the COVID-19 pandemic (Solomon 2021). Zheng et al. (2021) created the survey to gauge user experience with online research databases; recently, Purnawirawan et al. (2012) adapted it for usage in Chinese universities and
verified its accuracy via translation. We have made some adjustments to both versions to see how well they serve our goal of measuring student satisfaction with online learning platforms. To this end, we reflect on the experiences and perspectives of postgraduate students in urban design and discuss the results of an online survey conducted during the 2021–2022 academic year’s subject delivery period, which included activities such as assessment, feedback, field study visits, workshops, and the use of digital platforms. Subsequently, 145 students from East China Normal University and Yuxi Normal University that were selected at random for this study were given the survey to pretest the modified instrument for responsiveness and clarity of questions. After doing statistical analysis using the Rasch model, changes were made. Each of the 33 questions on the official questionnaire used in this research was scored on a 6-point Likert scale. The TSM model dimensions that the survey examined were made. Each of the 33 questions on the official questionnaire used in this research was scored on a 6-point Likert scale. The TSM model dimensions that the survey examined are presented for your perusal in Table 1. Before distributing the questionnaires to college students, we had gotten ethical approval for this study.

Students at all levels of education in China’s higher institutions who were enrolled in courses taught online because of the COVID-19 epidemic were included in the study. The Institute for Information Management provided the necessary ethical clearance for the investigation. An information sheet was included in the online survey to facilitate the collecting of informed consent. There were two phases to the sampling process. The first step was to compile a list of the 145 Chinese colleges that provide distance learning. We chose 45 institutions at random from among these 145 that provide courses in at least two different academic fields (including but not limited to the fields of social sciences, natural sciences, engineering and technology, arts and humanities, and business). The researchers visited different departments at the 45 institutions they had previously chosen to use the convenience sampling strategy to gather data from students. The information was gathered with the use of a Question Pro-built online survey. Once completed, students were sent the link to the questionnaire through WhatsApp and Facebook groups. The different faculty groups and department heads at the institution were also asked for assistance in spreading the questionnaire’s central role in the students’ relationships. There were 450 responses in all, overall, 267 from women and 183 from men. SPSS (version 22) was used to analyze the data.

**Characteristics relating to individuals’ lives and education**

The participants’ demographic data is shown in Table 1. Two-hundred sixty seven (59.33%) of the 450 participants were female, while 183 (40.67%) were male. A total of 310 students, or 68.88%, came from institutions of higher education supported by taxpayer dollars. Participants’ levels of education ranged from undergraduate (215; 47.78%) through graduate (90; 20%) to postgraduate (145; 32.22%). Out of the total number of participants, 93 (20.67%) had degrees in social science; 67 (14.87%) economics; 150 (33.35%) in engineering and technology; 54 (12%) in business, management, or commerce; 43 (9.55%) in the arts and humanities; 20 (4.45%) in health sciences; and 23 (5.11%) in agriculture. The majority of the 450 respondents (62.2%) said they had access to a common study space, whereas just 37% of the respondents (170) said they had access to a private room.

**Data analysis**

PLS-SEM is a method that is often used to test and assess intricate statistical models; thus, it was used for the goal of carrying out this investigation. The CB-SEM approach is another method that may be used in order to assess the quality of a structural model (Hayajneh et al. 2022). It assumes normally distributed data but performs poorly in social science studies. PLS-SEM, on the other hand, does not rely on parametric assumptions; therefore, it may be used with data that does not follow a normal distribution, and it uses ordinal and binary scales effectively so long as they are recorded correctly (Sharma and Aggarwal 2019). PLS-SEM, on the other hand, is capable of dealing with complicated models and producing superior results (Hair et al. 2017). Non-normal data, small sample sizes, and the usage of formative constructs have all contributed to PLS-SEM’s rising popularity in recent years, making it a viable option in a variety of fields. In recent years, SEM’s toolbox has grown to accommodate more intricate model creation and address data shortcomings such heterogeneity (Wong 2013). PLS-SEM was determined to be an appropriate method for testing the hypotheses in this investigation. As we have seen, it offers a number of benefits for studying higher level concepts. To analyze the connection between these two variables, we used the “Two-stage Approach” proposed by Avkiran (2018). All of the reliability and validity tests were carried out during the first phase of the project, which saw the construction of the lower order measurement model. In the second step, we used a structural equation model to test our hypotheses, which were formed based on the findings from the first stage, in which we identified the indicators for the higher order construct.

**Results and analysis**

There was a total of 450 acceptable replies, and descriptive statistics were calculated using SPSS. PLS-SEM is an abbreviation for partial least squares structural equation model, which was used in the analysis of the data, which included...
a two-stage structural equation modeling procedure. The hypothesis is tested by first evaluating the measurement model and then by putting the test the structural model. In the sections that follow, you will discover the results.

**Descriptive statistics**

To guide future empirical study, descriptive statistics of the variable are essential. TMS, SMQ, SEQ, IPS, ST, EL, HS, and BEN were the primary research foci. Table 2 presents a number of descriptive statistics about the variables. These statistics include the mean, median, standard deviation, skewness, and kurtosis. All variables reflect a high level of care, since there is little variation between their means and medians. This table shows that the mean value for “built environment” is the greatest and the mean value for “student satisfaction” is the lowest. The absence of a statistically significant disparity between the mean and the median indicates the absence of an outlier in the data set. The outcomes of the normality tests (skewness, standard deviation, and kurtosis) and the summary measures between variables are shown in Table 2. Data are properly distributed if and only if the skewness values are close to 0. Furthermore, kurtosis was utilized to evaluate the tail weight of the series relative to the normal distribution.

**Assessment of measurement model**

Convergent validity and discriminant validity were evaluated using criteria proposed by Vasic et al. (2019) during the measurement model phase. Table 3 displays the results of the convergent validity study for the latent constructs. This includes the composite reliability, average variance extracted (AVE), square root of AVE, and correlations between the components. Convergent validity of a measurement model is established if factor loadings are greater than 0.7 (Fatima et al. 2023). Because their associated AVE values were more than 0.5, items with loadings of 0.6 to 0.7 were kept (Qalati et al. 2021). All of the AVE values for the constructs presented are more than the suggested threshold value of 0.50, providing strong evidence for convergent validity (Sarfraz et al. 2022), and every one of the results for composite reliability (C.R.) is greater than 0.7 (Qalati et al. 2021). Internal consistency is shown by a Cronbach’s alpha (C.A.) score of 0.8, above the threshold for statistical significance.

Fornell-Larcker’s criterion analysis results for evaluating discriminant validity are shown in Table 4. All the indicators have greater loadings than the other constructs in this research (bolded loadings). High discriminant validity for the measurement model is shown when the square root of the average correlation across all components is compared to the correlations across the constructs.
Using six fit indices, we analyzed the model’s accuracy in accordance with Kura (2011), Babajide et al. (2021), and Xue et al. (2022). These indices comprise the ratio of $\chi^2$ to the degree of freedom ($\chi^2$/df), the Root Mean Square Error Approximation (RMSEA), the Adjusted Goodness of Fit Index (AGFI), the Normed Fit Index (NFI), and the Comparative Fit Index (CFI). Table 5 shows that all fit indices were well within their acceptable ranges, suggesting that the measurement model was accurate.

Results from verifying the hypotheses are summarized in Table 6. Findings with a $p$ value below 0.05 are typically recognized as statistically significant, according to Vasic et al. (2019), with the exception of medical research. Six of the eight elements have direct correlations with customer happiness: the quality of the overall management system, the quality of the total management system’s services, and the quality of the institutional policy governing the total management system; there was a statistically significant relationship between service quality, e-learning, and the health and safety of the built environment on student satisfaction (H1, H2, H6, and H8). According to the model’s overall coefficient determination, these six variables adequately explained 59.3% of the variation in reported levels of satisfaction among those involved in online learning. The current research indicated that the three most important aspects that may have a negligible influence and were not supported by the students’ satisfaction were institutional policy, service quality, and system quality.

### Discussion of analysis

This section demonstrates that the quality of mobile learning applications was considerably impacted by three of the four educational environment aspects (change management, institutional policy, and support from top management). Based on these findings, it seems that a combination of factors, including system characteristics, user experience, and content, is necessary for high-quality mobile learning apps to satisfy the expectations and demands of students. Both software and hardware availability, as well as administrative support, pertinent institutional policy, and organized change management, are crucial. So, it is not only about having access to the right software and hardware in order to develop superior mobile educational applications designed with kids in mind. The mobile learning literature lacks studies that examine how senior-level buy-in, institutional policy, and change management affect the adoption and use of mobile learning systems. This study’s findings provide strong empirical evidence for the importance of these characteristics, which are crucial to the performance of mobile learning systems. It was shown, however, that different organizational

### Model fit analysis

| Variables | TMS | SMQ | SEQ | IPC | ST | EL | HS | BEN |
|-----------|-----|-----|-----|-----|----|----|----|-----|
| TMS       | 0.954 |     |     |     |    |    |    |     |
| SMQ       | 0.378 | 0.732 |     |     |    |    |    |     |
| SEQ       | 0.323 | 0.443 | 0.876 |     |    |    |    |     |
| IPC       | 0.367 | 0.564 | 0.412 | 0.832 |    |    |    |     |
| ST        | 0.643 | 0.442 | 0.564 | 0.634 | 0.887 |    |    |     |
| EL        | 0.523 | 0.478 | 0.474 | 0.721 | 0.711 | 0.812 |    |     |
| HS        | 0.896 | 0.654 | 0.439 | 0.784 | 0.677 | 0.645 | 0.809 |     |
| BEN       | −0.037 | 0.078 | 0.021 | 0.045 | 0.016 | −0.085 | 0.012 | 0.834 |
structures had little effect on the quality of mobile learning systems. Possible causes include a disorganized infrastructure for sharing information and coordinating efforts among mobile learning system stakeholders (including students, teachers, and administrators). Because most mobile learning technologies at universities were not created by the institution itself, their creators are often not considered insiders. Further, we discovered that effective change management, institutional policy, and leadership buy-in significantly and positively impact service quality. As this research shows, a mobile learning system’s ability to provide high-quality services relies heavily on management buy-in, institutional policy, and change management. Ren et al. (2022) propose that the success of e-learning programs depends heavily on institutional policies, change management, and top-down support. Quality of mobile learning services is not shown to be substantially impacted by organizational structure.

Furthermore, student happiness with mobile learning systems is greatly impacted by service quality. According to our data, high-quality service has a constructive effect on students’ overall contentment. The quality of the service provided is a proxy for how well the mobile learning system meets the demands of the students using it. As a result, the level of satisfaction with mobile learning systems may be measured against the quality of the service provided. Most people who work on mobile learning systems focus on creating features and fixing bugs rather than making sure users are happy. Therefore, it is crucial for university-based mobile learning system providers to prioritize meeting the demands of their customers as they build and provide their products and services. Furthermore, student satisfaction had a mediating role between service quality and the degree to which mobile learning technologies were actually used. Students’ satisfaction with the service they get is crucial to the widespread adoption of mobile learning solutions. Therefore, this research recommends that, in order to guarantee the long-term success of mobile learning systems, suppliers and developers provide their full backing to an analysis of students’ needs and requirements at each stage of the process. To keep up with the pace of technological development, they should also ensure that sufficient funds are set out for system upgrades. These findings agree with those of research by Qin et al. (2021). These results are consistent with the literature that shows that students’ views of learning outcomes and satisfaction improve when there is high quality in the system, course design, interactions between students, and between students and course materials. There are two types of contact between students and teachers that influence student happiness, as shown in the cited studies. Similarly, Baber’s study (Kothari et al. 2020) discovered that students’ perceived learning result and student satisfaction are highly influenced by interaction, student motivation, course structure, teacher expertise, and facilitation. During the COVID-19 pandemic, he warned that pupils would be harmed by the difficulties inherent in online learning when it comes to fostering social contact (Shen et al. 2021). In addition, self-discipline was shown to have a substantial impact on both academic success and overall happiness. Higher aspirations for achievement may account for the correlation between self-discipline and success. It should be evident that the learner’s capacity to take responsibility of his or her education is directly related to the learner’s level of self-discipline. Cao et al. (2022) indicated that almost all students (96%) are susceptible to distractions (such as gaming and YouTube) while using online learning resources; nevertheless, several research showed that self-discipline did not substantially predict either success metric (IEA 1973).

According to the findings, other factors, such as the quality of the underlying system, are more important to a person’s satisfaction with their e-learning experience than their degree of technical competence. These findings are consistent with those from other research (He et al. 2021) that revealed that system quality is positively connected to users’ perceptions of satisfaction, but at odds with those from Zhang et al. (2018) that found no such connection. We also discovered that using different distribution strategies enhanced the system’s quality. Although research has shown that the quality and diversity of a home’s infrastructure may affect the performance of the system, it is not a decisive component. According to these findings, students benefit from a variety of teaching methods, but a well-established physical space is less crucial. One of the three most essential aspects of e-learning quality, and hence students’ overall satisfaction, was found to be online instruction reports of how satisfied they are with the course and how well they are doing in it. Information quality is one metric that may be used to evaluate an online course, but there are many others to examine as well, such as the teacher’s commitment to and comfort with the medium, the frequency with which assignments are completed, and the willingness to include students’ ideas and feedback (Mohsin et al. 2021). Teachers’ accessibility in an online classroom, whether via fast feedback or the responding of queries, may provide light on the credibility of the provided information (Blanco et al. 2015). In light of the recent coronavirus outbreak, the purpose of this research was to identify the ways in which students’ perceptions of and responses to their physical surroundings affect their satisfaction with and success in remote learning. Indicators of student success and teacher happiness were used to evaluate the built environment’s success in providing a healthy, safe, and comfortable setting.

Conclusion and policy suggestions

The current study set out to investigate and evaluate how the home-built environment affected the happiness and success of distant learners during the COVID-19 epidemic.
The area has been defined by the borders of China. The preparation of the physical environment was evaluated for both its direct and indirect implications on the enhancement of student satisfaction with distant learning. There are several theoretical and practical ramifications of this research. University administrators, service providers, developers, and designers are provided with findings and suggestions for enhancing the quality of mobile learning systems and their understanding of multidimensional elements for effective utilization. First, officials at institutions should encourage projects to deploy mobile learning by investing adequate finances and resources. University administrators should focus on factors that significantly increase the quality of mobile learning applications in order to boost learning efficiency and student success. First, administrators at universities should back initiatives to implement mobile learning by allocating enough funds and resources. University administrators should focus on factors that significantly increase the quality of mobile learning applications in order to boost learning efficiency and student success. Third, the study validates the significance of classroom context and students’ authentic use of mobile learning devices. Students require the support of faculty and staff to increase their actual use of mobile learning technology. Finally, this research’s findings can inform the creation of mobile learning systems at universities, ensuring that students have access to course materials that are well designed for their level of knowledge, that a variety of multimedia features are supported, and that students have access to online discussion forums where instructors can respond to their questions. Satisfaction and real usage of mobile learning systems from students would increase with the presence of such quality aspects.

Understanding the factors that affected students’ performance after the rapid introduction of e-learning should be helpful for decision-makers and everyone involved in implementation. As a consequence, our study’s findings suggest an actionable plan for future instruction, investigation, and policymaking. It is urged and encouraged to invest in the growth of students’ and faculty’s digital skills, as well as to foster programs that promote research and multidisciplinary inventive cooperation across the many facets of online higher education. Researchers might further design homes that are resilient to pandemics, while policymakers are urged to prioritize the development of digital equality for diverse living locations for more effective teaching procedures during pandemics. This study enriched the existing literature on residential facility development, particularly in the field of improved communication technology equipment for remote places. Therefore, we suggest that future works account for social elements that may significantly affect students’ happiness throughout the online learning process. We also suggest taking into account the influence of the major, since students’ interests and career goals may have significant bearing on their experience with distance learning.

### Limitation and future work

Several caveats are mentioned. To begin, the learning results and student satisfaction with online learning environments may vary among courses and pedagogical demands. Students from a public Chinese university served as the sample, and a convenient sampling method was used. This may reduce the sample’s representativeness and the generalizability of the findings. Our results may not apply to all college students or even all college students in the world, depending on the demographics of our primary sample. Our research provides a foundation for future studies to duplicate and compare the perspectives of other college students, particularly those from different nations. Studying the effects of the COVID-19 pandemic on online learning outcomes and student happiness at a university is important, but extrapolating those results to other learning platforms is problematic. The study used Tron Class and Ding Talk as learning platforms and interactive tools. While a questionnaire was utilized to gauge students’ perspectives in this research, a qualitative examination might provide richer insights into participants’ thoughts and feelings as well as more nuanced analyses of the connections between the hypothesized dimensions. Therefore, integrating quantitative and qualitative methodologies in future studies may help corroborate these results.

### Author contribution

Shaobin Weng: conceptualization, data curation, and methodology. Yuanyuan Qin: writing — original draft, data curation, visualization, supervision, editing, writing — review and editing, and software.

### Data availability

The data can be available on request.

### Declarations

**Ethics approval and consent to participate** We declare that we have no human participants, human data, or human tissues.

**Consent for publication** N/A.

**Competing interests** The authors declare no competing interests.

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