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Extending the technology acceptance model to understand the use of e-learning during COVID-19 pandemic for enhancing learning process: Iraqi universities' students

Suad Shatti Azeez, Salih Hajem Glood, Mohammad Kasib Layous Alhasnawi

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Extending the technology acceptance model to understand the use of e-learning during COVID-19 pandemic for enhancing learning process: Iraqi universities' students

Suad Shatti Azeez

IT Department,
Ministry of Education,
H.8, Zuona, 00964, Baghdad, Iraq
Email: Suad.hr06@gmail.com

Salih Hajem Glood*

College of Education for Pure Sciences,
University of Thi-Qar,
Our8, Nasiria, 00964, Thi-Qar, Iraq
Email: salihglood@utq.edu.iq
*Corresponding author

Mohammad Kasib Layous Alhasnawi

Faculty of Health, Engineering and Sciences,
University of Southern Queensland,
16 Platz St., Darling Heights, Toowoomba, QLD, Australia
Email: Mohammad.alhasnawi@usq.edu.au
and
Faculty of Administration and Economics,
University of Sumer,
Thi-Qar, Iraq
Email: mohammad.kasib@uos.edu.iq

Abstract: Although the influencing factors on the use of e-learning (EL) were examined in previous studies, the physical characteristics of the educational environment and their impact on the use of EL during the COVID-19 pandemic are still to be investigated. Therefore, to bridge this gap, this study adapted TAM as a theoretical model and extended it by adding learning content; and lighting and noise as environmental variables. This study aims to investigate the effecting factors of EL on Iraqi universities during outbreaks of COVID-19. Moreover, the study used an online questionnaire of 455 students of the southern region universities in Iraq and Smart-PLS technique for data analysis. The findings revealed the relationships amongst the core constructs of TAM supported; learning content has a positive effect on perceived ease of use and perceived usefulness; moderating effect of environmental factors on the relationship between perceived usefulness and intention behaviour was supported. The implication is that the decision-makers of EL should focus on factors that play an influential role in promoting students' use of EL.

Keywords: COVID-19; e-learning; electronic learning; higher education; technology acceptance model; TAM; Iraqi universities; Smart-PLS technique; educational environment; use of e-learning.

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Biographical notes: Suad Shatti Azeez received her MSc in Information Technology from the University of Cankaya, Turkey and she obtained her Bachelor's degree from Baghdad University in Computer Science. Azeez is working in the Iraqi education Ministry, information and communication department, as a trainer of Icdl methodology. Her main research interests are big data analytics, e-learning, and also networks.

Salih Hajem Glood received his PhD in Information Technology (IT) from Utara Malaysia University, Malaysia, in 2016, and MSc in Information and Communication Technology from Utara Malaysia University, Malaysia in 2010. He is an Assistant Professor at the College of Education Pure Sciences in Thi-Qar University. He is currently the Assistant Dean of Pharmacy College. During his career, Glood participated in multiple international scientific and industrial projects, devoted to the formal modelling, design, and development of advanced software systems. He has published over 20 research papers in highly reputed journals. He is a certified recognised reviewer by several leading journals in Elsevier. His current research interests include technology adoption, m-e-government, m-e-learning, and knowledge management. In addition, he is working on different research areas in computer science and is currently interested in conducting research in e-learning and its impacts on higher education.

Mohammad Kasib Layous Alhasnawi received his MSc in Information Communication and Technology (ICT) from the University Utara Malaysia (UUM), Malaysia in 2011. He received his PhD in a Computer Network from The University of Southern Queensland (USQ), in Toowoomba, Queensland, Australia in 2020. He is currently working with The University of Southern Queensland (USQ) and the Sumer University, Thi-Qar, Iraq. His current research interests include wireless networks, mobile communications, mobility management, ad hoc and sensor networks, and cross-layer protocol design.

1 Introduction

In late December 2019, coronavirus-19, popularly known as COVID-19, was first recognised in Wuhan, China, which became widespread in more than 200 countries (Shen and Ho, 2020; Temsah et al., 2020). On 11 March 2020, the World Health Organization (WHO) announced COVID-19 as a global pandemic (Adnan and Anwar, 2020; Kapasia et al., 2020). Therefore, several procedures were issued by the majority of governments to inhibit the spread of this pandemic, such as stay-at-home instructions and social distancing. On 10 May 2020, the WHO stated that the COVID-19 pandemic affected the lives of millions of people worldwide, such as researchers, academics, and students

(Hussein et al., 2020). One of the impacts is the closures of schools and higher education institutions (HEIs) for inhibiting the spread of a pandemic. Due to the imposition of closure for a long time, the lockdown has caused a heavy use of online technology to continue the learning process for learners, instructors, and other stakeholders.

The need to use technologies for educational purposes during the pandemic is unavoidable; this issue has been addressed by some current studies (such as Kerres, 2020; Mailizar et al., 2020; Wang et al., 2020). One of those technologies used during the pandemic of COVID-19 is e-learning (EL). According to Sukendro et al. (2020), EL refers to an innovative approach to provide excellent educational services with a flexible and personal platform to learners, to continuously enhance their knowledge, skills, and other results (Saxena et al., 2020; Shah et al., 2021). EL is considered an alternative method to traditional learning during this unprecedented time.

Online learning could not happen overnight. At this point, the rapid transformation may be facing various challenges and obstacles (Crawford et al., 2020). But since no one knows when this pandemic will disappear completely, educational institutions worldwide have decided to use the technical resources that are already available to create online educational material for students from all academic fields (Kaur, 2020). Online learning can be effective in developed countries (Basilaia and Kvavadze, 2020; Mutambara and Bayaga, 2021); but it is not produce desired results in some developing countries due to several challenges such as the lack of infrastructure, access to the internet, reliable internet connections, and unstable electricity, as well as the lack of funds allocated to the information and communication technology (ICTs) initiatives in the higher education sector that hinders the process of EL especially for learners who inhabit in rural areas and who have low of income (Glood et al., 2018, 2019). Iraq is not excluded from the developing countries' conditions, but also it has a different case due to wars and civil conflicts that continue until now. Bahloos et al. (2021) asserted that Iraq is different from other developing countries due to the conditions and challenges it suffers from (environmental, economic, technological, and political conditions). AbdulRazak and Ali (2019) reported that several issues faced the EL implementation in Iraq (e.g., the lack of technology infrastructure, accessibility and reliability of the internet, and instability of Electricity).

On the other side, in the current time of the COVID-19 pandemic, the lockdown of Universities and higher educational institutes has caused enforced students to pursue their online classes for continuing their learning (Baber, 2020). This situation forced students to work from home as a workspace, which plays an influential role in using or continuing to use online learning (Douglas et al., 2020; Legido-Quigley et al., 2020). Poor design of workspace represents a risk factor for students due to the uncomfortable conditions; they are exposed to, especially when they force to work for several consecutive hours a day, which affects their well-being (Samuel et al., 2016). Poor workspace design causes students forced into uncomfortable physical postures, which make musculoskeletal disorders (MSDs). These conditions may represent a risk for students. Therefore, the comfortable design of the workspace supports the students' use of the EL platform. For example, Parvez et al. (2019) stated that sitting for a long time on inappropriate furniture and poor posture caused students to suffer from various types of MSDs.

Similarly, a study conducted by Aghahi et al. (2018) explained that up to 69% of students reported discomfort in their body; 23% of them had felt pain in their hands and elbows, and 19% had experienced headaches due to inappropriate furniture and spaces for students. Likewise, other authors have found that students may be exposed to work

environment hazards caused by environmental factors. Also, Zhong et al. (2019) reported that the lack of fresh air or exposure to high hot, cold, humid conditions, noise, and extremely bright or dark lighting, can negatively influence students in online classes. Therefore, it is clear from previous information that students could be exposed to uncomfortable and unsafe conditions in the online classroom that may be affecting their use of EL platforms. According to the literature review, there is a lack of literature explained the influencing of environmental conditions (such as noise and lighting) on EL during outbreaks of COVID-19 in developing countries. In addition, studies related to the implementation of EL are still limited in developing nations. Consequently, this study aims to determine the effecting factors on the use of EL among Iraqi universities student during the period of outbreaks of COVID-19. This study adapted the technology acceptance model (TAM) as a theoretical model and extended it by adding learning content (LC) as external variable and environmental factors (lighting and noise) as moderators' variables. In line with that, the main research question that this paper trying to answer is: What are the factors that influence the use of EL among Iraqi students of higher education during the period of outbreaks of COVID-19.

The rest of this article is organised as follows: Section 2 introduces related studies (including the research model and hypotheses). Section 3 provides the method of the research study (including instrument, data collection). Section 4 introduces the results of the study, while Section 5 discusses the results. Finally, Section 6 concludes the study.

2 Related works

2.1 Technology use during COVID-19 in education

In most governmental institutions, especially educational institutions, the implementation of ICT is a critical agent for advancing teaching and learning, which prompted the countries to invest in developing the ICT infrastructure and maintenance (Chuang et al., 2015; Javed and Samara, 2019; Thorpe and Alsuwayed, 2019). Therefore, users' intention to use and use the technology is investigated extensively in information science in different contexts (Smarkola, 2007). Due to the COVID-19 pandemic, enthusiasm in users' intention has risen toward using the technology in the education environment; because technology usage is considered a critical factor to determine the success or failure of technology (Davis, 1989).

In actuality, when crises and wars break out amongst countries, societies begin to adapt themselves to existing emergency conditions. The Coronavirus pandemic is an emergency condition that has spread to nearly 200 countries. This pandemic has severely affected most sectors, especially the education sector. In the education sector, schools and universities have been closed to prevent the spread of the Coronavirus. According to United Nations Educational, Scientific and Cultural Organization (UNESCO) (2020), school closures have affected more than 1 billion students worldwide due to the COVID-19 pandemic. At the same time, the pandemic provided an opportunity to exploit and use modern technologies to change and facilitate the learning process (Abbasi et al., 2020).

In the education sector, during the outbreak of Coronavirus, most educational institutions in the world made great efforts to continue the education process. And put it on the right track by exploiting technologies that support EL. Therefore, investigating the

factors that predict the use of EL during the Corona pandemic is a critical issue. The next sub-section will discuss the role of EL in HEIs.

2.2 EL in HEIs

EL indicates the process of learning based on the internet to make students more independent and improve student-centred learning (Schworm and Gruber, 2012). Furthermore, AbdulRazak and Ali (2019) asserted that EL allows free access to the internet without regard to time and places constraints through web technologies to enhance learning. It has features (e.g., chat rooms, whiteboards, discussion forums, polls, quizzes, and surveys) that provide students to share LC and communicate online synchronously and asynchronously (Islam and Azad, 2015). Therefore, most countries worldwide (e.g., British, Malaysia, Singapore, Australia, USA, Finland, Tunis, Saudi Aribia, Jordan, Egypt, United Arab Emirates) were adopted EL due to its huge benefits for educational institutions and the learning process (universities and schools); these benefits centred on both students and teachers (Sánchez-Gómez et al., 2020). In other words, EL adoption focuses essentially on the needs of students and provides an effort for the teacher in delivering information. Elameer and Idrus (2011) stated that 'dealing with the inability of the staff in the university to make a digital curriculum to complement student classroom learning' is considered the main benefit of EL. Also, Elameer and Idrus (2010, 2011) reported that EL supports student-centred education, addresses the need for up-to-date information, and utilises the latest ICTs to enhance student learning. Smedley (2010) confirmed that EL provides much flexibility of time and place, improves the learning efficacy, and displays abilities to support communications among the students.

Since 2003, Iraq has witnessed exceptional circumstances such as wars and civil conflicts and a breakdown in its infrastructure. As well as, most of the public/private sectors in Iraq also collapsed, and the higher education sector was not excluded from them. The higher education sector is like other sectors whose infrastructure has collapsed during the violence and civil conflicts that Iraq has passed. UNESCO reported that from 2003 to 2012, about 500 academics and professors of higher education were killed (AbdulRazak and Ali, 2019). Comparing Iraq with the neighbouring countries, many obstacles have delayed Iraq in keeping pace with technological development. These challenges included inappropriate costs, insecurity, and lack of readiness (Matar et al., 2011). The first Iraqi use of EL was in 2010; Moodle was implemented and used through limited departments of Iraqi universities (Elameer and Idrus, 2010). In 2015, most institutions and universities used Moodle (Al-Din and Al-Radhi, 2007). Since 2016 till now, there has been a great effort and attempts to make Iraq keep pace with the current technological development. At the same time, there are several projects launched annually to create EL platforms to meet the acute shortage in Iraqi educational institutions. Generally, these platforms are still working well, but Iraqi universities still need further development and progress to regain their place among their peers from neighbouring countries.

2.3 EL: TAM perspectives

In spite of the advance made in educational technology, there are some issues related to the appropriate and sufficient adoption of technology by students that still exist (Al-Qirim

et al., 2018). This lack of use of technology in a higher education institution may be caused by some obstacles such as technology infrastructure, instructors' effort, technology contentment, students' proficiency, attitudes toward technology, and the resistance of students to transform (Luan and Teo, 2009; Althunibat, 2015; Kim and Park, 2018; Teo et al., 2018).With the rising dependence on technology in educational society, determining the main factors that influence on the intention to use technology among students is still a critical concern (Tarhini et al., 2017; Raza et al., 2018). According to previous studies, the motivation forces for intention to use technology among students can be illustrated through studying the technology acceptance (Al-Emran et al., 2016).

Through reviewing the literature, many frameworks/models were used to investigate the acceptance, usage, understand, and integration of technology (Venkatesh et al., 2012). The TAM as a model (developed by Davis in 1989) considers as one of the most important of the Information system (IS) models, which have been widely applied by researchers to examine the factors that impact users' intention to use and use of technology (Sánchez-Gómez et al., 2020). Users' intention to use innovation is a result of various factors including cultural and social influence. Furthermore, the TAM model has been vastly applied in developed countries; while there have been a few studies that applied this model in developing nations, especially in Middle East countries such as Iraq (Nicholas-Omoregbe et al., 2017). Due to this model was developed and tested in Western countries; the findings may not apply to non-Western developing countries (Tarhini et al., 2016).

In the original model of TAM, Davis (1989) defined the attitude as the "people's feeling, whether positive or negative, as regards the behavioral intention towards accepting the use of a system, is predicted by their perceived usefulness (PU) and perceived ease of use (PEOU)". On the other hand, DeLone and McLean (2003) and Mohammadi (2015) reported that the intention to use construct can be considered as an attitude. In the context of the current study is EL which a mandatory system becomes during the period of the COVID-19 pandemic. During the outbreak of Coronavirus, most educational institutions in Iraq made great efforts to continue the education process by moving to EL. The sudden transition from traditional learning to EL with low experience of the new technology, most students are not familiar before with this technology, lack supporting resources (access to the learning centre, library, interaction with professors, etc.). Making students face difficult challenges during the transition process to EL. Therefore, they felt pressured and more responsibilities which led to confusion and uncertainty about using EL, leading to their hesitation to clarify their attitudes towards EL. The second reason, DeLone and McLean (2003) asserted that intention to use can also be considered an attitude. A third reason, although some studies indicate a positive attitude of students toward using EL during the crisis (Allo, 2020), some studies are inconsistent with other studies, such as the study conducted by Popa et al. (2020) on students in Eastern Europe. This study confirms the negative attitude of students towards the use of EL. Lu and Viehland (2008) claimed that the relationship between attitude and behaviour intention is not supported. Consistent with this, Davis et al. (1989) have also proven that attitude may not be a strong determinant of intentions in workplace settings. Buabeng-Andoh et al. (2019) and Muhaimin et al. (2020) by their studies confirmed this finding. However, PU was not a strong predictor of attitude. Davis et al. (1989) suggest a weak direct link between PU and attitude. Furthermore, DeLone and McLean (2003)

asserted that intention to use can be considered an attitude. Therefore the attitude construct was excluded from the current study.

In the first model of TAM, Davis (1989) described behavioural intention (BI) as 'the degree to which people perform or not perform for specific future behaviour'; it is predicted by the usefulness and PEOU. Besides, PEOU is predicted by the PU also reported. Finally, the actual use of a system (dependent variable) is predicted by BI. In various contexts, several studies have presented some external constructs to accompany the TAM constructs (such as Abdullah and Ward, 2016; Kemp et al., 2019; Aguilera-Hermida et al., 2020). Specifically, in the EL context, several researchers used the TAM model as the theoretical model and extended it by adding different external constructs (Alshare et al., 2011; Sharma et al., 2014; Cakır and Solak, 2015; Mohammadi, 2015; Ramírez-Correa et al., 2019; Al-Okaily et al., 2020).

2.4 Research model and hypotheses

As mention above, several previous studies have adapted the TAM model to explore the factors that predict the use of EL. In the same way, this study proposes an extended TAM-based model to investigate factors predicting the use of EL during the coronavirus pandemic. Firstly, LC was presented as the external variable to accompany the core TAM-based constructs. Secondly, environmental factors (lighting and noise) were introduced as moderators' variables to investigate their effects on the use of EL during the coronavirus pandemic among students of Iraqi universities. This section will present the constructs of the research model and its hypotheses.

LC refers to the extent to which the learning materials provided to students are correct and available in an orderly and timely manner; the LC includes material of courses, quizzes, and collective learning (Wu et al., 2012; Uppal et al., 2018). Lederer et al. (2000) confirmed that 'ease of understanding and ease of finding contents (material of courses and quizzes) predict ease of use'. It implies that if the services of EL are presented with correct, plentiful content and available in an orderly and timely manner to meet the needs of students, students will be more likely to feel that the use of EL services is easy. In the context of EL, the services that focus on learners and deliver the correct and available content will facilitate the perceived ease of EL use. Furthermore, DeLone and McLean (1992) postulated in their model that information quality has a significant impact on user intention. Komito (2007) confirmed that LC quality has a significant effect on PU. It implies that students acquisitive a new LC may make students feel that EL is a beneficial method of gaining new knowledge. Therefore, the following two hypotheses were proposed:

H1 LC has a positive effect on students' PEOU of EL during the COVID-19 pandemic.

H2 LC has a positive effect on students' PU of EL during the COVID-19 pandemic.

PEOU as one of the main factors of TAM, is defined as the level at which students' believe that using EL during COVID-19 will be easy and free of effort. In the literature review, several previous studies (Šumak et al., 2011; Chen and Tseng, 2012; Buabeng-Andoh et al., 2019; Muhaimin et al., 2019; Shah et al., 2021) revealed that PEOU was one of the exogenous constructs to be significant in predicting BI for EL use. It implies that the easier to use EL, the more positive the intention to use it; thus higher the probability that it will be used. Moreover, Halawi and Mccarthy (2008) and

Ramírez-Correa et al. (2019) and Mohammadi (2015) reported that PEOU was significant in predicting PU for EL use; as well as, Chen and Tseng (2012) said that PEOU has an indirect effect on the intention to use through PU. However, the inconsistent relationship between PEOU and BI, PU surfaced also in the EL studies (e.g., Saadé et al., 2009).These lead to the following hypotheses:

H3 Students' PEOU positively affects their BI to use EL during the COVID-19 pandemic.

H4 Students' PEOU positively affects their PU of the use EL during the COVID-19 pandemic.

PU refers to the level of students' believes that using EL during COVID-19 would support and enhance the continuity of their learning process (Davis, 1989). Mohammadi (2015) stated that PU is considered a key determinant of intention to use that encourages IS users to use more user-friendly technologies, which gives users greater freedom. In other words, an individual's desire to use a particular IS for his activities depend on his perception of its use (Hanafizadeh et al., 2014). PU found to have a positive impact on intention to use EL (Šumak et al., 2011; Chen and Tseng, 2012; Chow et al., 2012; Mohammadi, 2015; Ramírez-Correa et al., 2015; Arthur-Nyarko et al., 2021). As a result, the more PU of EL, the more positive is the intention to use it; the probability of its use increases. Therefore, the authors expected that the PU maybe has a strong correlation with BI to use EL during COVID-19. Thus, the following hypothesis presented:

H5 Students' PU positively affects their BI to use EL during the COVID-19 pandemic.

Finally, this study includes the BI, based on the TAM, which indicated as students' intention to use EL during COVID-19. BI plays a significant role in the actual use of an IS (Davis, 1989). Moreover, DeLone and McLean (2003) considered the intention to use as an attitude. Based on the previous studies that revealed BI was significantly related to the actual use of EL (Teo et al., 2008; Alkhalaf et al., 2012; Hassanzadeh et al., 2012; Ramírez-Correa et al., 2015; Arthur-Nyarko et al., 2021). Therefore, this study expects that BI has a significant relationship with the actual use of EL during COVID-19. Thus, the following hypothesis proposed:

H6 Students' BI to use positively affects their actual use of EL during the COVID-19 pandemic.

2.4.1 The moderating effect of environments variables (noise and lighting) on EL during the CONID-19 pandemic

A moderator variable refers to the variable that influences (positive or negative) the relationship between two variables (Dawson, 2014). Broekhuizen and Huizingh (2009) recommended that examining the moderating effect is significant to researchers. Henseler and Chin (2010) strongly recommended future research involving a moderator because there is a gap in the literature regarding the studies with moderators. Therefore, this study involves and testes the role of environmental factors (lighting and noise) as a moderate effect on using EL during the COVID-19 pandemic.

On another side, The COVID-19 pandemic and the mandatory stay-to-home period forced university students had adopted online classes rather than traditional classes to continue their learning. This transition required them to adapt themselves to new

technologies and environmental conditions that were different from the classrooms at their university. Specifically, these new environmental conditions can be uncomfortable and may impact the students' desire to use EL (Gilavand and Hosseinpour, 2016). In the education process, the place of study plays a critical role in the students' learning outcomes (Buchari and Matondang, 2017). Therefore, the learning process requires a calm atmosphere rather than any inconveniences (e.g., noise, lighting), which are considered environmental variables. Moreover, Choi and Suk (2016) and Realyvásquez-Vargas et al. (2020) asserted that the studies investigated the influence of environmental conditions factors on online learning of university students are still very limited.

Lighting problems are considered one of the significant physical characteristics of the educational environment that may affect the use of traditional or technological educational systems. The primary purpose of adequate lighting levels is to make the learning environment more comfortable and with less effort to learn. Samani (2011) asserted that understanding the influences of lighting levels in educational places can enhance the learners' behaviour toward using learning systems. Therefore, the lighting of learning place is a relevant aspect of students' behaviour (learners) and performance during the education process because the lighting has a direct relation with students' development (Oselumese et al., 2016). It implies that the right type of lighting in the environment can help people to be better see what they are doing and make the task easier to do. On the other hand, light has different resources and types of natural light to artificial light. Having daylight in educational places is very important and beneficial, but a daylight source in classrooms or learning places is not practically possible.

Maldonado-Macías et al. (2014, p.20) cited that "lighting to be effective, daylight must be supplemented by automatically controlled electric lighting that dims response to daylight levels". It shows that good lighting in educational environments is achievable by integrating direct and indirect lighting. Therefore, this study also focused on the impact of light level (both artificial and natural) of learning place (home or classroom) on the students' behaviour intention to use EL. Poor lighting in learning places may cause discomfort, poor performance, and some visual injury such as burning eyes, exhaustion, and headaches among students (Samani, 2011). Moreover, Oselumese et al. (2016) asserted that poor lighting leads to discomfort, unwillingness to use education systems, and thus poor academic performance. The poor lighting level and the lack of attention to improving it or using daylight only are critical problems that face students in the learning environment (Lyons, 2001). Explicitly, when students have a learning place with not well control of lighting level, their behaviour may be affected negatively toward the education process (Johnson, 2015).

The previous information revealed that students can be exposed to uncomfortable and unsafe environmental conditions during their using online learning, and consequently, it may lead to reluctance to use EL. One of these environmental conditions is lighting level impacts on the students' behaviour to use learning systems and their performance in learning places. For instance, the study conducted by Hviid et al. (2020) revealed whether lighting impacted the students' abilities or not. Ninety two students have participated in this study to measure processing speed, concentration, logical reasoning, and students' math solving abilities under lighting's different levels. It found that when the lighting level constantly changed from warm light of 2900 K-450 lux to a dynamic cool light of 4900 K-750 lux, the processing speed, concentration, and math skills improved (6.6%, $p < 0.001$, 8.3%, $p < 0.001$, and 11.8%, $p < 0.006$, respectively). Furthermore, Sleegers

et al. (2013) observed a positive effect of dynamic lighting on the concentration of Dutch elementary students. In support of this argument, Wessolowski (2014) recorded a significant impact of the lighting on the behaviour of German students. He found an improvement in the students' performance in terms of increased reading speed, decreased errors, and decreased hyperactive behaviour. Although these studies found a positive effect of lighting on the students' behaviour to use learning systems and their performance in learning places, as mentioned above, some studies have disputed these effects. For instance, Zhong et al. (2019) claimed that very bright or dark lighting could negatively influence students' attendance in their online classes and their academic performance. Moreover, Gilavand and Hosseinpour (2016) investigated the effect of classroom lighting on the learning process of primary school students, with a sample comprising 210 students from Ahvaz, Iran. They did find that classroom lighting has a significant effect on primary school students' learning process. In developing countries, especially countries that suffer from poor electricity, students face several challenges in using EL from home compared with students in developed countries. It implies that less electricity leads to less lighting, where lighting has a primary role in the success of EL during the COVID-19.

As a consequence of the above, there is an inconsistency in the findings regarding the influence of lighting on the students' behaviour to use learning systems and their performance in learning places; this study attempts to explain this phenomenon in an unstable environment (COVID-19 pandemic) in a different context, such as Iraq. Specifically, this study tries to test the moderating effect of lighting (LG) on the relationships between PEOU, PU, and BI. Moreover, Sleegers et al. (2013) emphasised that researchers should do more research on the importance of lighting for learning. Therefore, this study was conducted in Iraq, which suffered and still suffers from continuous electric cuts, especially in rural areas, that may impact the use of EL among students. Therefore, the following hypotheses were proposed:

H7 The relationship between PEOU and BI is moderated by lighting while using EL from home during the COVID-19 pandemic.

H8 The relationship between PU and BI is moderated by lighting while using EL from home during the COVID-19 pandemic.

Noise defines as undesirable sounds that can affect the individual both physically (like hearing loss) and psychologically (like nuisance and frustration) (Abbaspour et al., 2015). Noise considers as one of the critical factors that affect the learning environment worldwide, especially in urban areas (Bulunuz et al., 2017). The affecting of noise on the learning environment can be lead to several troubles in students like less hearing and poor communication and intelligence. Buchari and Matondang (2017) confirmed that noise in the learning environment influences the teaching and learning process.

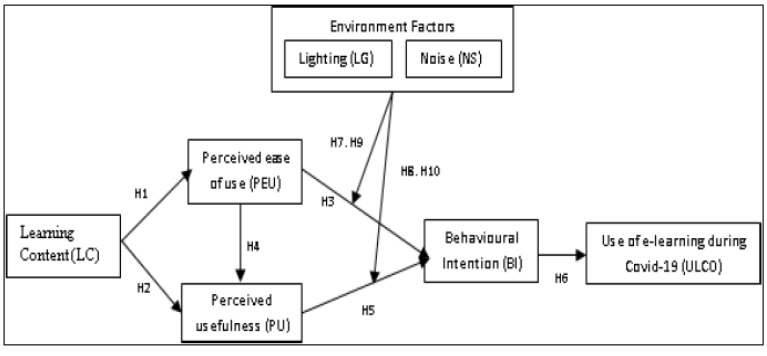
In the literature, there are several previous studies that addressed the impacts of noise on the learning process. For instance, Braat-Eggen et al. (2017) applied a questionnaire from five studying environments in the Netherlands to investigate the effect of noise on students when they performed their tasks. Their study revealed that when students performed complex tasks like tests, reading, or writing, nearly 38% of them were distracted due to the noise. In addition, Batho et al. (2020) studied the effect of noises on the educational performance of youth that have attention deficit trouble (N = 52). The research revealed that noise improves students' reading and writing performance, but the

accuracy of their writing did not vary or improve. Likewise, Smith (2017) studied the influencing factors on the achievement of universities students. Their study used a questionnaire to collect data from a sample comprised of 327 university students. This research showed that the noise was not directly related to students' academic achievement.

In addition, Bhang et al. (2018) examined how high noise influenced the students' learning performance. Their study (a sample of 268 students) revealed that the noise significantly influenced the continuous performance of the students. This agreement with Realyvásquez-Vargas et al. (2020), noise has a significant impact on students such as concentration deficits, which may lead to poor performance of the students. In the same way, this study conducts in Iraq as one of the developing countries that suffered and still suffer from the deployment of the COVID-19 disease, where the outbreak of COVID-19 forces most students to stay at home and adopted online classes rather than traditional classes to continue their learning. On another side, most Iraqi students live with large families in small houses, and in addition to the loud sounds of cars and motorbikes out of their homes, all those noises may affect the students' desire to use EL. Therefore, hypotheses H9, H10 are proposed:

H9 The relationship between PEOU and BI is moderated by noise while using EL from home during the COVID-19 pandemic. H10: The relationship between PU and BI is moderated by noise while using EL from home during the COVID-19 pandemic.

Figure 1 Proposed model



3 Method

The Iraqi government announced education institutions' closures on May 20, 2020, as a procedure to prevent the COVID-19 separation. In this period, the current study was conducted from April 2021 to Jun 2021 by using an online survey approach. This study used the quantitative method due to the number of participants and the geographical coverage. Furthermore, this study aimed to investigate the interrelationship of various independent and dependent variables among students of pharmacy colleges of Iraqi universities in the southern region of Iraq. The research model was evaluated using the partial least squares-based structural equation modelling (PLS-SEM) procedures.

3.1 Instrumentation

This study uses the survey questionnaire as an instrument to collect data from participants; it was developed based on previous studies that reflect the constructs as identified in the research model. The survey questionnaire consisted of seven constructs (PEOU, PU, BI, LC, use of EL during the COVID-19, noise, and lighting) to reflect the current research model structure. The items for each construct were adapted from valid and reliable survey instruments items from various earlier studies, then refining them to suit the current study context (COVID-19 and EL). In more detail, the survey instrument has consisted of 28 items. They were PEOU construct (four items), PU (four items), and BI (three items) were adopted from Davis (1989) and Khan et al. (2021); while the four items for the LC construct were adopted from the studies of Lee et al. (2009) and Saxena et al. (2020). The construct of use of EL during the COVID-19 (ULCO) was assessed through four items derived from DeLone and McLean (2003) and Alshare et al. (2011) and Sukendro et al. (2020) measurements, whilst noise (NIS) construct was measured by five items adapted from Banbury and Berry (2005) and Alzahrani and Goodwin (2012) and Bulunuz et al. (2017), Pillay and Vieira (2020), Realyvásquez-Vargas et al. (2020). Finally, the lighting (LGH) construct was measured by four items drawn from the Mills et al. (2007) and Michael and Heracleous (2017) and Realyvásquez-Vargas et al. (2020). All items were evaluated according to a five-point Likert scale indicating students' answers, strongly agree (5), agree (4), nature (3), disagree (2), and finally strongly disagree (1).

At first, the survey questionnaire was pilot-tested to establish the validity and reliability of the content, to define whether it was understandable, suitable, and plain to the target population. The content validity was revised by four academic experts in the study field from Iraq and Malaysia using the Google meets application. The survey questionnaires were pilot-tested with 100 students of the pharmacy college of Thi-Qar University not involved in the current study. The experts' and students' comments were used to improving the survey instrument. Additionally, the internal consistency of items was examined by performing a Cronbach's alpha reliability test. This test showed that constructs have Cronbach's alpha coefficient values ranging from 0.702 to 0.902 indicating good reliability of the constructs (see Table 1). Furthermore, the survey questionnaire instrument translates using back translation, English and Arabic language (Behr, 2017).

3.2 Data collection

The current study adopts a quantitative research method due to a large number of participants and wide geographical coverage. Sekaran et al. (2007) asserted that quantitative research deals with a huge number of respondents and wide geographical coverage. Furthermore, Creswell (2009) asserted that quantitative research is a deductive approach, in which hypotheses are developed based on theory and data are collected to test the hypotheses. The Study was conducted in four public universities of the southern region of Iraq. The reason to choose the southern region rather than middle and northern regions of Iraq is the southern region is more stability than other regions that suffering Political and civil conflicts and at low cost of travelling between southern' universities. These universities are Basra University, Thi-Qar University Misan University, and Al-Muthanna University. In addition, According to Sekaran et al. (2007, p.265) 'a

population refers to the entire group of people; events or topics of interest that the researcher wishes to investigate'. The target population in this study consists of all the students of fourth and fifth stages (second semester of academy year 2020–2021) of the pharmacy college of each university, due to these stages' students have more experience of computer skills than other stages' students. According to department of students' issues at each pharmacy college, the total number of fourth and fifth stages (second semester of academy year 2020–2021) was 940 students as following: Basra University (260 students), Thi-Qar University (234 students), Misan University (216 students), and Al-Muthanna University (230 students).

According to the current study's aim, a purposeful sampling technique was used to investigate the study hypotheses. The prime purpose of this sample, as stated by Cohen et al. (2011), is 'assess knowledgeable people who have in depth knowledge about a particular issue'. Therefore, the main purpose of the sample in the present study is to relate the participants with the study subject, regarding the influencing factors on the use of EL, ultimately to enable the students to present reliable data.

During the closure of schools and educational institutions and the outbreak of the Coronavirus, the survey was distributed using the Google form application. Through the specialist groups in the Telegram application for fifth and fourth stages students of each pharmacy college of each university, and obtaining permission from the deans and supervisors concerned of each group, and gain their approval for distributing the questionnaire in all groups. The survey questionnaire was conducted over two months from 12 April 2021 to 10 June 2021 for collecting data. The researchers were able to obtain 455 respondents' answers out of the total number of students (354 respondents were female, and 101 respondents were males). All return answers were filed into Microsoft Excel and moved to the Smart-PLS. Furthermore, in terms of demographic variables, the variables' statistical frequency distribution in the questionnaire was categorised and shown in such a way that the originality of the research is reflected. Therefore, the demographic information for respondents of this study can be seen in Appendix.

4 Results

The proposed model was analysed using the PLS-SEM technique. According to Chin (1998), the results report into two steps. The first step is to evaluate the measurement model, which refers to test the measures' reliability and validity. The second step is to evaluate the structural model, which refers to test the hypothesised relationships. The following subsections will discuss the measurement and structural models in detail.

4.1 Measurement model assessment

The measurement model indicates the assessment procedures to test the measures' reliability and validity. Reliability evaluates through composite reliability (CR) and Cronbach's alpha (Bagozzi and Yi, 1988). The findings of the current study reported that the Cronbach values (α) ranged from 0.702 to 0.902, above the acceptable threshold of 0.60 (Hair et al., 2014b) and also the values of CR ranged from 0.817 to 0.939, above the acceptable threshold of 0.70 (Bagozzi and Yi, 1988). Therefore, the reliability of all constructs of the research model is available, as shown in Table 1.

Whereas the constructs' validity is evaluated by convergent validity (CV) and discriminant validity (DV), for conducting the CV test, the average variance extracted (AVE) and factor loadings have been used. According to Fornell and Larcker (1981), when all variables have AVE values above 0.50, the CV is confirmed. Therefore, all AVE values are above 0.50 (as shown in Table 1), which implies that the CV is confirmed. Moreover, the results of the algorithm process in PLS-SEM reveal that the loadings of items ranged from 0.634 to 0.930. All items implemented the recommended loading values of > 0.5 (Chin, 1998), as shown in Table 1. This implies that the CV is confirmed.

Table 1 Measurement properties of constructs

Construct	*Item*	*Loading*	*Cronbach's alpha*	*CR*	*(AVE)*
Behavioural intention (BI)	BI1	0.902	0.902	0.939	0.837
	BI2	0.930			
	BI3	0.912			
Learning content (LC)	LC1	0.818	0.788	0.876	0.701
	LC2	0.833			
	LC3	0.860			
Perceived ease of use (PEOU)	PEU1	0.815	0.721	0.843	0.643
	PEU2	0.870			
	PEU3	0.713			
Perceived usefulness (PU)	PU1	0.698	0.702	0.817	0.528
	PU2	0.790			
	PU3	0.696			
	PU4	0.718			
Use of EL during the COVID-19 (ULCO)	ULCO1	0.722	0.777	0.847	0.584
	ULCO2	0.634			
	ULCO3	0.843			
	ULCO4	0.838			

4.1.1 Discriminant validity

DV defines the extent to which a factor is different from other factors (Hair et al., 2014a, 2014b). In this step, the Fornell Larcker criterion performs where the square root of the AVE of each construct compares with the correlations between the construct and other constructs. The square root of the AVE exceeded the highest correlation between that construct and the other constructs [see Table 2], thereby proving DV.

Moreover, DV is assessed by the cross-loadings test of all items. When the value of loading on a construct is higher than all of its cross-loadings values on the other constructs, the DV presents (see Table 1). Thus, the DV was satisfied. DV also appears that the HTMT values are lower than 0.900. Table 3 reports the values of HTMT were lesser than 0.900. The results indicate that the values are significantly different from 1.

Table 2 DV values (Fornell-Larcker criterion)

	BI	*LC*	*PEU*	*PU*	*ULCO*
BI	*0.915*				
LC	0.592	*0.837*			
PEU	0.559	0.543	*0.802*		
PU	0.498	0.497	0.459	*0.727*	
ULCO	0.528	0.451	0.423	0.606	*0.764*

Table 3 DV values (HTMT)

	BI	*LC*	*PEU*	*PU*
BI				
LC	0.698			
PEU	0.678	0.703		
PU	0.617	0.661	0.624	
ULCO	0.574	0.542	0.520	0.830

4.1.2 Collinearity issue

Collinearity test is a necessary need to the structure model because the regression coefficient's standard error increases with an increase in the collinearity, which leads to the doubtfulness of affected coefficients' statistical significance. Collinearity computes using Variance Inflation Factor (VIF) values following the recommendation of several researchers (Hair et al., 2014a). The collinearity will be accepted if the VIF value is less than 3.00 (Hair et al., 2014a). BI has a role as a predictor of the use of EL during COVID-19 (VIF = 1.000). LC is the predictor of PEOU (VIF = 1.000) and PU (VIF = 1.418). PEOU is the predictor of PU (VIF = 1.418). PEOU is the predictor of BI (VIF = 1.268). Lastly, PU is the predictor of BI (VIF = 1.268). All VIF values are less than 3 (Table 4). Therefore, collinearity does not emerge as an issue in this study (Hair et al., 2014b; Muhaimin et al., 2020).

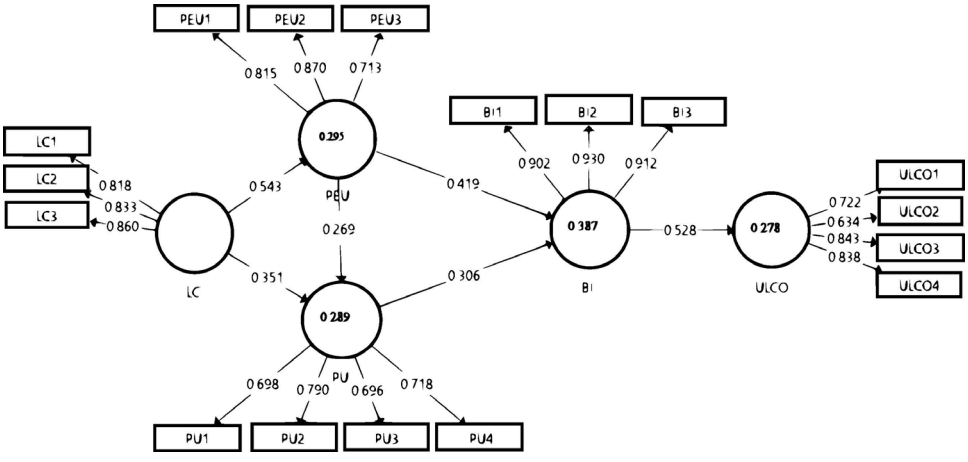
Table 4 Inner VIF values

	BI	*LC*	*PEU*	*PU*	*ULCO*
BI					1.000
LC			1.000		
PEU	1.268			1.418	
PU	1.268			1.418	

4.2 Assessment of structural model

After finishing the measurement model procedures, the next phase evaluates the structure model and hypotheses by using Bootstrapping; it includes some steps, in the first step, the hypothesised relationships of the path model examine. The coefficient of determination (R^2) calculates in step two. In the third step, the effect size (f^2) of the construct relevance is computed. Finally, in step fourth, the Q^2 values were reported by the blindfolding procedure of PLS-SEM.

Figure 2 Validated measurement model



4.2.1 Significance and relevance of structural model relationships

In this section, the evaluation process of the proposed hypotheses, between endogenous and exogenous constructs, in the research model was explained. The bootstrapping function technique was applied to evaluate the significance of hypothesised relationships (Hair et al., 2014a) in SmartPLS 3.3, which used 5,000 resamples to perform the bootstrap. LC has a significant positive impact on PU (β: 0.351, $p < 0.01$) and LC has a strong positive relationship with the PEU (β: 0.543, $p < 0.01$). PEU has a significant effect on BI (β: 0.418, $p < 0.01$); and on PU (β: 0.269, $p < 0.01$). Further, PU has a significant effect on BI (β: 0.307, $p < 0.01$). BI also has a significant positive impact on ULCO (β: 0.528, $p < 0.01$), as shown in Table 5, and Figure 3.

Table 5 Results of path coefficients in model

HYP no.	*Relation*	*Path coefficients (O)*	*Standard deviation*	*T-Statistics*	*P-values*	*Significant*
H1	LC → PEU	0.543	0.040	13.421	0.000	Yes
H2	LC → PU	0.351	0.057	6.109	0.000	Yes
H3	PEU → BI	0.418	0.045	9.353	0.000	Yes
H4	PEU → PU	0.269	0.050	5.420	0.000	Yes
H5	PU → BI	0.307	0.047	6.547	0.000	Yes
H6	BI → ULCO	0.528	0.036	14.694	0.000	Yes

4.2.2 Coefficient of determination (R^2)

The coefficient of determination (R^2) is the value of regression analysis output that interprets the proportion of variance in the endogenous variable explained by the exogenous variable(s). Simply, it implies how much change in the dependent variable can predict from the independent variable(s). The value of R^2 is ranged from 0 to 1, where a higher value (0.75) is substantial, 0.50 is moderator, whereas 0.25 is weak (Hair et al., 2014a). In this study, Table 6 shows the result of R^2; BI (0.387, weak), PEU (0.295, weak), PU (0.298, weak), ULCO (0.278, weak).

Figure 3 Validated structural model

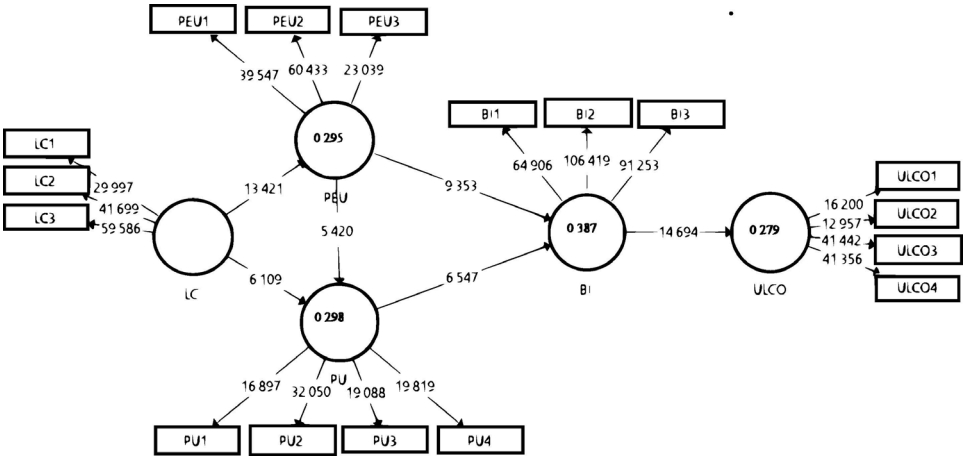


Table 6 Values of coefficient of determination (R2)

	R^2	*Consideration*
BI	0.387	Weak
PEU	0.295	Weak
PU	0.298	Weak
ULCO	0.278	Weak

4.2.3 Effect size (f^2)

The effect size (f^2) measures the extent to which an exogenous construct can affect the endogenous construct. In other words, the effect size (f^2) examines the change of R^2 value when an exogenous construct remove from the model. According to Hair et al. (2014a), the f^2 is effect size (>= 0.02 is small, >= 0.15 is medium, and >= 0.35 is large effect). The current study reveals that the relationship between LC and PEU has the largest f^2 (0.418), BI to ULCO has a large effect (0.386), and LC to PU has a small effect (0.124). Furthermore, the relationship between PEU and BI has a medium effect (0.225), while the relationship between PEU and PU has a small effect (0.073), and PU to BI has a small effect (0.121), as shown in Table 7.

Table 7 Values of Effect size (f^2)

	f^2	*Effect size*
BI → ULCO	0.386	Large
LC → PEU	0.418	Large
LC → PU	0.124	Small
PEU → BI	0.225	Medium
PEU → PU	0.073	Small
PU → BI	0.121	Small

4.2.4 Cross-validated redundancy

Predictive relevance (Q^2) measures whether a model has predictive relevance or not (the Q^2 value of > 0 indicated the establishment of the model's predictive relevance). Further, Q^2 establishes the predictive relevance of the endogenous constructs (Hair et al., 2014a). Q^2 value can find by running the Blindfolding procedure in SmartPLS. Hair et al. (2014a) reported that threshold values of Q^2 are 0.02 (small), 0.15 (medium), and 0.35 (large). The results showed that BI has the largest value of the predictive relevance (Q^2 = 0.319), while ULCO has the smallest value of the predictive relevance (Q^2 = 0.147), as shown in Table 8.

Table 8 Values of predictive relevance (Q^2)

	Q2	*Predictive relevance*
BI	0.319	Large
PEU	0.179	Medium
PU	0.154	Medium
ULCO	0.147	Small

Table 9 Results of moderation effect model

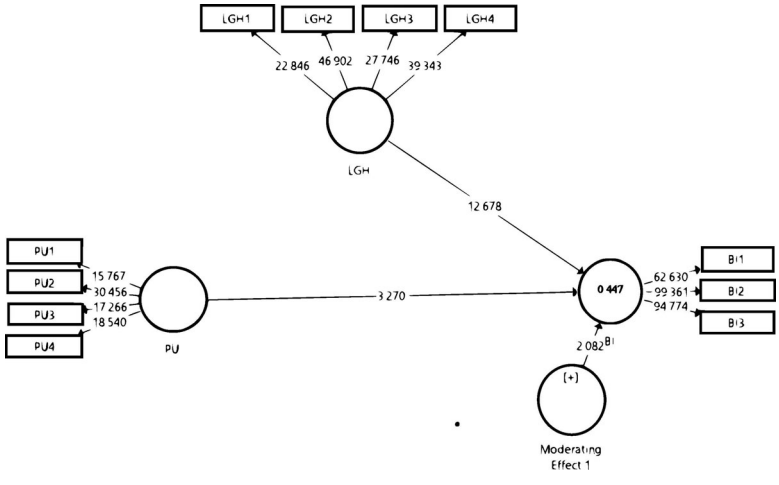
HYP. no.	*Hypothesis statement*	*Path coefficient*	*Standard deviation (STDEV)*	*T-Statistics*	*P-values*	
H10	PU * NIS → BI	0.035	0.017	2.091	0.037	Supported
H8	PU * LGH → BI	0.039	0.019	2.082	0.038	Supported
H7	PEU * LGH → BI	0.020	0.023	0.851	0.395	Not supported
H9	PEU * NIS → BI	0.023	0.021	1.100	0.272	Not supported

Note: 1.65 (*p < 0.10), 1.96 (**p < 0.05), 2.58 (***0.01).

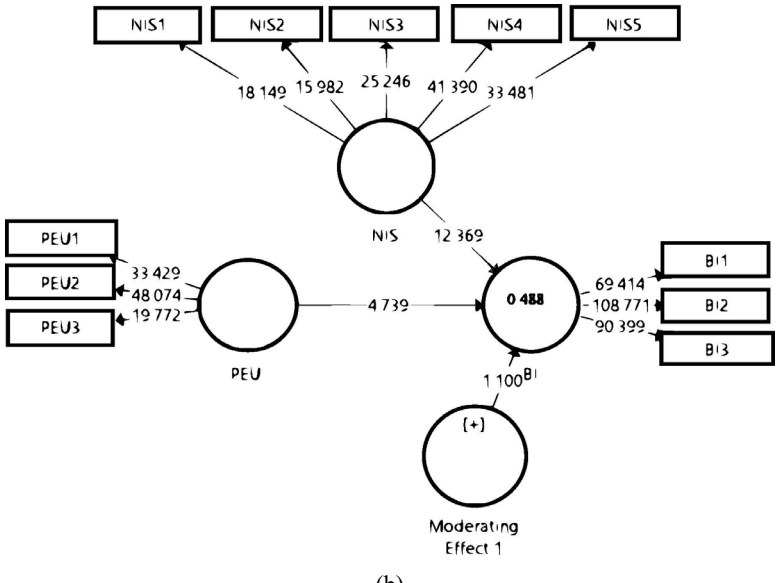
4.2.5 Moderating effects of environment variables (noise and lighting)

A moderate variable is defined as a quantitative/qualitative variable that affects (positive or negative) the direction or strength of the relationship between the endogenous variable and the exogenous variable (Baron and Kenny, 1986). According to Baron and Kenny (1986), a moderator provides in situations in which researchers have different opinions regarding the relationship between endogenous and exogenous variable. Additionally, researchers such as Henseler and Chin (2010) and Glood et al. (2016) recommended that future research should include a moderator variable due to a gap in the literature regarding the moderator. Therefore, the current study examines the NIS and LGH as moderators in our models, as shown in Figure 4.

Figure 4 (a) The moderator effect of LGH on the relationship between PU and BI, (b) The moderator effect of NIS on the relationship between PEU and BI, (c) The moderator effect of NIS on the relationship between PU and BI and (d) The moderator effect of LGH on the relationship between PEU and BI

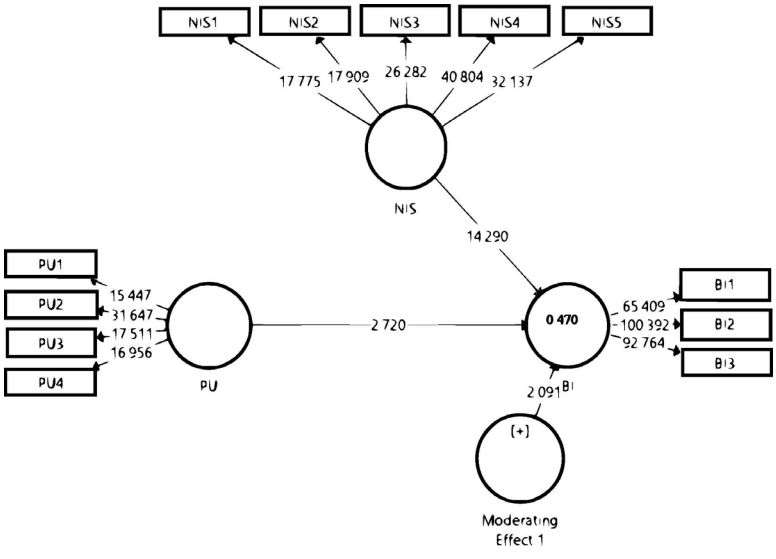


(a)

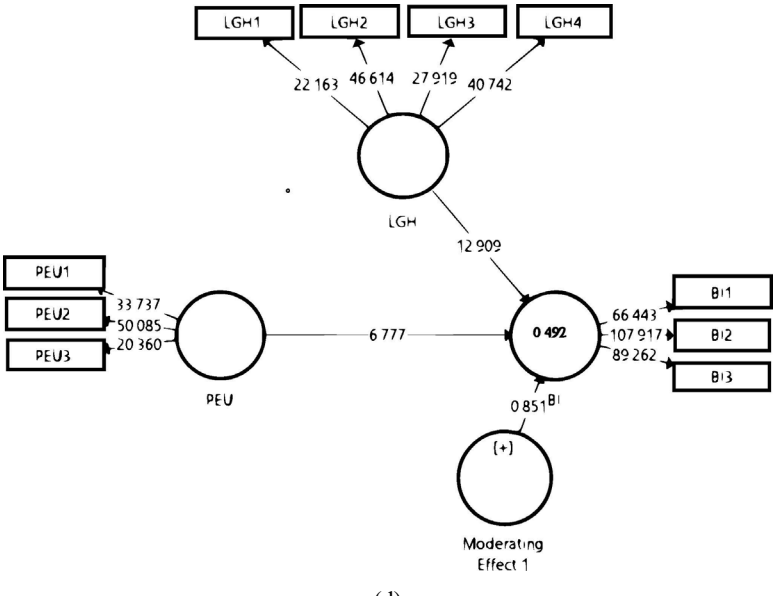


(b)

Figure 4 (a) The moderator effect of LGH on the relationship between PU and BI, (b) The moderator effect of NIS on the relationship between PEU and BI, (c) The moderator effect of NIS on the relationship between PU and BI and (d) The moderator effect of LGH on the relationship between PEU and BI (continued) (see online version for colours)



(c)



(d)

Bootstrapping procedure of PLS-SEM has been used to measure the moderating effect of noise and lighting on the relationships between various variables and BI. The results (see Table 9) showed that LGH (β = 0.039, p < 0.05) and NIS (β = 0.035, p < 0.05) positively moderate the effect of PU on IB; this implies that the lighting and noise level has a significant impact on the relationship between PU and IB among students of universities to use EL during the COVID-19 pandemic. Therefore, Hypotheses H8 and H10 are supported. While LGH and NIS do not moderate the effect of PEU on IB, Hypotheses H7 and H9 are not supported.

5 Discussion

The deployment of the COVID-19 pandemic has disrupted most public sectors around the world; the higher education sector is unexceptional to it. During the deployment of the pandemic, most of the educational institutions involving higher education shifted toward EL which considers as the best alternative available for continuing education. This shifting toward EL is sudden and forced. Therefore, investigating the influencing factors (environmental, technological, and psychosocial) on the use of EL is critical.

The study aims to investigate the factors predicting the use of EL during COVID-19. The research model involves TAM as a theoretical basis, including content learning variable as influential external variable and environment variables (lighting and noise) as moderators to explain the impact of the environmental conditions on EL during COVID-19 perceived by the Iraqi students from five HEIs.

In the current study, LC indicates the extent to which students of Iraqi universities believe that the EL platform has good content. The findings revealed that the LC has a significant influence on PEU (β: 0.543, p < 0.01) and thus H1 was accepted. It implies that students felt that the content of learning is informative and updated regularly, the material provided in an organised and timely fashion, and the LC is easy to use and provides relevant information during the pandemic, making their learning process easy. To support this result, previous studies (such as DeLone and McLean, 1992; Lee et al., 2012; Al-Aulamie, 2013; Alkandari, 2015; Uppal et al., 2018) confirmed that LC of EL is one of the determinants of PEOU for students. Moreover, the results demonstrated that LC has a significant impact on PU (β: 0.351, p < 0.01), confirming the H2, and thus H2 was supported. This result is consistent with previous studies' results in EL context (such as Lee et al., 2012; Al-Aulamie, 2013; Shah et al., 2013; Alkandari, 2015) confirmed the influence of LC on students' PU. In contrast, this result disagrees with the results of Kang and Shin (2015) revealed that LC does not affect PU in the virtual classes' context, which is different from the context of the current study.

In addition, the finding of the current study indicated that PEU has a significant influence on PU (β: 0.269, p < 0.01); and thus H4 was accepted. This indicates that students who perceive the EL system as easy to use, they believe using the EL system will help them to improve and learn new skills and knowledge. The result indicates that if the EL is easy to use (searching, browsing, and downloading the learning materials), the students will be more motivated and interested to use EL more frequently; thus students become more aware of the usefulness of EL. Especially, It implies that when students perceive the EL to be user-friendly, the students' feelings toward using EL improved during the COVID-19. This result is consistent with the findings of previous studies (such as Mohammadi, 2015; Ramírez-Correa et al., 2015; Sukendro et al., 2020). Furthermore,

The PEU has a significant influence on BI (β: 0.418, $p < 0.01$); and thus H3 was accepted. It implies that if students think the EL is easy, their behaviour (during COVID-19) toward using EL will be better. Sukendro et al. (2020) and Muhaimin et al. (2019) confirmed this result.

However, the result revealed that PU was a strong predictor of BI (β: 0.307, $p < 0.01$); and thus H5 was accepted. This result indicates that students tend to use the EL system during the COVID-19 pandemic to continue their education and to achieve their educational goals, as these goals can be achieved by performing basic level tasks such as downloading materials of study, teaching schedules, online chatting, or discussion forums (Al-Aulamie, 2013). Achieving these educational goals will allow students to perceive the EL system usefulness leading them towards the intention to use EL system. Briefly, it implies that if students' perceived that EL benefits educational activities, the BI is more likely to improve. This finding is consistent with the results of previous studies such as (Zhang et al., 2010; Ramírez-Correa et al., 2015).

Moreover, BI has a significant influence on the ULCO (β: 0.528, $p < 0.01$); and thus H6 was accepted. It implies that students use the EL system mainly in the current conditions (COVID-19) because they perceive the EL system to be more useful to continue the educational process and because the EL system is interesting and easy to use. This result is consistent with the findings of previous studies (such as Ramírez-Correa et al., 2015; Sukendro et al., 2020). They explained that BI considers as the main predictor for EL use throughout learning processes. Therefore, should always be promoted to try to make students more comfortable using technology during pandemics such as the COVID-19 pandemic. These findings assert the causal relationships between TAM variables, perceived ease o use, PU, Actual Use, and BI.

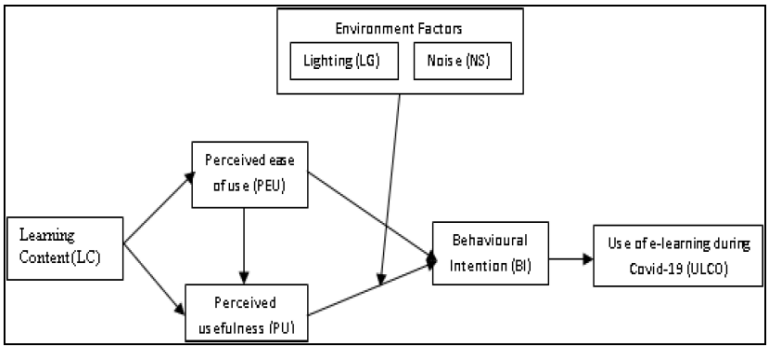
Finally, the results (see Table 9) showed that LGH ($\beta = 0.039$, $t = 2.082$, $p < 0.05$) has a positive moderate effect on the relationship between PU on BI among students of Iraqi universities to use EL during the COVID-19 pandemic conditions. Therefore, Hypothesis H8 was supported. It implies that when the LGH is conformable level, PU was found to have a stronger impact on BI. The primary reason of that when the lighting level is constantly steadying, comfortable, and electricity is constant, the students' learning process speed, concentration, and skills improved; thus the intention toward using EL increases. This result is consistent with studies conducted by Gilavand and Hosseinpour (2016) and Zhong et al. (2019), who have investigated the impact of classroom lighting on the learning process of the students, they found that classroom lighting has a significant effect on students' learning process and online classes.

As well, the results express that NIS ($\beta = 0.035$, $t = 2.091$, $p < 0.05$) has a positive moderate effect on the relationship between PU on BI among students of Iraqi universities to use EL during the COVID-19 pandemic conditions. Therefore, Hypothesis H10 was supported. It implies that at NIS higher, PU was found to have a stronger impact on BI. The primary reason of that most Iraqi society (including students) have become accustomed and adapted to living with the un-normal conditions resulting from the military wars and civil conflicts and the sequential crises and disasters (economic blockade) since years in Iraq. Secondly, the gathering of students and the loud voices resulting from their discussions with each other to exchange information during online classes has increased their desire to use EL to continue their education. While LGH and NIS have not moderate effect on the relationship between PEU and BI among the students of Iraqi universities to use EL during the COVID-19 pandemic conditions,

hypotheses H7 and H9 are not supported. The main reason behind this result is that most students use electric generators to compensate for the continuous interruptions in the national electricity due to wars, crises, and conflicts. In addition, the expected benefit of using EL prompted students to use other means (such as generators or the use of a mobile phone network) to continue using EL. The students also explained that several places in the home are far from the noise (external and internal); are used during EL.

Finally, this study shows that the confidence interval for these coefficients does include zero. It implies that zero is not a reasonable value for the real difference in the mean population. Therefore, if another researcher tests this model again, there is a significant difference between the two populations.

Figure 5 Revised model



5.1 Implications

The present study provides noteworthy implications for the subject area as it has been able to develop and validate a model for the usage of EL, especially in the context of the new normal due to the COVID-19 pandemic. This study is one of few studies in the field the students' EL in the new abnormal of a COVID-19 pandemic. Therefore, this study contributes to the literature by developing a model in response to this pandemic. This study also confirmed the role of environmental factors and LC in the use of EL during a crisis. The discovered moderating role of environmental factors on the relationship between 'PEU' and BI posits a good case for further study. Henseler and Chin (2010) and Henseler and Fassott (2010) and Yau et al. (2011) and Hair et al. (2014b), strongly recommended that moderators should be involved in future research as there is a gap in the literature regarding studies with moderators. The majority of the studies that have tried to examine the TAM model developed by Davis (1989) were undertaken in developed countries, Whereas there have been very few studies conducted in the context of developing nations in the new abnormal of a COVID-19 pandemic. Therefore, the current study aims to test the TAM model in a country that faces abnormal conditions (unstable and COVID-19 pandemic), namely Iraq, a Middle-Eastern country. Furthermore, this study revealed that the TAM model is valid and can be used to examine the acceptance and use of EL in different cultures. Finally, the current study provides empirical data that increases the rate of using or adopting EL in Iraq.

In addition to theoretical implications, the present study also has noteworthy practical implications. The extended TAM model was developed with the aim to understanding the

students' use of EL systems during times of the current COVID-19 pandemic clearly triggering a paradigm shift in the world of learning and teaching. Positive change is unavoidable, and the study findings can be used to create better systems not only for the duration of the pandemic but also for future times. The findings of the current study provide a deeper understanding of external factors and contribute as a useful resource for policymakers, professionals, developers, and designers to effectively adopt the EL systems. Second, the decision-makers and managers of EL centres in the higher educational institutions (especially in Iraq) should focus on those factors that play an influential role in promoting students' acceptance or use of those systems. Third, in accordance with these findings. The significant moderating effect of NIS and LGH between 'PUE' and BI calls for immediate action toward the provision of empathetic solutions in cooperation with local governments for encouraging students to use the EL system

6 Conclusions

Many previous studies in different countries addressed EL and explored the factors influencing on use of EL in HEIs in normal conditions (such as Zhang et al., 2010; Mohammadi, 2015; Ramírez-Correa et al., 2015). In abnormal conditions, such as the COVID-19 pandemic, few studies investigated the use of EL. Consequently, the present study enriches the literature by understanding the circumstances of EL during colleges and schools closure due to epidemics, which are fundamental guidelines for future studies. In the current time, due to most colleges and school closures, acceptance and use of EL by students are more complex. Therefore, it is important to evaluate the factors influencing the use of EL in HEIs during outbreaks of epidemics such as COVID-19 in various contexts.

This study focused on the EL for pharmacy students of Iraqi universities in the southern regions during the COVID-19 outbreak. The findings of the current research ensured that most of the research model relationships are significantly correlated. Stakeholders should be ready better for facing EL events due to an outbreak of epidemics.

6.1 Limitations and future research

There are some limitations to this study. First, the current study used a small sample size and non-random selection (pharmacy colleges only from five universities in the southern region of Iraq). The non-random selection limits the generalisability of the findings. Therefore, future researchers should be either increase the sample size with different backgrounds and regions (North or Middle regions) or use random selection techniques. Another limitation, this study uses a questionnaire approach to collect data; I recommend understanding EL usage through qualitative perspectives (interview or group discussions) for future studies. Moreover, this study showed that the confidence interval for coefficients does include zero, which may have implications for the study's findings. Therefore, I recommend including zero on the confidence interval for a correlation or regression for future studies.

References

Abbasi, S. et al. (2020) 'Perceptions of students regarding e-learning during covid-19 at a private medical college', *Pakistan Journal of Medical Sciences*, Vol. 36, No. COVID19-S4, pp.S57–S61, DOI: 10.12669/pjms.36.COVID19-S4.2766.

Abbaspour, M. et al. (2015) 'Hierarchal assessment of noise pollution in urban areas – a case study', *Transportation Research Part D: Transport and Environment*. Elsevier Ltd., Vol. 34, pp.95–103, DOI: 10.1016/j.trd.2014.10.002.

Abdullah, F. and Ward, R. (2016) 'Developing a general extended technology acceptance model for e-learning (GETAMEL) by analysing commonly used external factors', *Computers in Human Behavior*, Vol. 56, pp.238–256, Elsevier Ltd., DOI: 10.1016/j.chb.2015.11.036.

AbdulRazak, N.S. and Ali, M.A. (2019) 'Challenges of implementation e-learning platforms in Iraqi universities', *Engineering and Technology Journal*, Vol. 37, No. 4, pp.9–10.

Adnan, M. and Anwar, K. (2020) 'Online learning amid the COVID-19 pandemic: students' perspectives', *Journal of Pedagogical Sociology and Psychology*, Vol. 2, No. 1, pp.45–51.

Aghahi, R., Darabi, R. and Hashemipour, M. (2018) 'Neck, back, and shoulder pains and ergonomic factors among dental students', *Journal of Education and Health Promotion*, Vol. 7, No. 40, pp.1–6, DOI: 10.4103/jehp.jehp.

Aguilera-Hermida, A.P. (2020) 'College students' use and acceptance of emergency online learning due to COVID-19', *International Journal of Educational Research Open*, September, Vol. 1, Elsevier Ltd., p.100011, DOI: 10.1016/j.ijedro.2020.100011.

Al-Aulamie, A. (2013) *Enhanced Technology Acceptance Model to Explain and Predict Learners' behavioural Intentions in Learning Management Systems*, Bedfordshire.

Al-Din, A. and Al-Radhi, K. (2007) 'Distance learning/e-learning for Iraq: concept and road map', *Bulletin of the American Society for Information Science and Technology*, Vol. 34, No. 3, pp.34–37.

Al-Emran, M., Elsherif, H.M. and Shaalan, K. (2016) 'Investigating attitudes towards the use of mobile learning in higher education', *Computers in Human Behavior*, March, Vol. 56, pp.93–102, Elsevier.

Ali Alzahrani, N. (2019) 'Workplace ergonomics and academic staff performance in college of education in Umm Al-Qura University in Makkah', *American Journal of Educational Research*, Vol. 7, No. 9, pp.604–617, DOI: 10.12691/education-7-9-2.

Alkandari, B. (2015) *An Investigation of the Factors Affecting Students' Acceptance and Intention to Use E-Learning Systems at Kuwait University: Developing a Technology Acceptance Model in E-Learning Environments*, Cardiff Metropolitan University.

Alkhalaf, S. et al. (2012) 'E-learning system on higher education institutions in KSA: attitudes and perceptions of faculty members', *Procedia – Social and Behavioral Sciences*, Citc 2010, Vol. 47, pp.1199–1205, DOI: 10.1016/j.sbspro.2012.06.800.

Allo, M.D.G. (2020) 'Is the online learning good in the midst of Covid-19 pandemic? The case of EFL learners', *Jurnal Sinestesia*, Vol. 10, No. 1, pp.1–10.

Al-Okaily, M. et al. (2020) 'Dataset on the acceptance of e-learning system among universities students' under the COVID-19 pandemic conditions', *Data in Brief*, Vol. 32, p.106176, Elsevier Inc., DOI: 10.1016/j.dib.2020.106176.

Al-Qirim, N. et al. (2018) 'Learning orientations of IT higher education students in UAE University', *Education and Information Technologies*, Vol. 23, No. 1, pp.129–142, Springer.

Alshare, K.A. et al. (2011) 'The impacts of system and human factors on online learning systems use and learner satisfaction', *Decision Sciences Journal of Innovative Education*, Vol. 9, No. 3, pp.437–461, DOI: 10.1111/j.1540-4609.2011.00321.x.

Althunibat, A. (2015) 'Determining the factors influencing students' intention to use m-learning in Jordan higher education', *Computers in Human Behavior*, Vol. 52, pp.65–71, Elsevier Ltd., DOI: 10.1016/j.chb.2015.05.046.

Alzahrani, M.E. and Goodwin, R.D. (2012) 'Towards a UTAUT-based model for the study of e-government citizen acceptance in Saudi Arabia', *International Journal of Humanities and Social Sciences*, Vol. 6, No. 4, pp.376–382.

Arthur-Nyarko, E., Gyan, S.B. and Asante, A. (2021) 'What determines students' behavioural intention to use mobile learning management systems? Empirical answers from a blended environment in Sub-Saharan Africa', *International Journal of Learning Technology*, Vol. 16, No. 4, pp.303–323, Inderscience Publishers (IEL).

Baber, H. (2020) 'Determinants of students' perceived learning outcome and satisfaction in online learning during the pandemic of COVID19', *Journal of Education and e-Learning Research*, Vol. 7, No. 3, pp.285–292, DOI: 10.20448/JOURNAL.509.2020.73.285.292.

Bagozzi, R.R. and Yi, Y. (1988) 'On the evaluation of structural equation models I ~ LI', *Journal of the Academy of Marketing Science*, Vol. 16, No. 1, pp.74–75.

Bahloos, M., Anad, M. and Glood, S. (2021) 'An analytical study of the obstacles and challenges facing the adoption and use of e-government in Iraq: citizens and it employees', *Solid State Technology*, Vol. 64, No. 1, pp.1–13 [online] https://solidstatetechnology.us/index.php/JSST/article/view/10022 (accessed 14 September 2021).

Banbury, S.P. and Berry, D.C. (2005) 'Office noise and employee concentration: identifying causes of disruption and potential improvements', *Ergonomics*, Vol. 48, No. 1, pp.25–37, DOI: 10.1080/00140130412331311390.

Baron, R.M. and Kenny, D.A. (1986) 'The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations', *Journal of Personality and Social Psychology*, Vol. 51, No. 6, p.1173, American Psychological Association.

Basilaia, G. and Kvavadze, D. (2020) 'Transition to online education in schools during a SARS-CoV-2 Coronavirus (COVID-19) pandemic in Georgia', *Pedagogical Research*, Vol. 5, No. 4, DOI: 10.29333/pr/7937.

Batho, L.P., Martinussen, R. and Wiener, J. (2020) 'The effects of different types of environmental noise on academic performance and perceived task difficulty in adolescents with ADHD', *Journal of Attention Disorders*, Vol. 24, No. 8, pp.1181–1191, SAGE Publications Sage CA, Los Angeles, CA.

Behr, D. (2017) 'Assessing the use of back translation: the shortcomings of back translation as a quality testing method', *International Journal of Social Research Methodology*, Vol. 20, No. 6, pp.573–584, Routledge, DOI: 10.1080/13645579.2016.1252188.

Bhang, S.Y. et al. (2018) 'Comparing attention and cognitive function in school children across noise conditions: a quasi-experimental study', *Psychiatry Investigation*, Vol. 15, No. 6, pp.620–627, DOI: 10.30773/pi.2018.01.15.

Braat-Eggen, P.E. et al. (2017) 'Noise disturbance in open-plan study environments: a field study on noise sources, student tasks and room acoustic parameters', *Ergonomics*, Taylor & Francis, DOI: 10.1080/00140139.2017.1306631.

Broekhuizen, T. and Huizingh, E.K.R.E. (2009) 'Online purchase determinants: is their effect moderated by direct experience?', *Management Research News*, 32(5), pp. 440–457, DOI: 10.1108/01409170910952949.

Buabeng-Andoh, C., Yaokumah, W. and Tarhini, A. (2019) 'Investigating students' intentions to use ICT: a comparison of theoretical models', *Education and Information Technologies. Education and Information Technologies*, Vol. 24, No. 1, pp.643–660, DOI: 10.1007/s10639-018-9796-1.

Buchari, M. and Matondang, N. (2017) 'The impact of noise level on students' learning performance at state elementary school in Medan', *AIP Conference Proceedings*, June, p.1855, DOI: 10.1063/1.4985498.

Bulunuz, N. et al. (2017) 'An evaluation of primary school students' views about noise levels in school', *International Electronic Journal of Elementary Education*, Vol. 9, No. 4, pp.725–740.

Cakır, R. and Solak, E. (2015) 'Attitude of Turkish EFL learners towards e-learning through TAM model', *Procedia – Social and Behavioral Sciences*, Vol. 176, pp.596–601, Elsevier B.V., DOI: 10.1016/j.sbspro.2015.01.515.

Chen, H.R. and Tseng, H.F. (2012) 'Factors that influence acceptance of web-based e-learning systems for the in-service education of junior high school teachers in Taiwan', *Evaluation and Program Planning*, Vol. 35, No. 3, pp.398–406, Elsevier Ltd., DOI: 10.1016/j.evalprogplan.2011.11.007.

Chin, W.W. (1998) 'The partial least squares approach to structural equation modeling', in *Modern Methods for Business Research*, p.44 Lawrence Erlbaum Associates, New Jersey [online] https://books.google.com/books?hl=en&lr=&id=EDZ5AgAAQBAJ&oi=fnd&pg=PA295&dq=Chin,+W.+W.+(1998).+The+partial+least+squares+approach+to+structural+equation+modeling+Modern+methods+for+business+research+(Vol.+295,+pp.+295-336).&ots=48rA4pp3lr&sig=2uIr6I0YSZu (accessed 9 March 2018).

Choi, K. and Suk, H.J. (2016) 'Dynamic lighting system for the learning environment: performance of elementary students', *Optics Express*, Vol. 24, No. 10, pp.A907–A916, Optical Society of America.

Chow, M. et al. (2012) 'Extending the technology acceptance model to explore the intention to use second Life for enhancing healthcare education', *Computers and Education*, Vol. 59, No. 4, pp.1136–1144, Elsevier Ltd., DOI: 10.1016/j.compedu.2012.05.011.

Chuang, H.H., Weng, C.Y. and Huang, F.C. (2015) 'A structure equation model among factors of teachers' technology integration practice and their TPCK', *Computers & Education*, August, Vol. 86, pp.182–191, Elsevier.

Cohen, L., Manion, L. and Morrison, K. (2011) *Chapter 23: Observation', Research Methods in Education*, 7th ed., pp.456–475, Routledge, London, UK.

Crawford, J. et al. (2020) 'COVID-19 : 20 countries ' higher education intra-period digital pedagogy responses', *Journal of Applied Learning & Teaching*, Vol. 3, No. 1, pp.1–20.

Creswell, J.W. (2009) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, third ed., SAGE Publications, Incorporated, California.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use and user acceptance of information technology', *MIS Quarterly*, Vol. 13, No. 3, pp.319–340.

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1989) '1989 user acceptance of computer technology – a comparison of two theoretical models', *Management Science*, Vol. 35, No. 8, pp.982–1003.

Dawson, J.F. (2014) 'Moderation in management research: what, why, when, and how', *Journal of Business and Psychology*, Vol. 29, No. 1, pp.1–19, DOI: 10.1007/s10869-013-9308-7.

DeLone, W. and McLean, E. (1992) 'Information system success: the quest for the dependent variable', *Information Systems Research*, Vol. 3, No. 1, pp.60–65.

DeLone, W. and McLean, E. (2003) 'The DeLone and McLean Model of information systems success: a ten-year update', *Journal of Management Information Systems*, Vol. 19, No. 4, pp.9–30, DOI: 10.1073/pnas.0914199107 [online] http://mesharpe.metapress.com/content/PEQDJK46VY52V4Q6 (accessed 14 September 2021).

Douglas, M. et al. (2020) 'Mitigating the wider health effects of covid-19 pandemic response', *The BMJ*, April, Vol. 369, pp.1–6, DOI: 10.1136/bmj.m1557.

Elameer, A.S. and Idrus, R.M. (2010) 'Modified Khan elearning framework for the IRAQI higher education', in *The Seventh International Conference on eLearning for Knowledge-Based Society*, pp.16–17.

Elameer, A.S. and Idrus, R.M. (2011) *National E-Learning Strategy to Enhance and Enrich the Iraqi Universities*, Online Submission, ERIC.

Fornell, C. and Larcker, D.F. (1981) 'Evaluating structural equation models with unobservable variables and measurement error', *Journal of Marketing Research*, Vol. 18, No. 1, p.39, DOI: 10.2307/3151312.

Gilavand, A. and Hosseinpour, M. (2016) 'Investigating the impact of educational spaces painted on learning and educational achievement of elementary students in Ahvaz, Southwest of Iran', *International Journal of Pediatrics*, Vol. 4, No. 2, pp.1387–1396, DOI: 10.22038/ijp.2016.6439.

Glood, S., Muhil, S. and Ibrahim, B. (2019) 'Role of using mobile phone among Iraqi farmers for agriculture development', *Journal of Engineering and Applied Sciences*, Vol. 14, No. 2, pp.5495–5500.

Glood, S., Osman, W. and Nadzir, M. (2016) 'The effect of civil conflicts and net benefits on m-government success of developing countries: a case study of Iraq', *Journal of Theoretical and Applied Information Technology*, Vol. 88, No. 3, pp.541–552.

Glood, S.H., Hussein, R.M. and Kamil, W.A. (2018) 'The effects of information quality, service quality, and compatibility on continue use of M-learning among students in the public universities of Iraqi', *Journal of Theoretical and Applied Information Technology*, Vol. 96, No. 12, pp.3739–3755.

Hair, J.F., Hult, T. et al. (2014a) *Partial Least Squares Structural Equation Modeling (PLS-SEM), Handbook of Market Research*, SAGE Publications, Inc., London, DOI: 10.1007/978-3-319-05542-8_15-1.

Hair, J.F., Sarstedt, M. et al. (2014b) 'Partial least squares structural equation modeling (PLS-SEM): an emerging tool in business research', *European Business Review*, Vol. 26, No. 2, pp.106–121, DOI: 10.1108/EBR-10-2013-0128.

Halawi, L. and Mccarthy, R. (2008) 'Measuring students perceptions of blackboard using the technology acceptance model: a PLS approach', *Issues in Information Systems*, Vol. 9, DOI: 10.48009/2_iis_2008_95-102.

Hanafizadeh, P. et al. (2014) 'Telematics and informatics mobile-banking adoption by Iranian bank clients', *Telematics and Informatics*, Vol. 31, No. 1, pp.62–78, Elsevier Ltd., DOI: 10.1016/j.tele.2012.11.001.

Hassanzadeh, A., Kanaani, F. and Elahi, S. (2012) 'A model for measuring e-learning systems success in universities', *Expert Systems with Applications*, Vol. 39, No. 12, pp.10959–10966, Elsevier Ltd., DOI: 10.1016/j.eswa.2012.03.028.

Henseler, J. and Chin, W.W. (2010) 'A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling', *Structural Equation Modeling*, Vol. 17, No. 1, pp.82–109, DOI: 10.1080/10705510903439003.

Henseler, J. and Fassott, G. (2010) 'Testing moderating effects in PLS path models: an illustration of available procedures', in *Handbook of Partial Least Squares*, pp.713–735, Springer, Berlin, Heidelberg.

Hussein, M.H. et al. (2020) 'Measuring instructors continued intention to reuse Google classroom in Iraq: a mixed-method study during COVID-19', *Interactive Technology and Smart Education*, DOI: 10.1108/ITSE-06-2020-0095.

Hviid, C.A., Pedersen, C. and Dabelsteen, K.H. (2020) 'A field study of the individual and combined effect of ventilation rate and lighting conditions on pupils' performance', *Building and Environment*, 15 March, Vol. 171, p.106608, Elsevier.

Islam, A.K.M.N. and Azad, N. (2015) 'Satisfaction and continuance with a learning management system: comparing perceptions of educators and students', *International Journal of Information and Learning Technology*, Vol. 32, No. 2, pp.109–123, https://doi.org/10.1108/IJILT-09-2014-0020.

Javed, Y. and Samara, K. (2019) 'Impact of tablet PCs on learning outcomes in a classroom environment', *International Journal of Learning Technology*, Vol. 14, No. 1, pp.59–77, Inderscience Publishers (IEL).

Johnson, L. (2015) *Teaching Outside the Box: How to Grab your Students by their Brains*, John Wiley & Sons, San Francisco, USA.

Kang, M. and Shin, W.S. (2015) 'An empirical investigation of student acceptance of synchronous e-learning in an online university', *Journal of Educational Computing Research*, Vol. 52, No. 4, pp.475–495, DOI: 10.1177/0735633115571921.

Kapasia, N. et al. (2020) 'Impact of lockdown on learning status of undergraduate and postgraduate students during COVID-19 pandemic in West Bengal, India', *Children and Youth Services Review*, June, Vol. 116, p.105194, Elsevier, DOI: 10.1016/j.childyouth.2020.105194.

Kaur, G. (2020) 'Digital life: boon or bane in teaching sector on COVID-19', *CLIO an Annual Interdisciplinary Journal of History*, Vol. 6, No. 6, pp.416–427.

Kemp, A., Palmer, E. and Strelan, P. (2019) 'A taxonomy of factors affecting attitudes towards educational technologies for use with technology acceptance models', *British Journal of Educational Technology*, Vol. 50, No. 5, pp.2394–2413, DOI: 10.1111/bjet.12833.

Kerres, M. (2020) 'Against: all odds education in Germany coping with Covid-19', *Postdigital Science and Education*, Vol. 2, No. 3, pp.690–694, DOI: 10.1007/s42438-020-00130-7.

Khan, M.A. et al. (2021) 'Students' perception towards e-learning during covid-19 pandemic in India: an empirical study', *Sustainability (Switzerland)*, Vol. 13, No. 1, pp.1–14, DOI: 10.3390/su13010057.

Kim, B. and Park, M.J. (2018) 'Effect of personal factors to use ICTs on e-learning adoption: comparison between learner and instructor in developing countries', *Information Technology for Development*, Vol. 24, No. 4, pp.706–732, Taylor & Francis.

Komito, L. (2007) 'Community and inclusion: the impact of new communications technologies', *Irish Journal of Sociology*, Vol. 16, No. 2, pp.77–96.

Lederer, A.L. et al. (2000) 'Technology acceptance model and the World Wide Web', *Decision Support Systems*, Vol. 29, No. 3, pp.269–282, DOI: 10.1016/S0167-9236(00)00076-2.

Lee, B.C., Yoon, J.O. and Lee, I. (2009) 'Learners' acceptance of e-learning in South Korea: theories and results', *Computers and Education*, Vol. 53, No. 4, pp.1320–1329, Elsevier Ltd., DOI: 10.1016/j.compedu.2009.06.014.

Lee, Y.H., Hsiao, C. and Hadi, S. (2012) 'Enhancing e-learning acceptance: an empirical examination on individual and system characteristics', *Academy of Management Proceedings*, Vol. 2012, No. 1, p.15828, DOI: 10.5465/ambpp.2012.15828abstract.

Legido-Quigley, H. et al. (2020) 'The resilience of the Spanish health system against the COVID-19 pandemic', *The Lancet Public Health*, Vol. 5, No. 5, pp.e251–e252, DOI: 10.1016/S2468-2667(20)30060-8.

Lu, X. and Viehland, D. (2008) 'Factors influencing the adoption of mobile learning', *ACIS 2008 Proceedings*, p.56, https://aisel.aisnet.org/acis2008/56.

Luan, W.S. and Teo, T. (2009) 'Investigating the technology acceptance among student teachers in Malaysia: an application of the technology acceptance model (TAM)', *Asia-Pacific Education Researcher*, Vol. 18, No. 2, pp.261–272, De La Salle University-Manila.

Lyons, J.B. (2001) *Do School Facilities Really Impact a Child's Education? IssueTrak: A CEFPI Brief on Educational Facility Issues*, ERIC.

Mailizar, A. et al. (2020) 'Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: the case of Indonesia', *Eurasia Journal of Mathematics, Science and Technology Education*, Vol. 16, No. 7, DOI: 10.29333/EJMSTE/8240.

Maldonado-Macías, A. et al. (2014) 'Intuitionistic fuzzy TOPSIS for ergonomic compatibility evaluation of advanced manufacturing technology', *The International Journal of Advanced Manufacturing Technology*, Vol. 70, No. 9, pp.2283–2292, Springer.

Matar, N. et al. (2011) 'E-learning acceptance and challenges in the Arab region', in *ICT Acceptance, Investment and Organization: Cultural Practices and Values in the Arab World*, pp.184–200, IGI Global, Hershey, Pennsylvania, USA.

Michael, A. and Heracleous, C. (2017) 'Assessment of natural lighting performance and visual comfort of educational architecture in Southern Europe: the case of typical educational school premises in Cyprus', *Energy and Buildings*, Vol. 140, pp.443–457, Elsevier B.V., DOI: 10.1016/j.enbuild.2016.12.087.

Mills, P.R., Tomkins, S.C. and Schlangen, L.J.M. (2007) 'The effect of high correlated colour temperature office lighting on employee wellbeing and work performance', *Journal of Circadian Rhythms*, Vol. 5, pp.1–9, DOI: 10.1186/1740-3391-5-2.

Mohammadi, H. (2015) 'Investigating users' perspectives on e-learning: an integration of TAM and IS success model', *Computers in Human Behavior*, Vol. 45, pp.359–374, Elsevier Ltd., DOI: 10.1016/j.chb.2014.07.044.

Muhaimin, H. et al. (2020) 'Science teachers' integration of digital resources in education: a survey in rural areas of one Indonesian province', *Heliyon*, Vol. 6, No. 8, p.e04631, Elsevier Ltd., DOI: 10.1016/j.heliyon.2020.e04631.

Muhaimin, H. et al. (2019) 'Predicting factors affecting intention to use Web 2.0 in learning: evidence from science education', *Journal of Baltic Science Education*, Vol. 18, No. 4, p.595, Scientia Socialis Ltd.

Mutambara, D. and Bayaga, A. (2021) 'Learners' and teachers' acceptance of mobile learning: an exploratory study in a developing country', *International Journal of Learning Technology*, Inderscience Publishers (IEL), 16(2), pp. 90–108.

Nicholas-Omoregbe, O.S. et al. (2017) 'Predicting the adoption of e-learning management system: a case of selected private universities in Nigeria', *Turkish Online Journal of Distance Education*, Vol. 18, No. 2, pp.106–121.

Oselumese, I.B., Omoike, D. and Andrew, O. (2016) 'Environmental influence on students' academic performance in secondary school', *International Journal of Fundamental Psychology and Social Sciences*, Vol. 6, No. 1, pp.10–14.

Parvez, M.S., Rahman, A. and Tasnim, N. (2019) 'Ergonomic mismatch between students anthropometry and university classroom furniture', *Theoretical Issues in Ergonomics Science*, Vol. 20, No. 5, pp.603–631, Taylor & Francis, DOI: 10.1080/1463922X.2019.1617909.

Pillay, D. and Vieira, B.L. (2020) 'Noise, screaming and shouting: classroom acoustics and teachers' perceptions of their voice in a developing country', *South African Journal of Childhood Education*, Vol. 10, No. 1, pp.1–9, DOI: 10.4102/sajce.v10i1.681.

Popa, D. et al. (2020) 'Using mixed methods to understand teaching and learning in Covid 19 times', *Sustainability*, Vol. 12, No. 20, p.8726, Multidisciplinary Digital Publishing Institute.

Ramírez-Correa, P. et al. (2019) 'Personality types as moderators of the acceptance of information technologies in organizations: a multi-group analysis in PLS-SEM', *Sustainability (Switzerland)*, Vol. 11, No. 14, DOI: 10.3390/su11143987.

Ramírez-Correa, P.E., Arenas-Gaitán, J. and Rondán-Cataluña, F.J. (2015) 'Gender and acceptance of e-learning: a multi-group analysis based on a structural equation model among college students in Chile and Spain', *PLoS ONE*, Vol. 10, No. 10, pp.1–17, DOI: 10.1371/journal.pone.0140460.

Raza, S.A. et al. (2018) 'The effects of attitudinal, normative, and control beliefs on m-learning adoption among the students of higher education in Pakistan', *Journal of Educational Computing Research*, Vol. 56, No. 4, pp.563–588, SAGE Publications Sage CA, Los Angeles, CAs.

Realyvásquez-Vargas, A., Maldonado-Macías, A.A. et al. (2020) 'The impact of environmental factors on academic performance of university students taking online classes during the COVID-19 pandemic in Mexico', *Sustainability (Switzerland)*, Vol. 12, No. 21, pp.1–22, Multidisciplinary Digital Publishing Institute, DOI: 10.3390/su12219194.

Saadé, R.G., Nebebe, F. and Mak, T. (2009) 'The role of intrinsic motivation in system adoption: a cross-cultural perspective', *Journal of Information, Information Technology & Organizations*, Vol. 4, No. 9, pp.107–126.

Samani, S.A. (2011) 'The Influence of light on student's learning performance in learning environments: a knowledge internalization perspective', *Journal of World Academy of Science, Engineering and Technology*, September, Vol. 81.

Samuel, O.A., Israel, D. and Moses, F. (2016) 'Anthropometry survey of nigerian occupational bus drivers to facilitate sustainable design of driver's workplace', *World Journal of Engineering and Technology*, Vol. 4, No. 2, pp.176–18, DOI: 10.4236/wjet.2016.42016.

Sánchez-Gómez, M.C., Martín-García, A.V. and Mena, J. (2020) 'Blended learning in tertiary education: teachers' beliefs according to the technology acceptance model', *International Journal of Learning Technology*, Vol. 15, No. 4, pp.341–359, Inderscience Publishers (IEL).

Saxena, C., Baber, H. and Kumar, P. (2020) 'Examining the moderating effect of perceived benefits of maintaining social distance on e-learning quality during COVID-19 pandemic', *Journal of Educational Technology Systems*, p.004723952097779, DOI: 10.1177/0047239520977798.

Schworm, S. and Gruber, H. (2012) 'E-Learning in universities: supporting help-seeking processes by instructional prompts', *British Journal of Educational Technology*, Vol. 43, No. 2, pp.272–281, DOI: 10.1111/j.1467-8535.2011.01176.x.

Sekaran, S. et al. (2007) '2-Aminoethoxydiphenylborane is an acute inhibitor of directly photosensitive retinal ganglion cell activity in vitro and in vivo', *The Journal of neuroscience*, Vol. 27, No. 15, pp.3981–3986 [online] https://www.jneurosci.org/content/27/15/3981.short (accessed 10 March 2018).

Shah, G.U.D. et al. (2013) 'Implementation of technology acceptance model in e-learning environment in rural and urban areas of Pakistan', *World Applied Sciences Journal*, Vol. 27, No. 11, pp.1495–1507, DOI: 10.5829/idosi.wasj.2013.27.11.1787.

Shah, T.R., Shah, T.T. and Jain, A. (2021) 'The role of technology readiness in students' perception and behaviour towards e-learning technologies', *International Journal of Learning Technology*, Vol. 16, No. 3, pp.197–224, Inderscience Publishers (IEL).

Sharma, S., Chandel, J. and Govindaluri, S. (2014) 'Students' acceptance and satisfaction of learning through course websites', *Education, Business and Society: Contemporary Middle Eastern Issues*, Vol. 7, Nos. 2/3, pp.1753–7983, DOI: 10.1108/ebs.2008.34901caa.002.

Shen, C.W. and Ho, J.T. (2020) 'Technology-enhanced learning in higher education: a bibliometric analysis with latent semantic approach', *Computers in Human Behavior*. Vol. 104, Elsevier B.V., DOI: 10.1016/j.chb.2019.106177.

Sleegers, P.J.C. et al. (2013) 'Lighting affects students' concentration positively: findings from three Dutch studies', *Lighting Research & Technology*, Vol. 45, No. 2, pp.159–175, Sage Publications Sage UK: London, England.

Smarkola, C. (2007) 'Technology acceptance predictors among student teachers and experienced classroom teachers', *Journal of Educational Computing Research*, Vol. 37, No. 1, pp.65–82, SAGE Publications Sage CA: Los Angeles, CA.

Smedley, J. (2010) 'Modelling the impact of knowledge management using technology', *OR Insight*, Vol. 23, No. 4, pp.233–250, Taylor & Francis.

Smith, A.P. (2017) 'Prior and current perceptions of noise exposure: effects on university students' wellbeing and attainment', *12th ICBEN Congress on Noise as a Public Health Problem*, pp.1–11 [online] http://orca.cf.ac.uk/101575/ (accessed 2 September 2021).

Sukendro, S. et al. (2020) 'Using an extended technology acceptance model to understand students' use of e-learning during Covid-19: Indonesian sport science education context', *Heliyon*, Vol. 6, No. 11, p.e05410, Elsevier Ltd., DOI: 10.1016/j.heliyon.2020.e05410.

Šumak, B., Heričko, M. and Pušnik, M. (2011) 'A meta-analysis of e-learning technology acceptance: The role of user types and e-learning technology types', *Computers in Human Behavior*, Vol. 27, No. 6, pp.2067–2077, DOI: 10.1016/j.chb.2011.08.005.

Tarhini, A. et al. (2017) 'Factors influencing students' adoption of e-learning: a structural equation modeling approach', *Journal of International Education in Business*, Vol. 10, No. 2, pp.164–182, https://doi.org/10.1108/JIEB-09-2016-0032, Emerald Publishing Limited.

Tarhini, A., Teo, T. and Tarhini, T. (2016) 'A cross-cultural validity of the e-learning acceptance measure (ElAM) in Lebanon and England: a confirmatory factor analysis', *Education and Information Technologies*, Vol. 21, No. 5, pp.1269–1282, Springer.

Temsah, M.H. et al. (2020) 'The psychological impact of COVID-19 pandemic on health care workers in a MERS-CoV endemic country', *Journal of Infection and Public Health*, Vol. 13, No. 6, pp.877–882, King Saud Bin Abdulaziz University for Health Sciences, DOI: 10.1016/j.jiph.2020.05.021.

Teo, T., Huang, F. and Hoi, C.K.W. (2018) 'Explicating the influences that explain intention to use technology among English teachers in China', *Interactive Learning Environments*, Vol. 26, No. 4, pp 460–475, Taylor & Francis.

Teo, T.S.H., Srivastava, S.C. and Jiang, L. (2008) 'Trust and electronic government success: an empirical study', *Journal of Management Information Systems*, Vol. 25, No. 3, pp.99–132, DOI: 10.2753/MIS0742-1222250303.

Thorpe, S.J. and Alsuwayed, H.M. (2019) 'Saudi academic perceptions of e-learning systems', *International Journal of Learning Technology*, Vol. 14, No. 3, pp.251–268, Inderscience Publishers (IEL).

UNESCO (2020) *COVID-19 Educational Disruption and Response*, UNESCO [online] https://en.unesco.org/covid19/educationresponse (accessed 10 December 2020).

Uppal, M.A., Ali, S. and Gulliver, S.R. (2018) 'Factors determining e-learning service quality', *British Journal of Educational Technology*, Vol. 49, No. 3, pp.412–426, DOI: 10.1111/bjet.12552.

Venkatesh, V., Thong, J.Y.L. and Xu, X. (2012) 'Consumer acceptance and use of information technology: extending the unified theory', *MIS Quarterly*, Vol. 36, No. 1, pp.157–178.

Wang, C., Teo, T.S.H. and Liu, L. (2020) 'Perceived value and continuance intention in mobile government service in China', *Telematics and Informatics*, September 2019, Vol. 48, p.101348, Elsevier, DOI: 10.1016/j.tele.2020.101348.

Wessolowski, N. (2014) *Wirksamkeit von dynamischem Licht im Schulunterricht*, Staats-und Universitätsbibliothek Hamburg Carl von Ossietzky.

Wu, W.H. et al. (2012) 'Review of trends from mobile learning studies: a meta-analysis', *Computers and Education*, Vol. 59, No. 2, pp.817–827, Elsevier Ltd., DOI: 10.1016/j.compedu.2012.03.016.

Yau, K.L.A. et al. (2011) 'Exploring sustainability of the deployment of wireless broadband in Malaysia rural areas: comprehensive insights', in *2011 IEEE Colloquium on Humanities, Science and Engineering*, pp.148–152.

Zhang, J., Huang, J. and Chen, J. (2010) 'Empirical research on user acceptance of mobile searches', *Tsinghua Science and Technology*, Vol. 15, No. 2, pp.235–245, DOI: 10.1016/S1007-0214(10)70056-0.

Zhong, L., Yuan, J. and Fleck, B. (2019) 'Indoor environmental quality evaluation of an institutional building', *Sustainability*, Vol. 11, No. 23, p.6591.

Appendix

Table A1 The survey items

Learning content (LC)		
The content of assignments is easy to understand محتوى المهام سهل الفهم	LC1	Lee et al. (2009) and Saxena et al. (2020)
The amount of LC is appropriate كمية محتوى ألتعلم مناسبة	LC2	
The delivery schedule of LC is flexible جدول تسليم محتوى التعلم مرن	LC3	
EL provides a variety of learning methods يوفر التعلم إللكتروني مجموعة متنوعة من أساليب التعلم	LC4	
Perceived usefulness (PU)		
During COVID-19, using EL provides flexibility to the study at a time convenient to the student. خالل Covid-19 ، يوفر استخدام التعلم االلكتروني مرونة في الدراسة في وقت مناسب للطالب	PU1	Davis (1989) and Khan et al. (2021)
EL can enable students to study regardless of where they are located. يمكن أن يم ّكن التعلم االلكتروني الطالب من الدراسة بغض النظر عن مكان تواجدهم	PU2	
There are technologies available to enable students to take tests and submit assignments electronically. هناك تقنيات متاحة لتمكين الطالب من إجراء االختبارات وإرسال المهام إلكترون ًيا	PU3	
There are electronic tools available to enable interactive communication between the instructor and his students without meeting face-to-face. هناك أدوات إلكترونية متاحة لتمكين التواصل التفاعلي بين المعلم وطالبه دون مقابلة وج ًها لوجه	PU4	
Perceived ease of use (PEOU)		
I believe the EL platform is user-friendly. أعتقد أن منصة التعلم االلكتروني سهلة االستخدام	PEOU1	Davis (1989) and Khan et al. (2021)
It would be easy for me to find necessary information when using an EL platform. سيكون من السهل بالنسبة لي العثور على المعلومات الضرورية عند استخدام منصة التعلم إللكتروني	PEOU2	
I believe that using EL can simplify the learning process. أعتقد أن استخدام التعلم إللكتروني يمكن أن يبسط عملية التعلم	PEOU3	
The set-up of the EL service is compatible with the way I learn. تتوافق إعداد خدمة التعلم إللكتروني مع طريقة التعلم	PEOU4	

Table A1 The survey items (continued)

Behavioural intention (BI)		
During COVID-19, I intend to use EL to assist my learning. خالل Covid-19 ، أعتزم استخدام التعلم اإللكتروني لمساعدة تعلمي	BI1	Davis (1989) and Khan et al. (2021)
During COVID-19, I intend to use EL to get updated my subject knowledge with the latest amendments. خالل Covid-19 ، أعتزم استخدام التعلم اإللكتروني لتحديث معرفتي بالموضوع بأحدث التعديالت	BI2	
During COVID-19, I intend to use EL as an autonomous (free) learning tool. خالل Covid-19 ، أعتزم استخدام التعلم اإللكتروني كأداة تعليمية مستقلة)مجانية)	BI3	
Use of EL during COVID-19 (ULCO)		
I use EL on daily basis during COVID-19 pandemic أستخدم التعلم اإللكتروني يوميا خالل جائحةCovid-19	ULCO1	DeLone and McLean (2003), Alshare et al. (2011) and Sukendro et al. (2020)
I use EL frequently during COVID-19 pandemic أستخدم التعلم اإللكتروني بشكل متكرر خالل جائحة Covid-19	ULCO2	
I depend upon the EL during COVID-19 pandemic أعتمد على التعلم اإللكترونى أثناء جائحة Covid-19	ULCO3	
I think the EL is very helpful during COVID-19 pandemic أعتقد أن التعلم اإللكتروني مفيد للغاية أثناء جائحة Covid-19	ULCO4	
Noise (NIS)		
I have privacy in learning place area when taking classes online. لدي خصوصية في منطقة الدراسة الخاصة بي عند أخذ الدروس عبر اإلنترنت	NIS1	Banbury and Berry (2005), Ali Alzahrani (2019), Pillay and Vieira (2020) and Realyvásquez-Vargas et al., 2020)
The noise level (coming from devices, people's talks, external sources) in my learning place allows me to concentrate, take the class, and clearly hear my teacher and classmates. يسمح لي مستوى الضوضاء)الصادر من األلجهزة ، ومحادثات األلشخاص ، والمصادر الخارجية(في منطقة الدراسة الخاصة بي بالتركيز ، وحضور الفصل ، وسماع معلمي وزمالئي بوضوح	NIS2	
I can control the noise level in my learning place (example: opening/closing doors or windows). يمكنني التحكم في مستوى الضوضاء في منطقة الدراسة)مثال: فتح / إغالق األلبواب او النوافذ)	NIS3	
In online lessons, the noise level allows me to hear teacher clearly. في المحاضرات االلكترونية، يسمح لي مستوى الضوضاء بسماع المحاضر بشكل واضح.	NIS4	Bulunuz et al. (2017)
In my online lessons, the noise level allows me to finish my tasks.	NIS5	Bulunuz et al. (2017)

Table A1 The survey items (continued)

Noise (NIS)		
في المحاضرات االلكترونية، يسمح لي مستوى الضوضاء بإتمام مهامي.		Bulunuz et al. (2017)
Lighting (LGH)		
The level of lighting in my learning place allows me to see clearly what is around. يسمح لي مستوى اإلضاءة في منطقة الدراسة الخاصة بي برؤية ما هو موجود بوضوح	LGH1	Mills et al. (2007) and Realyvásquez-Vargas et al. (2020)
The level of lighting in my learning place allows me to concentrate when taking online classes. يسمح لي مستوى اإلضاءة في منطقة الدراسة الخاصة بالتركيز عند أخذ دروس عبر اإلنترنت	LGH2	
I can control the level of lighting in my learning place when taking online classes (for example: opening/closing blinds, curtains; having a table lamp; dimmers within reach). .كنني التحكم في مستوى اإلضاءة في منطقة الدراسة الخاصة بي عند أخذ دروس عبر االنترنت)على سبيل المثال ، فتح / إغالق الستائر والستائر ؛ وجود مصباح مكتبي ؛ مخفتات اإلضاءة في متناول اليد)	LGH3	
The level of lighting (from lamps, computer screen) in my learning place allows me to have visual comfort when taking online classes. يسمح لي مستوى اإلضاءة)من المصابيح وشاشة الكمبيوتر (في منطقة الدراسة الخاصة بي بالراحة البصرية عند أخذ دروس عبر االنترنت	LGH4	

Table A2 Participant's demographic information

Demographic variable	*Category*	*(N = 455) Frequency*	*Percentage %*
Gender	Male	101	22.2
	Female	354	77.8
Age	23–26	296	65
	27–30	129	28.4
	30 or above	30	6.6
Mobile-device	Smart phone	340	74.7
	Laptop	75	16.5
	Others	40	8.8
Experience	Advance	345	75.8
	Normal	110	24.2