Analyzing Students' Perceptions of Information Communication Channels as E-Learning Platforms in Higher Education

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Abstract

The e-learning platforms are regarded the best innovation in higher education especially in China, due to the advancement in technologies and the increase access to the internet. This study examines students' perception of information communication channels as e-learning platforms and assesses the impact of perceived ease of use, content accessibility, and interaction quality on student engagement and learning effectiveness. The data was collected using convenience sampling technique from 1000 students of various universities in Beijing, China. For data analysis, structural equation modeling (SEM) was used in AMOS software. The findings of the study indicate that all the research hypotheses were supported. The results reveal that perceived ease of use, content accessibility, and interaction quality significantly influences student engagement and learning effectiveness. Student engagement also found to have positive impact on learning effectiveness. Additionally, student engagement mediated these independent variables (perceived ease of use, content accessibility, and interaction quality) and learning effectiveness. Educators and platform developers should focus on how to improve usability, accessibility, and interaction quality to achieve higher educational outcomes. These insights will be useful in the process of defining the further development of higher education in China in the context of modern trends.

Keywords

Perceived Ease of Use, Content Accessibility, Interaction Quality, Student Engagement, Learning Effectiveness, Higher Education, China.

1. Introduction

Most universities across the globe have incorporated e-learning platforms in the education sector in response to the fast growth digitalization (**Matthew *et al.***, 2021; **Khan *et al.***, 2022). Such platforms are innovative and provide open, flexible, and easily accessible means to support teaching and learning irrespective of time or space (**Gupta; Gupta**, 2020). The Covid-19 pandemic contributed much to the advancement of e-learning as it was the only way for continuity of the learning process (**Fauzi**, 2022). Among the key determinants that define the efficiency of the e-learning platforms

are the behaviors and perceptions of the students toward those technologies (**Panigrahi *et al.***, 2021). It is crucial to understand such perceptions in order to improve the learners' performance particularly in online learning environment. In China, e-learning has received a lot of support especially in higher education institutions as China seeks to incorporate technology in its learning systems (**Osadcha *et al.***, 2021). Chinese e-learning platforms provide different types of communication tools that include learning management systems, virtual classrooms, and threaded discussions which facilitate students learning content and interacting with other students and instructors (**Lu *et al.***, 2020). However, the success of e-learning platforms is still questionable, and some students are hesitant to participate effectively in the e-learning platforms due to perceived barriers such as usability, content access, and interaction quality.

Despite the prospects offered by e-learning platforms to improve the learning outcomes, several studies indicate that the effectiveness of such approach depends on the perception and behavioral change in students. Perceived ease of use is the extent to which the use of a particular system is perceived to be trouble-free (**Davis**, 1989). Perceived ease of use has a strong effect on the students' intention to use e-learning platforms as well as the perceived usefulness of these platforms in improving learning outcomes (**Bakı *et al.***, 2018). Further, content accessibility and the quality of interactions that are enabled by the platforms are determining variables of engagement and learning outcomes among the students (**Salas-Pilco *et al.***, 2022). Enhanced communication is necessary for positive interaction and application of knowledge without discrimination while access to the material should be encouraged to meet the needs of students.

There is a plethora of studies in the field of e-learning; however, few empirical research works have attempted to explain the nature of these relationships and their effects on students' engagement and achievement in the context of Chinese higher learning institutions. For instance, **Chen *et al.*** (2022) and **Deng *et al.*** (2020) pointed out that engagement serves as a mediator between the characteristics of platforms and learning outcomes; nonetheless, it remains unclear if this is also valid for China because the culture and usage of technology differ. This lack of research necessitates a better understanding of how students perceive the information communication channels as e-learning platforms in China. Therefore, this research aims at exploring the variables that affect the Chinese students' participation and performance in e-learning settings. More precisely, this research examines the role that perceived ease of use, content accessibility, and interaction quality play in determining students' engagement and learning effectiveness. Furthermore, it identifies the mediating effect of engagement on the interactions between the platform features and the learning effectiveness. The study addresses the following questions in particular.

1. How have students in Chinese higher education perceived e-learning platforms in the recent past?
2. Which are the most significant predictors of student engagement and learning effectiveness in e-learning context?
3. Which communication channels can contribute to the effectiveness of e-learning platforms in Chinese higher education institutions?

The results of this study would help to reveal the patterns of students' engagement and learning effectiveness in e-learning environments.

2. Literature Review and Hypotheses Development

2.1. Perceived Ease of Use and Student Engagement

Perceived ease of use is one of the constructs used in the technology accept model (TAM) and illustrates to what extent a system is perceived easiness by the users (**Davis**, 1989). Some features such as convenience and ease of use can improve the willingness of students to use the available technology in educational settings in the most efficient manner (**Bansah; Darko Agyei**, 2022). On the other hand, student engagement is defined as a level of interest, passion and involvement a student demonstrates during learning process. It has the emotional, behavioral and the cognitive component thus enhancing learning and achievement (**Barkley; Major**, 2020). When students realize that an educational tool or technology is convenient, they will engage with it effectively. This ease minimizes the cases when students spend most of their time grappling with the systems or gadgets than learning. For instance, a simple and clear layout of a virtual learning environment underlines the importance of using all its components resulting in higher levels of engagement (**Papaioannou *et al.***, 2023). Additionally, easy to use systems reduce the task difficulty and increases the students' perceived usefulness hence boosting the engagement levels attributed to technology use (**Panigrahi *et al.***, 2021). On the other hand, bulky or complex designs of learning tools may demotivate the students, or make them look for other means of learning (**Pratama; Dewi**, 2022). In this way, by making educational technologies easy to use, educators and developers can provide the context in which students are willing to engage with their learning activities. This necessitates to test the hypothesis:

H1: Perceived ease of use significantly influences student engagement

2.2. Perceived Ease of Use and Learning Effectiveness

Learning effectiveness is one of the major measures of success that indicates the degree to which learning objectives have been met in terms of enhanced knowledge, skill, attitude or behavior (**Tsang *et al.***, 2021). It includes the ability to

grasp, remember and apply knowledge as seen from coursework performance or practical skills. Some of the content qualities that directly affect learning include teaching approaches, learners' attitudes, and facility in using the teaching tools. This means that when the learning environment has a clear, accessible and relevant context, the student will be equipped to attain any intended objectives (**Niemi**, 2021). When the educational technologies or tools are easy to manage and do not demand much effort to manage then students can devote much of their time focusing on the content rather than the tool (**Reich**, 2020). This interaction enhances learning environment since students learning becomes easier and effective. For instance, nice graphical interfaces of virtual learning environment and optimized features, including drag-and-drop, automatic assessment, and comprehensive structure of the course will contribute to the decrease of cognitive load and increase the concentration (**Darejeh *et al.***, 2024). Such platforms enable students to engage in content discovery in the most flexible manner thus enhancing comprehension and improved knowledge retention. On the other hand, complex tools which are hard to navigate may result in low use by learners and, therefore, poor learning. It means that by creating systems that are easy to use, educators and developers can improve the effectiveness of the learning environment (**Prather *et al.***, 2023). Reducing the complexity of the technology interfaces in a way that enables students to have meaningful and effective learning experiences is important in ensuring that the education a student gains translates into actual achievement. This requires to test the hypothesis:

H2: Perceived ease of use significantly influences learning effectiveness.

2.3. Content Accessibility and Student Engagement

Content accessibility refers to how well students can access, comprehend, and apply educational materials, regardless of physical, intellectual or technological limitations. It includes features like digital access, precise organization, provision of assistive devices, and diverse learning style compatibility (**Beyene *et al.***, 2023). For education materials to be accessible, it means that all students can access them hence promoting the learning environment for equality, and giving people control of the curriculum (**de Klerk; Palmer**, 2021). This is especially relevant for creating an environment that encourages inclusion within a learning environment so that fewer impediments to student engagement and more invigoration of functionalities are present. If educational content is accessible, students will have the motivation to engage and that increases engagement levels (**Ferrer *et al.***, 2022). The content accessibility minimizes the frustration stemming from ineffective layouts or lack of information and enables students to concentrate on learning their lessons. Moreover, this encourages independent learning since a student can easily engage with content at any moment or in any way (**Huang *et al.***, 2020). That is why educators and educational institutions should pay more attention to making content more accessible in their teaching strategies. This necessitates to test the hypothesis:

H3: Content accessibility significantly influences student engagement.

2.4. Content Accessibility and Learning Effectiveness

Content accessibility is an important aspect in the current learning environment, and it determines the learning effectiveness. When educational content is developed for the utilization of all students, for instance, proper format, and incorporation of technologies to assist students and multiple delivery methods, students are able to understand and remember what is taught to them (**Al Mamun; Lawrie**, 2023). It is particularly useful in multicultural contexts since students possess a wide range of characteristics that prevail in learning processes. In the interest of expounding on how content accessibility improves the effectiveness of learning, one of the major facets is by minimizing the barriers to content consumption (**Clark; Mayer**, 2023). It will be easier for students to participate actively in their learning process if they can easily find the content. For example, content that is accessible for the screen reader or contains subtitles in videos can help significantly enhance the learning of the disability students (**Sloan *et al.***, 2013). In this regard, education aims to provide basic needs to enhance the goal of delivering an equal chance to everyone to acquire knowledge. In addition, when content is made more accessible, understanding and recall of the information is enhanced (**Skulmowski; Xu**, 2022). Students who can easily find and comprehend the knowledge can apply it in practice more successfully. It is especially valuable for platforms that support digital education as easily navigable interfaces and designs help students to train without complicated obstacles. This necessitates to test the hypothesis:

H4: Content accessibility significantly influences learning effectiveness.

2.5. Interaction Quality and Student Engagement

Interaction quality can be defined as the amount of effectiveness, clarity and satisfaction of the communication that occurs between students, instructors and the e-learning system (**Alhendawi; Baharudin**, 2014). It includes aspects such as getting feedback on time, communication and contact ease, relevance of posted content and meaningful communication. High interaction quality guarantees the efficient flow of information which creates a positive and effective learning atmosphere (**Al-Samarraie *et al.***, 2018). In the context of e-learning, the interaction quality addresses the perceived lack of total face-to-face education and the collaborative environment required for student achievement. Fast and profound replies of instructors, inclusive and exciting conversations, and user-friendly platforms help to catch and encourage students' attention (**Ahmad**, 2024). Students will be more willing to engage within the learning process,

if they feel that their inputs are appreciated and questions answered immediately. Further, appropriate interaction mechanisms lead to feelings of belonging among students and instructors hence improving the engagement of students (**Heilporn *et al.***, 2021). On the other hand, low quality of the interactions may pose a negative influence on engagement, as a result the users feel left out and unmotivated (**Hammedi *et al.***, 2021). For instance, where respondents are given delayed feedback or where there is some technical hitch, the students are likely to be discouraged from continuing with the lessons. Therefore, the e-learning platforms that have a focus on high interaction quality can greatly improve students' engagement as it provides an interactive and fully responsive learning environment (**Wagino *et al.***, 2024). This necessitates to test the hypothesis:

H5: Interaction quality significantly influences student engagement.

2.6. Interaction Quality and Learning Effectiveness

Interaction quality is one of the most significant factors determining the results of learning environments. High quality interaction creates a positive environment and this is very important in learning (**Rusticus *et al.***, 2023). Quality interactions foster positive learning climate and encourages learners. This includes not only the proper transmission and receiving of information but also ensuring the learners can engage, ask questions and provide ideas. In fact, learning effectiveness is likely to improve when students are encouraged to participate in such interactions as knowledge comprehension and retention are improved (**Yang**, 2023). Another factor that greatly influences interaction quality is the effort that instructors put in to personalizing delivery mechanisms to fit participants' learning requirements. If the feedback is provided together with the support based on one's needs, it helps to overcome those gaps in comprehension which exist in most cases and make students immerse in the topic better (**Vaughn *et al.***, 2024). The two-way communication process between teacher and student is consistent with the hypothesis because it reveals how active, good quality interactions foster better learning. Moreover, the interaction quality is not limited to the student-teacher interaction but involves students too (**Miao *et al.***, 2022). Group work, discussions, or projects give students and teachers a chance to discuss and build content together and learn from everyone's unique ideas. As a result, it not only adds value to the learning process and makes it more effective but also helps the development of other skills such as critical thinking or collaboration as parts of the team.

H6: Interaction quality significantly influences learning effectiveness.

2.7. Student Engagement and Learning Effectiveness

Student engagement can be seen in terms of their emotional, cognitive, and behavioral participation in different academic processes. Students' positive attitude contributes to willingness to learn more about the subject and overcome difficulties of its mastering. This increased positive attitude also leads to improved student learning outcomes (**Ramzan *et al.***, 2023). Critical thinking and problem solving or what has been termed here as cognitive participation is equally important. Students who use their energy, efforts, and focus in learning new ideas and facts, comparing the information, and comprehending the knowledge usually gain excellent academic results (**Doyle**, 2023). This level of cognitive engagement thus leads to improved knowledge retention and utilization fulfilling the condition for learning gained from effectiveness assertion. In addition, behavioral engagement which can be observed by active participation in classroom activities, attending classes and submission of assignments as when due reflects proactive learning (**Li *et al.***, 2021). Students who take the most responsibility for what is going on in class and are engaged in the learning process are more likely to achieve the educational objectives. This also reemphasizes the need to embrace the engagement as a key factor for effective learning. Teachers are also very central in developing the interactive teaching and learning processes that elicit students' interest and involvement with the use of technology and student feedback (**Carless**, 2022). In other words, the kind of environment that is provided by the teachers has the potential of making students be interested in the learning activities. Further, students can also enhance their engagement by performing tasks in group activities or discussions. This requires to test the hypothesis:

H7: Student engagement significantly influences learning effectiveness.

2.8. Mediating Role of Student Engagement

Malureanu *et al.* (2021) states that user friendly educational tools reduce cognitive barriers, resulting in increased confidence and positive attitude towards learners. Such simplicity makes it easy to encourage active participation and sustained focus, and so enhances deeper engagement with the learning process. Proactive exploration and use of the tool's features by engaged students lead to significant interaction and deeper cognitive processing. Ease of use decreases frustration and cognitive overload, creating the effective learning environment for motivation and sustained interaction (**Gupta; Prashar**, 2024). The critical link between usability and positive educational outcomes is engagement — better understanding, retention, and application of knowledge. Ease, engagement, effectiveness pathway highlights the need for intuitive design of the platforms to amplify the benefits of usability. Educational technology amplifies engagement to bridge the gap between learning success and user experience (**Haleem *et al.***, 2022). It helps students to fully immerse in learning activities since it drives academic performance as a result of the usability of the tools. This

dynamic emphasizes the importance of user centered design to allow students to play an active part in their own learning journey. This necessitates to test the hypothesis:

H8: Student engagement acts as a mediator between perceived ease of use and learning effectiveness

Content accessibility is the foundation of learning; however, it is active student engagement which turns it into meaningful educational outcomes. Motivation leads to engagement, and engagement leads to higher students' ability to process, retain, and apply knowledge (**Ferrer *et al.***, 2022). If students are engaged stronger with the material, whether critical thinking, in collaboration or real-world application, they will likely understand and internalize the content. Active engagement improves processing and retention of the content. Engagement also helps students to make new knowledge fit with the previous knowledge, further extending the understanding of the subject (**Kim *et al.***, 2021). Highly accessible content can sometimes fail to yield meaningful learning experiences unless there is engagement. Also, student engagement makes the lesson process more personalized and relevant since students will want to venture into the content more deeply and thoughtfully. The more engaged the students are, the more likely they will achieve successful learning outcomes (**Rajabalee *et al.***, 2020). Engagement, in a sense, covers the gap between content accessibility and learning effectiveness by making sure that the content is not just read, but actually processed and applied. This necessitates to test the hypothesis:

H9: Student engagement acts as a mediator between content accessibility and learning effectiveness

Appropriate levels of engagement build up positive emotions which leads to identified motivation and perseverance. They also foster opportunities for socialization and promote intellectual interest enhancing analysis and application of concepts making instructional quality to be consistent with the goal of education (**Zhang *et al.***, 2024). Participation and accountability, which is a part of behavioral engagement, makes interaction to have a positive impact on learning outcomes. In other words, collaborative learning through social activities enhances the effectiveness of peer influence, overall education, and learning. Constructive feedback given through quality interaction is effectively used by interested student who develops better learning techniques as well as improves performance (**Hooda *et al.***, 2022). Classroom communication fosters self-organizing processes to facilitate goal setting and self-motivated progress assessments augment the impact of the presented lessons. Accommodation in digital learning environment is about effective interaction with the content as well as fellow learners in the teaching and learning process and using technology appropriately (**Kelly; Zakrajsek**, 2023). In addition, culturally appropriate communication also enhances student learning. Long-term engagement is more beneficial as the student is trained to be critical thinker and lifetime learner. This necessitates to test the hypothesis:

H10: Student engagement acts as a mediator between interaction quality and learning effectiveness

Figure 1 depicts the research framework showing the hypotheses and their inter-relationship.

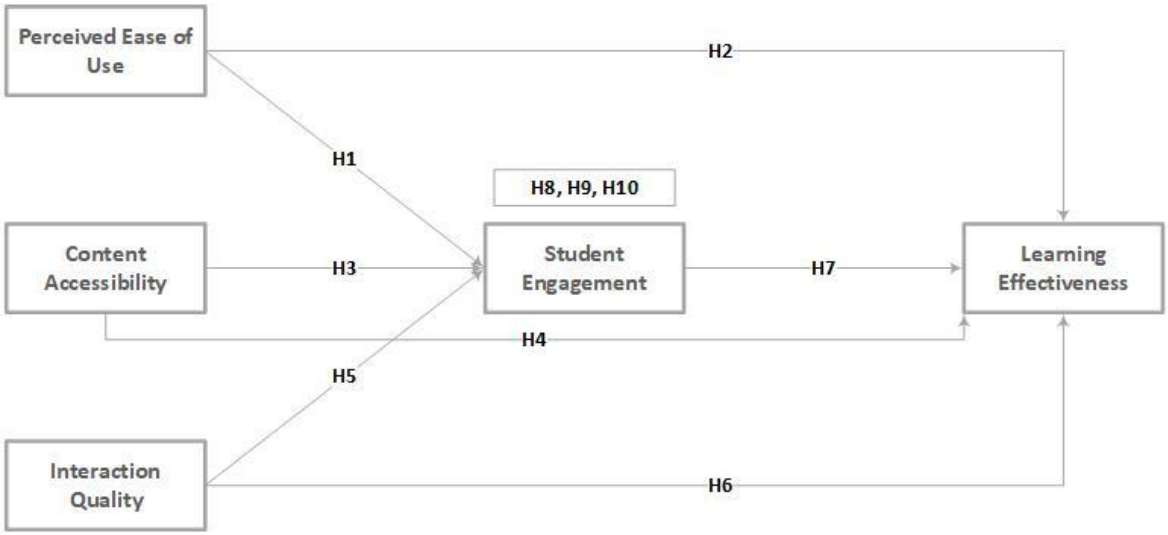

Figure 1: Research Framework.

3. Research Methodology

3.1. Research Design

The study used a quantitative research method to assess students' perceptions on information communication channels as e-learning platforms in higher education. The study adopted an exploratory, cross-sectional research design in which all the data were collected at one point in time to reflect the current trends or state of the variables being investigated. This design facilitated the assessment of perceived constructs such as perceived ease of use, content accessibility, interaction

quality, student engagement, and learning effectiveness. The use of quantitative approach also made it easy for the study to gather facts and complicated relationship could be explained statistically. Despite the limitations arising from the cross-sectional research design, it was useful to gain an understanding of the views of students on e-learning platforms with reference to higher education in Beijing, China while attempting to explore new possibilities.

3.2. Sampling

In order to select participants for the study, a convenience sampling method was adopted. This method was used because it is easy and time effective in terms of the number of university students one can reach in a short span of time. The target population included 1000 students studying in different universities of Beijing, China. To increase the sample's variability, students from different disciplines, educational levels, and experiences of e-learning platforms were recruited. This diversity further improved the generalizability of the findings within the field of study in Beijing's higher education institutions. The convenience sampling may raise some concerns such as, skewed sample resulting from selection bias was considerably eliminated through assignment of large sample size across institutions.

3.3. Questionnaire Development

The questionnaire used in this study was constructed systematically to enhance its validity and reliability. It was developed based on the reliable scales in previous studies on e-learning, educational technology, and students' engagement. The first step included reviewing literature in order to establish an available list of scales and items that could support the goals of the study. Only items that were relevant and suitable for the context of e-learning platforms in higher education, especially in China, were selected and modified. Some modifications were made in order to enhance cultural sensitivity and fit within the target population. To make sure that the questionnaire captured all areas of interest, consultation was made with specialists in the subject areas. Five specialists in educational technology and teaching methods were invited to offer comments on the content, language and relevance of the instrument to the research goals. Accordingly, some of the items were deleted as duplicates, while the wording of others was improved for greater clarity. The final questionnaire was designed to contain several parts that featured questions on demography and the study variables. All questions were answered on a Likert scale ranging from 1 to 5, in order to avoid mistakes and for easier interpretation of results. This systematic and iterative approach meant that questionnaire was efficient, credible and appropriate for gaining information on students' perception towards e-learning platforms.

3.4. Pilot Study

A pilot study was conducted prior to conducting the large-scale survey in order to determine the accuracy and adequacy of the survey instrument. This phase included 50 students from various universities across Beijing, who volunteered to be in the study sample and were selected based on the criteria used in the primary study.

The main goals of the pilot testing were:

1. To make sure the understanding of each item in the questionnaire.
2. To establish the reliability of the constructs and scales employed in the questionnaire.
3. To measure the time taken by the participants to respond the questions.

Participants were also interviewed informally after they had filled the questionnaire to get their feedback. They were asked questions regarding the level of understanding and readability of instructions, items, and flow of the survey. According to the participants' feedback, some changes were made: complicated terms were substituted by the basic ones, some items were reworded so that there were no doubts as to their meaning, and the placement of some questions in the questionnaire was changed for improved clarity. For the purpose of verifying the reliability of the instrument, Cronbach alpha coefficient was computed and all the alpha coefficients for each construct were above the acceptable level of 0.70. This affirmed the internal reliability of the scales. The pilot study also revealed that it took participants 12-15 minutes to complete the questionnaire, thus creating the applicability of conducting a large survey.

3.5. Data Collection Process

Participants were recruited using both online and face-to-face techniques over a four-week period. Online survey questionnaires were sent to institutional mail lists and the social networks most accessed by university students. Face-to-face data collection included administering paper-based questionnaires in classrooms, library and other places within the university. Before the survey data was collected, participants were well informed of the purpose of the survey and their entitlement to anonymity and confidentiality. Consent forms were incorporated with affirmations of voluntary participation. To ensure high response rates, follow-up messages were sent to the participants who had been invited to fill the survey periodically. The response rate was 80% and thus the total number of completed responses received was one thousand.

3.6. Data Analysis

The data collected for this study were analyzed using structural equation modeling (SEM) in IBM SPSS AMOS software. During the screening process of the data before SEM analysis, no missing values or outliers were noted and thus no

issues were identified. To prepare for the structural model test, the measurement model was assessed and confirmed using confirmatory factor analysis. Following the CFA, the structural model was tested to determine the hypothesized relationship between the variables. To test the mediation effects, bootstrapping technique was employed.

4. Results

4.1. Survey Respondents' Profile

Regarding gender distribution, the sample was almost equally distributed with 52% females and 48% males. The largest proportion of the respondents (70%) were between 18 and 25 years, and they were mostly undergraduates and early postgraduate students. Further 20% of respondents were between 26 and 30 years of age while the remaining 10% of respondents were more than 30 years of age. The respondents included 60% undergraduates, 30% postgraduates, and 10% doctoral students. Regarding the academic background of the respondents, 35% were from science and technology, 25% from arts and humanities, 20% from business and economics and other 20% from other interdisciplinary fields. The findings showed that 80% of the respondents had previous experience in using e-learning platforms whereas 22% were novice.

4.2. Structural Equation Modeling Analysis

The current study used the two-stage approach as suggested by **Anderson and Gerbing** (1988). In the first step, the measurement model is followed by the testing of the structural model in the second step.

4.3. Measurement Model

Right at the outset, the analysis of the construct reliability included testing the Cronbach's alpha and composite reliability for each of the constructs (**Anderson; Gerbing**, 1988). Table 1 shows that Cronbach's alpha was found to be above the acceptable level of 0.70 as recommended by **Nunnally and Bernstein** (1994). Cronbach's alpha was demonstrated as a minimum of 0.872 for content accessibility while the maximum value was achieved by interaction quality with 0.895 as shown in Table 1. It is also seen that the composite reliability (CR) of all the latent constructs is greater than the recommended value. The maximum and minimum values of the constructs are as follows: perceived ease of use with a maximum value of 0.896 and learning effectiveness with a minimum value of 0.879.

Table 1: Constructs Reliability.

Constructs	Cronbach's Alpha (α)	Composite Reliability (CR)
Perceived Ease of Use (PEOU)	0.884	0.896
Content Accessibility (CA)	0.872	0.882
Interaction Quality (IQ)	0.895	0.912
Student Engagement (SE)	0.889	0.904
Learning Effectiveness (LET)	0.881	0.879

The factor loadings for all the constructs (see Table 2) were above the suggested value of 0.60 (**Hair *et al.***, 2016). The AVE for all the latent constructs was also calculated and it was found to be higher than the prescribed minimum threshold value of 0.50 (**Hair *et al.***, 2010). As it can be seen from Table 2, the highest AVE value is recorded for the interaction quality with 0.721 while the lowest AVE value is for the learning effectiveness with 0.645.

Table 2: Constructs Validity.

Constructs	Items	Factor Loading	Average Variance Extracted (AVE)
Perceived Ease of Use (PEOU)	**PEOU1:** The e-learning platform is quite simple to use	0.791	0.684
	PEOU2: I think it is easy to locate any course content on e-learning platforms	0.811	
	PEOU3: I find it easy to learn how to use e-learning platform	0.860	
	PEOU4: E-learning platform interface is user-friendly	0.845	
Content Accessibility (CA)	**CA1:** I can retrieve course material at any time convenient to me	0.835	0.652
	CA2: The e-learning platform offers a broad range of educational materials available for use	0.812	
	CA3: The content available is well categorized and can easily be accessed by the users	0.763	
	CA4: The platform also enables use of content through several devices such as mobile and laptop	0.819	
Interaction Quality (IQ)	**IQ1:** E-learning platform provides interaction with instructors to be more efficient	0.822	0.721
	IQ2: Use of discussion forums in the platform help in enhancing my learning	0.890	
	IQ3: I interact with my fellow students through dynamic features on the platform	0.839	
	IQ4: E-learning platform provides prompt remarks on my actions and questions	0.844	
Student Engagement (SE)	**SE1:** I engage myself in learning activities on e-learning platform	0.810	0.701
	SE2: E-learning platform encourages me to stay engaged in my studies	0.825	
	SE3: I devote a lot of time to the navigation of e-learning platform	0.869	
	SE4: E-learning platform also increases my involvement in academics	0.846	
Learning Effectiveness (LET)	**LET1:** The platform has enhanced my learning of course topics	0.830	0.645
	LET2: I get better academic results using e-learning platform	0.817	
	LET3: Knowledge acquired through e-learning platform is easier to retain	0.757	
	LET4: I believe e-learning platform helps me to be more successful in general educational setting	0.809	

As shown in Table 3, the measurement fit indices were as such: CMIN/DF=2.387; GFI=0.921; CFI=0.966; RMSEA=0.068; NFI=0.958; RMR=0.044; SRMR=0.038. All the fit indices were found within their recommended level (**Bentler**, 1990; **Hu; Bentler**, 1998).

Table 3: Measurement Model and Structural Model Results.

Metric	Recommended Cut-Off Values	Measurement Model Scores	Structural Model Scores
CMIN/DF	< 3.0	2.387	2.240
CFI	> 0.90	0.966	0.969
NFI	> 0.90	0.958	0.962
GFI	> 0.90	0.921	0.924
RMR	< 0.08	0.044	0.042
SRMR	< 0.08	0.038	0.036
RMSEA	< 0.08	0.068	0.065

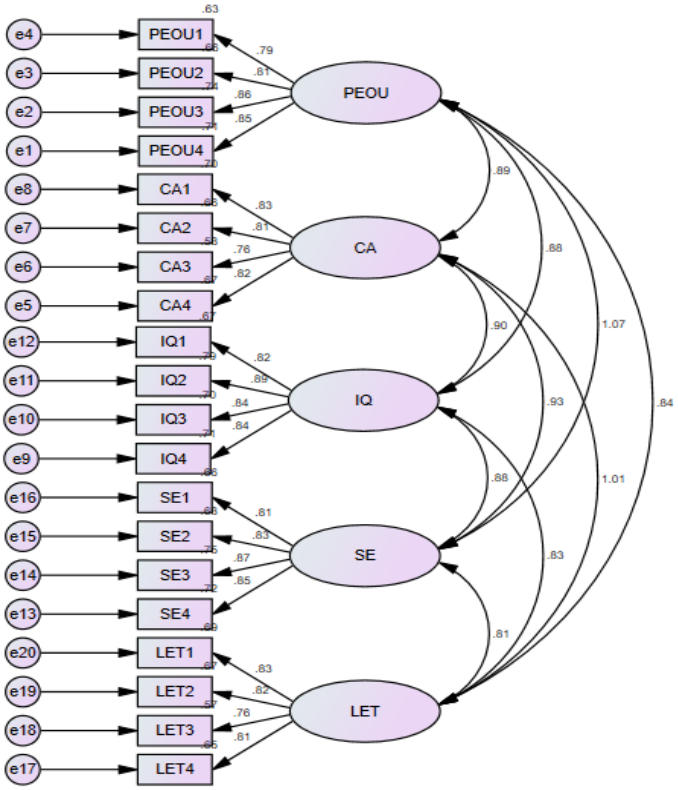

Figure 2: Measurement Model.
Note: PEOU- Perceived Ease of Use; CA- Content Accessibility; IQ-Interaction Quality; SE-Student Engagement; LET-Learning Effectiveness.

Discriminant validity was tested using the Fornell & Larcker criterion (FLC) and the Heterotrait-Monotrait (HTMT) ratio test. The AVE had higher square root than the inter-construct correlations estimates, which conforms with the **Fornell and Larcker** (1981) requirement. The new method HTMT ratio was also used to evaluate discriminant validity (**Henseler *et al.***, 2015). Each value in the HTMT table should be less than 0.90 (**Gold *et al.***, 2001). The results presented in Table 4 indicates that all the values were below 0.90.

Table 4: HTMT Matrix.

	Perceived Ease of Use	Content Accessibility	Interaction Quality	Student Engagement	Learning Effectiveness
Perceived Ease of Use					
Content Accessibility	0.62				
Interaction Quality	0.59	0.55			
Student Engagement	0.48	0.43	0.39		
Learning Effectiveness	0.36	0.33	0.25	0.21	

4.4. Structural Model

To test the study hypotheses, the structural model was estimated by employing the IBM SPSS AMOS software. **Hair *et al.*** (2010) noted that CMIN/DF, CFI, NFI, GFI and RMR, SRMR and RMSEA should be in certain ranges for the structural model to fit properly. It can be seen therefore from the analysis of the results (Table 3) that all these fit indices were within the recommended ranges hence implying a good fit of the model. Moreover, it was revealed that the R2 for student engagement was 0.61, and for learning effectiveness was 0.67.

The results of the study revealed that all the hypotheses were supported. The findings show that perceived ease of use positively impacts student engagement (β = 0.410, t = 3.106, p < 0.001) and learning effectiveness (β = 0.626, t = 6.589, p < 0.001), therefore H1 and H2 were accepted. The results indicate that content accessibility significantly influences student engagement (β = 0.513, t = 4.310, p < 0.001) and learning effectiveness (β = 0.635, t = 5.619, p < 0.001), thus H3 and H4 were supported. Interaction quality also found to have positive relationship with student engagement (β = 0.359, t = 9.447, p < 0.001) and learning effectiveness (β = 0.538, t = 5.912, p < 0.001), therefore H5 and H6 were supported. The analysis results show that student engagement increases learning effectiveness (β = 0.724, t = 4.309, p < 0.001), so H7 was accepted.

The mediation results demonstrate that student engagement significantly mediates the relationship between perceived ease of use and learning effectiveness (β = 0.296, p < 0.05), content accessibility and learning effectiveness (β = 0.371, p < 0.05), interaction quality and learning effectiveness (β = 0.259, p < 0.05), hence H8, H9, and H10 were accepted. Path coefficients (direct and indirect effects) are provided in Table 5 and Figure 3.

Table 5: Analysis Results of Hypotheses.

Path	Estimate	T-value	P-value
PEOU → SE	.410	3.106	***
PEOU → LET	.626	6.589	***
CA → SE	.513	4.310	***
CA → LET	.635	5.619	***
IQ → SE	.359	9.447	***
IQ → LET	.538	5.912	***
SE → LET	.724	4.309	***
*** p<0.001			

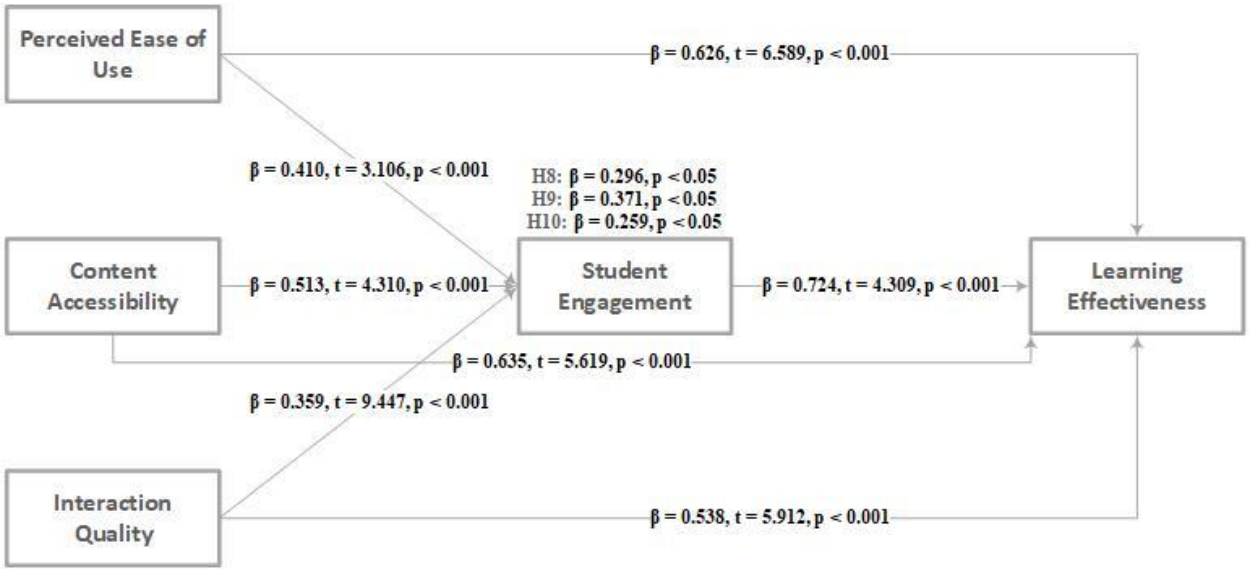

Figure 3: Path coefficients (direct and indirect effects).

5. Discussion

The findings have made evident that all hypotheses framed for the study were supported, suggesting that all variables are significantly related. It is proven that perceived ease of use has positive impact on student engagement. When students are able to interact favorably with e-learning platforms, they are likely to be active participants meaning that interface design matters (**Cheng**, 2020). It was also revealed that perceived ease of use significantly influences learning effectiveness. Ease of access of learning aids minimizes time that is spent on searching for such tools, hence students devote more time on gaining content, hence better understanding and employability of knowledge (**Elumalai *et al.***, 2021). Similarly, content accessibility greatly enhances student engagement as a way of allowing students easy access of content from any part of the world at any time. That flexibility in turn makes the student use the e-learning platform more often thus increasing engagement of the students (**El-Sabagh**, 2021). The findings suggest that the content accessibility improves learning effectiveness. When students are able to retrieve what they need without interference, it gives continuity to learning and enhances recall (**Karataş; Tuncer**, 2020).

The results also reveal positive and significant impact of interaction quality on student engagement. Open discussions and debates combined with a feedback and collaboration system foster engagement in a course (**Zhang; Hyland**, 2022). Interaction quality also found to have significant impact on learning effectiveness indicates that meaningful and dynamic interaction is essential to the process of learning. Students and instructors' communication promote mastery of contents by engaging in discussions, asking questions, and even getting clarification on doubts as well as solving

problems together (**Xu *et al.***, 2020). Such interactions foster recognition and encouragement that makes the learners willing to participate (**Han**, 2021). In addition, meaningful feedback within these interactions allows learners to recognize deficiency and develop themselves. Finally, interaction quality enables a more pleasing and meaningful learning process (**Kumar *et al.***, 2021). The study also revealed that active engagement of students would contribute to better learning effectiveness. When students are engaged and have a positive attitude towards learning, they concentrate more, assimilate the content for longer and can utilize the existing knowledge more aptly. Engagement promotes the development of critical thinking, innovativeness, and problem-solving skills due to the opportunity of relating between concepts and practices learnt by students (**Okolie *et al.***, 2022). Moreover, engaged learners are more likely to have successful interactions with other learners, thus providing the supportive and active learning environment. This increased engagement increases their self-confidence and motivation and propels them to excel academically (**Zitha *et al.***, 2023).

Finally, the mediation analysis shows that student engagement found as a significant mediator in the relationship between perceived ease of use, content accessibility, interaction quality, and learning effectiveness. This means that whenever the student is more engaged, these factors can be impactful in exploration, understanding and memory and thus better usage of knowledge (**Dong *et al.***, 2020). Engagement can be used as an important strategy to improve effectiveness of tools and methods used in teaching learning process to create a positive learning environment.

6. Conclusion

This study examined the understanding of students' perceptions about information communication channels as e-learning platforms with focus on perceived ease of use, content accessibility, and interaction quality in the determination of educational outcomes. These factors are also presented as multifaceted since each of them impacts directly the student engagement and the learning effectiveness. Student engagement was found to be a critical mediator, which highlighted its role in the e-learning environment even further. The perceived ease of use emerges as a core component, because it ensures that students can go through platforms with relative ease, thus avoiding any hindrances to their education. Likewise, the feature of accessibility gives the convenience and flexibility that is required in meeting the learning needs of a variety of learners while at the same time promoting regular use. Interaction quality enhances the relational context allowing for purposeful communications that facilitate further knowledge construction. The findings of the study are useful for educators and the developers of the platforms. For effective e-learning platforms, the developers should create e-learning platforms that are easy to use, have a properly designed interface and show content in a manner that encourages engagement. On the other hand, such platforms can be beneficial for educators who can use them in order to make the course and learning process more diverse and effective. In doing so, this research extends the literature on learning effectiveness in higher education institutions by examining the dynamic relationships between these factors and exploring how they collectively shape the learning experience in the digital age. This underlines the fact that there is the need for further development of e-learning platforms to fit into new education systems.

6.1. Implications, Limitations and Recommendations

This research adds to the existing knowledge about e-learning platforms by exploring the complex interconnection between perceived ease of use, content accessibility, interaction quality, student engagement, and learning effectiveness. The results confirm that engagement can be viewed as the mediator between these independent variables and the learning effectiveness, which explains the impact of user experience on performance in digital learning environments from a different angle. Therefore, the theoretical models of technology adoption and engagement in higher learning institution can be enriched by considering student engagement as a mediating variable that plays a central role in the process of improving effectiveness of the learning process. In addition, the study aims at identifying how the various dimensions of e-learning platforms influence students' perception towards their success in education. Future research could complement this evidence by considering other external variables, including academic discipline or culture, that might also help mediate the relationship between the given factors.

From a practical perspective, the results point out the need for developing e-learning environments that are easy to use, easily accessible, and characterized by high interaction quality. It implies that educators and platform developers should pay attention to these factors in order to increase students' engagement and, therefore, effectiveness of learning. From educators' perspective, adding more interactive and easily adaptable tools into e-learning can help to increase student engagement and make learning process more engaging. From the developers' perspective, making platforms more usable — making them easier to navigate, and creating better pathways to content — can have a large impact on the learning process. This study also serves as a reference for higher learning institutions in China and across the world to improve their e-learning models to ensure that the digital tools satisfy the needs of the current students and enhance learning. Moreover, institutions may offer workshops and seminars that help to enhance the use of these technologies by the educators to improve the integration of innovations with the general aims and students' requirements.

Some of the study limitations include the use of a convenience sampling technique which may restrict the generalization of the results, the students only form Beijing, China excludes regional differences. As the study uses cross-sectional data

from the participants the findings might not be free from self-report bias. Moreover, the study focuses only on three independent variables. Future research should examine utilization factors like instructor's content quality, peer learning and technological support in e-learning environments. Research could also generalize the sample to cover students within different regions or countries in order to compare cultural differences. Longitudinal studies could be used to determine the changes in perceptions and behavior over time while qualitative studies focused on the individual academic disciplines, their influence on e-learning engagement, and the result on e-learning effectiveness could also be useful.

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