

How does limited student engagement in virtual classrooms affect students' academic performance? A stressor–strain–outcome perspective

Sheikh Mohammad Rabby, Asma Azad Akhi, Md. Shamim Talukder and Sumon Das

Abstract

Purpose – This study aims to investigate the impact of limited student engagement in virtual classroom environments on their academic performance, examining key stressors including infrastructural hindrance, instructors' incompetency and distractions.

Design/methodology/approach – A sample of 304 students from various Bangladeshi universities participated in this study. Using the partial least squares-structural equation modeling approach, the research assessed the proposed model and hypotheses.

Findings – The research uncovers that stressors, specifically infrastructural hindrance, instructors' incompetency and distractions, significantly impede student engagement within virtual classrooms. Furthermore, limited student engagement within online learning environments results in poor academic performance.

Research limitations/implications – This study holds implications for educational service providers, offering insights into enhancing the effectiveness of online classroom platforms. The findings can foster improved strategies that positively impact students' academic performance.

Originality/value – The application of the stressor–strain–outcome framework to elucidate the complex interplay between stressors, limited student engagement and academic performance within virtual classrooms during a global pandemic contributes original insights to the field of educational research.

Keywords Online classroom, Limited student engagement, Academic performance, Stressor–strain–outcome framework, Higher education

Paper type Research paper

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Introduction

The Covid-19 pandemic has changed the landscape of education systems worldwide (Dubey *et al.*, 2023). Responses to the pandemic by higher education providers varied, ranging from social isolation strategies to rapid redevelopment of their academic policies to offer online courses (Crawford *et al.*, 2020). These diverse responses resulted in both challenges and opportunities, shaping the experiences of students and teachers in this changed era.

Online learning through virtual classroom settings, also known as e-learning, remote learning, Web-based learning and computer-assisted learning, refers to a learning environment where students study and interact with their instructors remotely and require an effective delivery method (Wilde and Hsu, 2019). Some studies have reported the benefits of online learning during the COVID-19 pandemic. For instance, students studying remotely were found to have demonstrated significant improvement in their test scores when

compared to on-campus students from the previous year (Gonzalez *et al.*, 2020). In addition, online courses offered during the lockdown period were found to have helped students and educators cope with stress temporarily (Chandra, 2021).

Despite the reported benefits, most existing studies have shown the negative aspects of online study platforms during the pandemic. For example, online learning environments were shown to have negatively affected students' mental health by creating stress and anxiety in numerous ways (Cao *et al.*, 2020; Essadek and Rabeyron, 2020). During online classes, students experienced the fear of sudden internet disconnection, which further harmed their mental health (Chakraborty *et al.*, 2021). In addition, due to online classes, students need to spend a considerable amount of time in front of their screens, leading to stress and sleep deprivation (Chakraborty *et al.*, 2021). Furthermore, in an online setting, students could not actively participate in any group work or in-class activities, and they failed to receive adequate help from their peers. They also lacked access to essential library and laboratory facilities (Patricia Aguilera-Hermida, 2020). Moreover, many universities abruptly transitioned to online classes in the middle of the semester. This sudden shift from traditional classroom-based learning to online learning required students to absorb a lot of new information within a single semester, which created unnecessary stress and cognitive overload for the students (Patricia Aguilera-Hermida, 2020).

In March 2020, the Government of Bangladesh decided to shut down all educational institutions, which affected around 40 million students (The Business Standard, 2020). At the time, Bangladesh had 158 universities in total, including 108 private, 50 public and 3 international universities (Nahar *et al.*, 2020). In response to the closure, these universities began operating online classes using platforms such as Zoom, Google Meet and Microsoft Teams. However, Bangladeshi students faced anxiety and stress due to the shift to online classrooms for several reasons (Hoque *et al.*, 2021). First, poor access to information and communication technology was the biggest barrier to operating online classes (Badiuzzaman *et al.*, 2021). In fact, Bangladesh had the lowest internet penetration rate and slowest internet speed in South Asia which severely affected online learning (The Daily Star, 2020). The decision to close the universities required students to leave their residential halls and return to their homes, most of which were located in rural and suburban areas (Hoque *et al.*, 2021). Many Bangladeshi students lacked high-speed internet connections, especially in rural regions, which disrupted their ability to attend online classes on time or caused interruptions during them (Miah *et al.*, 2023).

The shift from in-person to online class platforms was relatively smooth for students, particularly those in developed countries. However, students, teachers and educational institutions in developing countries experienced significant challenges during this rapid transition, as they were largely unprepared and unequipped for online classroom environment (Simbulan, 2020). For instance, students in South Asia experience significant technology-related stress due to inadequate infrastructural facilities, which directly impacts their online learning experiences. Research by Islam *et al.* (2020a, 2020b) found that approximately 70% of students participating in online classes reported anxiety arising from poor internet connectivity. Similarly, Mukhtar *et al.* (2020) stated that around 68% of Indian students failed to engage effectively with online classes due to difficulties adapting to digital instruction methods. The problem appears particularly acute among poor populations. For instance, students from Bangladesh, especially from low-income backgrounds experience 2.3 times higher stress levels than their more affluent peers when participating in online education (Hasan and Bao, 2020). These findings collectively demonstrate how systemic technological barriers adversely affect online learning outcomes for South Asian students.

Active participation in virtual classroom platforms depends predominantly on digital equity, where each students should have fair and equitable access to the internet and other digital technologies (van Dijk, 2020). Unfortunately, students from marginalized groups and low-income areas often face substantial barriers in accessing to these resources (Amjad *et al.*, 2024).

Specifically, students with limited access to technological devices and reliable internet connections struggle to participate effectively in online classes (Hohlfeld and Barron, 2010; Zhong, 2020). In addition, challenges arise from insufficient home learning atmosphere such as sharing of devices, distractions and lack of quiet study space which affect their engagement with the online class (Cuerdo-Vilches *et al.*, 2021; Zhang *et al.*, 2020). These components collectively impact their academic performance.

To manage stress and anxiety induced by the online classroom environment, students can adopt various coping mechanisms. For instance, increasing physical exercise can improve relaxation and enhance physical fitness (Wang *et al.*, 2022). In addition, teachers may reduce students' stress levels by scheduling individualized meetings (Li and Che, 2022). This study further suggests that reducing screen time through paper-based courseware such as textbooks, handwritten notes and printed assignments for in-class activities could alleviate the health problems associated with increased screen time. In this case, students can use smart wearable technologies to monitor and manage their wellbeing (Nagarajan *et al.*, 2021).

Existing studies on online education and its broad impact are well-documented (Badiuzzaman *et al.*, 2021; Hoque *et al.*, 2021; Miah *et al.*, 2023; Rahman *et al.*, 2021). However, several significant aspects remain unexamined, such as the factors that hinder the effectiveness of virtual classroom settings and how it affects Bangladeshi students' academic performance. For instance, Hoque *et al.* (2021) investigated the impact of COVID-19 pandemic on Bangladeshi students' anxiety and depression. Recently, Rahman *et al.* (2021) examined the predictors of online learning motivation and satisfaction among Bangladeshi students. However, to date no studies have been conducted in Bangladesh examining how the shift to online class has affected students' academic performance.

To address this research gap, this study aims to investigate how limited engagement in virtual classrooms affects Bangladeshi students' academic performance. Building on infrastructural hinderance, instructor competency and distractions as key factors, we argue that these elements collectively influence students' engagement levels (Alghamdi *et al.*, 2020; Muthuprasad *et al.*, 2021), which in turn affect students' academic performance. Specifically, this research focuses on answering the following research questions (RQs):

RQ1. What are the key associated factors affecting students' engagement in online learning?

RQ2. How does limited engagement influence students' academic performance?

By examining these questions, our study aims to contribute to the existing literature by examining the relationship between engagement and academic performance in the context of Bangladesh.

Our study provides practical insights to help educators, administrators and policymakers develop strategies for enhancing online learning and promoting student success in challenging environment. As education continues changing, the outcome of our research seeks to guide the development of effective teaching practices.

Theoretical background

Stressor–strain–outcome theory

The stressor–strain–outcome (SSO) theory was originally proposed by Koeske and Koeske (1993) in the field of psychological research to understand the stress process. This framework comprises three fundamental elements: stressor, strain and outcome. Stressors encompass environmental circumstances individuals perceive as problematic and potentially beyond their control. Strain refers to the disturbed mental state experienced by individuals, serving as a mediating factor between stressful events and behavioral outcomes (Koeske and Koeske, 1993). Such disruptions often impede an individual's concentration, psychological state and

emotional equilibrium. Finally, outcome encapsulates the behavioral or psychological responses resulting from the interaction of stress and strain (Tian *et al.*, 2025). The SSO framework is helpful to understand the stress process because it links stressors with the outcome by placing strain as the mediating factor (Koeske and Koeske, 1993).

The SSO theory has been widely applied to investigate stress-related contexts (Ayyagari *et al.*, 2011; Choi *et al.*, 2014; Dhir *et al.*, 2018; Ye *et al.*, 2023; Tian *et al.*, 2025). For example, Choi *et al.* (2014) used the SSO theory to examine technostress experienced by IT users. Similarly, Yu *et al.* (2018), used the SSO framework to explore stress phenomena, unveiling that the compulsive use of social media (stressor) in the workplace leads to social media overload (strain), which leads to poor job performance (outcome). In the context of online shopping, excessive information supplied to consumers (stressor caused by environment) generates website anxiety (emotional response) which affects their buying behavior (behavioral response) (Ding *et al.*, 2017). These studies collectively highlight technology platforms as stressors that generate technostress (Lee *et al.*, 2016), manifesting as psychological fatigue, mental fragility and discontent, with negative behavioral outcomes (Hsiao, 2017).

Application of the theory to the current study context

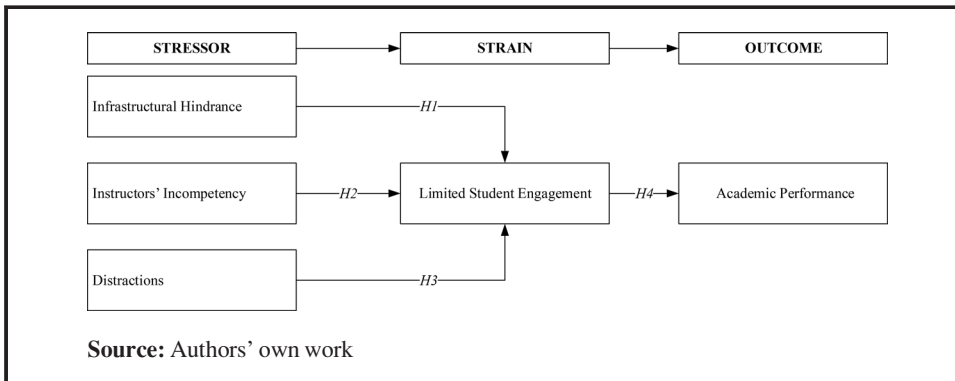
The SSO theory has been effectively applied to analyze the stress dynamics in technology-mediated learning environment. Notably, the online learning environment, serving as a technology-facilitated educational platform, has been recognized as a potent stress-inducing agent for students (Al-Kumaim *et al.*, 2021). Building upon this premise, our study aims to use the SSO theory to scrutinize the stress phenomena caused by online learning environment. Within the contexts of our study, we conceptualize stressors as a combination of three key factors: infrastructural hindrance, instructors' inefficiency and distractions. Drawing from information systems literature, stressors can be defined as any element, stimuli, event or condition that individuals experience which promotes stress (Ragu-Nathan *et al.*, 2008). We propose that students experience these factors as distinct stress-inducing elements.

A plausible psycho-physiological reaction to these stressors is strain. Strain impacts on a person's attention and emotion (Ahmed *et al.*, 2022; Gökçearsan *et al.*, 2018), propels our introduction of "limited student engagement" as a strain. This notion contemplates the environmental cues of infrastructural hindrance, instructors' incompetency and distractions as potential triggers of this strain. On the other hand, the psychological and behavioral response to strain crystallizes as the outcome. Prior research has effectively used the SSO theory to examine the interplay between cognitive-emotional engagement and students' academic performance (Masood *et al.*, 2022). Therefore, using the SSO paradigm, our study offers a structured framework that investigates the impact of limited student engagement on academic performance in an online learning environment in the context of Bangladesh.

Thus, the SSO theory provides as an effective framework for examining the relationship between different stressors (infrastructural hindrances, instructors' incompetency and distractions), strain (limited student engagement) and outcome (academic performance) (see Figure 1). Definitions of all constructs are given in Table 1.

Hypothesis development

Infrastructural hindrance and limited student engagement. Work-oriented infrastructure pertains to the comprehensive systems that underpin a specific organizational domain (Hanseth and Lundberg, 2001). Within the realm of virtual classrooms, a robust technological infrastructure is essential for seamless operations (Muthuprasad *et al.*, 2021).

Figure 1 Proposed research model**Table 1** Construct definitions

| Construct | Definition | Reference |
|----------------------------|--|---|
| Infrastructural hindrance | In an e-learning platform, infrastructural hindrance refers to the technical constraints that limit the successful operation of online classes. It includes the digital divide (not everyone has equal access to technological devices), limited data, poor connectivity, device incompatibility, non-recordable videos, technical issues and systems incompatibility | Muthuprasad <i>et al.</i> (2021) |
| Instructors' incompetency | Instructors' incompetency denotes the fear of a teacher to handle the technology effectively. It also includes a poorly designed curriculum, poor teaching and limited assessment skills | Muthuprasad <i>et al.</i> (2021) |
| Distractions | Distractions denote the troublesome environment, such as noise that distracts students from focusing on online classes | Aroonsrimarakot <i>et al.</i> (2023) |
| Limited student engagement | Student engagement is a multi-dimensional construct of three key aspects: behavioral, emotional and cognitive. The behavioral aspect focuses on the time and energy students provide towards those activities that are connected to an institution's program learning outcome. The emotional aspect of engagement describes the degree of connection students display toward their teachers, peers and institutions. On the other hand, cognitive engagement highlights both positive engagement (attendance, participation) and negative engagement (class boycott) | Chipchase <i>et al.</i> (2017); Hagel <i>et al.</i> (2012) |
| Academic performance | Academic performance is the degree to which a student accomplishes his/her short-term or long-term educational goals, usually examined by grade point average (GPA), learning, satisfaction and quality | Masood <i>et al.</i> (2022); Sebastianelli <i>et al.</i> (2015) |

Source(s): Authors' own work

This sophisticated infrastructure assumes the mantle of a crucial facilitator, not only fostering social presence but also shaping students' participation patterns (Ruthotto *et al.*, 2020). On the other hand, infrastructural hindrance encompasses a group of challenges, including inadequate internet connectivity, sluggish data speed and restrictive data limits, all of which have negative impact on student learning experiences (Aroonsrimarakot *et al.*, 2023). The disruptive impact of these hindrance becomes apparent in scenarios where students grapple with the loss of visual and auditory cues due to technological interruptions, thereby impinging upon their active involvement within the virtual classroom setting (Weitze *et al.*, 2013). Infrastructural hindrances cause students to leave online classes, resulting in dissatisfaction with online courses. Since infrastructural hindrances affect online learners' engagement and participation, we placed infrastructural hindrances as drivers of limited student engagement:

H1. Infrastructural hindrance is positively associated with limited student engagement

Instructors' incompetency and limited student engagement. From the student's viewpoint, a competent instructor embodies someone with unique knowledge and credentials, fostering

satisfaction and elevating performance (Gopal *et al.*, 2021). In online education, instructors are pivotal in establishing a positive learning atmosphere marked by support, respect, responsiveness and skillful course content development (Kaufmann *et al.*, 2016). Competent instructors also facilitate student interactions, creating an engaging peer learning environment (Cocquyt *et al.*, 2019). Beyond behavior, instructor competence extends to perceiving the course from students' vantage. On the contrary, instructors lacking technical proficiency, collaboration skills or classroom management abilities are deemed incompetent (Essex, 2012). This deficiency is particularly acute in online settings, where inadequate IT skills hinder effective digital adaptation (El Said, 2021). Furthermore, inadequate teaching skills, technical issues and disorganized content challenge effective online instruction (Aroonsrimarakot *et al.*, 2023).

In the context of online learning, instructor competence is integral to diverse assessment design (Bojović *et al.*, 2020). This intricate interplay between instructors' competence and student engagement is obvious (Maina *et al.*, 2015). Consequently, our study asserts that instructors' competence significantly shapes student engagement in online learning, underscoring the pivotal role of pedagogical proficiency in driving student involvement:

H2. Instructors' incompetency is positively associated with limited student engagement.

Distractions and limited student engagement. Distraction, denoting the diversion of attention from a primary task, presents a challenge in maintaining focused engagement (Lee *et al.*, 2008). Particularly in academic contexts, distraction has garnered significant attention from educational providers (Lai and Bower, 2019). This issue has become even more pertinent due to the transition from face-to-face instruction to online learning, compelled by events like the COVID-19 pandemic (Dontre, 2021). Within the e-learning context, educators face limited opportunities to directly supervise students, making it easier for learners to become distracted during online classes (Dontre, 2021). In addition, attempting to perform multiple tasks concurrently, emerges as a primary catalyst for distraction among students. According to the concept of bounded rationality, individuals struggle to process a vast amount of information simultaneously, leading to a negative impact on their learning (Mayer and Moreno, 2003).

Furthermore, students often find themselves simultaneously engaging with social networking sites and applications while undertaking academic tasks in the virtual realm (Jacobsen and Forste, 2010). Even environmental factors contribute to distractions, such as noise and disturbances from home or external sources, further undermining engagement (Patricia Aguilera-Hermida, 2020). As a result, distracted learners experience reduced engagement levels during online classes, affecting their overall learning experience. Therefore, we hypothesized that:

H3. Distractions positively influence limited student engagement.

Limited student engagement and academic performance. Student engagement encompasses the effort and enthusiasm learners invest in their learning environment (Bond and Bedenlier, 2019). Scholars have dissected engagement into three dimensions: behavioral, affective and cognitive. Behavioral engagement hinges on a student's level of focus, participation and involvement in academic tasks (Hirschfield and Gasper, 2011). Affective engagement measures emotional responses including motivation, frustration, interest or boredom (Fredricks *et al.*, 2020). Cognitive engagement is tied to learning outcomes and self-regulation. This study embraces all three dimensions of engagement. Previous research has established a positive correlation between engagement and performance (Akhi, 2022). For instance, study by Finn and Zimmer (2012) stated that behavioral engagement has a positive impact on improved academic outcomes. In the virtual classroom, students must exhibit self-discipline to foster engagement and achieve learning goals (Wiles and Ball, 2013). Effective instructor-learner interaction further influences affective engagement (Urdan and Schoenfelder, 2006). Finally, cognitive engagement flourishes in a favorable learning environment (Strambler and Weinstein, 2010).

However, the virtual classroom's inherent lack of physical presence limits instructors' control over students' engagement (Raes *et al.*, 2020). Drawing parallels to our study, we posit that limited student engagement will impact their poor academic performance:

H4. Limited student engagement is positively associated with poor academic performance.

Methodology

Measures and procedure

Our proposed model consisted of five key constructs: infrastructural hindrance, instructors' incompetency, distractions, limited student engagement and poor academic performance. All measurement items were adapted from prior literature and slightly modified to suit the context of virtual classrooms. The sources for each construct are listed below: four items of infrastructural hindrance were drawn from Muthuprasad *et al.* (2021) and Djidu *et al.* (2021), focusing on technology-related barriers. Instructors' incompetency was measured using four items adapted from Muthuprasad *et al.* (2021) and Eom *et al.* (2006), reflecting online teaching ability, responsiveness and digital proficiency. Likewise, distractions were evaluated based on three items from Adhani and Remijn (2023) and Muthuprasad *et al.* (2021), encompassing factors like multitasking, social media use and environmental disturbances. Similarly, limited student engagement was assessed using five items from Chipchase *et al.* (2017), incorporating behavioral, affective and cognitive aspects of participation in virtual learning environments. Finally, academic performance was evaluated using four items from Whelan *et al.* (2020), reflecting students' perceived learning outcomes, achievement of academic goals and satisfaction with their performance. In interpreting academic performance, we adopted a broader student-centric perspective, incorporating not only traditional learning outcomes but also perceived academic relevance and career development. In contexts like Bangladesh and other Global South regions, students often equate academic success with long-term career prospects. A full list of measurement items is available in [Appendix](#).

An online survey questionnaire was used to collect the data. The questionnaire was prepared in English and was distributed and shared through social media pages and students' social networking groups. The questionnaire comprised two parts: part A and part B. Part A contained 20 questions regarding the different latent variables of the proposed research model. In part B, we included the demographic details such as age, gender and education level of the respondents. Questionnaires were prepared using a five-point Likert scale with response choices ranging from "Strongly disagree (1)" to "Strongly agree (5)." The questionnaire underwent pre-testing and pilot testing on a limited scale. First, two researchers with expertise in the information systems domain were invited to examine the rationality, terminology usage, context relevance and clarity of the questionnaire items. Second, 30 university students participated in a pilot study to obtain further feedback and enhance the quality of the questionnaire.

After receiving feedback and recommendations from the pre-test and pilot tests, minor adjustments were made to the measurement items, such as improving the structure and sequencing of the questionnaire items. The final survey was performed after the questionnaire was finalized. A non-probability sampling technique was used to reach out to the respondents. This technique was chosen because it required fewer resources (e.g. time and technical resources) and was more manageable and accessible than probabilistic sampling methods.

Participants

The study was conducted in Bangladesh. Both undergraduate and graduate students who were shifted to online classroom settings due to the COVID-19 pandemic were the

participants of this study. The target user group was reached through various social media platforms due to its convenience as well as its low marginal cost (Schillewaert and Meulemeester, 2005). No incentive was offered to encourage complete responses. We included a filtering question stating, "Please check 'yes' if your classes were shifted from face-to-face to online due to COVID-19." The incorporation of such questions helped us to exclude participants who did not attend online classes. To overcome socially desirable responses, we included an introduction stating the aim of the study. Furthermore, respondents were assured that data will be kept confidential and will be used only for this research. We received 319 responses in total. After eliminating 15 incomplete responses, 304 valid responses were used for further analysis.

Data analysis and results

A variance-based structural equation modeling (SEM) using partial least squares (PLS) was applied in this study for several reasons. First, PLS is a dominant second-generation modeling system that fits the confirmation of theory testing in fact-finding studies (Hair *et al.*, 2016). Second, it permits scientists to study different model elements widely (Shmueli *et al.*, 2019). Third, it instantaneously evaluates the measurement and structural models in the finest way and investigates multifaceted causal models, including numerous constructs with several experimental items (Chin, 1998). Finally, PLS has strong statistical potential compared to other maximum-likelihood covariance based on SEM methods (Hair *et al.*, 2016). This study used Smart PLS software v. 3.2.6 for data analysis.

Demographic information

The demographic characteristics of respondents exhibited in Table 2 indicate that out of 304 respondents, there were 188 males (62%) and 116 females. Most of the respondents (84%) were aged between 18 and 23 years, and 82% of respondents had undergraduate-level education.

Non-response bias. Our study assessed nonresponse bias by comparing early-wave respondents (those who submitted their responses within the first two months, $n = 185$) and late-wave respondents (those who submitted their responses later, $n = 119$), following the approach recommended by Armstrong and Overton (1977). We conducted t -tests on the early and late wave data for all variables. The results of these statistical tests revealed no significant differences between the early and late respondents (i.e. $p > 0.05$), suggesting that nonresponse bias is not a major concern in our study.

Common method bias. To mitigate common method bias (CMB), we used procedural remedies following the recommendations of Podsakoff *et al.* (2003) these included maintaining respondent anonymity, simplifying our questionnaire to avoid complex items

| Descriptions | Frequency | % |
|----------------------------------|-----------|----|
| <i>Gender</i> | | |
| Male | 188 | 62 |
| Female | 116 | 38 |
| <i>Educational qualification</i> | | |
| Bachelor | 249 | 82 |
| Masters | 55 | 18 |
| <i>Age</i> | | |
| 18–23 | 256 | 84 |
| More than 23 | 48 | 16 |
| Source(s): Authors' own work | | |

and using different scale endpoints for predictor and criterion variables. Statistically, we performed Harman's single-factor test to assess the presence of common method variance (Podsakoff *et al.*, 2003). According to the result, a single construct accounted for 39.43% of the total variance, which is below the recommended value of 50% (Podsakoff *et al.*, 2003). Moreover, we conducted a marker variable test to calculate the CMB-adjusted correlations. The difference between the original correlations and the CMB-adjusted values was 0.039, indicating no significant change in the correlation levels. This result suggests that CMB was not a concern in our analysis.

We also ensured whether our data had a multicollinearity issue by analyzing the full variance inflation factors (VIFs). Because the values of the full VIFs of all variables were below the 3.3 thresholds recommended (Hair *et al.*, 2016; Shmueli *et al.*, 2019), the concern about the multicollinearity problem could be eased.

Measurement model. The measurement model was measured in terms of reliability, convergent and discriminant validity of all constructs. Reliability was assessed using Cronbach's alpha (α) and Composite Reliability (CR). Results indicate that the lowest α value was 0.743, and the CR was 0.855, which was greater than the recommended value of 0.7 (refer to Table 3). For the measurement of convergent validity, factor loadings and Average Variance Extracted (AVE) should be more than 0.5. As shown in Table 3, all factor loadings and AVE values were above 0.5, which is the criterion for good convergent validity.

We found that the square root of the AVE of each latent variable was greater than the correlations that each has with other variables in the correlation matrix, which is the criterion for good discriminant validity (see Table 4). The Heterotrait–Monotrait ratio of correlations (HTMT) was used as the approach for the discriminant validity assessment. As reported in Table 5, we got all HTMT indicators that were below 0.9, which fulfils the criteria.

Structural model. After ensuring that all results from the measurement model assessment passed the quality standard, we performed the PLS-SEM estimation. The predictive power of a structural model is assessed using the R^2 value in the endogenous constructs (Chin, 1998). The percentage of explained variance R^2 for limited students' engagement is 0.594,

Table 3 Measurement model

| Constructs | Items | VIF | Loadings | Cronbach's alpha | CR | AVE |
|----------------------------|-------|-------|----------|------------------|-------|-------|
| Infrastructural hindrance | IH1 | 2.407 | 0.867 | 0.909 | 0.937 | 0.787 |
| | IH2 | 2.535 | 0.841 | | | |
| | IH3 | 1.027 | 0.868 | | | |
| | IH4 | 2.172 | 0.968 | | | |
| Instructors' incompetency | II1 | 1.383 | 0.717 | 0.809 | 0.875 | 0.637 |
| | II2 | 1.712 | 0.819 | | | |
| | II3 | 1.845 | 0.818 | | | |
| | II4 | 1.908 | 0.834 | | | |
| Distractions | DIS1 | 1.333 | 0.758 | 0.743 | 0.854 | 0.662 |
| | DIS2 | 1.779 | 0.854 | | | |
| | DIS3 | 1.594 | 0.825 | | | |
| Limited student engagement | LSE1 | 2.234 | 0.851 | 0.824 | 0.876 | 0.588 |
| | LES2 | 1.443 | 0.699 | | | |
| | LES3 | 1.461 | 0.742 | | | |
| | LSE4 | 2.081 | 0.789 | | | |
| | LSE5 | 1.759 | 0.743 | | | |
| Academic performance | AP1 | 1.404 | 0.742 | 0.773 | 0.855 | 0.597 |
| | AP2 | 2.064 | 0.829 | | | |
| | AP3 | 1.936 | 0.806 | | | |
| | AP4 | 1.270 | 0.708 | | | |

Note(s): AVE = Average variance extracted; CR = composite reliability; VIF = variance inflation factor

Source(s): Authors' own work

Table 4 Correlation matrix and the square root of the AVE

| Construct | AP | DIS | IH | II | LSE |
|-----------|-------|-------|-------|-------|-------|
| AP | 0.773 | | | | |
| DIS | 0.654 | 0.813 | | | |
| IH | 0.600 | 0.572 | 0.887 | | |
| II | 0.647 | 0.554 | 0.601 | 0.798 | |
| LSE | 0.683 | 0.594 | 0.688 | 0.663 | 0.767 |

Note(s): IH = Infrastructural hindrance; II = instructors' incompetency; DIS = distractions; LSE = limited student engagement, AP = academic performance

Source(s): Authors' own work

Table 5 Heterotrait–Monotrait Ratio (HTMT)

| Construct | AP | DIS | IH | II | LSE |
|-----------|-------|-------|-------|-------|-----|
| AP | | | | | |
| DIS | 0.861 | | | | |
| IH | 0.714 | 0.698 | | | |
| II | 0.822 | 0.718 | 0.705 | | |
| LSE | 0.847 | 0.751 | 0.791 | 0.797 | |

Note(s): IH = Infrastructural hindrance; II = instructors' Incompetency, DIS = distractions, LSE = limited student engagement, AP = academic performance

Source(s): Authors' own work

and for academic performance, it is 0.467, suggesting that the structural model has predictive relevance (Hair *et al.*, 2016). Another means to assess the model's predictive relevance is the Q^2 value called blindfolding. According to Hair *et al.* (2016), Q^2 values larger than zero for a particular endogenous construct indicate that the path model's predictive accuracy is acceptable. In our study, the Q^2 value of limited students' engagement is 0.334, and for academic performance, it is 0.269, suggesting that the structural model has predictive relevance.

Finally, the statistical significance of our model's path coefficients was examined by using the bootstrapping procedure (5,000 subsamples). The hypotheses were evaluated based on the path coefficients, t -statistics and p -values. For $H1$, the relationship between infrastructural hindrance and limited student engagement was positive and significant and, was, therefore, supported ($\beta = 0.380$, $t = 6.472$, $p < 0.001$). This indicates that infrastructural hindrance experienced by the students during online class positively influences limited student engagement. $H2$, the path from instructors' incompetency to limited student engagement was supported ($\beta = 0.327$, $t = 5.673$, $p < 0.001$), indicating that limited student engagement is influenced directly and positively by instructors' incompetency. $H3$, suggesting an effect of distractions on limited student engagement was supported ($\beta = 0.195$, $t = 3.695$, $p < 0.001$), demonstrating that distractions directly and positively influence limited student engagement. $H4$, the coefficients for the pathways from limited student engagement to academic performance was positive and significant and, was, therefore, supported ($\beta = 0.683$, $t = 20.355$, $p < 0.001$). This indicates that limited student engagement directly and positively influences students' poor academic performance (see Table 6).

Finally, we conducted an Importance–Performance Matrix Analysis (IPMA) in PLS as a post hoc procedure, using performance impact as the outcome variable. The IPMA aimed to assess the significance and performance of antecedent constructs in explaining limited student engagement. This method identifies constructs with high importance but low performance, indicating areas requiring strategic improvement (Hair *et al.*, 2016). As shown

Table 6 Structural model

| Hypothesis | Path | Coefficient (β) | t-value | p-values | Supported | R ² | Q ² |
|------------|-----------|-------------------------|---------|----------|-----------|----------------|----------------|
| H1 | DIS → LSE | 0.195 | 3.695 | 0.000 | Yes | 0.594 | 0.334 |
| H2 | IH → LSE | 0.380 | 6.472 | 0.000 | Yes | | |
| H3 | II → LSE | 0.327 | 5.673 | 0.000 | Yes | | |
| H4 | LSE → AP | 0.683 | 20.355 | 0.000 | Yes | 0.467 | 0.269 |

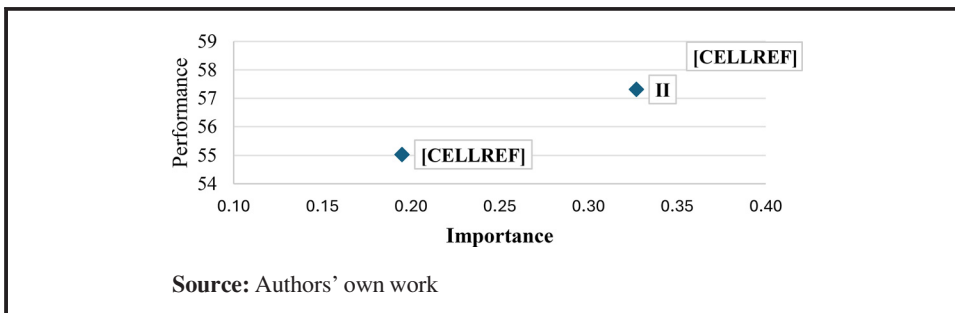
Source(s): Authors' own work

in [Figure 2](#), infrastructural hindrance emerged as the most important and high-performing factor, followed by instructor incompetency and student distraction.

Discussion and implications

Students' limited engagement in online classroom platforms has been recognized as a critical contributor to poor academic performance ([Broadbent, 2017](#); [Dixson, 2015](#)). While identifying the causes of limited student engagement and implementing corrective actions are crucial for ensuring effective online learning, no studies to date, have investigated the specific factors leading to limited engagement and subsequent poor academic performance. To address this gap, our study proposes a comprehensive research framework using the SSO theory to examine how limited student engagement impacts academic performance. We identified three key antecedents of limited engagement in online learning environments: infrastructural hindrance, instructors' incompetency and distractions, all of which were empirically investigated in our study.

First, the study identified infrastructure hindrances (IH) as one of the most significant stressors affecting student engagement (*H1*). The coefficient ($\beta = 0.380$), performance (58.474) and the high T-value (6.472) for IH → limited student engagement (LSE) reveal that technological issues, such as poor internet access (IH1), insufficient data (IH2) and incompatible devices (IH3, IH4), have a substantial effect on engagement. These barriers hinder students' ability to access online classes effectively, thus, limiting their cognitive, affective and behavioral engagement with the course content ([Bond and Bedenlier, 2019](#)). This finding is consistent with several previous studies (e.g. [Al-Amin et al., 2021](#); [Aroonsrimarakot et al., 2023](#)), which highlight that technological challenges – such as low-quality audio/video transmission and the use of incompatible devices – are significant predictors of reduced student engagement in online learning environments. The significant impact of IH aligns with prior studies that highlight how technological limitations in the Global South restrict online learning participation ([Muthuprasad et al., 2021](#)). This stressor

Figure 2 IPMA For limited student engagement

had the highest coefficient value, indicating its dominant role in predicting limited student engagement.

Instructor's incompetency (II) also significantly affects engagement, with a coefficient of 0.327 (performance = 57.309). This suggests that factors such as instructors' inability to adapt to online environments (II1), poor course structuring (II2) and lack of follow-up support (II4) can undermine student motivation and reduce engagement. Our findings corroborate previous studies that highlight the role of instructors in facilitating or hindering online student engagement (Brown, 2016; Muthuprasad *et al.*, 2021). Students in our study who rated their instructors poorly on these competencies reported lower levels of engagement, which, in turn, impacted their academic performance (Martin and Bolliger, 2018). Specifically, students noted that a lack of instructor interaction or follow-up (II4) and poorly structured courses (II3) led to disengagement, making it harder to connect with course material. These findings suggest that improving instructors' digital pedagogical skills and fostering greater student-instructor interaction could alleviate engagement challenges in online settings (Khan *et al.*, 2021; Raes *et al.*, 2020).

Distractions (DIS), while still a significant stressor, had the smallest impact on student engagement compared to the other two stressors ($\beta = 0.195$, performance = 55.026). Items such as students' difficulty staying focused during class (DIS3), and challenges in communicating with instructors (DIS1, DIS2), were found to significantly contribute to LSE. The struggle to stay focused (DIS3) was a particular concern, as it reflects the lack of a conducive learning environment at home, where students face various interruptions (Joshi *et al.*, 2021). This finding aligns with literature on how environmental factors affect concentration and engagement in online learning (Johnson *et al.*, 2008). Broadbent and Poon (2015) additionally found that students often exhibit poor self-regulation in online learning environments, further enhancing disengagement. The study also found that online communication, despite being more convenient (DIS1), sometimes hindered meaningful interaction, leading to further disengagement.

Finally, our fourth hypothesis (H4) proposed a positive association between limited student engagement and poor academic performance, which was confirmed by our analysis. Students who reported lower engagement on items such as not participating in discussions (LSE1), not collaborating with peers (LSE2), and not reviewing course materials (LSE3, LSE5) demonstrated lower academic outcomes. These results support previous findings (Dixson, 2015; Wang *et al.*, 2017) showing that less engaged students perform worse academically than their more engaged peers. Online learning environments require greater self-discipline and motivation, and students who lack behavioral, emotional and cognitive engagement tend to achieve poorer academic outcomes (Fredricks *et al.*, 2020). This reinforces the crucial role of student engagement as a determinant of academic success in virtual learning environments.

Theoretical implications

The study findings have several theoretical implications. Our study contributes to the understanding of some key concepts that were not examined rigorously in the prior studies. First of all, our study is a new attempt to understand "limited student engagement" within the virtual classroom context. Existing studies have used the concept of student engagement as a factor linked to learning, retention and academic success (Chipchase *et al.*, 2017). Similarly, to the best of our knowledge, this is the first attempt to understand the association between infrastructural hindrance, instructors' incompetency, distractions and limited student engagement. Prior studies have examined how infrastructural constraints, instructors' incompetency and distractions induce stress among students (Aroonsrimarakot *et al.*, 2023; Muthuprasad *et al.*, 2021). Therefore, our study contributes to the existing literature by building an association between infrastructural hinderance, instructors' incompetency, distractions and limited student engagement.

Second, the proposed study adopted the SSO theory to build a conceptual understanding of how limited student engagement within the virtual classroom platform impacts students' academic performance. Previous studies used the SSO framework to understand digital technology, such as social media and related platforms (Masood *et al.*, 2022). Likewise, some studies built work-family conflict literature during COVID-19 using the integrated conceptual model (Shagirbasha *et al.*, 2024). As a result, this is possibly the first empirical study that has examined the psychosocial stress-related aspects of fragile virtual classroom settings using the SSO paradigm, thus, significantly contributing to theory development.

Third, we examined the relationship between limited student engagement and academic performance by taking samples from Bangladesh. None of the present studies have examined such a relationship within this sample. Existing studies focused mostly on the psychological distress faced by students while having online classes (Hasan and Bao, 2020). Therefore, this is a novel and unique study that has extended the literature by investigating the engagement–performance relationship within the virtual classroom platform in the context of Bangladesh.

Practical contributions

This study offers valuable practical implications for various stakeholders, including students, teachers, service operators, government authorities and educational institutions. First, universities and educational institutions must recognize the importance of ensuring that online learning is not just a temporary solution, but a sustainable and effective model for education. The study suggests that addressing infrastructural hindrances, instructor incompetency and distractions is crucial for improving student engagement and, ultimately, academic performance. Universities should invest in the necessary infrastructure, such as high-quality internet connections, adequate devices and digital tools, to support online learning. In addition, faculty members should receive targeted training to enhance their digital pedagogical skills and improve their ability to engage students in virtual environments. Teachers can also benefit from learning how to structure online courses effectively, incorporating interactive activities and assessments to keep students motivated and engaged.

Second, policymakers in developing countries such as Bangladesh can gain critical insights into the state of technological infrastructure in higher education. The data underscores the urgent need for reform in the digital ecosystem, particularly in terms of internet accessibility, device availability and data affordability. Strengthening the digital backbone of education can serve as a long-term investment not only in education but also in the overall digital transformation of the country. Moreover, public-private partnerships could be explored to ensure that technology is accessible to all students, irrespective of their socio-economic background.

Third, one of the main priorities of internet service providers is to increase the number of internet users. Therefore, to achieve this goal, service providers should focus on user experience and satisfaction. For example, a fragile internet connection may lead users toward discontinuous service adoption. Therefore, it has become crucial for internet service providers to plan and develop features and to ensure customer satisfaction and user-friendliness.

Fourth, education providers should design a comprehensive roadmap to ensure the smooth execution of online education. This involves understanding the stressors affecting students and creating an environment that mitigates these challenges. Teachers should consider modifying assessment techniques to fit the online platform, ensuring that students do not feel overwhelmed by technological limitations. Educational institutions should implement initiatives that encourage students to build self-discipline and avoid distractions while attending online classes.

Finally, this study emphasizes the importance of self-regulation for students in online learning environments. Students should be encouraged to develop strategies to manage distractions and remain focused during virtual classes. Moreover, universities and educators can assist students in making the most of limited resources by providing clear guidelines for online learning and creating supportive communities within virtual classrooms.

Limitations and future research directions

Like any other empirical study, this study has some limitations that paved the way for future research. First, the study was conducted taking samples from Bangladesh. So, there is a potential risk of getting different results when the same test is used in other countries or cultural groups. So, future research could be conducted in another country to ensure the generalizability of the findings. Second, although the SSO framework was appropriate for examining the relationships in this study, future research might benefit from alternative theoretical models such as the stimulus–organism–behavior–consequence framework (Davis and Luthans, 1980), which can capture both behavioral responses and their downstream consequences (Islam *et al.*, 2024).

Third, this study used a quantitative approach, which, while useful for statistical generalization, may have overlooked the nuanced experiences of participants – particularly regarding constructs like instructor incompetency. Future studies could adopt a mixed-methods design to provide deeper qualitative insights alongside quantitative validation (Venkatesh *et al.*, 2013). Fourth, our measures of limited student engagement are self-reported. Students might not be aware that they have limited engagement with studies. Consequently, scholars could use an approach that directly measures students' cognitive engagement, such as nuances of the voice, facial expression and movement of an object. In addition, future research should explore other outcomes of an online class in relation to a psychological point of view, e.g. whether an online classroom setting positively impacts health and well-being. Finally, one of the key limitations of this study is the measurement items we used to measure academic performance. Instead of adopting items related to grade point average (GPA), we highlighted learning, satisfaction and career development to measure academic performance. Hence, future studies could be conducted either to develop and validate a new scale or to adopt items related to self-reported GPA.

Conclusion

This study examined the effects of infrastructural hindrance, instructors' incompetency and distractions on students' engagement and subsequent academic performance in virtual classrooms, drawing on the SSO framework. Using data collected from university students in Bangladesh and analyzed through PLS-SEM, our findings confirm that these stressors significantly limit student engagement, which results in poor academic performance. The study contributes to the growing body of literature on online education, particularly from a Global South perspective, by highlighting how digital inequalities and instructional limitations hinder meaningful virtual learning experiences.

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Appendix

Table A1 Measurement items

| <i>Constructs</i> | <i>Items</i> | <i>Sources</i> |
|---|---|---|
| Infrastructure hindrances | IH1. I have an uninterrupted internet connection IH2. I have sufficient data to access the class/materials IH3. I have devices to attend the class IH4. I have a device compatible with the applications used for online classes | Muthuprasad <i>et al.</i> (2021) and Djidu <i>et al.</i> (2021) |
| Instructor's incompetency | II1. The instructor understands the online environment and makes it easy to learn continuously II2. Online classes help me comprehend the course materials more than classroom learning II3. I prefer my online courses as they are very structured with set due dates like face-to-face courses II4. Instructors are reluctant to arrange follow-up sessions for the students | Muthuprasad <i>et al.</i> (2021) and Eom <i>et al.</i> (2006) |
| Distractions | DIS1. The online environment makes it easier for me to communicate with my instructor than a classroom environment DIS2. I am more comfortable responding to questions by email than orally DIS3. Sometimes I struggle to stay focused in class for no reason | Adhani and Remijn (2023) and Muthuprasad <i>et al.</i> (2021) |
| Limited student engagement | LSE1. I never participated in online discussion groups LSE2. I do not collaborate with other students during class activities LSE3. I do not feel like accessing the subject information LSE4. I do not prepare for the class in advance LSE5. I do not review notes after the class | Chipchase <i>et al.</i> (2017) |
| Academic performance | AP1. My quality of study increasing AP2. I am developing the skills needed for your future career AP3. I am making progress in my career AP4. I am seeking out career development opportunities | Whelan <i>et al.</i> (2020) |
| <p>Note(s): The item "making progress in career" reflects students' perceived academic benefit and long-term applicability of online learning in their professional development Source(s): Authors' own work</p> | | |

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