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Looking back to move forward: comparison of instructors' and undergraduates' retrospection on the effectiveness of online learning using the nine-outcome influencing factors

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This study delves into the retrospections of undergraduate students concerning their online learning experiences after the COVID-19 pandemic, using the nine key influencing factors: behavioral intention, instruction, engagement, interaction, motivation, self-efficacy, performance, satisfaction, and self-regulation. 46 Year 1 students from a comprehensive university in China were asked to maintain reflective diaries throughout an academic semester, providing first-person perspectives on the strengths and weaknesses of online learning. Meanwhile, 18 college teachers were interviewed with the same questions as the students. Using thematic analysis, the research identified 9 factors. The research revealed that instruction ranked highest among the 9 factors, followed by engagement, self-regulation, interaction, motivation, and others. Moreover, teachers and students had different attitudes toward instruction. Thirdly, teacher participants were different from student participants given self-efficacy and self-regulation due to their variant roles in online instruction. Lastly, the study reflected students were not independent learners, which explained why instruction ranked highest in their point of view. Findings offer valuable insights for educators, administrators, and policy-makers involved in higher education. Recommendations for future research include incorporating a more diverse sample, exploring relationships between the nine factors, and focusing on equipping students with skills for optimal online learning experiences.

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Introduction

The outbreak of the COVID-19 pandemic has had a profound impact on education worldwide, leading to the widescale adoption of online learning. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), at the peak of the pandemic, 192 countries had implemented nationwide closures, affecting approximately 99% of the world's student population (UNESCO 2020a). In response, educational institutions, teachers, and students quickly adapted to online learning platforms, leveraging digital technologies to continue education amidst the crisis (Marinoni et al. 2020).

The rapid and unexpected shift to online learning brought about a surge in research aiming to understand its impact, effectiveness, and challenges. Researchers across the globe have been investigating various dimensions of online learning. Some focus on students' experiences and perspectives (Aristovnik et al. 2021), technological aspects (Bao 2020), pedagogical strategies (Hodges et al. 2020), and the socio-emotional aspect of learning (Ali 2020). Tan et al. (2021) found that motivation and satisfaction were mostly positively perceived by students, and lack of interaction was perceived as an unfavorable online instruction perception. Some center on teachers' perceptions of the benefits and challenges (Lucas and Vicente, 2023; Mulla et al. 2023), post-pandemic pedagogisation (Rapanta et al. 2021), and post-pandemic further education (Kohnke et al. 2023; Torsani et al. 2023). It was worth noting that elements like interaction and engagement were central to the development and maintenance of the learning community (Lucas and Vincente 2023),

The rise of online learning has also posed unprecedented challenges. Studies have pointed out the digital divide and accessibility issues (Crawford et al. 2020), students' motivation and engagement concerns (Martin and Bolliger 2018), and the need for effective online instructional practices (Trust and Whalen 2020). The rapid transition to online learning has highlighted the need for robust research to address these challenges and understand the effectiveness of online learning in this new educational paradigm.

Despite the extensive research on online learning during and after the COVID-19 pandemic, there remains a notable gap in understanding the retrospective perspectives of both undergraduates and teachers. Much of the current literature has focused on immediate response strategies to the transition to online learning, often overlooking the detailed insights that reflective retrospection can provide (Marinoni et al. 2020; Bao 2020). In addition, while many studies have examined isolated aspects of online learning, they have not often employed a comprehensive framework, leaving undergraduates' voices, in particular, underrepresented in the discourse (Aristovnik et al. 2021; Crawford et al. 2020). This study, situated in the context of the COVID-19 pandemic's impetus toward online learning, seeks to fill this crucial gap. By exploring online learning from the perspectives of both instructors and undergraduates, and analyzing nine key factors that include engagement, motivation, and self-efficacy, the research contributes vital insights into the dynamics of online education (Wang and Wang 2021). This exploration is especially pertinent as digital learning environments become increasingly prevalent worldwide (UNESCO 2020b). The findings of our study are pivotal for shaping future educational policies and enhancing online education strategies in this continuously evolving educational landscape (Greenhow et al. 2021). Thus, three research questions were raised:

Q1: How do undergraduates and teachers in China retrospectively perceive the effectiveness of online learning after the COVID-19 pandemic?

Q2: Which of the nine outcome influencing factors had the most significant impact on online learning experiences after the pandemic, and why?

Q3: What recommendations can be proposed to enhance the effectiveness of online learning in the future?

The research takes place at a comprehensive university in China, with a sample of 46 Year 1 students and 18 experienced teachers. Their reflections on the effectiveness of online learning were captured through reflective diaries guided by four questions. These questions investigated the students' online learning states and attitudes, identified issues and insufficiencies in online learning, analyzed the reasons behind these problems, and proposed improvements. By assessing their experiences and perceptions, we seek to explore the significant factors that shaped online learning outcomes after the pandemic and the means to enhance its effectiveness.

This paper first presents a review of the existing literature, focusing on the impact of the pandemic on online learning and discussing the nine significant factors influencing online learning outcomes. Following this, the methodology utilized for this study is detailed, setting the stage for a deeper understanding of the research process. Subsequently, we delve into the results of the thematic analysis conducted based on undergraduate students and teachers' retrospections. Finally, the paper concludes by offering meaningful implications of the findings for various stakeholders and suggesting directions for future research in this critical area.

Literature review

Online learning application and evaluation in higher education. Online learning, also known as e-learning or distance learning, refers to education that takes place over the Internet rather than in a traditional classroom setting. It has seen substantial growth over the past decade and has been accelerated due to the COVID-19 pandemic (Trust and Whalen 2020). Online learning allows for a flexible learning environment, breaking the temporal and spatial boundaries of traditional classroom settings (Bozkurt and Sharma 2020). In response to the COVID-19 pandemic, educational institutions globally have embraced online learning at an unprecedented scale. This has led to an immense surge in research focusing on the effects of the pandemic on online learning (Crawford et al. 2020; Marinoni et al. 2020).

Researchers were divided in their attitudes toward the effects of online learning, including positive, neutral, and negative. Research by Bahasoan et al. (2020), Bernard et al. (2004), Hernández-Lara and Serradell-López (2018), and Paechter and Maier (2010) indicated the effectiveness of online learning, including improved outcomes and engagement in online formats, providing flexibility and enhancing digital skills for instance. Research, including studies by Dolan Hancock and Wareing (2015) and Means et al. (2010), indicates that under equivalent conditions and with similar levels of support, there is frequently no substantial difference in learning outcomes between traditional face-to-face courses and completely online courses.

However, online learning was not without its challenges. Research showing less favorable results for specific student groups can be referenced in Dennen (2014), etc. The common problems faced by students included underdeveloped independent learning ability, lack of motivation, difficulties in self-regulation, student engagement and technical issues (Aristovnik et al. 2021; Martin and Bolliger 2018; Song et al. 2004; Zheng et al. 2022).

Moreover, factors like instructional strategies, course design, etc. were also linked to learning outcomes and successful online learning (Ali 2020; Hongsuchon et al. 2022). Careaga-Butter et al. (2020) critically analyze online education in pandemic and post-pandemic contexts, focusing on digital tools and resources for teaching in synchronous and asynchronous learning modalities. They discuss the swift adaptation to online learning during the

pandemic, highlighting the importance of technological infrastructure, pedagogical strategies, and the challenges of digital divides. The article emphasizes the need for effective online learning environments and explores trends in post-pandemic education, providing insights into future educational strategies and practices.

Determinants of online learning outcomes. Online learning outcomes in this paper refer to the measurable educational results achieved through online learning methods, including knowledge acquisition, skill development, changes in attitudes or behaviors, and performance improvements (Chang 2016; Panigrahi et al. 2018). The literature review identified key factors influencing online learning outcomes, emphasizing their significant role in academic discourse. These factors, highlighted in scholarly literature, include student engagement, instructional design, technology infrastructure, student-teacher interaction, and student self-regulation.

Student Engagement: The level of a student's engagement significantly impacts their learning outcomes. The more actively a student is engaged with the course content and activities, the better their performance tends to be. This underscores the importance of designing engaging course content and providing opportunities for active learning in an online environment (Martin and Bolliger 2018).

Instructional Design: How an online course is designed can greatly affect student outcomes. Key elements such as clarity of learning objectives, organization of course materials, and the use of diverse instructional strategies significantly impact student learning (Bozkurt and Sharma 2020).

Technology Infrastructure: The reliability and ease of use of the learning management system (LMS) also play a significant role in online learning outcomes. When students experience technical difficulties, it can lead to frustration, reduced engagement, and lower performance (Johnson et al. 2020).

Student-Teacher Interaction: Interaction between students and teachers in an online learning environment is a key determinant of successful outcomes. Regular, substantive feedback from instructors can promote student learning and motivation (Boling et al. 2012).

Student Self-Regulation: The autonomous nature of online learning requires students to be proficient in self-regulated learning, which involves setting learning goals, self-monitoring, and self-evaluation. Students who exhibit strong self-regulation skills are more likely to succeed in online learning (Broadbent 2017).

While many studies have investigated individual factors affecting online learning, there is a paucity of research offering a holistic view of these factors and their interrelationships, leading to a fragmented understanding of the influences on online learning outcomes. Given the multitude of experiences and variables encompassed by online learning, a comprehensive framework like is instrumental in ensuring a thorough investigation and interpretation of the breadth of students' experiences.

Students' perceptions of online learning. Understanding students' perceptions of online learning is essential for enhancing its effectiveness and student satisfaction. Studies show students appreciate online learning for its flexibility and convenience, offering personalized learning paths and resource access (Händel et al. 2020; Johnson et al. 2020). Yet, challenges persist, notably in maintaining motivation and handling technical issues (Aristovnik et al. 2021; Händel et al. 2020). Aguilera-Hermida (2020) reported mixed feelings among students during the COVID-19 pandemic, including feelings of isolation and difficulty adjusting

to online environments. Boling et al. (2012) emphasized students' preferences for interactive and communicative online learning environments. Additionally, research indicates that students seek more engaging content and innovative teaching approaches, suggesting a gap between current online offerings and student expectations (Chakraborty and Muya Nafukho 2014). Students also emphasize the importance of community and peer support in online settings, underlining the need for collaborative and social learning opportunities (Lai et al. 2019). These findings imply that while online learning offers significant benefits, addressing its shortcomings is critical for maximizing its potential.

The pandemic prompted a reconsideration of instructional modalities, with many students favoring face-to-face instruction due to the immediacy and focus issues (Aristovnik et al. 2021; Trust and Whalen 2020). Despite valuable insights, research gaps remain, particularly in long-term undergraduate reflections and the application of nine factors of comprehensive frameworks, indicating a need for more holistic research in online learning effectiveness.

Teachers' perceptions of online learning. The pandemic has brought attention to how teachers manage instruction in virtual learning environments. Teachers and students are divided in terms of their attitudes toward online learning. Some teachers and students looked to the convenience and flexibility of online learning (Chuenyindee et al. 2022; Al-Emran and Shaalan 2021). They conceived that online learning provided opportunities to improve educational equality as well (Tenório et al. 2016). Even when COVID-19 was over, the dependence on online learning was likely here to stay, for some approaches of online learning were well-received by students and teachers (Al-Rahmi et al. 2019; Hongsuchon et al. 2022).

Teachers had shown great confidence in delivering instruction in an online environment in a satisfying manner. They also agreed that the difficulty of teaching was closely associated with course structures (Gavranović and Prodanović 2021).

Not all were optimistic about the effects of online learning. They sought out the challenges facing teachers and students during online learning.

A mixed-method study of K-12 teachers' feelings, experiences, and perspectives that the major challenges faced by teachers during the COVID-19 pandemic were lack of student participation and engagement, technological support for online learning, lack of face-to-face interactions with students, no work-life balance and learning new technology.

The challenges to teachers' online instruction included instruction technology (Maatuk et al. 2022; Rasheed et al. 2020), course design (Khojasteh et al. 2023), and teachers' confidence (Gavranović and Prodanović 2021).

Self-regulation challenges and challenges in using technology were the key challenges to students, while the use of technology for teaching was the challenge facing teachers (Rasheed et al. 2020).

The quality of course design was another important factor in online learning. A research revealed the competency of the instructors and their expertise in content development contributed a lot to students' satisfaction with the quality of e-content.

Theoretical framework

The theoretical foundation of the research is deeply rooted in multifaceted framework for online learning, which provides a comprehensive and interwoven model encompassing nine critical factors that collectively shape the educational experience in online settings. This framework is instrumental in guiding our analysis

and enhances the comparability and interpretability of our results within the context of existing literature.

Central to Yu's framework is the concept of behavioral intention, which acts as a precursor to student engagement in online learning environments. This engagement, inherently linked to the students' intentions and motivations, is significantly influenced by the quality of instruction they receive. Instruction, therefore, emerges as a pivotal element in this model, directly impacting not only student engagement but also fostering a sense of self-efficacy among learners. Such self-efficacy is crucial as it influences both the performance of students and their overall satisfaction with the learning process.

The framework posits that engagement, a derivative of both strong behavioral intention and effective instruction, plays a vital role in enhancing student performance. This engagement is tightly interlaced with self-regulation, an indispensable skill in the autonomous and often self-directed context of online learning. Interaction, encompassing various forms such as student-teacher and peer-to-peer communications, further enriches the learning experience. It significantly contributes to the development of motivation and self-efficacy, both of which are essential for sustaining engagement and fostering self-regulated learning.

Motivation, especially when intrinsically driven, acts as a catalyst, perpetuating engagement and self-regulation, which ultimately leads to increased satisfaction with the learning experience. In this framework, self-efficacy, nurtured through effective instruction and meaningful interactions, has a positive impact on students' performance and satisfaction, thereby creating a reinforcing cycle of learning and achievement.

Performance in this model is viewed as a tangible measure of the synergistic interplay of engagement, instructional quality, and self-efficacy, while satisfaction reflects the culmination of the learning experience, shaped by the quality of instruction, the extent and nature of interactions, and the flexibility of the learning environment. This satisfaction, in turn, influences students' future motivation and their continued engagement with online learning.

Yu's model thus presents a dynamic ecosystem where changes in one factor can have ripple effects across the entire spectrum of online learning. It emphasizes the need for a holistic approach in the realm of online education, considering the complex interplay of these diverse yet interconnected elements to enhance both the effectiveness and the overall experience of online learning.

Method

The current study employed a qualitative design to explore teachers' and undergraduates' retrospections on the effectiveness of online learning during the first semester of the 2022–2023 school year, which is in the post-pandemic period. Data were collected using reflective diaries, and thematic analysis was applied to understand the experiences based on the nine factors.

Sample and sampling. The study involved 18 teachers and 46 first-year students from a comprehensive university in China, selected through convenience sampling to ensure diverse representation across academic disciplines. To ensure a diverse range of experiences in online learning, the participant selection process involved an initial email inquiry about their prior engagement with online education. The first author of this study received ethics approval from the department research committee, and participants were informed of the study's objectives two weeks before via email. Only those participants who provided written informed consent were included in the study and were free to withdraw at any time. Pseudonyms were used to protect participants' identities during the data-coding process. For direct

Table 1 Information of student participants.

Major		Gender	
English	11	Male	37
Non-English	35	Female	9
total	46		46

Table 2 The Basic Information of the 18 Teacher Participants.

Teachers	Gender	Major	Years of Teaching
T1	Female	English	23
T2	Female	English	22
T3	Female	English	22
T4	Female	English	20
T5	Female	English	19
T6	Female	English	14
T7	Female	English	14
T8	Female	English	14
T9	Male	Non-English	9
T10	Male	Non-English	7
T11	Male	Non-English	8
T12	Female	Non-English	8
T13	Female	Non-English	14
T14	Male	Non-English	23
T15	Female	Non-English	16
T16	Female	Non-English	5
T17	Male	Non-English	8
T18	Female	Non-English	5

citations, acronyms of students' names were used, while "T+number" was used for citations from teacher participants.

The 46 students are all first-year undergraduates, 9 females and 37 males majoring in English and non-English (see Table 1).

The 18 teachers are all experienced instructors with at least 5 years of teaching experience, 13 females and 5 male, majoring in English and Non-English (see Table 2).

Data collection. Students' data were collected through reflective diaries in class during the first semester of the 2022–2023 school year. Each participant was asked to maintain a diary over the course of one academic semester, in which they responded to four questions.

The four questions include:

1. What was your state and attitude toward online learning?
2. What were the problems and shortcomings of online learning?
3. What do you think are the reasons for these problems?
4. What measures do you think should be taken to improve online learning?

This approach provided a first-person perspective on the participants' online teaching or learning experiences, capturing the depth and complexity of their retrospections.

Teachers were interviewed separately by responding to the four questions the same as the students. Each interview was conducted in the office or the school canteen during the semester and lasted about 20 to 30 min.

Data analysis. We utilized thematic analysis to interpret the reflective diaries, guided initially by nine factors. This method involved extensive engagement with the data, from initial coding to the final report. While Yu's factors provided a foundational

Table 3 Nine factors with the corresponding interviews of 18 teachers and 46 undergraduates.

Categories	Student Response Subthemes	Teacher Response Subthemes
Behavioral Intention	Varied levels of seriousness, engagement difficulties, lack of eye contact, mixed attitudes	Challenges with computer-based interaction, difficulty gauging student attention, need for enhanced enthusiasm.
Instruction	Issues with feedback, distance from instructors, emotional disconnect, lack of supervision, technical problems	Similar challenges plus the need to complement traditional instruction
Engagement	Less engagement on online platforms, distraction, passive learning, expression difficulties	Similar student issues noted, added difficulty maintaining student attention
Interaction	Reduced teacher-student connection, limited online communication, emotional gap in interaction	Emotional disconnect, less fluent communication, absence of face-to-face interaction
Motivation	Difficulties initiating and maintaining interest in online learning	Challenges in material suitability and stimulating critical thinking
Self-efficacy	Self-regulation issues, distractions, difficulty maintaining focus	Technological challenges impacting supervision, difficulty in gauging student learning
Performance	Learning difficulties without supervision, focus issues, reluctance to engage, fatigue.	Observations mirroring student challenges in unsupervised settings
Satisfaction	Boredom with subjects, fatigue, course dislike	Inefficiencies compared to in-person teaching, technological interruptions
Self-regulation	Need for enhanced concentration and motivation in online learning	Emphasis on student responsibility for self-regulation and knowledge-seeking

structure, we remained attentive to new themes, ensuring a comprehensive analysis. Our approach was methodical: familiarizing ourselves with the data, identifying initial codes, systematically searching and reviewing themes, and then defining and naming them. To validate our findings, we incorporated peer debriefing, and member checking, and maintained an audit trail. This analysis method was chosen for its effectiveness in extracting in-depth insights from undergraduates’ retrospections on their online learning experiences post-pandemic, aligning with our research objectives.

Results

According to the nine factors, the interviews of 18 teachers and 46 Year 1 undergraduates were catalogued and listed in Table 3.

Behavioral intention towards online learning post-pandemic.

Since the widespread of the COVID-19 pandemic, both teachers and students have experienced online learning. However, their online teaching or learning was forced rather than planned (Baber 2021; Bao 2020). Students more easily accepted online learning when they perceived the severity of COVID-19.

When entering the post-pandemic era, traditional teaching was resumed. Students often compared online learning with traditional learning by mentioning learning interests, eye contact, face-to-face learning and learning atmosphere.

“I don’t think online learning is a good form of learning because it is hard to focus on learning.” (DSY) “In unimportant courses, I would let the computer log to the platform and at the same time do other entertains such as watching movies, listening to the music, having snacks or do the cleaning.” (XYN) “Online learning makes it impossible to have eye contact between teachers and students and unable to create a face-to-face instructional environment, which greatly influences students’ initiative and engagement in classes.” (WRX)

They noted that positive attitudes toward online learning usually generated higher behavioral intention to use online learning than those with negative attitudes, as found in the research of Zhu et al. (2023). So they put more blame on distractions in the learning environment.

“Online learning relies on computers or cell phones which easily brings many distractions. ... I can’t focus on

studying, shifting constantly from study and games.” (YX) “When we talk about learning online, we are hit by an idea that we can take a rest in class. It’s because everyone believes that during online classes, the teacher is unable to see or know what we are doing.” (YM) “...I am easily disturbed by external factors, and I am not very active in class.” (WZB)

Teachers reported a majority of students reluctantly turning on their cameras during online instruction and concluded the possible reason for such behavior.

“One of the reasons why some students are unwilling to turn on the camera is that they are worried about their looks and clothing at home, or that they don’t want to become the focus.” (T4)

They also noticed students’ absent-mindedness and lazy attitude during online instruction.

“As for some students who are not self-regulated, they would not take online learning as seriously as offline learning. Whenever they are logged onto the online platform, they would be unable to stay focused and keep their attention.” (T1)

Challenges and opportunities in online instruction post-pandemic.

Online teaching brought new challenges and opportunities for students during and after the pandemic. The distractions at home seemed to be significantly underestimated by teachers in an online learning environment (Radmer and Goodchild 2021). It might be the reason why students greatly expected and heavily relied on teachers’ supervision and management.

“The biggest problem of online learning is that online courses are as imperative as traditional classes, but not managed face to face the same as the traditional ones.” (PC) “It is unable to provide some necessary supervision.” (GJX) “It is incapable of giving timely attention to every student.” (GYC) “Teachers can’t understand students’ conditions in time in most cases so teachers can’t adjust their teaching plan.” (MZY) “Some courses are unable to reach the teaching objectives due to lack of experimental conduction and practical operation.” (YZH) “Insufficient teacher-student interaction and the use of cell phones make both

groups unable to engage in classes. What's more, though online learning doesn't put a high requirement for places, its instructional environment may be crucial due to the possible distractions." (YCY)

Teachers also viewed online instruction as an addition to face-to-face instruction.

"Online learning cannot run as smoothly as face-to-face instruction, but it can provide an in-time supplement to the practical teaching and students' self-learning." (T13, T17)
 "Online instruction is an essential way to ensure the normal function of school work during the special periods like the pandemic" (T1, T15)

Factors influencing student engagement in online learning.

Learning engagement was found to contribute to gains in the study (Paul and Diana 2006). It was also referred to as a state closely intertwined with the three dimensions of learning, i.e., vigor, dedication, and absorption (Schaufeli et al. 2002). Previous studies have found that some key factors like learning interaction, self-regulation, and social presence could influence learning engagement and learning outcomes (Lowenthal and Dunlap 2020; Ng 2018). Due to the absence of face-to-face interaction like eye contact, facial expressions and body language, both groups of interviewees agreed that the students felt it hard to keep their attention and thus remain active in online classes.

"Students are unable to engage in study due to a lack of practical learning environment of online learning." (ZMH, T12) "Online platforms may not provide the same level of engagement and interaction as in-person classrooms, making it harder for students to ask questions or engage in discussions." (HCK) "The Internet is cold, lack of emotional clues and practical connections, which makes it unable to reproduce face-to-face offline learning so that teachers and students are unlikely to know each other's true feelings or thoughts. In addition, different from the real-time learning supervision in offline learning, online learning leaves students more learning autonomy." (XGH) "Lack of teachers' supervision and practical learning environment, students are easily distracted." (LMA, T9)

Just as Zhu et al. (2023) pointed out, we had been too optimistic about students' engagement in online learning, because online learning relied more on students' autonomy and efforts to complete online learning.

Challenges in teacher-student interaction in online learning.

Online learning has a notable feature, i.e., a spatial and temporal separation among teachers and students. Thus, online teacher-student interactions, fundamentals of relationship formation, have more challenges for both teachers and students. The prior studies found that online interaction affected social presence and indirectly affected learning engagement through social presence (Miao and Ma 2022). In the present investigation, both teachers and students noted the striking disadvantage of online interaction.

"Online learning has many problems such as indirect teacher-student communication, inactive informative communication, late response of students and their inability to reflect their problems. For example, teachers cannot evaluate correctly whether the students have mastered or not." (YYN) "Teachers and students are separated by screens. The students cannot make prompt responses to the teachers' questions via loudspeakers or headphones. It is

not convenient for students to participate in questioning and answering. ...for most of the time, the students interact with teachers via typing." (ZJY) "While learning online, students prefer texting the questions to answering them via the loudspeaker." (T7)

Online learning interaction was also found closely related to online learning engagement, performance, and self-efficacy.

"Teachers and students are unable to have timely and effective communication, which reduces the learning atmosphere. Students are often distracted. While doing homework, the students are unable to give feedback to teachers." (YR) "Students are liable to be distracted by many other side matters so that they can keep their attention to online learning." (T15)

In the online learning environment, teachers need to make efforts to build rapport and personalizing interactions with students to help them perform better and achieve greater academic success (Harper 2018; Ong and Quek 2023) Meanwhile, teachers should also motivate students' learning by designing the lessons, giving lectures and managing the processes of student interactions (Garrison 2003; Ong and Quek 2023).

Determinants of self-efficacy in online learning. Online learning self-efficacy refers to students' perception of their abilities to fulfill specific tasks required in online learning (Calaguas and Conunji 2022; Zimmerman and Kulikowich 2016). Online learning self-efficacy was found to be influenced by various factors including task, learner, course, and technology level, among which task level was found to be most closely related (Xu et al. 2022). The responses from the 46 student participants reveal a shared concern, albeit without mentioning specific tasks; they highlight critical aspects influencing online learning: learner attributes, course structure, and technological infrastructure.

One unifying theme from the student feedback is the challenge of self-regulation and environmental distractions impacting learning efficacy. For instance, participant WSX notes the necessity for students to enhance time management skills due to deficiencies in self-regulation, which is crucial for successful online learning. Participant WY expands on this by pointing out the distractions outside traditional classroom settings, coupled with limited teacher-student interaction, which hampers idea exchange and independent thought, thereby undermining educational outcomes. These insights suggest a need for strategies that bolster students' self-discipline and interactive opportunities in virtual learning environments.

On the technological front, participants WT and YCY address different but related issues. Participant WT emphasizes the importance of up-to-date course content and learning facilities, indicating that outdated materials and tools can significantly diminish the effectiveness of online education. Participant YCY adds to this by highlighting problems with online learning applications, such as subpar functionalities that can introduce additional barriers to learning.

Teacher participants, on the other hand, shed light on objective factors predominantly related to course content and technology. Participant T5's response underscores the heavy dependency on technological advancement in online education and points out the current inability of platforms or apps to adequately monitor student engagement and progress. Participant T9 voices concerns about course content not being updated or aligned with contemporary trends and student interests, suggesting a disconnect between educational offerings and learner needs. Meanwhile, participant T8 identifies unstable network services as a

significant hindrance to online teaching, highlighting infrastructure as a critical component of online education's success.

Teachers also believed the insufficient mastery of facilities and unfamiliarity with online instruction posed difficulty.

"Most teachers and students are not familiar with online instruction. For example, some teachers are unable to manage online courses so they cannot design the courses well. Some students lack self-regulation, which leads to their distraction or avoidance in class." (T9)

Influences on student performance in online learning. Students' performance during online lessons is closely associated with their satisfaction and self-efficacy. Most of the student participants reflected on their distractions, confusion, and needs, which indicates their dissatisfaction with online learning.

"During online instruction, it is convenient for the students to make use of cell phones, but instead, cell phones bring lots of distraction." (YSC) "Due to the limits of online learning, teachers are facing the computer screen and unable to know timely students' needs and confusion. Meanwhile, it's inconvenient for teachers to make clear explanations of the sample questions or problems." (HZW)

They thought their low learning efficiency in performance was caused by external factors like the learning environment.

"The most obvious disadvantage of online learning goes to low efficiency. Students find it hard to keep attention to study outside the practical classroom or in a relaxing environment." (WY) "Teachers are not strict enough with students, which leads to ineffective learning." (WRX)

Teacher participants conceived students' performance as closely related to valid online supervision and students' self-regulation.

"Online instruction is unable to create a learning environment, which helps teachers know students' instant reaction. Only when students well regulate themselves and stay focused during online learning can they achieve successful interactions and make good accomplishments in the class." (T11) "Some students need teachers' supervision and high self-regulation, or they were easily distracted." (T16)

Student satisfaction and teaching effectiveness in online learning. Online learning satisfaction was found to be significantly and positively associated with online learning self-efficacy (Al-Nasa'h et al. 2021; Lashley et al. 2022). Around 46% of student participants were unsatisfied with teachers' ways of teaching.

"Comparatively, bloggers are more interesting than teachers' boring and dull voices in online learning." (DSY) "Teachers' voice sounds dull and boring through the internet, which may cause listeners to feel sleepy, and the teaching content is not interesting enough to the students." (MFE)

It reflected partly that some teachers were not adapted to online teaching possibly due to a lack in experience of online teaching or learning (Zhu et al. 2022).

"Some teachers are not well-prepared for online learning. They are particularly unready for emergent technological problems when delivering the teaching." (T1) "One of the critical reasons lies in the fact that teachers and students are not well trained before online learning. In addition, the online

platform is not unified by the college administration, which has led to chaos and difficulty of online instruction." (T17)

Teachers recognized their inadequate preparation and mastery of online learning as one of the reasons for dissatisfaction, but student participants exaggerated the role of teachers in online learning and ignored their responsibility in planning and managing their learning behavior, as in the research of (Xu et al. 2022).

The role of self-regulation in online learning success. In the context of online learning, self-regulation stands out as a crucial factor, necessitating heightened levels of student self-discipline and autonomy. This aspect, as Zhu et al. (2023) suggest, grants students significant control over their learning processes, making it a vital component for successful online education.

"Online learning requires learners to be of high discipline and self-regulation. Without good self-regulation, they are less likely to be effective in online learning." (YZJ) "Most students lack self-control, unable to control the time of using electronic products. Some even use other electronic products during online learning, which greatly reduces their efficiency in learning." (GPY) "Students are not well developed in self-control and easily distracted. Thus they are unable to engage fully in their study, which makes them unable to keep up with others" (XYN)

Both groups of participants had a clear idea of the positive role of self-regulation in successful learning, but they also admitted that students need to strengthen their self-regulation skills and it seemed they associated with the learning environment, learning efficiency and teachers' supervision.

"If they are self-motivated, online learning can be conducted more easily and more efficiently. However, a majority are not strong in regulating themselves. Teachers' direct supervision in offline learning can do better in motivating them to study hard...lack of interaction makes students less active and motivated." (LY) "Students have a low level of self-discipline. Without teachers' supervision, they find it hard to listen attentively or even quit listening. Moreover, in class, the students seldom think actively and independently." (T13)

The analysis of participant responses, categorized into three distinct attitude groups – positive, neutral, and negative – reveals a multifaceted view of the disadvantages of online learning, as shown in Tables 4 and 5. This classification provides a clearer understanding of how attitudes towards online learning influence perceptions of self-regulation and other related factors.

In Table 4, the division among students is most pronounced in terms of interaction and self-efficacy. Those with neutral attitudes highlighted interaction as a primary concern, suggesting that it is less effective in an online setting. Participants with positive attitudes noted a lack of student motivation, while those with negative views emphasized the need for better self-efficacy. Across all attitudes, instruction, engagement, self-regulation, and behavior intention were consistently identified as areas needing improvement.

Table 5 sheds light on teachers' perspectives, revealing a consensus on the significance and challenges of instruction, motivation, and self-efficacy in online learning. Teachers' opinions vary most significantly on self-efficacy and engagement. Those with negative attitudes point to self-efficacy and instructional quality as critical areas needing attention, while neutral attitudes focus on the role of motivation.

Discussions

Using a qualitative and quantitative analysis of the questionnaire data showed that among the 18 college teachers and 46 year 1

Table 4 Results of undergraduates' attitude toward the disadvantages of online learning.

Attitude		Positive	Neutral	Negative	Total
Factors	Behavior intention	4	3	3	10
	Instruction	10	10	11	31
	Engagement	5	7	7	19
	Interaction	1	8	2	11
	Motivation	2	5	4	11
	Self-efficacy	1	0	8	9
	Performance	1	1	1	3
	Satisfaction	2	0	0	2
	Self-regulation	4	6	4	14

Table 5 Results of teachers' attitude toward the disadvantages of online learning.

Attitude		Positive	Neutral	Negative	Total
Factors	Behavior intention	1	1	1	3
	Instruction	6	2	7	15
	Engagement	1	1	4	6
	Interaction	3	2	3	8
	Motivation	2	5	4	11
	Self-efficacy	1	0	8	9
	Performance	1	1	1	3
	Satisfaction	1	1	1	3
	Self-regulation	1	1	2	4

undergraduate students of various majors taking part in the interview, about 38.9% of teachers and about 30.4% of students supported online learning. Only two teachers were neutral about online learning, and 50% of teachers did not support virtual learning. The percentages of students who expressed positive and neutral views on online learning were the same, i.e., 34.8%. This indicates that online learning could serve as a complementary approach to traditional education, yet it is not without challenges, particularly in terms of student engagement, self-regulation, and behavioral intention, which were often attributed to distractions inherent in online environments.

In analyzing nine factors, it was evident that both teachers and students did not perceive these factors uniformly. Instruction was a significant element for both groups, as validated by findings in Tables 3 and 5. The absence of face-to-face interactions in online learning shifted the focus to online instruction quality. Teachers cited technological challenges as a central concern, while students criticized the lack of engaging content and teaching methods. This aligns with Miao and Ma (2022), who argued that direct online interaction does not necessarily influence learner engagement, thus underscoring the need for integrated approaches encompassing interactions, self-regulation, and social presence.

Furthermore, the role of technology acceptance in shaping self-efficacy was highlighted by Xu et al. (2022), suggesting that students with higher self-efficacy tend to challenge themselves more. Chen and Hsu (2022) noted the positive influence of using emojis in online lessons, emphasizing the importance of innovative pedagogical approaches in online settings.

The study revealed distinct priorities between teachers and students in online learning: teachers emphasized effective instruction delivery, while students valued learning outcomes, self-regulation, and engagement. This divergence highlights the unique challenges each group faces. Findings by Dennen et al. (2007) corroborate this, showing instructors focusing on content and guidance, while students prioritize interpersonal communication and individualized attention. Additionally, Lee et al.

(2011) found that reduced transactional distance and increased student engagement led to enhanced perceptions of learning outcomes, aligning with students' priorities in online courses. Understanding these differing perspectives is crucial for developing comprehensive online learning strategies that address the needs of both educators and learners.

Integrating these findings with broader contextual elements such as technological infrastructure, pedagogical strategies, socio-economic backgrounds, and environmental factors (Balanskat and Bingimlas 2006) further enriches our understanding. The interplay between these external factors and Yu's nine key aspects forms a complex educational ecosystem. For example, government interventions and training programs have been shown to increase teachers' enthusiasm for ICT and its routine use in education (Balanskat and Bingimlas 2006). Additionally, socio-economic factors significantly impact students' experiences with online learning, as the digital divide in connectivity and access to computers at home influences the ICT experience, an important factor for school achievement (OECD 2015; Punie et al. 2006).

In sum, the study advocates for a holistic approach to understanding and enhancing online education, recognizing the complex interplay between internal factors and external elements that shape the educational ecosystem in the digital age.

Conclusion and future research

This study offered a comprehensive exploration into the retrospective perceptions of college teachers and undergraduate students regarding their experiences with online learning following the COVID-19 pandemic. It was guided by a framework encompassing nine key factors that influence online learning outcomes. To delve into these perspectives, the research focused on three pivotal questions. These questions aimed to uncover how both undergraduates and teachers in China view the effectiveness of online learning post-pandemic, identify which of the nine influencing factors had the most significant impact, and propose recommendations for enhancing the future effectiveness of online learning.

In addressing the first research question concerning the retrospective perceptions of online learning's effectiveness among undergraduates and teachers in China post-COVID-19 pandemic, the thematic analysis has delineated clear divergences in attitude between the two demographics. Participants were primarily divided into three categories based on their stance toward online learning: positive, neutral, and negative. The results highlighted a pronounced variance in attitude distribution between teachers and students, with a higher percentage of teachers expressing clear-cut opinions, either favorably or unfavorably, towards the effectiveness of online learning.

Conversely, students displayed a pronounced inclination towards neutrality, revealing a more cautious or mixed stance on the effectiveness of online learning. This prevalent neutrality within the student body could be attributed to a range of underlying reasons. It might signify students' uncertainties or varied experiences with online platforms, differences in engagement levels, gaps in digital literacy, or fluctuating quality of online materials and teaching methods. Moreover, this neutral attitude may arise from the psychological and social repercussions of the pandemic, which have potentially altered students' approaches to and perceptions of learning in an online context.

In the exploration of the nine influential factors in online learning, it was discovered that both teachers and students overwhelmingly identified instruction as the most critical aspect. This was closely followed by engagement, interaction, motivation, and other factors, while performance and satisfaction were perceived as less influential by both groups. However, the attitudes of teachers and students towards these factors revealed notable differences, particularly about instruction. Teachers often

attributed challenges in online instruction to technological issues, whereas students perceived the quality of instruction as a major influence on their learning effectiveness. This dichotomy highlights the distinct perspectives arising from their different roles within the educational process.

A further divergence was observed in views on self-efficacy and self-regulation. Teachers, with a focus on delivering content, emphasized the importance of self-efficacy, while students, grappling with the demands of online learning, prioritized self-regulation. This reflects their respective positions in the online learning environment, with teachers concerned about the efficacy of their instructional strategies and students about managing their learning process. Interestingly, the study also illuminated that students did not always perceive themselves as independent learners, which contributed to the high priority they placed on instruction quality. This insight underlines a significant area for development in online learning strategies, emphasizing the need for fostering greater learner autonomy.

Notably, both teachers and students concurred that stimulating interest was a key factor in enhancing online learning. They proposed innovative approaches such as emulating popular online personalities, enhancing interactive elements, and contextualizing content to make it more relatable to students' lives. Additionally, practical suggestions like issuing preview tasks and conducting in-class quizzes were highlighted as methods to boost student engagement and learning efficiency. The consensus on the importance of supervisory roles underscores the necessity for a balanced approach that integrates guidance and independence in the online learning environment.

The outcomes of our study highlight the multifaceted nature of online learning, accentuated by the varied perspectives and distinct needs of teachers and students. This complexity underscores the necessity of recognizing and addressing these nuances when designing and implementing online learning strategies. Furthermore, our findings offer a comprehensive overview of both the strengths and weaknesses of online learning during an unprecedented time, offering valuable insights for educators, administrators, and policy-makers involved in higher education. Moreover, it emphasized the intricate interplay of multiple factors—behavioral intention, instruction, engagement, interaction, motivation, self-efficacy, performance, satisfaction, and self-regulation—in shaping online learning outcomes. presents some limitations, notably its reliance on a single research method and a limited sample size.

However, the exclusive use of reflective diaries and interviews restricts the range of data collection methods, which might have been enriched by incorporating additional quantitative or mixed-method approaches. Furthermore, the sample, consisting only of students and teachers from one university, may not adequately represent the diverse experiences and perceptions of online learning across different educational contexts. These limitations suggest the need for a cautious interpretation of the findings and indicate areas for future research expansion. Future research could extend this study by incorporating a larger, more diverse sample to gain a broader understanding of undergraduate students' retrospections across different contexts and cultures. Furthermore, research could also explore how to better equip students with the skills and strategies necessary to optimize their online learning experiences, especially in terms of the self-regulated learning and motivation aspects.

Data availability

The data supporting this study is available from <https://doi.org/10.6084/m9.figshare.25583664.v1>. The data consists of reflective diaries from 46 Year 1 students from a comprehensive university

in China and 18 college teachers. We utilized thematic analysis to interpret the reflective diaries, guided initially by nine factors. The results highlight the critical need for tailored online learning strategies and provide insights into its advantages and challenges for stakeholders in higher education.

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Author contributions

XSX was responsible for conceptualization and, alongside YFZ, for data curation. YJS and XYX conducted the formal analysis. Funding acquisition was managed by YFZ. The investigation was carried out by YJS and YFZ. Methodology development was a collaboration between YJS and XSX. XSX and YJS also managed project administration, with additional resource management by SSH and XYX. YJS handled the software aspect, and supervision was overseen by XSX. SSH and XYX were responsible for validation, and visualization was managed by YJS. The original draft was written by XSX and YJS, while the review and editing were conducted by YFZ and SSH.

Competing interests

The authors declare no competing interests.

Ethical approval

The questionnaire and methodology for this study were approved by the Human Research Ethics Committee of Wenzhou University (Ethics approval number WGY202302).

Informed consent

Informed consent was diligently obtained from all participants involved in the study, ensuring adherence to ethical standards. Detailed consent forms, outlining the study's scope and participants' rights, were signed by participants. Documentation of this process is well-maintained and can be provided upon request during peer review or post-publication.

Additional information

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