The relationship between information literacy and online learning engagement: a moderated mediating model

Jun Zhao[1*]

Abstract

Purpose This study aims to examine how college students' information literacy affects their online learning engagement and what factors contribute to this relationship.

Method The research adopted the method of cluster sampling to deliver a questionnaire survey to a sample of 1421 students' representative of four colleges. Information Literacy Scale, Online Learning Engagement Scale, Information Literacy Self-Efficacy Scale, and Psychological Resilience Scale were utilized in this study. SPSS 26.0 and the PROCESS plugin were used for correlation analysis, mediation effect and moderating effect testing. This study was based on the theories of learning engagement and self-determination and centred on building a moderated mediating model with online learning college students as its primary focus.

Result (1) Among college students, there was a positive association between information literacy and online learning engagement; (2) Information literacy self-efficacy was demonstrated to mediate the relationship between information literacy and online learning engagement; (3) The impact of information literacy self-efficacy on online learning engagement and the influence of information literacy on online learning engagement were both moderated by psychological resilience.

Conclusion Colleges have the potential to enhance the online learning engagement of college students by improving their information literacy abilities, hence increasing their involvement in online learning projects. Implementing strategies including increasing the availability of online courses and improving teacher support in online learning can improve college students' information literacy self-efficacy and psychological resilience. This, in turn, can increase their participation in online learning activities.

Keywords Information literacy, Information literacy self-efficacy, Psychological resilience, Online learning engagement

*Correspondence:
Jun Zhao
1548153619@qq.com
[1]Mental Health Education and Counseling Center, Nanchang Hangkong University, 696, Fenghe South Avenue, Nanchang 330063, China

Introduction

With the continuous iterative development of digital networks, the education industry has played a significant role in advancing online education [1, 2]. As a result of the swift advancement of online courses worldwide, educational institutions at all levels have depended on web-based platforms and online software to facilitate online instruction and learning during the pandemic. They have also launched initiatives for online teaching and research, which have garnered significant recognition from both the community and the general public [3]. China has surpassed 76,800 online Massive Open Online Courses (MOOCs), attracting a total of 1.277 billion learners. The building and implementation of MOOCs in China have experienced significant growth, and online education has emerged as a crucial element of the government's overall agenda [4]. In 2019, COVID-19 broke out in the world, bringing huge challenges to human education activities. Governments around the world have adopted varying degrees of closed management measures in the face of the epidemic, and are conducting online teaching and learning activities. Students' involvement in online learning environments is a growing area of research [5, 6].

Online learning engagement refers to the participation in learning using online learning platforms, and student engagement in online learning is not only the behavioural performance such as reading course resources, asking questions, completing assignments, etc., but more importantly, it is the cognitive performance of the learner's cerebral effort and initiative in selecting and evaluating the relevant information and resources, applying the new knowledge to different contexts, and the affective performance is the learner's achievement of satisfactions [7, 8]. Behavioural, emotional, and cognitive indicators of online learning engagement serve as indicators of concentration capability [9, 10]. The level of engagement in online learning is a significant measure of an individual's involvement in the online learning process, their academic performance, and their overall pleasure [11, 12]. However, online learning has also encountered problems such as distractions, lack of learning motivation, insufficient network skills, and low course completion rates [13, 14]. During the outbreak, regardless of teachers and students, all kinds of online education and teaching are in a state of inexperience and unpreparedness, and are also prone to the impact of low college students' learning engagement, which is difficult to ensure for the online education effect [15].

While the growth of online courses has expanded the accessibility of higher education, it is important to increase student engagement if the recognized benefits are to be maximized [16, 17]. From the results of previous studies, A scarcity of empirical research exists regarding the participation of college students in online learning, and the underlying factors that influence their engagement, as well as the strategies to enhance their involvement in online educational contexts, remain elusive [18]. It has been demonstrated that learner intrinsic factors, such as course mastery and satisfaction, have a significant impact on increasing the level of learning engagement and facilitating the occurrence of deep learning [16, 19]. Thus, this study intends to promote the in-depth development of online learning among college students by investigating the influence of the aspects of intra-individual factors that affect college students' online learning engagement and their internal mechanisms. In addition, this study provides specific recommendations to address this issue.

Information literacy and online learning engagement

Information literacy can be perceived more dynamically as a reflection of the cultural, social, and economic advancements intertwined with the information society. There exist diverse methods through which individuals comprehend information literacy. The frequently cited definition is that information literacy refers to the ability to manage, use, and evaluate information effectively, comply with ethical and legal requirements, integrate information from various sources, identify needs, and solve a variety of life and learning challenges [20, 21]. Information literacy significantly improves the ability to recognize erroneous, irrelevant information [22]. Despite the growing emphasis on the role of information literacy, surveys conducted by university research departments have found that this competency is lacking among college students. For example, in a study of 3,000 American college students on information literacy, only 13% of them had the corresponding ability [23]. Scholar Kearsley proposed the Engagement Theory of Learning, in which he argued that learners' learning behaviours can only be effective if they are fully engaged in the process [24, 25]. Cognitive engagement was shown to be positively impacted by the level of task competence [26], affective engagement [27], and behavioural engagement [28]. It has been found that college students with higher information literacy can quickly identify information needs, and by acquiring information knowledge and skills, they can solve problems in their studies quickly, and their level of engagement increases [29]. For example, Widowati, Siswanto and Wakid [30] found that information literacy was positively and significantly related to academic performance and engagement among college students. Fosnacht [31] found that a strong positive correlation was found between information literacy and sophisticated and extensive knowledge learning. Given this, we proposed the following hypothesis:

H1: Online learning engagement is positively correlated with information literacy.

The mediator role of information literacy self-efficacy

Self-efficacy is the term used to describe an individual's confidence in their capacity to achieve an objective [32]. The extent of persistence in a task is determined by self-efficacy, which influences individuals' behavioral choices. It is not the competence itself but the individual's subjective feeling of competence [33]. Researchers proposed the definition of information literacy self-efficacy which refers to individuals' subjective judgments about their ability to acquire, evaluate, and effectively use information [34, 35]. According to Social Learning Theory, it is known that when an individual interacts with the environment, the individual gathers different information and it is from the cognitive processing of this information that self-efficacy is formed [36, 37]. The more complex information problems students face, the more experience they have in solving them, and therefore the level of information literacy self-efficacy increases. For example, the investigations revealed a substantial and favourable correlation between competencies in information literacy in academic programs, employment performance, and information literacy self-efficacy [38, 39]. Scholars Hwang, Zou and Wu [40] found that knowledge mastery can increase self-confidence among college students, which increases information literacy self-efficacy.

Individuals who possess a heightened feeling of self-efficacy tend to exhibit increased effort and dedication when confronted with challenging tasks [41]. Academic studies have shown that self-efficacy both predicts and mediates academic motivation [42]. Previous studies have found that learning engagement is positively correlated with information literacy self-efficacy, and information literacy self-efficacy was a proximal factor affecting learning engagement [28, 43]. Self-efficacy and engagement among pupils have been demonstrated to be positively correlated by researchers. For example, Getenet, Cantle, Redmond and Albion [16] found in their study on online learning that college students with high self-efficacy are better at using the Internet and are more invested in online course learning. Salanova, Lorente, Chambel and Martínez [44] found through a longitudinal study that individuals with high self-efficacy increased their level of task engagement when their level of interaction with the environment increased. Self-Determination Theory [45] states that there exist three fundamental psychological demands that humans possess, namely autonomy, competence, and connection needs. As an individual's degree of information literacy progresses, their cognitive requirements are satisfied, leading to a corresponding enhancement in their self-assurance [38], to enhance information literacy self-efficacy. It has been demonstrated that individuals who are more self-efficacy in information literacy have a greater likelihood of engaging in behavioural activities [16]. In light of the established relationships among these three variables, we put forward the following hypothesis:

H2: Information literacy self-efficacy would mediate the relationship between information literacy and online learning engagement.

Psychological resilience serves as a moderating influence

Although information literacy may predict online learning engagement through information literacy self-efficacy, its role may vary among individuals. This study will investigate whether other factors moderate the mediating process of information literacy —information literacy self-efficacy—online learning engagement. Through the review of previous literature, this study found that psychological resilience is likely to moderate this mediating process [46]. Luthar and Cicchetti [47] proposed that psychological resilience is a dynamic process that involves positive adaptation in the context of significant adversity. It encompasses the individual's qualities of adaptability to change, goal perseverance, and regulation of negative emotions [48]. The capacity of learners to enhance their engagement in the learning process is significantly impacted by psychological resilience [49]. Psychological resilience is a positive psychological quality and a protective factor [50]. People who possess a high level of psychological resilience demonstrate a greater number of adaptive behaviours and possess a greater number of internal resources [51]. Psychological resilience has been discovered to moderate an individual's adaptation to the environment in previous research [52]. People who possess a high level of psychological resilience can convert advantageous elements in the learning process into protective resources, hence enhancing their learning behaviour [53]. Researchers have found that psychological resilience was a significant indirect predictor of school engagement, with high levels of resilience prompting individuals to become more involved in school engagement [54]. A study discovered that persons with high academic levels observe a direct enhancement in their online mathematics learning engagement due to their psychological resilience [55]. Researcher Lawrence [56] found that resilience transforms favourable factors such as social support during an individual's learning process into psychological resources, thereby promoting their level of learning participation. College students with strong psychological resilience could handle various difficulties that arise during the learning process, promote individual learning self-efficacy, enhance learning skills, and enhance their behavioural practice level [57]. Accordingly, we propose the following hypothesis:

H3a: Psychological resilience would be a moderating factor in the relationship between information literacy and online learning engagement.

H3b: Psychological resilience would be a moderating factor in the relationship between information literacy self-efficacy and online learning engagement.

The present study
By the findings of prior scholars, this study was conducted with college students who were studying online and constructed a moderated mediating model. It investigated the elements that influence college students' information literacy and its impact on their online learning engagement. Additionally, the study also evaluated the function of information literacy self-efficacy as a mediator and psychological resilience as a moderator (Fig. 1).

Materials and methods
Participants
1421 questionnaires were distributed to three colleges in Jiangxi Province using the cluster sampling method. The criteria for unqualified samples were less than 180 s to complete questionnaires with a total of 89 questions and regularity of answers, such as the same score in each item or a regular pattern of scores (1,2,3,4,5,1,2,3,4,5,1,2,3,4,5, etc.). After excluding unqualified samples (e.g., completed questionnaire in less than 180 s and answered regularly), an effective rate of 97.67% was achieved by collecting 1388 valid questionnaires. With a variation of ages from 17 to 21, the mean age of the 1388 participants was 19.54 years (SD=1.36). 322 freshmen accounted for 23.19%; 319 sophomore students, accounting for 22.98%; 361 third-year students, accounting for 26.01%; 386 senior students, 27.81%.

Measures
Information literacy scale
The study used the Information literacy scale developed by Shu [58], which consists of 20 questions and covers four dimensions: information awareness, competence, knowledge, and ethics. Subject responded to all items of the scale (e.g., Can you judge whether the information obtained meets your requirements and adjust your search strategy?). Scores were based on a five-point scale,

Fig. 1 A developed moderated mediation model

with higher scores indicating greater information literacy. In this research, the scale of Cronbach's α was 0.93. The Cronbach's α of the four dimensions were 0.90 (information awareness), 0.89 (competence), 0.92 (knowledge), and 0.92 (ethics). Confirmatory factor analysis (CFA) of the Information literacy scale suggested that the one-factor model fit the data well: CFI=0.92, TLI=0.91, RMSEA=0.08, 90%CI = [0.06, 0.09].

Online learning engagement scale
Developed by Hoi and Le Hang [8], the Online learning engagement scale was implemented by the researchers. The measure has a total of 16 items and encompasses four dimensions, namely behavioural engagement, cognitive engagement, emotional engagement, and social engagement. Subject responded to all items of the scale (e.g., I think participating in online discussions is very comfortable). In the context of online learning, the study implemented a five-point scale, with higher scores suggesting heightened levels of involvement by learners. In this research, the scale of Cronbach's αwas 0.95. The Cronbach's α of the four dimensions were 0.93 (behavioural engagement), 0.90 (cognitive engagement), 0.91 (emotional engagement), and 0.94 (social engagement). Confirmatory factor analysis (CFA) of the Online learning engagement scale suggested that the one-factor model fit the data well: CFI=0.91, TLI=0.91, RMSEA=0.08, 90%CI = [0.07, 0.09].

Information literacy self-efficacy scale
Serap Kurbanoglu, Akkoyunlu and Umay [34] developed the Information literacy self-efficacy scale, which was implemented by the researchers. Seven dimensions comprise the scale, which consists of a total of 28 items: identifying the need for information, initiating a search strategy, locating and accessing resources, evaluating and comprehending information, interpreting synthesizing and using information, communicating information, and evaluating the product and process. Subject responded to all items of the scale (e.g., Select information most appropriate to the information need). A five-point scale was implemented by the researchers, with higher scores indicating a higher level of information literacy self-efficacy. In this study, the Cronbach's α for the scale was 0.91. The Cronbach's α of the seven dimensions were 0.90 (identifying the need for information), 0.88 (initiating a search strategy), 0.83 (locating and accessing resources), 0.89(evaluating and comprehending information), 0.88 (interpreting synthesizing and using information), 0.89 (communicating information), 0.88 (evaluating the product and process). Confirmatory factor analysis (CFA) of the Information literacy self-efficacy scale suggested that the one-factor model fit the data well: CFI=0.91, TLI=0.91, RMSEA=0.07, 90%CI = [0.06, 0.09].
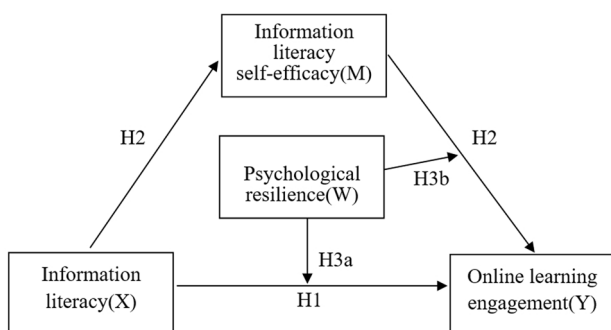
Psychological resilience scale

Yu and Zhang [59] developed the Psychological resilience scale. The scale is comprised of a total of 25 items, including three dimensions: optimism, resilience and strength. Subjects responded to all questions (e.g., I can adapt to change.), The researchers employed a five-point scale, with higher scores indicating that students are more mentally resilient. The scale in this investigation had a Cronbach's α of 0.91. The Cronbach's α of the three dimensions were 0.89 (optimism), 0.87 (resilience), and 0.83 (strength). Confirmatory factor analysis (CFA) of the Psychological resilience scale suggested that the one-factor model fit the data well: CFI=0.92, TLI=0.90, RMSEA=0.07, 90%CI = [0.06, 0.09].

Procedure

The Ethics Committee of the Psychological Counselling Centre of Nanchang Hangkong University approved the study, and subjects voluntarily participated in the questionnaires, which were distributed through on-site distribution, with instructions read out, and questionnaires accompanied by standard instructions. The content of all questionnaires was kept strictly confidential, and subjects could unconditionally withdraw from the questionnaire during the participation process.

Data analysis

Data were standardized for all variables before data analysis. SPSS 26.0 and the PROCESS plugin were used for correlation analysis, mediation effect and moderating effect testing. To begin with, the assessment of common method bias was conducted using Harman's single-factor test. Subsequently, Pearson product-moment correlation coefficients were computed to examine the correlations among variables. Furthermore, path analysis-based moderator and mediator analyses were conducted using the PROCESS plugin (version 3.4) in SPSS. This plugin was particularly created by Hayes to test moderator-mediator models and combinations. Corrected for bias Confidence intervals at the 95% level for conditional direct and indirect effects were derived from 5,000 data resamples, with significance indicated by intervals that excluded zero.

Results

Common method deviation test

The research suggested that the utilization of self-report methods for data collecting may give rise to the concern of common method bias. The presence of 10 factors with eigenvalues exceeding 1 was identified through the application of the Harman one-way test for common method bias. It was important to note that the initial factor accounted for 21.31% of the observed variance, which was below the critical threshold of 40% [60]. Thus, there was no indication of common method bias in the current study.

Descriptive statistics and correlation analysis

The correlations among all variables were illustrated in Table 1. The correlations between the variables, information literacy and information literacy self-efficacy (r=0.38, P<0.01), and online learning engagement (r=0.62, P<0.01), were found to be positive. Online learning engagement was positively correlated with information literacy self-efficacy (r=0.37, P<0.01). Psychological resilience was positively correlated with online learning engagement (r=0.12, P<0.01), information literacy (r=0.11, P<0.01), and information literacy self-efficacy (r=0.52, P<0.01). Significant correlations were observed between the variables. This showed that hypothesis 1 is accepted.

Mediation effect test

The research presupposed that information literacy self-efficacy mediated the relationship between information literacy and online learning engagement. In this study, assessments were conducted using the SPSS macro PROCESS, which was developed by Hayes [61]. As illustrated in Table 2, in the first step, there was a substantial positive correlation (β=0.62, p<0.001) between online learning engagement and information literacy. In the second step, information literacy was positively (β=0.38, p<0.001) associated with information literacy self-efficacy. In the third step, although information literacy self-efficacy was included, the correlation between online learning engagement and information literacy remains significant (β=0.56, p<0.001). Information literacy self-efficacy partially mediated the association between information literacy and online learning engagement (indirect

Table 1 Correlations among variables

	M ± SD	1	2	3	4	5
1. Age	19.54 ± 1.36	1				
2. Psychological resilience	1.57 ± 0.49	-0.03	1			
3. Information literacy	2.47 ± 0.89	0.02	0.11**	1		
4. Information literacy self-efficacy	2.85 ± 0.73	-0.01	0.52**	0.38**	1	
5. Online learning engagement	2.56 ± 0.81	0.03	0.12**	0.62**	0.37**	1

Note N=1388, **p<0.05(2-tailed)

Table 2 Linear regression models

Predictors	Model1(ILSE)		Model2(OLE)		Model3(OLE)		Model4(OLE)	
	β	t	β	t	β	t	β	t
Age	-0.02	-0.81	0.02	1.15	0.02	1.33	0.03	1.76
IL	0.38	15.31***	0.62	29.65***	0.56	25.31***	0.53	22.78***
ILSE					0.15	6.65***	0.21	8.01***
PR							-0.05	-2.27*
ILSE × PR							-0.08	-5.57***
IL × PR							0.07	3.85***
R2	0.14		0.38		0.41		0.42	
F	116.75***		442.05***		319.64***		170.29***	

Note $N=1388$, ***$p<0.001$, *$p<0.05$(2-tailed), IL=information literacy, ILSE=information literacy self-efficacy, OLE=online learning engagement, PR=psychological resilience
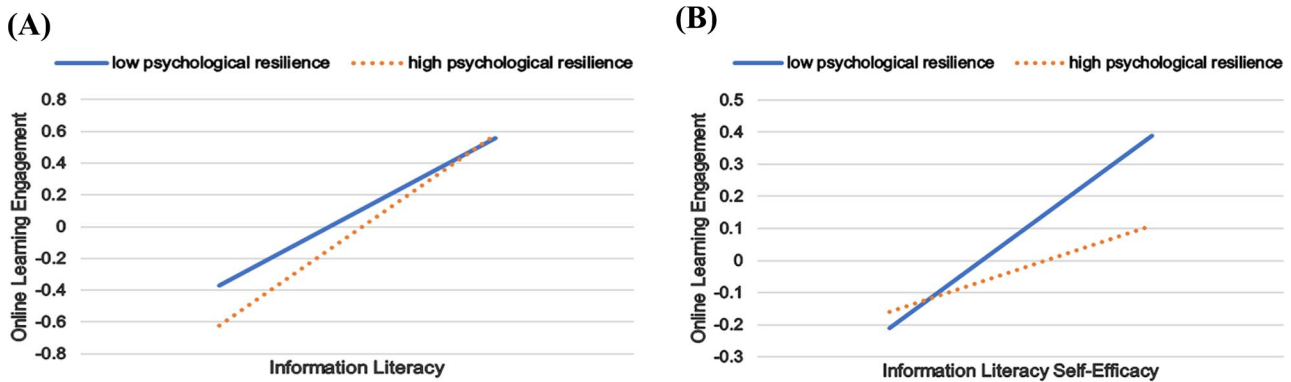
(A)

(B)

Fig. 2 (**A**) Information Literacy × Psychological Resilience. (**B**) Information Literacy Self-Efficacy × Psychological Resilience

effect=0.19, 95% CI=0.11, 0.29), with a mediating effect that accounts for 30.63% of the overall effect of information literacy on online learning engagement. H2 was supported by the results, which showed the significance of both mediation routes in Fig. 1.

Moderated mediation effect test
Establishing moderating and mediating models using SPSS involves a multitude of meticulous steps, necessitating the testing of numerous models in segments. Consequently, to address this inefficiency, Hayes [61] devised a complimentary plug-in named PROCESS, which integrated seamlessly with SPSS. This plug-in facilitated researchers in directly analyzing models encompassing mediating effects, moderating effects, or a combination of both. As anticipated in this investigation, Model 15 in SPSS macro PROCESS was implemented to investigate whether psychological resilience could potentially moderate the direct correlation between information literacy and online learning engagement, as well as the mediation effect of information literacy self-efficacy (specifically, the correlation between online learning engagement and information literacy self-efficacy). The results are presented in Table 2.

According to the analysis, information literacy was associated with online learning engagement ($\beta=0.53$,

$p<0.001$), while information literacy self-efficacy was associated with online learning engagement ($\beta=0.21$, $p<0.001$). Aside from that, there was a significant interaction between information literacy self-efficacy and psychological resilience ($\beta=-0.08$, $p<0.001$) for online learning engagement, as well as the interaction between information literacy and psychological resilience ($\beta=0.07$, $p<0.001$). As a result, the moderated mediating model that was hypothesized was confirmed. Visual representations of the interaction effect are illustrated in Fig. 2A. A significant impact of information literacy on online learning engagement was observed in college students with high and low levels of psychological resilience, as indicated by the results of simple slope tests; The effect of information literacy on online learning engagement, however, was greater for college students with high psychological resilience ($b_{simple} = 0.59$, $t=24.48$, $p<0.001$, 95% CI=0.55, 0.64) than for students with low psychological resilience ($b_{simple} = 0.47$, $t=14.25$, $p<0.001$, 95% CI=0.41, 0.53), indicating that psychological resilience functioned as a protective factor. The interaction effect is shown graphically in Fig. 2B. According to simple slope tests ($b_{simple} = 0.29$, $t=8.81$, $p<0.001$, 95% CI=0.23, 0.37), information literacy self-efficacy was shown to have a significantly strong impact on online learning engagement in college students with poor psychological resilience.

Conversely, the study found that information literacy self-efficacy had a strong impact on online learning engagement among college students with high psychological resilience. However, the relationship was weaker ($b_{simple} = 0.13$, $t = 4.91$, $p < 0.001$, 95% CI = 0.08, 0.19) indicating that psychological resilience acted as a buffer.

The indirect effect of information literacy on online learning engagement through information literacy self-efficacy was moderated by psychological resilience, as indicated by the bias-corrected percentile bootstrap analysis. Specifically, the indirect effect of information literacy on online learning engagement of college students with low psychological resilience was significant ($\beta = 0.11$, SE = 0.02, 95% CI = 0.08, 0.15) through information literacy self-efficacy. Even though it was weaker, the indirect impact was significant for college students who had strong psychological resilience ($\beta = 0.05$, SE = 0.01, 95% CI = 0.03, 0.08). Therefore, Hypothesis 3 was supported.

Discussion

Through reviewing previous literature, few researchers have examined how college students' information literacy levels correlate with their participation in online learning. This study utilized theoretical research on information literacy, online learning engagement, psychological resilience, and information literacy self-efficacy to investigate the determinants and mechanisms of online learning engagement among college students. College students' information literacy, information literacy self-efficacy, psychological resilience and online learning engagement were positively correlated with one another, according to the study's findings. College students' information literacy self-efficacy mediated the association between information literacy and online learning engagement. Psychological resilience moderated both the effect of information literacy on online learning engagement and the impact of information literacy self-efficacy on online learning engagement. Therefore, hypotheses 1, 2, and 3 have been confirmed.

Correlation between online learning engagement and information literacy

Information literacy and online learning engagement were significantly positively correlated among college students, indicating that higher levels of information literacy were linked to increased levels of online learning engagement. The research results supported the Engagement Theory [24]. Scholars have found that the perception and mastery of online learning platforms among college students have a promoting effect on online learning behaviour [62], which is an important influencing factor in the online learning process of learners [63]. The research results conformed to the Self Determination Theory, which states that when college students master information literacy, they exhibit more positive psychological states during the learning process, meet individual psychological needs, stimulate their intrinsic behavioural motivation, and thus exhibit more positive learning behaviours [64].

The enhancement of college students' information literacy and the facilitation of their engagement in online learning are of paramount significance. Firstly, universities can build and enhance digital learning infrastructure to promote teaching mode reform. Develop a course plan to enhance the information literacy of college students, encourage them to learn courses through online platforms, and provide credit certification. Through general education courses, college students can enhance their theoretical and practical abilities in information literacy, enhance their abilities in information collection, identification, classification, and application, cultivate their confidence in online learning, and stimulate their participation in online learning [65, 66]. Secondly, teachers can develop some online learning courses, and college students can independently choose to practice the process of online learning, enhancing their frequency of exposure and awareness of using information technology. Familiarize college students with the use of information-based learning tools and develop online learning strategies [67]. When college students encounter difficulties in online learning, teachers should provide timely guidance and improvement. College students could enhance their confidence in information literacy abilities and further enhance their participation in online learning through a closed-loop learning process of "learning -reflection -learning" [68, 69].

The mediating effect of information literacy self-efficacy

In light of the current research, this study provided novel evidence supporting the hypothesis that information literacy self-efficacy served as a mediator. A positive predictive relationship between an individual's information literacy self-efficacy and information literacy was established in the initial phase of the intermediate process. The Self-Efficacy Theory [70] was substantiated by these research findings, which asserted that college students who possessed a higher level of information literacy self-efficacy were also more likely to be proficient in the skill. When participating in online learning, through theoretical and practical exercises, one can enhance their awareness of using information technology and mastery of information knowledge, and improve their level of information literacy. Online learning offers students increased practice opportunities, while professors offered valuable feedback to address their learning difficulties. Through continuous summary and improvement, college students had positive experiences, college students' self-confidence was improved, and then individual information

literacy self-efficacy was enhanced. During the subsequent phase of the mediation process, as college students' information literacy self-efficacy increased, their level of participation in online learning also increased. According to the findings, there was support for the Self-Determination Theory [45]. The online learning behaviours of college students were significantly influenced by the internal motivating mechanism of information literacy self-efficacy. When college students' self-efficacy was high, they would be more confident in their ability to cope with the learning methods and frustrations of the digital age, and more willing to meet the adjustments, which in turn led to greater willingness to participate in online learning [71, 72].

Teachers set up reasonable learning goals for students from the perspective of practical problems in the process of online teaching, which makes students experience a greater sense of achievement and increase positive inner beliefs. Teachers should encourage students to use online platforms to learn about relevant knowledge and demonstrate it in the classroom through online technology, to improve students' skills in using the Internet, enhance their ability to search and grab information on the Internet, and improve their ability to use the Internet to improve themselves. Focusing on the process evaluation, the progress obtained by the college students gave timely affirmation, this was to ensure that individuals were satisfied with their online learning experience.

The moderation of psychological resilience

This study's findings indicated that psychological resilience served as a moderating factor. Information literacy had a more substantial positive predictive influence on online learning engagement among college students who possessed high levels of psychological resilience. Individuals with high levels of psychological resilience had a better mindset in the face of adversity [73], which contributed to better adaptability in the use of digital tools and enhanced digital literacy [74]. Psychological resilience could improve the individual's awareness of digital tools and resources and enhances the individual's online learning [75] awareness, and increase individual online learning behaviours [76]. This result supported the "facilitation hypothesis" [77, 78], which suggested that one resource factor amplified or enhanced the favourable effects of another resource factor on an individual's development, known as the "icing on the cake" effect [79, 80]. The findings of this study also served as a reference for the investigation of the online learning engagement of college students in China.

This research was intended to enhance the positive psychological qualities of students, mastered their general knowledge of mental health and psychological adjustment skills, and fully exploited the moderating effect of psychological resilience. Teachers should pay attention to the construction of students' positive psychological environment in the course design session, and help students activate positive psychological energy and play the protective role of psychological resilience through the channels of teaching content and instructional design. Furthermore, the "exclusion hypothesis" [77, 78] was corroborated by the observation that the beneficial impact of information literacy self-efficacy on the online learning engagement of college students was diminished when individuals possessed high levels of psychological resilience. That is, high levels of psychological resilience could reduce the positive effects of information literacy self-efficacy on college students' online learning engagement, which had been referred to as the "saturation" effect [80]. However, these results did not imply that psychological resilience was a negatively influencing factor for the engagement of college students in online learning. Rather, the reason for this regulatory pattern might be that individuals with high levels of psychological resilience were at a lower level of online learning engagement, which made the facilitating effect of information literacy self-efficacy encountered a "bottleneck". Therefore, college students' engagement in online learning is more significantly influenced by their information literacy self-efficacy when they possess a lower degree of psychological resilience. Through the findings of this study, teachers are required to provide different teaching methods and content depending on the students.

Limitations and implication

It is important to acknowledge the existing limitations of the present study. To begin with, this study did not adopt the longitudinal tracking research method, which could not well show the dynamic change process between variables over time. Additionally, as was the case with any study that exclusively relied on self-reported data for data collection, the results of this analyzed might have been influenced by response bias. To further investigate the current findings, subsequent investigations might try to gather data from a diverse array of informants. Furthermore, the age distribution within the sample exhibited limited heterogeneity. To get more widely applicable conclusions, it is necessary to replicate the findings using other samples that are more inclusive or representative.

To improve understanding of the relationship between information literacy and online learning engagement, this study expanded upon previous research. It emphasized the mediating influence of information literacy self-efficacy and the moderating influence of psychological resilience. From a practical perspective, colleges could promote the level of online learning participation by enhancing the information literacy of college students. Enhancing college students' information literacy

self-efficacy, and psychological resilience and stimulating their online learning behaviour may be achieved by the implementation of measures such as the expansion of online courses and the reinforcement of teacher support in the online learning process.

Conclusions

This research fostered an exploration of how intra-individual factors influence their online learning engagement, along with the inherent mechanisms involved. Moreover, the study offered precise recommendations to tackle the challenges identified in this regard. Colleges have the potential to enhance the online learning engagement of college students by improving their information literacy abilities, hence increasing their involvement in online learning projects. Implementing strategies including increasing the availability of online courses and improving teacher support in online learning can improve college students' information literacy self-efficacy and psychological resilience. This, in turn, can increase their participation in online learning activities.

Abbreviations
IL   Information literacy
ILSE   Information literacy self-efficacy
OLE   Online learning engagement
PR   Psychological resilience

Author contributions
Jun Zhao is the singular contributor who undertook the tasks of conceptualization, performed formal analysis, conducted investigations, developed the theoretical framework along with the hypotheses, collected data, designed the methodology, analyzed the data, supervised the process, validated the results, authored the original draft, reviewed the content, and edited the final work.

Data availability
The information presented in this research can be acquired upon request made to the corresponding author. However, due to privacy constraints, the data cannot be accessed by the public.

Declarations

Ethics approval and consent to participate
The Ethics Committee of the Psychological Counselling Centre of Nanchang Hangkong University approved the research design following a comprehensive evaluation on July 11, 2022, adhering to the principles delineated in the Declaration of Helsinki. We obtained written informed consent from college students and their faculty members for this investigation.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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