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Investigating the learning self-efficacy of a fully online teaching environment among undergraduate Chinese medical students: a cross-sectional study

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Abstract

Background Fully online learning has become a common option in many universities worldwide in the post-COVID-19 era. The study aimed to evaluate the dimensions and characteristics of the fully online learning self-efficacy among Chinese undergraduate medical and nonmedical students.

Methods A cross-sectional study was conducted from January to August 2023 at Xihua University in China. A stratified cluster sampling method was used to enroll participants of undergraduate students. The Chinese version of the online learning self-efficacy scale (OLSES) was used to collect the demographic information. Cronbach's alpha coefficient, exploratory factor analyses, confirmatory factor analyses, and linear regression analyses were conducted in the study.

Results A total of 203 college students were included in the study. One hundred and twenty (59.1%) of the participants were medical students and 83 (40.9%) were nonmedical students, and most of them (64.5%) were from rural areas. The Cronbach's alpha coefficients were determined to be 0.90, 0.86, 0.87, and 0.95 for the learning in a fully online environment, time management, technology use subscales, and the whole scale, respectively. Exploratory factor analysis revealed the justifiability of factor analysis. In the confirmatory factor analysis, the majority of the goodness-of-fit indices reached an acceptable threshold (χ^2/df = 3.14, RMR = 0.06, RMSEA = 0.10, NFI = 0.84, RFI = 0.80, IFI = 0.89, TLI = 0.85, CFI = 0.90). More than half of the students reported insufficient self-efficacy for learning in a fully online environment and time management, whereas 55.7% showed good self-efficacy for technology use. Although more medical students than non-medical students had higher self-efficacy scores in the three domains of self-efficacy, the proportion of students with good self-efficacy was slightly lower among medical students than non-medical students, with no significant differences between the medical students and nonmedical students.

Conclusions Most Chinese university students' that participated to our study found self-efficacy for fully online learning as insufficient (results on the three domains, ranging from 36.5 to 55.7%) and had a good level of fully online learning self-efficacy. Medical students and nonmedical students are not differences in the self-efficacy of fully online

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learning. Thus, pedagogues should take measures to help students including medical and nonmedical improve their self-efficacy in online environment learning, time management and technology use, ultimately enhancing their academic success.

Keywords Online learning, Undergraduate students, Self-efficacy, Factor analysis

Background

Since the COVID-19 pandemic, fully online learning has become a common practice in medical and nonmedical science schools worldwide and has become a useful and practical teaching model for curriculum delivery worldwide [1, 2]. Numerous benefits of online learning for learners, such as convenient access to knowledge, effective content delivery, personalized instruction, self-paced learning, interactivity, convenience, and students accessing learning materials and activities without being in a school classroom, have been documented in the literature [3, 4].

Fully online learning is a format allowing students to learn at home through the internet. During the teaching and learning activities of the course, the synchronous portion of the classroom (previously held physically on campus) was then transitioned to a synchronous, web-based video conference platform (for example, Zoom, Rainsclass, WEBEX, Coursera, Tencent, Chaoxing, QQLive platform, etc.) to continue to provide instructor lectures and assistant support and peer online learning opportunities [5, 6].

However, compared to traditional face-to-face teaching, the fully online teaching system may encounter some challenges at home, such as e-technology use, e-resources, the use of an e-classroom environment, etc. [7], which may cause problems such as a lack of concentration and discipline, the inability to resist temptation, social isolation, and stress [8, 9], and subsequently impact student academic learning. Fully online teaching format also allows for the physical separation of students and teachers, disregarding the requirement for face-to-face interaction in a conventional school environment. When students' academic-related self-efficacy is threatened by those challenges, they are more inclined to lose interest in learning and give up attempting it [10]. Academic learning is of utmost importance because it plays a pivotal role in determining students' performance, surpassing other cognitive processes [11]. Online learning self-efficacy (OLSE) is a core element of a successful learning environment [12].

Self-efficacy is a widely studied concept in both traditional and online educational settings. Students with greater academic self-efficacy may tend to possess higher levels of self-discipline and increased confidence in overcoming challenges encountered during fully online learning [13]. According to social cognitive theory, self-efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments," and it is widely recognized as a pivotal predictor of individual behavior [14, 15]. Higher academic self-efficacy is directly correlated with students' coping behavior (correlation coefficient $r=0.816$ and $P<0.01$). Academic self-efficacy influences students' coping behavior by enhancing their belief in their ability to overcome academic challenges, manage stress effectively, and persist in the face of difficulties, ultimately leading to improved academic performance [16]. Students with high self-efficacy might have more confidence in adapting to the ensuing challenges. Students with higher self-efficacy are more likely to exhibit persistence in their approach, meaning that they do not easily give up or lose confidence but instead continuously strive to achieve their goals [10, 17].

A cross-sectional study in Ethiopia explored the impact of the COVID-19 pandemic on university students' self-efficacy in learning. The findings of the study showed that the overall level of self-efficacy among re-entering campus students was low, and studying conditions and favourable attitude were significant predictors of self-efficacy in learning [18]. Another cross-sectional study in the Kingdom of Saudi Arabia showed only 51% of undergraduate students expressed satisfaction with online e-learning, indicating low self-efficacy for online learning. The study highlighted the strong connection between students' satisfaction with online learning and their self-efficacy levels, especially in key areas like time management, technology utilization, and learning strategies. Students demonstrating higher self-efficacy in these domains tended to report enhanced satisfaction with their online learning experiences [19].

The academic self-efficacy of fully online learning for undergraduate students could be influenced by demographic characteristics (i.e., gender, age, level of education, field of major, and residence), and other factors, such as having skills in time management and online technology use, motivation with e-learning systems, and the e-classroom environment, and student self-efficacy influence the success of e-learning programs [20–22]. Male students excelled at finding information and using online technology, but struggled with time management. Female students were challenged in managing the e-classroom environment, although they excelled in academic planning and course skills. High grade students showed strengths in information retrieval and relationship management with teachers, whereas low grade

students showed strengths in academic planning and motivation with e-learning systems [20–22]. Learning in an online learning environment, time management and technology use are the main factors contributing to academic success [23].

Different tools have been developed to measure various aspects of self-efficacy in relation to virtual, online, or distance learning. The online learning self-efficacy scale (OLSES), developed by Zimmerman and Vulakovich in 2016, is a common scale used to measure online learning self-efficacy [23]. The OLSES possesses the characteristics of validity, reliability, and simplicity, making it suitable for assessing online learning self-efficacy. The domains of online learning self-efficacy (learning, time management, and technology) may have been affected by differences in national education. The research on the overall online learning self-efficacy of Chinese undergraduate students and the factors influencing self-efficacy is lacking. Therefore, the main objectives of the study were to investigate the dimensions and characteristics of online learning self-efficacy among Chinese students at universities.

Materials and methods

Study design and participants

A cross-sectional study was conducted at Xihua university between January and August 2023. The study followed the STROBE checklist for observational studies (Appendix 1 of the supplementary material). A stratified cluster sampling method was used to enroll participants at Xihua university. There were total of 2,180 undergraduate students majoring in agriculture, food science, engineering, medical informatics, health management, pharmacy and medicine at the Xihua University and the number of students in each major was about from 180 to 320. The study included students from the medical field (medicine, pharmacy, medical informatics, and health management, referred to as medical students) and from other fields (agriculture, food science, engineering, referred to as nonmedical students). Students from sixty-two eligible classes were selected, and eight classes randomly selected from the teaching classes of the school using the random sampling method (Hao Zhang and Xingming Ma). Freshmen are first-year students, sophomores are second-year students, juniors are third-year students, and seniors are fourth-year students in university. The inclusion criteria for the study were as follows: (a) full-time undergraduate students at Xihua university; (b) voluntary participation of all students; (c) at least one course experienced with fully online teaching and learning activities; (d) included students from all grades; and (e) included students from medical and nonmedical students. The exclusion criteria were as follows: (a) unwillingness to participate in the study and (b) not having completed one course with fully online teaching and learning activities.

Sample size

According to the Ministry of Education of the People's Republic of China's report on the quality of general university undergraduate education teaching, the rate of opening of the university's online course was 91% in 2020. The online course opening rate in 2022 is not available but is estimated to be approximately 85%. To determine the sample size, Cochran's formula was used: $n = Z^2 p(1\text{-}p)/e^2$. Here, Z is 1.96 at a 95% confidence interval, p is the estimated population proportion of 85%, and e is a margin of error of 5%. The minimum sample size was calculated as $n = 196$. Considering potential dropouts, 240 students were selected for the study.

Measurement

The survey used in the study included an online learning self-efficacy scale (OLSES) [23] and demographic data. The participants' demographic information included sex, age, place of residence, major and grade level. The English version of the 22-item online learning self-efficacy scale was developed and verified by Zimmerman et al. [23] and Aldhahi et al. [15]. The Chinese version was obtained from on online (https://www.wjx.cn/xz/229453588.aspx) and used in the study (Appendix 2 of the supplementary material). Meanwhile, we discussed with an English expert and a Chinese expert together to confirm that the Chinese version of OLSES from online was accurate and culturally appropriate for Chinese students. Next, a pre-survey of Chinese version scale was conducted and 42 sample were collected, and then the Cronbach's α coefficients were analyzed. The results showed that the Cronbach's alpha coefficients for the online learning environment, time management, and technology use subscales were 0.89, 0.85, and 0.84, respectively, which indicated good internal consistency and could be used for formal trials.

The OLSES covers three subscales of academic self-efficacy: time management (5 items), technology use (7 items), and learning in an online learning environment (10 items). The response to each item is on a six-point Likert scale ranging from one (strongly disagree) to six (strongly agree) points, including "strongly disagree", "disagree", "slightly disagree", "slightly agree", "agree", and "strongly agree". The scores were assigned from one to six points. The OLSES scores range from 22 to 132, with breakdowns as follows: time management (5–30), technology use (7–42), and learning environment (10–60), and a higher score on each subscale represents greater online learning self-efficacy [24, 25].

In the present study, students' online learning self-efficacy levels were classified into three levels based on the

total scores of OLSES scale: poor (<60%) self-efficacy, inadequate (60–80%) self-efficacy and good (>80%) self-efficacy. Self-efficacy levels in the three domains of time management, technology use and learning environment were each categorized into three levels based on the individual dimension scores of each subscale: poor (<60%) self-efficacy, inadequate (60–80%) self-efficacy and good (>80%) self-efficacy.

Data collection

The surveys were generated using an offline and online survey system (Sojump, https://www.wjx.cn/). Students who are unable to complete the questionnaire online can complete the offline paper version of the questionnaire. Each student participated in either the offline or online questionnaire, and there was no repeated participation in the questionnaire. Each internet protocol address for the online survey system could only be submitted once. The survey took approximately 5 min to complete. Students who answered no more than 95% of the questions were excluded from the study.

Ethics considerations

The procedures of the study adhered to the guidelines of the Declaration of Helsinki, and approval for the teaching study was obtained from the curriculum development committee and the ethics committee at the School of Health Management of our university (No: XJJG2021040-40, December 20, 2021). All participants were told that they could voluntarily choose whether to complete the questionnaire and could withdraw from the study at any time without risk. Those participants were assured that the data would be used only for research purposes and informed consent was obtained from all participants.

Data analysis

Cronbach's alpha coefficient and quantitative data were analyzed using SPSS 27.0 for Windows software (SPSS Inc., Chicago, IL, USA). All the data of the students' self-efficacy scores are reported as the means ± SEs. The chi-squared test or Fisher's exact test were used to compare the frequency of self-efficacy responses. Exploratory and confirmatory factor analyses were conducted using SPSS 27.0 for Windows software. Multiple linear regression analyses were performed in SPSS, using students' time management, technology use, learning environment, and OLSES scores as dependent variables, and demographic characteristics (gender, age, grade level, type of specialization and residence) as independent variables, respectively. Statistical significance was defined as $P<0.05$.

Results

In the study, a total of 209 questionnaires were collected from 240 undergraduate students, for a response rate of 85%. After excluding 6 incomplete questionnaires, 203 valid questionnaires were identified, and the effective response rate was 97%. The demographic characteristics of the participants are shown in Table 1. The histogram indicated that the scores of OLSES exhibited a tendency towards a normal distribution (Appendix 3 of the supplementary material).

Table 1 Demographic characteristics and univariate analysis of full online learning self-efficacy

Variables	No of repondents ($n=203$)	Frequency (%)	Scores of OLSES (mean ± SD)	Statistical value
Sex				
Male	64	31.5	102.47 ± 17.26	t = 0.59, $P=0.55$
Female	139	68.5	101.04 ± 15.27	
Age, year				
18 ~ 19	35	17.2	99.17 ± 15.74	F = 0.51, $P=0.60$
20 ~ 21	130	64.0	101.74 ± 15.66	
≥ 22	38	18.7	102.76 ± 17.04	
Grade level				
freshman	18	8.9	102.44 ± 13.61	F = 1.37, $P=0.25$
Sophomore	80	39.4	99.60 ± 14.74	
Junior	62	30.5	100.85 ± 16.09	
Senior	43	21.2	105.53 ± 18.18	
Type of specializations				
Medical field	120	59.1	101.56 ± 16.21	t = 0.07, $P=0.94$
Nonmedical field	83	40.9	101.40 ± 13.63	
Residence				
Cities and towns	72	35.5	109.65 ± 16.55	t = 5.53, $P<0.001$
Rural area	131	64.5	97.01 ± 13.63	

Statistical significance was set at a level of $P<0.05$. Independent sample t tests were used for sex, type of specialization and residence; one-way ANOVA was used for age and grade level in the analysis

The evaluation of the internal consistency of the Chinese version of the OLSES indicated good internal consistency, with Cronbach alpha coefficients of 0.90, 0.86, 0.87, and 0.95 for the learning in an online learning environment, time management, technology use, and overall scale, respectively. These coefficients suggest that the items within each subscale and the entire scale are reliable and consistent measures of the constructs they represent. The majority of the *Chinese* university students (68.5%) were female. The mean age of the university students was 20.5±1.05 years. The age range varied from a minimum of 18 years to a maximum of 23 years. Of the 203 Chinese undergraduate students, 59.1% were medical students, and 40.9% were nonmedical students. Among the Chinese undergraduates, 48.3% were lower class students (freshmen and sophomores), and 51.7% were upper class students (juniors and seniors). Additionally, 131 students (64.5%) resided in rural areas, and 72 students (35.5%) resided in cities and towns in China. The study findings revealed a significant difference in fully online learning self-efficacy based on place of residence ($P<0.05$) (Table 1).

In the exploratory factor analysis (principal component analysis), the Kaiser–Meyer–Olkin coefficient was 0.92, and Bartlett's test of sphericity was statistically significant ($P=0.001$, $\chi=3374.27$, and df. = 231), indicating the adequacy of sampling and the justifiability of factor analysis. Table 2 showed the exploratory factor loadings of the scale. Subsequently, in the confirmatory factor analysis, most of the goodness-of-fit indices were acceptable ($\chi^2/df=3.14$, RMR (root mean square residual)=0.06, RMSEA (root mean square error of approximation)=0.10, NFI (normed fit index)=0.84, RFI (relative fit index)=0.80, IFI (incremental fit index)=0.89, TLI (Tucker–Lewis coefficient)=0.85, CFI (comparative fit index)=0.90).

Table 2 Communality, % of variance, and factor loading of the Chinese version of the fully online learning self-efficacy scale items

Scale items	Communality	% of Variance	Factor number	Factor loadings
1	0.73	51.28	2	0.64
2	0.70	7.25	2	0.64
3	0.70	5.53	2	0.62
4	0.66	4.56	3	0.52
5	0.63	3.95	2	0.64
6	0.77	3.27	2	0.75
7	0.58	3.03	2	0.65
8	0.81	2.93	2	0.78
9	0.82	2.57	2	0.78
10	0.54	2.22	2	0.55
11	0.72	1.95	2	0.74
12	0.67	1.74	2	0.7
13	0.63	1.59	2	0.63
14	0.69	1.39	2	0.72
15	0.76	1.32	3	0.56
16	0.64	1.07	1	0.71
17	0.70	1.00	1	0.78
18	0.56	0.88	2	0.56
19	0.71	0.76	1	0.8
20	0.70	0.63	2	0.65
21	0.72	0.56	3	0.62
22	0.66	0.53	3	0.61

The descriptive statistical results obtained from the questionnaire regarding the three domains are presented in Fig. 1. More than half of the students reported poor or insufficient self-efficacy for learning in an online learning environment (65.6%) and time management (64.6%). Nevertheless, they indicated a high level of perceived self-efficacy for the technology being used in fully online learning (55.7%).

Fully online learning self-efficacy is influenced by many factors. As shown in Tables 3, 4 and 5, the three domains of students' fully online learning self-efficacy differed significantly in terms of their degree of residence ($P<0.001$, $P<0.001$ and $P<0.001$, respectively).

In the domain of online learning environment, medical students had higher self-efficacy scores (45.87±7.79) and the proportion of students reporting good self-efficacy was 34.2% compared to nonmedical students with self-efficacy scores of 44.66±7.55 and 32.5% reporting good self-efficacy. Notably, 65.8% of medical students still perceived their learning self-efficacy as inadequate and poor, compared to 67.5% of nonmedical students (Table 3). However, statistical analysis showed that the difference in self-efficacy scores and frequency of students for the online learning environment between the two groups was not significant ($P>0.05$).

In the domain of time management, although medical students had higher self-efficacy scores than nonmedical students, the frequency of medical students with good self-efficacy (33.3%) was slightly lower than that of nonmedical students (38.6%). It is noteworthy that the percentage of medical students reporting insufficient and poor self-efficacy (66.7%) was higher than that of nonmedical students (61.4%) (Table 4). But, the difference in self-efficacy scores and frequency of students for time management between these two groups was not significant ($P>0.05$).

In the domain of technology application, more than half of both medical (54.2%) and nonmedical (57.8%) students reported good self-efficacy. In addition, a significant proportion of medical students (45.8%) reported inadequate and poor self-efficacy in this domain, compared with 42.2% of nonmedical students (Table 5). However, the difference in technology use self-efficacy between two groups was not significant ($P>0.05$).

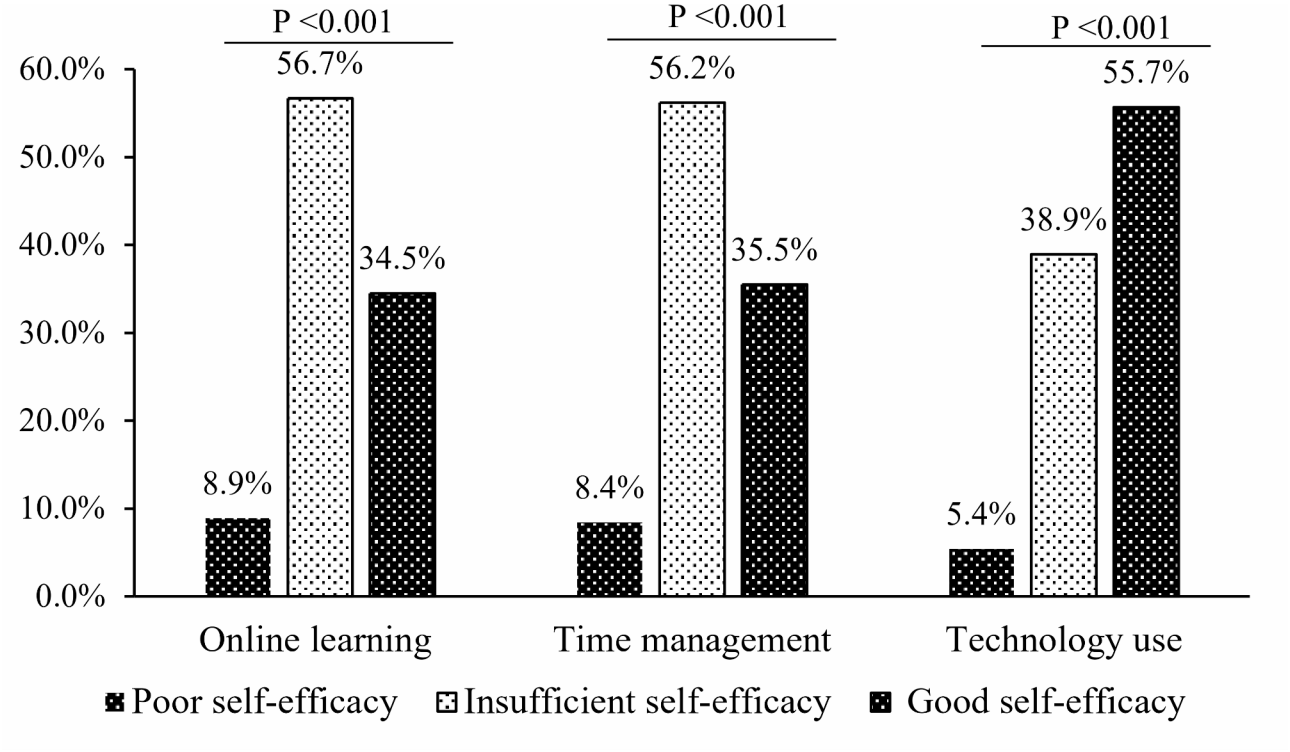

Fig. 1 Participants' responses to the fully online learning self-efficacy domains. Frequency was calculated based on the total OLSES scores with poor self-efficacy (scores < 60%), inadequate self-efficacy (scores 60–80%) and good self-efficacy (scores > 80%). The data are presented as percentage (%) according to the OLSES. Fisher's exact test was used in the analysis. Statistical significance was set at a level of $P < 0.05$

Table 3 Level of self-efficacy in the learning of online learning environment domain by student characteristics

Variables	Online learning domain					
	Scores (mean ± SD)	*P* value	Poor (*n*, %, 95%CI)	Insufficient (*n*, %, 95%CI)	Good (*n*, %, 95%CI)	*P* value
Sex						
Male (64)	46.06 ± 8.14	0.38	7 (10.9) (5.4–19.8)	30(46.9) (36.2–57.9)	27(42.2) (31.5–53.6)	0.08
Female (139)	45.06 ± 7.49		10 (7.2) (4.3–11.6)	88(63.3) (56.2–70.1)	41(29.5) (23.3–36.5)	
Age, year						
18 ~ 19 (35)	44.00 + 7.59	0.32	4(11.4) (4.6–23.3)	19(54.3) (40.8–67.2)	12(34.3) (22.6–48.1)	0.19
20 ~ 21 (130)	45.35 ± 7.55		9(6.9) (3.8–11.7)	81(62.3) (55.7–68.5)	40(30.8) (25.1–37.2)	
≥ 22 (38)	46.71 ± 8.24		4(10.5) (3.9–23.2)	18(47.4) (33.8–61.3)	16(42.1) (29.5–55.6)	
Grade level						
≤Sophomore (98)	44.48 ± 7.09	0.11	8(8.2) (3.9–14.6)	61(62.2) (53.3–70.7)	29(29.6) (22.1–37.8)	0.49
≥Junior (105)	46.21 ± 8.16		9(8.6) (4.7–14.5)	57(54.3) (46.6–61.9)	39(37.1) (29.8–45.1)	
Type of specializations						
Medical field (120)	45.87 ± 7.79	0.27	10(8.3) (4.6–12.0)	69(57.5) (51.7–63.3)	41(34.2) (28.6–40.8)	0.97
Nonmedical field (83)	44.66 ± 7.55		7(8.4) (3.7–13.1)	49(59.0) (52.4–65.6)	27(32.5) (26.9–38.1)	
Residence						
Cities and towns (72)	49.07 ± 8.05	< 0.001	4(5.6) (1.8–12.4)	31(43.1) (33.2–53.5)	37(51.4) (41.5–61.3)	< 0.001
Rural area (131)	43.34 ± 6.70		13(9.9) (6.3–15.2)	87(66.4) (59.3–72.9)	31(23.7) (17.8–30.6)	

The data are presented as frequencies (n) and percentages (%) according to the OLSES. Independent sample t tests and one-way ANOVA tests were used for the OLSES scores of the online learning domain, and Fisher's exact test was used for the levels of self-efficacy. Statistical significance was set at a level of $P < 0.05$. 95% CI: 95% confidence interval

Multiple linear regression analysis was conducted using students' OLSES scores as the dependent variable and the variables of sex, age, grade level, type of specialization and residence. The results of the regression analysis showed that the residence ($\beta = -0.40$, $P < 0.001$) of undergraduate students had a significant effect on self-efficacy for learning in an online learning environment ($\beta = -0.36$, $P < 0.001$), time management ($\beta = -0.41$, $P < 0.001$), and

Table 4 Level of self-efficacy in the time management domain by student characteristics

Variables	Time management domain					
	Scores (mean ± SD)	*P* value	Poor (*n*, %, 95%CI)	Insufficient (*n*, %, 95%CI)	Good (*n*, %, 95%CI)	*P* value
Sex						
Male (64)	22.96 ± 3.95	0.34	3(4.7) (1.6–12.3)	35(54.7) (43.8–65.2)	26(40.6) (30.2–51.9)	0.32
Female (139)	22.38 ± 4.13		14(10.1) (6.8–14.6)	79(56.8) (50.3–63.1)	46(33.1) (26.9–40.0)	
Age, year						
18 ~ 19 (35)	22.14 ± 3.65	0.62	5(14.3) (4.8–30.6)	16(45.7) (30.8–61.4)	14(40.0) (26.2–55.6)	0.42
20–21 (130)	22.77 ± 3.94		8(6.2) (2.7–12.7)	78(60.0) (51.9–67.5)	44(33.8) (27.1–41.2)	
≥ 22 (38)	22.26 ± 4.86		4(10.5) (2.9–25.8)	20(52.6) (37.8–67.1)	14(36.8) (24.1–51.5)	
Grade level						
≤Sophomore (98)	22.39 ± 4.25	0.43	10(10.2) (4.7–19.8)	53(54.1) (44.4–63.6)	35(35.7) (26.9–45.6)	0.63
≥Junior (105)	22.84 ± 3.87		7(6.7) (3.1–13.2)	61(58.1) (49.2–66.5)	37(35.2) (27.4–43.8)	
Type of specializations						
Medical field (120)	22.38 ± 4.25	0.43	11(9.2) (4.7–16.3)	69(57.5) (49.6–65.1)	40(33.3) (26.4–40.8)	0.07
Nonmedical field (83)	22.84 ± 3.81		6(7.2) (3.8–13.1)	45(54.2) (45.4–62.8)	32(38.6) (30.1–47.6)	
Residence						
Cities and towns (72)	24.65 ± 3.63	< 0.001	2(2.8) (0.7–7.4)	29(40.3) (30.9–49.9)	41(56.9) (47.3–66.2)	< 0.001
Rural area (131)	21.42 ± 3.85		15(11.5) (7.9–16.1)	85(64.9) (58.3–71.2)	31(23.7) (18.2–29.9)	

The data are presented as the frequency (n) and percentage (%) according to the OLSES. Independent sample t tests and one-way ANOVA were used for the OLSES scores of the time management domain. For the frequency of self-efficacy levels, Fisher's exact test was used. Statistical significance was set at a level of $P<0.05$

Table 5 Level of self-efficacy in the technology use domain by student characteristics

Variables	Technology use domain					
	Scores (mean ± SD)	*P* value	Poor (*n*, %, 95%CI)	Insufficient (*n*, %, 95%CI)	Good (*n*, %, 95%CI)	*P* value
Sex						
Male (64)	33.43 ± 5.80	0.84	5(7.8) (2.9–17.3)	24(37.5) (27.4–48.6)	35(54.7) (43.9–65.2)	0.59
Female (139)	33.59 ± 4.69		6(4.3) (1.6–10.2)	55(39.6) (32.1–47.5)	78(56.1) (48.5–63.5)	
Age, year						
18 ~ 19 (35)	33.02 ± 5.18	0.78	3(8.6) (2.4–22.1)	18(51.4) (36.7–65.8)	14(40.0) (26.9–54.5)	0.09
20 ~ 21 (130)	33.61 ± 5.04		6(4.6) (1.7–10.7)	45(34.6) (28.2–41.4)	79(60.8) (83.9–67.1)	
≥ 22 (38)	33.79 ± 5.07		2(5.3) (1.0-16.5)	16(42.1) (28.7–56.2)	20(52.6) (39.3–65.5)	
Grade level						
≤Sophomore (98)	33.24 ± 4.43	0.41	3(3.1) (0.7–8.4)	46(46.9) (37.7–56.2)	49(50.0) (41.1–58.9)	0.009
≥Junior (105)	33.82 ± 5.58		8(7.6) (3.8–14.1)	33(31.4) (23.9–40.1)	64(61.0) (52.7–68.9)	
Type of specializations						
Medical field (120)	33.30 ± 5.18	0.42	7(5.8) (2.6–11.4)	48(40.0) (32.2–48.3)	65(54.2) (46.5–61.8)	0.86
Nonmedical field (83)	33.89 ± 4.87		4(4.8) (1.7–11.2)	31(37.3) (29.0-46.2)	48(57.8) (49.3–63.3)	
Residence						
Cities and towns (72)	35.93 ± 5.66	< 0.001	4(5.6) (1.8–12.4)	13(18.1) (10.9–27.6)	55(76.4) (67.1–84.2)	< 0.001
Rural area (131)	32.23 ± 4.16		7(5.3) (2.6–10.0)	66(50.4) (42.5–58.2)	58(44.3) (36.9–52.0)	

The data are presented as the frequency (n) and percentage (%) according to the OLSES. Independent sample t tests and one-way ANOVA were used for the OLSES scores of the technology use domain. For the frequency of self-efficacy levels, Fisher's exact test was used. Statistical significance was set at a level of $P<0.05$. 95% CI: 95% confidence interval

technology use (β = –0.38, $P<0.001$). The residency of undergraduate students was one of the independent influential factors for full online learning self-efficacy (Table 6).

Discussion

The study analyzed 203 valid questionnaires showed that most of Chinese university students' self-efficacy for fully online learning is insufficient. Although medical students displayed higher self-efficacy in online learning environment, time management, and technology use compared to nonmedical students, no significant differences were observed between two the groups. Particularly, a significant difference in self-efficacy was found based on place of residence, with rural area students exhibiting lower self-efficacy across all three domains of self-efficacy. Multiple regression analysis highlighted residency as a key factor influencing self-efficacy in online learning, time

Table 6 Multiple linear stepwise regression analysis of OLSES scores ($N=203$)

Variables	B value	β value	t value	*P* value	F/*P* value	Adjusted R2
Scores of OLSES						
Constant	114.10		13.80	< 0.001	7.61, < 0.001	0.14
Sex	-1.37	-0.04	-0.60	0.54		
Age	2.57	0.09	1.21	0.22		
Grade level	0.65	0.02	0.25	0.79		
Type of specializations	3.76	0.11	1.58	0.11		
Residence	-13.24	-0.40	-5.98	< 0.001		
Scores of online learning domain						
Constant	52.14		12.87	< 0.001	6.53, < 0.001	0.12
Sex	-0.80	-0.04	-0.72	0.46		
Age	1.37	0.10	1.32	0.18		
Grade level	0.29	0.02	0.23	0.81		
Type of specializations	0.66	0.04	0.56	0.57		
Residence	-5.81	-0.36	-5.35	< 0.001		
Scores of time management domain						
Constant	26.59		12.60	< 0.001	8.04, < 0.001	0.15
Sex	-0.67	-0.07	-1.16	0.24		
Age	0.38	0.05	0.71	0.47		
Grade level	0.08	0.01	0.12	0.90		
Type of specializations	1.35	0.16	2.22	0.27		
Residence	26.59	-0.41	12.60	< 0.001		
Scores of technology use domain						
Constant	35.36		13.34	< 0.001	6.85, < 0.001	0.13
Sex	0.11	0.04	0.15	0.87		
Age	0.82	0.09	1.21	0.22		
Grade level	0.27	0.02	0.34	0.73		
Type of specializations	1.75	0.17	2.29	0.05		
Residence	-3.98	-0.38	-5.60	< 0.001		

management, and technology use for Chinese undergraduate students.

Self-efficacy is a well-researched concept in both traditional and online educational settings. Individual factors such as self-efficacy and demographic characteristics may have significant impacts on e-learning or online learning behaviors. While there have been limited studies on self-efficacy specifically related to online learning in traditional educational environments, previous research in the area has focused primarily on technology-related self-efficacy (such as computer skills, learning management systems, and internet usage) [25].

The emergence of the 2019 novel coronavirus disease (COVID-19) resulted in a surge of fully online learning. It is crucial to employ a reliable tool for evaluating students' self-efficacy in the online setting. The study was conducted to assess the psychometric properties of the Chinese version of the OLSES. The results of the study revealed that the Chinese version of the OLSES had good psychometric properties and was a reliable and valid instrument for assessing self-efficacy related to complete online learning. Similar to the original version [23], Turkish version [22] and Persian version [25] of the OLSES, the Chinese version of the scale also had good reliability according to the Cronbach's alpha coefficient. The Cronbach's alpha coefficients for the subscales and overall scale were all above the recommended threshold of 0.70, indicating good internal consistency [26].

In exploratory factor analysis [27], Bartlett's test of sphericity was found to be statistically significant ($P<0.05$), which suggested that online learning environment, time management and technology use were three latent variables of self-efficacy in learning. Subsequently, in the confirmatory factor analysis, most of the goodness-of-fit indices reached an acceptable level. The Chinese version of the OLSES is a valid and reliable tool for measuring academic-related self-efficacy for fully online learning among Chinese students.

In the current study, there was no difference in the student self-efficacy scores between the variables of gender, age, grade level, and type of specialization. No significant differences were observed in the self-efficacy between medical and nonmedical students. The finding is consistent with similar results reported in other studies within the literature [28, 29]. However, the results of the study revealed that students from cities and towns had higher self-efficacy scores than did students from rural areas. The results suggests that geographical location, whether

rural or urban, may play a role in shaping students' self-efficacy beliefs in full online learning. A prior study has showed the difference in students' learning self-efficacy between rural and urban areas in the use of multimedia for learning and access to technology [30]. The disparity may be due to factors such as limited access to technology, inadequate internet connectivity, and less familiarity with online learning platforms [31], which may result in unequal access to learning resources and support systems. Therefrom, by considering geographical factors, it is the need for targeted interventions such as internet promotion in rural areas, training in e-learning techniques and so on to address these challenges and increase the self-efficacy of rural students in online learning in China. A study suggested that when students become online learners, especially for the first time, they may feel less confident, even if they are familiar with the day-to-day use of technology, which is because they may still lack the essential learning and technology skills required for higher education and online learning [32]. Most of studies have considered learner control and online learning self-efficacy to be significant predictors that can enhance academic success [32]. Previous studies have suggested that students with high levels of academic self-efficacy tend to experience lower levels of academic anxiety and stress and are more successful in completing academic tasks [33–35]. Various factors may play essential roles in shaping students' overall online learning self-efficacy. Among the factors, learning in an online learning environment, time management and technology use are the most important contributors to academic success [23, 36–38]. University teachers should increase students' self-efficacy for online learning by improving their computer use, time management, and internet and information-seeking skills.

Almost two-thirds of the students reported poor or insufficient self-efficacy in an online learning environment, suggesting that the Chinese students may lack confidence in their ability to learn effectively and succeed in an online setting. This finding is consistent with previous research that has highlighted the challenges associated with online learning, such as difficulties in engaging with course materials, lack of face-to-face interaction with instructors, and limited opportunities for peer collaboration [39–41]. The challenges may contribute to a decrease in self-efficacy for learning in an online environment. Although a greater percentage of medical students reported good self-efficacy in the online learning environment than did nonmedical students in the online learning environment, there was no significant difference between two the groups. Medical students are more familiar with using technology in their studies and are therefore more confident in their ability to learn online [41, 42]. Consequently, implementing strategies that focus on fostering a supportive online learning environment, providing clear e-learning instructions, offering interactive activities, and promoting opportunities for peer collaboration could help boost students' self-efficacy in online learning, ultimately enhancing their overall academic performance and satisfaction with the learning experience.

Time management is also one of the crucial skills for successful online learning, as students need to allocate sufficient time to studying, completing assignments, and participating in online discussions. A lack of self-efficacy in time management could lead to procrastination, poor performance, and increased stress levels among students [42, 43]. In online learning, reasons for low self-efficacy in time management among students may include ineffective supervision, lack of self-motivation, poor self-monitoring, deficient time management skills, and distractions from the learning environment. One study revealed three main reasons for poor time management among online learners: studying in a noisy environment, ignoring the importance of synchronous online learning and attending online lectures while juggling other work or household chores [44]. Interestingly, compared with male students, female students had significantly greater self-efficacy in time management, and a greater percentage of nonmedical students expressed good self-efficacy in time management. It is therefore important for university teachers to provide guidance and support to help all students develop effective strategies for managing time.

On the other hand, a high level of self-efficacy was observed for the technology being used in fully online learning. Students feel confident in their ability to navigate and utilize technological tools and platforms for learning purposes. There were no significant differences observed in the technology use domain self-efficacy scores between medical and nonmedical students. It is important to note that a high level of self-efficacy in technology use may have a positive impact on students' overall online learning experience, as it enables them to navigate and utilize digital resources effectively [41, 45]. Therefore, university teachers should increase students' self-efficacy in using technology by providing relevant training and support that encourages active engagement with technological tools. This in turn can improve the quality and effectiveness of their online learning experience.

Hence, when developing fully online teaching strategies to boost the academic performance of Chinese students, university instructors should prioritize students' online learning self-efficacy in three domains, as well as their previous experience with online learning, specialization, geographical location, behavioral and emotional engagement. To effectively address these issues, universities are setting up specially tailored training programs to help

students improve their online learning efficacy, beliefs and engagement.

Limitations

Nevertheless, the study has several limitations. First, the study design was cross-sectional, which limits its ability to establish cause-and-effect relationships between the variables. Second, the sample of 203 students from one university is not representative of Chinese university students and may not reflect the self-efficacy situation of Chinese university students for fully online learning, and its representativeness is limited. Follow-up research can examine students from different regions and backgrounds to increase the representativeness of the sample and test the results of this research. Third, the data collection relied on self-reports, which implies that the results may be influenced by social desirability. The future studies need to reduce measurement bias by evaluating students' self-efficacy through multi-subject reports, such as diverse data sources, online classroom interaction observations and interviews from teachers' perspectives. Fourth, the study did not investigate other factors that may influence online learning self-efficacy, such as family support, interactions with classmates and instructors during online courses, the number of online courses taken by students, the quality of course instruction, and ongoing faculty support. Additionally, we utilized a subjective tool to measure the self-efficacy domains and learning satisfaction, which might introduce bias that could affect the survey's construct validity. However, with the development of fully online teaching modes, the relationship between students' learning self-efficacy and academic achievement is an emerging area of research. Future research should include behavioral and objective instruments to measure self-efficacy and academic performance to provide more comprehensive information.

Conclusions

The Chinese version of the OLSES has good psychometric properties and can serve as a reliable and valid tool for assessing Chinese students' self-efficacy in fully online learning. The three domains of OLSES, namely, learning in the online environment, time management, and technology use, played crucial roles in students' academic self-efficacy during fully online learning. Furthermore, most evaluated Chinese university students' self-efficacy for fully online learning is inadequate, and only between 36.5% and 55.7% of students had a good level of self-efficacy for fully online learning. Although medical students had slightly higher levels of self-efficacy for online learning including the domain of online environment, time management, and technology use than nonmedical students, there were no significant differences between the two groups. The findings suggest the importance of developing proactive strategies and approaches to enhance all aspects of students' self-efficacy, enabling them to effectively embrace fully online learning for medical and nonmedical students. The study's findings outline the salience of academic self-efficacy and emphasize its significance in fully online teaching.

Supplementary Information

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Supplementary Material 1

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Author contributions

Xingming Ma designed and drafted the original manuscript. Hao Zhang collected and analyzed the data. Xinmiao Zhou analyzed the data and reviewed the manuscript. Li Bo analyzed the data.

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Data availability

The analysed data is all in the manuscript, and the anonymized dataset of this study is available upon request from the corresponding author.

Declarations

Human ethics and consent to participate declarations

Not applicable.

Competing interests

The authors declare no competing interests.

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