Research article

# Chinese nursing students' academic self-concept and deep learning in online courses: Does psychological capital play a moderating role?

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## ARTICLE INFO

## ABSTRACT

The advent of online education has become indispensable for nursing students seeking to acquire knowledge. However, the efficacy of online education often falls short of initial expectations. Deep learning (DL) can assist learners tackle complex problems and make innovative decisions. Despite its potential, there has been limited exploration into the underlying mechanisms of DL among nursing students, both domestically and globally. This study examined the potential moderating effect of psychological capital (PC) on the association between academic self-concept (AS-c) and DL among nursing students from China enrolled in online courses. Conducted from October 2022 to January 2023, the survey involved 635 nursing students from four public universities in eastern China, utilizing convenience sampling. Data was collected using the AS-c scale, psychological capital scale, and DL scale in online courses. Correlation analyses, univariate analyses, multiple linear regression analyses, and the PROCESS macro were employed for a comprehensive examination. The results revealed a strong positive relationship between nursing students' DL and both their AS-c ($r = 0.766$, $P < 0.01$) and PC ($r = 0.714$, $P < 0.01$), respectively. Additionally, the effect of AS-c on DL was stronger among individuals with high PC ($\beta = 0.34$, SE $= 0.03$, $P < 0.001$) compared to those with low ($\beta = 0.29$, SE $= 0.02$, $P < 0.001$) or medium ($\beta = 0.24$, SE $= 0.02$, $P < 0.001$) levels of PC, indicating that PC exerts moderating effects and promotes DL among nursing students enrolled in online courses. Based on these findings, several implications are suggested for the theory and practice of facilitating DL.

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## 1. Introduction

The proliferation of online educational resources and various forms of digital learning has enabled learners to overcome temporal and spatial constraints, thereby expanding their educational prospects and equipping them with the necessary skills to thrive in an increasingly competitive educational landscape [1,2]. Given the rapid pace at which nursing professional knowledge is being updated, along with the intricate and diverse nature of its contents [3], and considering the complexity of future nursing duties [4], nursing students must cultivate the capacity to learn efficiently using online tools. This will enable them to proactively tackle the multifaceted challenges they may encounter in their future nursing careers [5].

Despite the numerous benefits associated with online education, it is imperative to acknowledge the emergence of several novel challenges. For instance, medical students have expressed dissatisfaction with online learning and harbor negative perceptions about the quality of distance education. For the most part, these students reported experiencing feelings of isolation or separation, as well as difficulties in staying focused during their online studies [6–8]. These circumstances suggest that learners often adopt surface-level approaches to online education. A study examining students' experiences with online learning found a consistent increase in surface-level learning throughout the semester [9].

Background.

In contrast to surface learning, deep learning (DL) involves a deliberate process wherein the learner actively interprets the text to establish connections with preexisting knowledge, synthesize ideas into coherent entities, and ultimately solve complex problems to make innovative decisions [10,11]. Numerous studies have demonstrated that the utilization of DL methods can help foster the growth and development of higher-order cognitive skills among learners, including critical thinking and integrative thinking [12,13]. Consequently, students who possess such advanced cognitive abilities are better equipped to overcome challenges associated with online learning, including the issue of limited interaction in asynchronous learning environments [14]. In nursing education, professionals have advocated for the integration of DL strategies, including ontological and reflexive approaches, as a means to cultivate skilled nursing practitioners [15].

Most prior research has focused on the macro-level influences of environmental and socio-demographic factors on DL, rather than delving into the intricacies of internal factors shaping individual behaviour [16,17]. However, studies have emphasized that strategies to promote DL should be learner-centered; effective online learning requires students to be self-motivated, autonomous, and accountable [18,19]. This underscores the importance of individual learner characteristics in determining the effectiveness of online learning. Despite this understanding, there is a lack of research on enhancing DL from the learner's perspective, particularly in the context of Internet education for nursing students.

Academic self-concept (AS-c), an intra-individual factor affecting DL, refers to a learner's stable cognition and assessment of their expected progress, learning capacity, and existing academic standing [20]. Self-concept acts as a guide, prompting individuals to behave in manners consistent with maintaining their self-perceptions [21]. Nursing students with a high AS-c are perceived as having good academic self-control behaviours, academic competence, and favorable academic emotions. Additionally, AS-c is positively associated with desirable outcomes such as increased educational aspirations, improved achievement, and more favorable learning behaviours [20]. Consequently, learners with a strong AS-c demand more from their learning experiences and tend to understand, criticize, construct, reflect, transform, and apply new knowledge (i.e., they adopt a deep approach to learning). Hence, we propose that AS-c positively influences DL when courses are offered online (Hypothesis 1).

Given the potential complexity in comparing AS-c with other educational constructs, it is important to recognize that learners, despite sharing similar AS-c, may still exhibit significant individual differences in how AS-c influences other educational constructs [22]. To better inform practical interventions, further investigation into the underlying causes and mechanisms leading to the desired outcome should be conducted.

Psychological capital (PC), as the fundamental psychological element encompassing hope, self-efficacy, resilience, and optimism, may serve as a crucial moderating variable in this context [23]. A moderating variable (also known as a moderator) determines the relationship between two variables of interest [24]. PC acts as a psychological resource supporting both individual development and performance enhancement. Within this framework, "hope" refers to a positive motivational state formed by an individual's experience of the motivation for success and the path to achieving it [23]. Therefore, learners with high levels of PC will be intrinsically motivated to learn, feel confident in their learning, and prefer to use understanding, critical, and supportive pedagogies, i.e., they will more frequently adopt an in-depth strategy for education [25].

A recent systematic review suggested that PC moderates both individual creativity and performance [26]. The complexity of DL varies among individuals with different levels of PC, as DL is a multifaceted learning approach that focuses on generating novel knowledge and optimizing performance. More precisely, individuals possessing an elevated level of PC prefer to view the intricacy of
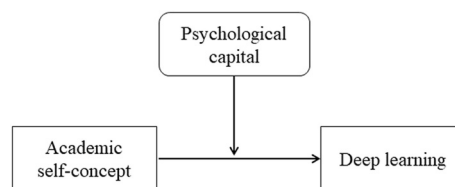


**Fig. 1.** Moderator model of this study.

the task as stimulating, whereas individuals with reduced levels of PC may view them as burdensome [26].

Social learning theory underscores that individual behaviour formation, including DL behaviours, is influenced by cognition, such as AS-c, and self-psychological states, like PC [27]. Therefore, it is reasonable to propose that a strong PC can enhance students' inclination toward DL and enhance the impact of AS-c on DL within the realm of distance learning. Consequently, we propose that PC has a positive influence on DL in the context of online education (Hypothesis 2) and moderates the association between AS-c and DL in the context of online education (Hypothesis 3). Fig. 1 illustrates the hypothesized model of this study.

Based on the perspective of intra-individual learner factors that affect DL ability, this study aims to investigate the relationships among PC, AS-c, and DL within the context of online education for nursing students.

## 2. Methods

### 2.1. Study design and participants

This study utilized an electronic cross-sectional research design, employing a convenience sampling technique to recruit participants from four public universities situated in Tianjin, Guangzhou, and Fuzhou, all of which are located in the eastern region of China. All eligible participants in this survey were full-time nursing students who volunteered and had received more than a year of distance education. Additionally, participants needed to be able to complete the survey online, while those with severe physical or mental illnesses, like depression, as well as those who were suspended from studies or on medical leave during the time of the study, were excluded.

The PASS 15.0 software (PASS, Kaysville, UT, USA) was used to calculate the sample size, considering a moderate $f^2$ effect size of 0.15, an Alpha level of 0.05, a power of 0.9, and 64 predictor variables. Accounting for a 20 % elimination rate, the estimated number of samples required was 398.

### 2.2. Measurements

The demographic data included gender, age, educational background, familial residence, daily duration of online learning, and grade point average (GPA).

Guo and Zhao et al. developed a 20-item AS-c scale to assess self-concept perception in academic settings [28]. This scale encompasses four distinct dimensions: academic competence perception, academic self-control behaviour, academic emotional experience, and academic achievement value. Participants rated each item on a Likert scale ranging from one to five, indicating their level of agreement, resulting in a total score between 20 and 100. Higher scores indicate a stronger AS-c. The scale demonstrated stable structural validity, with a Cronbach's α of 0.957 in this research, indicating high internal consistency.

Consistent with Xu's study, a 33-item scale was developed to assess psychological capital (PC) among university students, covering self-efficacy, hope, optimism, and resilience [29]. Participants rated each item on a five-point Likert scale, with higher total scores indicating greater levels of PC. The scale demonstrated strong structural validity, with a Cronbach's α of 0.941 in this research, indicating excellent internal consistency among Chinese nursing students.

Building on existing literature and considering the current landscape of distance education, the DL scale in distance education was refined by incorporating the DL subscale from the NSSE-China questionnaire [30]. Comprising eleven items, this scale assesses higher-order learning, integrative learning, and reflective learning on a Likert scale from one to five, yielding a total score between 11 and 55. Higher scores indicate a higher degree of DL in the context of distance learning for participants. Exploratory factor analysis revealed three common factors explaining a significant portion of the variance (78.491 %) [31]. Additionally, the scale demonstrated good internal consistency with a Cronbach's α of 0.921 in this research.

### 2.3. Data collection and ethical considerations

The Ethics Committee approved the project (2022-C-150). Data collection took place from October 2022 to January 2023, utilizing the Wen Juan Xing survey platform (Changsha Ranxing Information Technology Co., Ltd., Changsha, China), which is widely used in China. First, the researchers displayed the research posters (including the purpose of the study, the content, and the inclusion and exclusion criteria of the respondents) in the universities where the survey was going to be conducted. The university counselor was then commissioned to use the poster to introduce the study, and students interested in participating were required to contact the counselor. The counselors, being familiar with the students, selected suitable participants based on the inclusion and exclusion criteria and provided additional information about the study's purpose to potential volunteers. Lastly, the counselors sent electronic questionnaires to participants who volunteered to participate in this study and kept their responses confidential and anonymous. Nursing students who agreed to participate completed the questionnaire and informed consent form online, with no time limit for response.

Notably, survey data were submitted only when all questionnaire items were answered. Out of 681 recovered questionnaires, 635 were deemed valid, resulting in a valid return rate of 93.2 % after excluding invalid questionnaires with evident patterns.

### 2.4. Data quality inspection

This study utilized an online questionnaire and self-reporting approach to assess all variables, potentially introducing common method bias [32]. To address this concern, the sample data underwent the Harman single-factor test. Findings indicated that the first

component only accounted for 39.77 % of the variance, falling below the 50 % threshold, suggesting acceptable homologous variance [33].

Additionally, the findings revealed no substantial multicollinearity concerns among the variables, as evidenced by the tolerances of all independent variables being <1 and the variance inflation factors being <3 [32].

### 2.5. Data analysis

All statistical analyses were performed utilizing the IBM SPSS Statistics 26.0 software (SPSS Inc, Chicago, Illinois, USA). Shapiro-Wilk tests revealed a normal distribution ($P > 0.05$), allowing for the use of parametric statistics. Descriptive statistics, such as frequencies and percentages, were employed to analyze the demographic questionnaires for nursing students.

Statistical significance was set at $P < 0.05$ based on a two-tailed test. Pearson product-moment correlations were utilized to assess the associations between DL, PC, and AS-c among nursing students. Furthermore, one-way ANOVA and independent *t*-test were employed to investigate the variations of participants' demographic features.

Hypotheses 1 and 2 were tested using multiple linear regression. Additionally, for testing Hypotheses 3, we employed PROCESS v3.5, a macro program, using 5000 bootstrapping samples and a 95 % confidence interval (CI) [34]. The study defined the independent variable as nursing students' AS-c, with PC identified as the moderator variable and DL as the dependent variable. Furthermore, participant characteristics that exhibited statistical significance in both the *t*-test and one-way ANOVA test were treated as covariates. The presence of a significant moderating effect was assessed by examining if the 95 % CI encompassed zero.

## 3. Results

### 3.1. Participants' demographics

The study collected a comprehensive set of 635 valid questionnaires, with 15.6 % of participants being men and 84.4 % being women. Urban residents comprised 52.3 % of the participants, and the average age ranged from 17 to 35 years, with a mean age of 20.87. Additionally, 67.4 % of the nursing students held either bachelor's or postgraduate degrees, and a significant proportion (68.1 %) reported a GPA exceeding 3.0. Furthermore, the majority of participants (81.9 %) devoted less than 4 h to online learning each day (Tables 1 and 2).

### 3.2. Descriptive statistics and correlation evaluation

The average score for DL was 33.08 (SD = 8.97). Moreover, the average scores for AS-c and PC were 62.38 (SD = 17.43) and 101.62 (SD = 28.51), respectively. The average item scores for the three dimensions of the DL scale were 3.64 for higher-order learning, 2.90 for integrative learning, and 3.96 for reflective learning.

The findings showed a strong positive correlation between DL and both PC (r = 0.714, $P < 0.01$) and AS-c (r = 0.766, $P < 0.01$). Additionally, a significant positive correlation was observed between PC and AS-c (r = 0.796, $P < 0.01$) (Table 2).

### 3.3. Univariate analysis of DL based on participant demographics

The findings of this study reveal that DL scores among distance education students change significantly depending on educational background, familial residence, gender, daily duration of online learning, and GPA (Table 3).

**Table 1**
Demographic characteristics of participants (n = 635).

| Variable | Group | Number | % |
|---|---|---|---|
| Gender | Male | 99 | 15.6 % |
| | Female | 536 | 84.4 % |
| Educational background | Junior college degree | 207 | 32.6 % |
| | Bachelor degree | 378 | 59.5 % |
| | Postgraduate degree | 50 | 7.9 % |
| Familial residence | City | 185 | 29.1 % |
| | Town | 147 | 23.2 % |
| | Countryside | 303 | 47.7 % |
| Daily duration of online learning (hour) | 0~1.99 h | 295 | 46.5 % |
| | 2~3.99 h | 225 | 35.4 % |
| | 4~5.99 h | 82 | 12.9 % |
| | ≥6 h | 33 | 5.2 % |
| GPA (Grade Point Average) | <1.0 | 14 | 2.2 % |
| | 1.0–1.9 | 25 | 4.0 % |
| | 2.0–2.9 | 163 | 25.7 % |
| | 3.0–3.9 | 368 | 57.9 % |
| | ≥4.0 | 65 | 10.2 % |

**Table 2**

Descriptive statistics and correlation analysis of variables (n = 635).

| Variable | Score range /age range | Mean | SD | AIS | SS | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Age | 17~35 | 20.87 | 2.36 | – | – | 1 | | | | | |
| 2 Academic self-concept | 21~97 | 62.38 | 17.43 | 3.12 | 62.40 | 0.105[a] | 1 | | | | |
| 3 Psychological capital | 33~157 | 101.62 | 28.51 | 3.07 | 61.40 | 0.092[b] | 0.796[a] | 1 | | | |
| 4 Deep learning | 13~50 | 33.08 | 8.97 | 3.00 | 60.00 | 0.140[a] | 0.766[a] | 0.714[a] | 1 | | |
| 5 Deep learning: Higher order learning | 4~20 | 11.56 | 3.64 | 2.89 | 57.80 | 0.120[a] | 0.691[a] | 0.629[a] | 0.866[a] | 1 | |
| 6 Deep learning: Integrative learning | 3~15 | 9.03 | 2.90 | 3.01 | 60.20 | 0.111[a] | 0.559[a] | 0.516[a] | 0.785[a] | 0.559[a] | 1 |
| 7 Deep learning: Reflective learning | 4~20 | 12.48 | 3.96 | 3.12 | 62.40 | 0.122[a] | 0.661[a] | 0.634[a] | 0.858[a] | 0.593[a] | 0.507[a] |

Abbreviation.

AIS, Aveage item score.

SD, Standard Deviation.

SS, Standard score.

[a] $P < 0.01$.

[b] $P < 0.05$.

**Table 3**

Univariate analysis of deep learning in online courses with different demographic characteristics of participants (n = 635).

| Variable | Group | Score (Mean ± SD) | t/F | P |
|---|---|---|---|---|
| Gender | Male | 35.09 ± 8.61 | 2.439 | 0.015 |
| | Female | 32.71 ± 8.99 | | |
| Educational background | Junior college degree | 31.64 ± 8.62 | 4.406 | 0.013 |
| | Bachelor degree | 33.92 ± 9.00 | | |
| | Postgraduate degree | 32.68 ± 9.52 | | |
| Familial residence | City | 35.08 ± 8.56 | 7.781 | 0.000 |
| | Town | 33.18 ± 9.21 | | |
| | Countryside | 31.81 ± 8.89 | | |
| Daily duration of online learning (hour) | 0~1.99 h | 30.90 ± 8.88 | 13.889 | 0.000 |
| | 2~3.99 h | 34.08 ± 8.83 | | |
| | 4~5.99 h | 36.57 ± 7.68 | | |
| | ≥6 h | 37.09 ± 8.60 | | |
| GPA (Grade Point Average) | <1.0 | 23.57 ± 8.95 | 6.176 | 0.000 |
| | 1.0–1.9 | 30.32 ± 8.78 | | |
| | 2.0–2.9 | 32.13 ± 8.51 | | |
| | 3.0–3.9 | 34.01 ± 8.88 | | |
| | ≥4.0 | 33.31 ± 9.27 | | |

*3.4. Results of multiple analyses*

The results of multiple analyses showed that DL was significantly influenced by AS-C and PC ($F = 507.315$, $P = 0.000$). The model explanatory power ($R^2$) was 61.6 %. These findings indicate that these two variables have significant explanatory power for the dependent variable (Table 4).

**Table 4**

Results of multiple analyses (N = 635).

| Variable | B | SE | β | t | P | Collinearity diagnostics | | F | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TOL | VIF | | |
| Constant | 6.712 | 0.861 | – | 7.797 | 0.000 | – | – | 507.315 | 0.616 |
| PC | 0.090 | 0.013 | 0.285 | 6.998 | 0.000 | 0.366 | 2.729 | | |
| AS-c | 0.277 | 0.021 | 0.539 | 13.241 | 0.000 | 0.366 | 2.729 | | |

Abbreviation.

AS-c: Academic self-concept.

β: Standardized Coefficients Beta.

B: Unstandardized Coefficients Beta.

PC: Psychological capital.

SE: Standard Error.

TOL:Tolerance.

VIF: Variance Inflation Factor.

*3.5. Moderating effect of PC*

The moderating impact of PC on AS-c and DL in online courses was investigated using Hayes' macro-program PROCESS (Table 5 and Fig. 2). AS-c had a significant impact on DL in distance education, regardless of the level of psychological empowerment. Moreover, the effect of AS-c on DL was stronger among individuals with high PC ($\beta = 0.34$, SE $= 0.03$, $P < 0.001$) compared to those with low ($\beta = 0.29$, SE $= 0.02$, $P < 0.001$) or medium ($\beta = 0.24$, SE $= 0.02$, $P < 0.001$) levels of PC. These findings accurately support hypotheses 1, 2, and 3.

## 4. Discussion

As far as we know, this is one of the few studies linking AS-c to PC, along with DL in distance education. Nursing students' AS-c and PC were positively associated with their DL capacity in online courses. Furthermore, our study addresses the research gap regarding the moderating impact of PC on AS-c and DL in distance education.

Several key points emerged from our findings. Firstly, we observed that Chinese nursing students' DL in online courses is at a mediocre level, indicating a pressing need to enhance the depth of their learning in such contexts. This finding is consistent with previous research on nursing students [31]. Additionally, our data supported the hypotheses proposed, providing further evidence for theories of self-concept, PC, and social learning [21,23,27]. These theories offer valuable insights into enhancing DL during distance education among nursing students from China.

*4.1. Current status*

The study participants were nursing students, of which 15.6 % were males and 84.4 % were females. This distribution aligns with prior investigations conducted by Sun Yumei et al. on a sample of 37,301 nursing students in China [5]. Furthermore, regarding family residence and educational background, the results of this study are consistent with earlier investigations conducted at multiple universities in China [31,35]. Specifically, 47.7 % of the nursing students in our study originated from rural areas, while 92.1 % possessed a bachelor's degree or lower. These statistics suggest that the participants in our survey are largely representative of the broader population of nursing students in China.

DL, an educational approach, involves individuals acquiring new knowledge through critical and comprehensive comprehension and applying existing knowledge to novel contexts to solve complex problems and foster inventive decision-making [30]. This approach encompasses three distinct dimensions: higher-order learning, integrative learning, and reflective learning.

The level of DL among nursing students in online courses was $33.08 \pm 8.97$ (average item score: 3.0). This result aligns with previous surveys conducted on DL methods employed by nursing students in China [31], suggesting that nursing students' proficiency with online DL falls within the intermediate range. Furthermore, the ranking of each dimension score, indicated that reflective learning had the highest score, followed by integrative learning, and then higher-order learning.

Higher-order learning involves the utilization of analytical, synthetic, evaluative, and applicative abilities during the learning process [36]. It typically fosters the growth of higher-order thinking and the cultivation of advanced skills [13], emphasizing the application of intricate knowledge and the transformation of outcomes [37]. Learners are required to move beyond memorizing, integrating, understanding, and reflecting on information to further analyze, evaluate, and create new knowledge or artifacts [13].

Therefore, nursing educators must prioritize the enhancement of nursing students' DL capacity, particularly by focusing on enhancing their higher-order learning skills, as this skill represents a deficiency in their learning approach.

**Table 5**
Moderation Analyses of psychological capital on the relationship between academic self-concept and deep learning (n = 635).

| Variable | β | SE | t | P | 95 % CI | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | | | LLCI | ULCI |
| AS-c | 0.290 | 0.022 | 13.562 | 0.000 | 0.248 | 0.332 |
| PC | 0.092 | 0.013 | 7.400 | 0.000 | 0.068 | 0.116 |
| AS-c*PC | 0.002 | 0.001 | 4.263 | 0.000 | 0.001 | 0.003 |
| $R^2 = 0.649$ | | | | | | |
| $F = 128.64$ | | | | | | |
| $P = 0.000$ | | | | | | |

Abbreviation.
AS-c: Academic self-concept.
CI: Confidence Interval.
LLCI: Lower Limit Confidence Interval.
PC: Psychological capital.
SE: Standard Error.
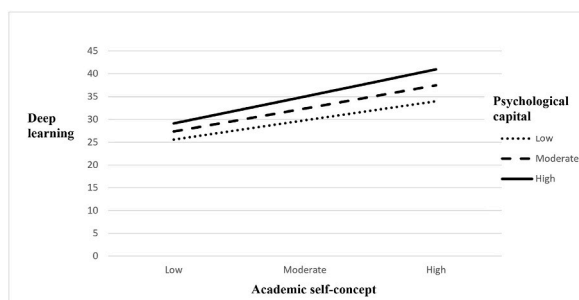ULCL: Upper Limit Confidence Limit Interval.

**Fig. 2.** Interaction effect of AS-c and PC on DL in online courses.

### 4.2. Correlation analysis

The research's conclusions provide evidence supporting the validity of hypothesis 1. An empirical investigation revealed a significant positive correlation between AS-c and DL [31], suggesting that nursing students with good AS-c are more inclined to engage in DL approaches within online educational settings. This finding could be attributed to the tendency of students who perceive themselves as academically capable to report positive learning experiences, leading to increased emotional investment and learning behaviours in online courses [38]. This helps learners use critical and comprehensive comprehension to effectively transform and implement new knowledge, thereby attaining enhanced academic accomplishments [39,40].

The findings of this study provide evidence that supports hypothesis 2, suggesting a positive association between individuals' PC and their inclination toward DL strategies. Similar to other studies, Harwood and Hassiotis et al. utilized the concept of PC to design and develop medical curriculum materials, aiming to promote learners' attainment of a deeper comprehension of the course content [41]. It is worth noting that DL, as a high-level learning approach aimed at addressing complex problems and fostering innovation, imposes heightened demands on learners' psychological disposition [42]. When learners possess a high degree of PC, characterized by self-efficacy, resilience, hope, and optimism, they are equipped with the necessary mindset to overcome the challenges encountered during the DL process, thus promoting learners' adoption of DL methods [43].

### 4.3. Moderating effect

Our findings also support Hypothesis 3. Considering that previous studies have demonstrated that learners, despite having similar AS-c, may still have large individual differences in how learners leverage their AS-c to influence other educational constructs [22]. Therefore, to better extend and refine the research model of online DL and to inform practical interventions, the mechanisms underlying the adoption of online DL approaches by nursing students need to be further analyzed.

Stronger associations were observed between AS-c and DL as PC increased. This observation is supported by the steeper slopes under the moderating effect of high PC compared to individuals with lower PC, indicating that higher levels of PC enhance the positive effect of AS-c on DL. Psychological and social factors influence the relationship between AS-c and learning approaches [31,44]. Prior research has demonstrated that PC serves as an advantageous tool, essential to learners' academic adaptation [45]. Positive PC can effectively alleviate the negative impact of learners' negative academic experience on their learning process and promote the cultivation and development of personal learning skills [46]. The self-concept theory is also consistent with this finding. The theory suggests that an individual's perception of self will guide behavioural tendencies consistent with that perception and that if an individual has an optimistic mindset (e.g., PC) and is positive about his or her ability to learn, and the expected development of learning (i.e., the AS-c), the individual will be more motivated to expand his internal and external social resources to solve complex problems and make innovative decisions (i.e., the DL) [21]. Consequently, irrespective of whether learners possess a high or low AS-c, positive PC catalyzes the adoption of DL strategies.

### 4.4. Limitations

The study acknowledges several limitations that warrant consideration. First, the cross-sectional nature of the research limits the depth of insight into the dynamics of DL among nursing students. Future longitudinal studies could offer a more comprehensive understanding of how AS-c, PC, and DL evolve within the context of online education. Second, the study's participant pool, while reflective of a significant portion of nursing students in China, was limited to those enrolled in public universities in eastern China. As such, the findings may not be fully generalizable to the broader population of nursing students across China.

The pandemic also had an impact on research operations, including limitations in funding and logistical constraints. Consequently, the responsibility for selecting eligible participants, based on predetermined inclusion and exclusion criteria, was partially delegated to student counselors rather than the research team. However, this approach raises concerns about potential biases introduced by the counselors' instructional roles and the social expectation effect. Given their duties, counselors may have been inclined to select participants perceived to have higher social expectations, possibly skewing the results towards a more favorable portrayal of the efficacy of distance learning (DL) in online education.

*4.5. Implications for nursing education*

The exploration of individual differences in PC and its impact on the relationship between AS-c and DL among nursing students represents a significant contribution to the field of medical education. By delving into these nuances, this study enhances our understanding of DL mechanisms in online learning models specifically tailored for nursing students. The insights garnered from this research are instrumental in informing medical education policymakers about the potential avenues for positive educational reforms. It is worth emphasizing that the results of this study can be applied in research models or in theoretical studies used to explain how to facilitate nursing students' access to online DL methods, as well as being used directly to guide practice.

In theoretical research, there is a need for further investigation to validate potential predictors of DL, especially those related to learners' personal characteristics such as academic mood and learning style preferences. While these predictors show promise in facilitating DL, empirical evidence on their relationship with DL remains limited. Therefore, future research should delve deeper into the complexity of online DL and explore the nuanced relationship between learners' personal characteristics and DL to enhance the robustness and practical value of these predictors in explaining DL.

Additionally, the findings of this study offer actionable insights for educational practice. The positive association between nursing students' AS-c and their adoption of online DL underscores the importance of fostering AS-c as a means to enhance DL capabilities. To translate these findings into actionable strategies, educators can implement methods aimed at developing AS-c among nursing students. Strategies such as increasing peer feedback, promoting academic engagement, and fostering goal (task) orientation have been shown to effectively enhance AS-c [47,48]. These measures have been proven to enhance learners' self-regulation practices, metacognition, and motivation to learn, all of which are essential for developing nursing students' ability to adopt DL.

More importantly, nursing educators should prioritize the enhancement of nursing students' PC (e.g., school-based multicomponent positive psychology interventions [MPPIs] targeting multiple constructs and group-based Acceptance and Commitment Therapy) [49,50] as a means of promoting DL. This is particularly crucial when immediate improvements in AS-c are unattainable. Indeed, by fostering an optimistic and promising positive psychological state, educators can effectively encourage the application of DL approaches in the context of online education for nursing students.

## 5. Conclusion

This study represents the first investigation into the associations among AS-c, PC, and DL in the specific setting of online courses for Chinese nursing students. Our results indicate a favorable correlation between AS-c and DL, as well as between PC and DL. Furthermore, for Chinese nursing students, PC assumes a moderating function in the relationship between AS-c and DL in online educational settings. Therefore, to encourage nursing students to embrace a DL approach to online learning, it is imperative to prioritize the cultivation of their AS-c and PC.

## Ethics statement

- This study was reviewed and approved by the Ethics Committee.
- All participants provided informed consent to participate in the study.
- All participants provided informed consent for the publication of their anonymized data.

## Data availability statement

Data will be made available on request. To request the data, contact the article's corresponding author.

## CRediT authorship contribution statement

**Siai Zhang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Bingyan Zhao:** Writing – review & editing, Writing – original draft, Software, Investigation. **Xuejiao Li:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Chunmei Zhang:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis. **Xinyu Lin:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis. **Yajun Zhang:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Methodology, Investigation, Formal analysis. **Jiajia Li:** Writing – original draft, Methodology, Investigation, Data curation. **Cuiwei Lai:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Siai Zhang reports financial support was provided by Tianjin Education Bureau. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e35150.

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