


BMJ Open Association of learning environment and self-directed learning ability among nursing undergraduates: a cross-sectional study using canonical correlation analysis

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ABSTRACT

Objectives This study explores the relationship between the perception of the learning environment and self-directed learning (SDL) ability among nursing undergraduates.

Design, setting and participants A cross-sectional study was conducted in December 2020 with 1096 junior and senior undergraduate nursing students (aged 16–22) from Wannan Medical College in Anhui Province, China.

Outcome measures The Chinese version of the Dundee Ready Educational Environment Measure questionnaire and a validated Chinese version of college students' SDL ability scale were used to assess students' perceptions about their learning environment and their SDL ability. Canonical correlation analysis was performed to evaluate their correlation.

Results The total score for the learning environment was 120.60 (scoring rate: 60.30%), and the score for SDL ability was 89.25 (scoring rate: 63.75%). Analysis indicated that the first canonical correlation coefficient was 0.701 and the contribution rate was 94.26%. The perception of the learning environment was mainly determined by students' perception of learning (SPL) and academic self-perceptions (SASP), with SDL ability mainly determined by self-management ability and cooperative learning ability. SPL and SASP were positively correlated with self-management ability and cooperative learning ability. Multiple linear regression analysis revealed that SPL, SASP, students' perceptions of atmosphere and students' social self-perceptions had a significant impact on SDL ability.

Conclusions The SDL ability of nursing undergraduates was not high. SPL and SASP were positively correlated with self-management ability and cooperative learning ability. Nursing educators can improve students' SDL ability by changing their learning environment, using, for example, new student-centred teaching methods.

INTRODUCTION

Self-directed learning (SDL) refers to an individual's the initiative in judging their learning needs, establishing their learning

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first study to explore the correlation between learning environment and self-directed learning ability among nursing undergraduates in China.
- ⇒ An advanced statistical method (canonical correlation analysis) was used to evaluate the relationship between the multiple dimensions of learning environment and self-directed learning.
- ⇒ A cross-sectional study approach was adopted and causality cannot be clearly proven.
- ⇒ The nursing undergraduates come from one medical college in Anhui Province in China and the nationwide generalisability was limited.

goals, selecting and implementing appropriate learning strategies and evaluating learning outcomes, with or without help from others.¹ SDL ability is a form of comprehensive ability that students exhibit in the process of learning.² Nursing is an applied discipline that requires students to have a strong skillset and is closely related to life safety and health interests.³ Clinical nursing is a profession that requires rapid knowledge updates and lifelong learning.⁴ Nursing staff need to continuously learn new knowledge and new technologies. Reliance on the knowledge learnt during school is insufficient to meet clinical needs, and nursing staff are required to strengthen their SDL ability to adapt to the rapid updating of nursing knowledge. To adapt to the ever-changing social healthcare needs, the cultivation of senior nursing talents who can independently acquire knowledge has become the main goal and task of training talents for higher nursing education.⁵ Good SDL ability is the foundation of lifelong learning for nursing undergraduates.⁶ Research in China has revealed that the awareness of SDL ability among nursing

undergraduates is weak, and many nurses also regard learning as a burden outside of work.^{7–9} The formation of SDL ability does not happen overnight, so it is particularly important to cultivate SDL ability as part of nursing education in college.¹⁰

The education environment is everything that happens inside a university, including the learning environment, perception of infrastructure, interaction between students and classmates, teachers' attitudes and skills, and many other related factors.¹¹ Students' perception of the educational environment plays a subtle role in learning and contributes positively to learning input and students achievement, which can stimulate students' interest in learning and affect their motivation.^{12–14} Understanding students' perception of the learning environment also helps improve the quality of learning.¹⁵ The Dundee Ready Education Environment Measure (DREEM) is an educational tool based on a questionnaire survey that can be used to 'quantify' the educational environment.¹⁶ It has been translated into a variety of languages and has been used worldwide.^{17–19} An educational experiment in an Iranian medical sciences university revealed that DREEM helps to reduce students' cognitive deficiencies in many aspects of the educational environment and to identify problems that hinder their improvement.²⁰

A survey of nursing and emergency medical services majors at King Saud University showed that a supportive learning environment, including good teaching, clear goals and standards, appropriate assessment, appropriate workload and emphasis on independence, encouraged students to participate in the SDL process, consequently improving their academic performance.²¹ Padugupati *et al* found that a flipped classroom learning environment was a dynamic and more social space that could effectively improve students' learning behaviour, including deep learning, self-efficacy and SDL.²² A mixed approach study involving Indian medical students highlighted that, given the importance of SDL in medicine, curriculum design should increase learning activities to promote SDL and provide strategies to make the learning environment more conducive to SDL.²³ At present, the formed educational environment in Chinese colleges and universities is not conducive to the cultivation and development of students' SDL ability.²⁴ The use of advanced and effective educational methods to create a harmonious and adaptable learning environment so that nursing students can master medical knowledge and clinical skills proficiently while at the same time having a good sense of SDL has become an urgent issue for colleges and universities.

This study investigated the correlations between learning environment and SDL ability among nursing undergraduates. The first purpose of the study was to understand students' perceptions of the learning environment and the levels of SDL ability. The learning environment and SDL ability are multidimensional, and therefore, it is difficult to directly evaluate the relationship between them. And that canonical correlation analysis is a multivariate statistical method, which has been

widely used to study the associations between two sets of variables.²⁵ Therefore, the second purpose of the study was to evaluate the relationship between learning environment and SDL ability by using canonical correlation analysis. This is of great significance for exploring the educational reform plan to improve the SDL ability of nursing undergraduates.

METHODS

Study designs and participants

The study was a cross-sectional descriptive survey conducted in December 2020. The participants were junior and senior undergraduate nursing students from Wannan Medical College in Anhui Province, China. Undergraduate nursing education lasts 3 years and is divided into 2 years basic sciences and clinical medicine education and 1-year internship. The school's nursing programme is composed of three grades: each grade has 20 classes, and each class has 25–33 students. As the students in grade 3 are interns, no questionnaire survey was conducted with them. All students in grades 1 and 2 (1,150 students) participated in the field survey.

The trained investigators distributed questionnaires to students in class. After the investigators read out the unified guidance and told the students to fill in the precautions, the students completed the questionnaire anonymously in the classroom, and the investigators took back the questionnaire on site. Informed consent was obtained and anonymity was ensured from all the participants. Finally, 1096 respondents were included in the final analysis (response rate: 1096/1150=95.30%).

Instruments

The self-designed questionnaire included three parts: sociodemographic characteristics, learning environment and SDL ability.

Demographic characteristics

Demographic variables include gender (male, female), age, grade (first grade, second grade) and birthplace (countryside, town).

Chinese version of DREEM

The Chinese version of the DREEM survey, translated by the medical education research centre of China Medical University, was used to assess students' perception of their learning environment.²⁶ This scale contains 50 items, of which 9 are reverse-scored. Each item is scored on a five-point Likert scale from 0 (strongly disagree) to 4 (strongly agree). The DREEM inventory has five subscales: students' perceptions of learning (SPL; 12 items; eg, 'I am encouraged to participate in class,' 'Long-term learning is emphasised over short-term learning'); students' perceptions of teachers (SPT; 11 items; eg, 'The teachers are knowledgeable,' 'The teachers give clear examples'); students' academic self-perceptions (SASP; 8 items; eg, 'Much of what I have to learn seems

relevant to a career in health care,' 'My problem-solving skills are being well developed') ; students' perceptions of atmosphere (SPA; 12 items; eg, 'The atmosphere is relaxed during consultation teaching,' 'The atmosphere motivates me as a learner') and students' social self-perceptions (SSSP; 7 items; eg, 'I have good friends in this school,' 'I seldom feel lonely'). The total DREEM score is calculated by adding the sum score of five subscales (total score range: 0–200). Calculation of average scoring rate (%): the actual score of the subscale is divided by the full score of the subscale. The higher the score rate, the better the learning environment. The DREEM has good validity and has been widely used among college students in China.^{27 28} Cronbach's alpha values of SPL, SPT, SASP, SPA and SSSP was 0.818, 0.864, 0.786, 0.834 and 0.675 in this study, respectively.

SDL ability

SDL ability was measured by a validated Chinese version of college students' Self-directed Learning Ability Scale.²⁹ This scale contains 28 items, of which 5 are reverse-scored and each item is rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale includes three dimensions: (1) self-management ability, 10 items including the ability to determine learning needs, time management ability and learning monitoring ability (eg, 'I often set learning goals'); (2) information capability, 11 items including information acquisition ability and information analysis and processing ability (eg, 'It is difficult for me to grasp the key points in my study') and (3) cooperative learning ability, 7 items including the ability to communicate and ask for help (eg, 'When other student ask me for my learning experience, I can always say one or two points'). The total score of SDL ability is the sum of the score for each item (total score range: 0–140). A higher score indicated a higher ability of SDL. Calculation of average scoring rate (%): the actual score of the subscale is divided by the full score of the subscale. In present study, Cronbach's α for self-management ability, information capability and cooperative learning ability subscale was 0.802, 0.709 and 0.764, respectively.

Patient and public involvement

None.

Data analysis

The statistical analysis was performed by SPSS V.25 for Windows. Scores for total and each domain were expressed as mean±SD. Categorical variables (eg, gender, grade) were expressed as frequencies or percentage. Pearson's correlation coefficients were calculated to examine the correlation between the learning environment and SDL ability. Canonical correlation analysis was used to analyse the correlation between learning environment and SDL ability. Each dimension of learning environment is taken as X group variables, the corresponding typical variable is U. Each dimension of SDL ability is taken as group Y variables and the corresponding typical variable as V. A

Table 1 Demographic characteristics of the participants (n=1096)

| Variables | Category | Frequency | % |
|---|------------------------------------|-----------|-------|
| Gender | Male | 223 | 20.35 |
| | Female | 873 | 79.65 |
| Class | Freshman | 462 | 42.15 |
| | Sophomore | 634 | 57.85 |
| Age | Mean±SD: 19.34±1.09, range (16–22) | | |
| Birthplace | Countryside | 802 | 73.18 |
| | Town | 294 | 26.82 |
| Do you plan to pursue this major in the future? | Yes | 508 | 46.35 |
| | No | 141 | 12.86 |
| | Uncertain | 447 | 40.79 |

multiple linear regression analysis was used to analyse the effect of learning environment on SDL ability among nursing undergraduates. A value of $p < 0.05$ (two tailed) was considered statistically significant.

RESULTS

Characteristics description

Among the 1096 nursing students in this study, 462 were freshmen and 634 were sophomores. The overall mean age was 19.34±1.09 years (range: 16–22 years). In terms of gender, females accounted for 79.65% of the total respondents and males 20.35%. Only 46.35% of students would plan to pursue their major in the future. Other basic information of 1096 students was listed in [table 1](#).

The overall DREEM mean score was 120.60 (60.30%) of a maximum score of 200, indicating a relative overall satisfaction with the environment but with room for improvement ([table 2](#)). According to subscale, the mean score was 29.01±6.46 for SPL (60.43%), 28.63±6.27 for SPT (65.07%), 17.81±4.54 for SASP (55.66%), 28.92±6.42

Table 2 Mean (SD) subscale and total DREEM scores for nursing undergraduates

| DREEM domains | Full marks | Mean (SD) | Average scoring rate (%) |
|-------------------|------------|----------------|--------------------------|
| SPL | 48 | 29.01 (6.46) | 60.43 |
| SPT | 44 | 28.63 (6.27) | 65.07 |
| SASP | 32 | 17.81 (4.54) | 55.66 |
| SPA | 48 | 28.92 (6.42) | 60.25 |
| SSSP | 28 | 16.25 (3.80) | 58.04 |
| Total DREEM score | 200 | 120.60 (24.72) | 60.30 |

.DREEM, Dundee Ready Education Environment Measure; SASP, students' academic self-perceptions; SPA, students' perceptions of atmosphere ; SPL, students' perception of learning; SPT, students' perception of teaching ; SSSP, students' social self-perceptions.

Table 3 Mean (SD) subscale and total score of SDL ability for nursing undergraduates

| Subscales | Full marks | Mean (SD) | Average scoring rate (%) |
|------------------------------|------------|---------------|--------------------------|
| Self-management ability | 50 | 32.81 (5.56) | 65.62 |
| Information capability | 55 | 34.71 (4.47) | 63.11 |
| Cooperative learning ability | 35 | 21.73 (3.65) | 62.09 |
| Total score | 140 | 89.25 (12.12) | 63.75 |

SDL, self-directed learning.

for SPA (60.25%) and 16.25±3.80 for SSSP (58.04%) domains. The average scoring rate of SASP is relative lower in all dimensions, followed by SSSP (table 2).

The overall SDL ability mean score was 89.25 (63.75%) of a maximum score of 140. According to subscale, the mean score was 32.81±5.56 for self-management ability (65.62%), 34.71±4.47 for information capability (63.11%) and 21.73±3.65 for cooperative learning ability (62.09%) (table 3).

Correlations between the learning environment and SDL ability

Pearson's correlation

The total DREEM scores were positively related with the total score of SDL ability ($r=0.680$, $p<0.001$). Similarly, all subscale scores of DREEM were positively related with three dimensions of SDL ability ($p<0.001$, table 4). It was worth noting that the correlation coefficients between learning environment and SDL ability scores were above 0.4 in all subscales, indicating a moderate level of correlation between them.

Canonical correlation

For the canonical correlation analysis, the X variables represented DREEM (X1=SPL, X2=SPT, X3=SASP, X4=SPA and X5=SSSP) and the Y variables represented SDL ability (Y1=Self-management ability, Y2=Information capability and Y3=Cooperative learning ability). Three

pairs of typical variables were extracted from the results of canonical correlation analysis, and the correlation coefficients of three pairs (0.701 and 0.221, respectively) were statistically significant ($p<0.05$, figure 1, Table 5). The cumulative contribution rate of the first typical variables has reached 94.26% (table 5). Therefore, this study took the first typical variable for explanation.

In canonical correlation analysis, the absolute value of standardisation coefficient represents the weight. The standardised linear functions of the first pair of typical variables are listed as follows: $U1(DREEM)=-0.377 \times X1 + 0.094 \times X2 - 0.350 \times X3 - 0.212 \times X4 - 0.240 \times X5$; $V1(SDL ability) = -0.470 Y1 - 0.299 Y2 - 0.357 Y3$ (table 6).

U1 mainly determined by X1 (SPL) and X3 (SASP), and V1 mainly determined by Y1 (self-management ability) and Y3 (cooperative learning ability). Further typical structural analysis showed that X1 and X3 were negatively correlated with U1, Y1 and Y3 were negatively correlated with V1. Therefore, SPL and SASP are positively correlated with self-management ability and cooperative learning ability.

Multiple linear regression analysis of educational environment on SDL ability among nursing students

In multiple linear regression analysis, the total score of SDL ability was defined as the dependent variable and scores on five dimensions of educational environment were defined as independent variables. After adjusting gender, age, class, birthplace and professional choice, the analysis showed positive significant relationships between score of SDL ability and SPL score ($\beta=0.263$, $p<0.001$); SASP score ($\beta=0.245$, $p<0.001$); SSSP score ($\beta=0.168$, $p<0.001$); SPA score ($\beta=0.153$, $p=0.002$) (table 7).

DISCUSSION

The score rates for self-management ability (65.62%), information capability (63.11%) and cooperative learning ability (62.09%) were all just above 60%, indicating that the SDL ability of nursing undergraduates was not high. The highest score rate was for self-management ability, which was consistent with the results in previous studies.^{30 31} This may be related to the fact that the nursing

Table 4 Pearson's correlation coefficients between learning environment and SDL ability among nursing undergraduates

| Subscales | Self-management ability | Information capability | Cooperative learning ability | Total score |
|-------------------|-------------------------|------------------------|------------------------------|-------------|
| SPL | 0.608* | 0.549* | 0.555* | 0.648* |
| SPT | 0.532* | 0.427* | 0.411* | 0.525* |
| SASP | 0.565* | 0.529* | 0.585* | 0.630* |
| SPA | 0.590* | 0.546* | 0.546* | 0.636* |
| SSSP | 0.574* | 0.520* | 0.565* | 0.625* |
| Total DREEM score | 0.639* | 0.570* | 0.585* | 0.680* |

*There was a significant correlation at 0.01 level (bilateral).

DREEM, Dundee Ready Education Environment Measure; SASP, students' academic self-perceptions; SDL, self-directed learning; SPA, students' perceptions of atmosphere; SPL, students' perception of learning; SSSP, students' social self-perceptions.

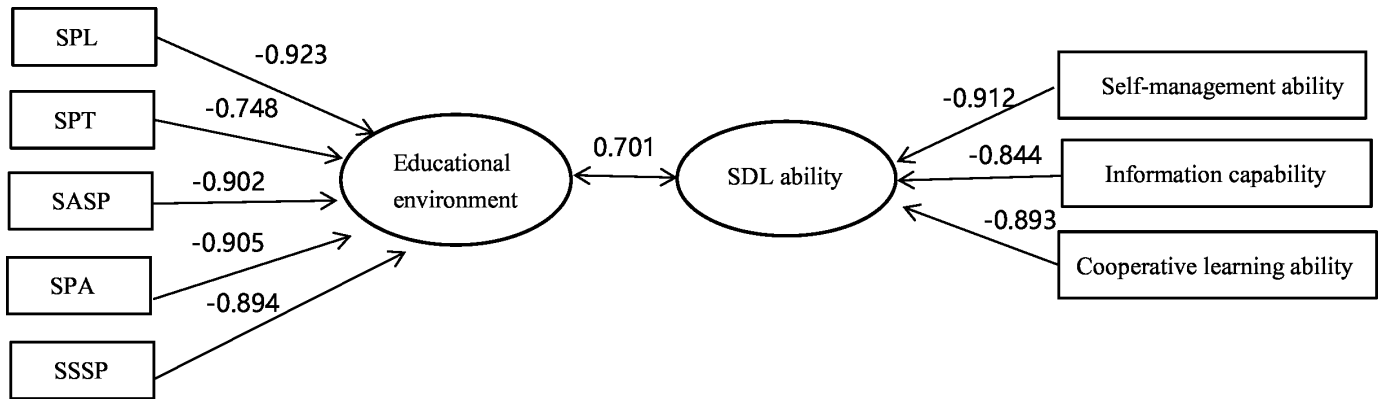


Figure 1 Structure coefficient of canonical factors among nursing undergraduates. SASP, students’ academic self-perceptions; SDL, self-directed learning; SPA, students’ perceptions of atmosphere; SPL, students’ perception of learning; SPT, students’ perception of teaching; SSSP, students’ social Self-Perceptions.

undergraduates were mainly females, and they had better self-planning and self-management for learning. Females’ management learning goals are significantly more positive than males’, because they use more learning self-regulation strategies and display a more positive learning attitude.³² Other studies have shown that females have clear learning goals, strong learning motivation and a strong ability to monitor their learning.³³

The total score for the learning environment was 120.60, with a scoring rate of 60.30%, indicating ‘a more positive than negative’ perception of the environment among nursing undergraduates. The students were generally satisfied with the learning environment. Similarly, the results of two studies conducted in China and India revealed scores of 121.95/200 and 119/200, respectively.^{34 35} The nursing undergraduates had the highest rate for SPT and the lowest rate for SASP, similar to the findings of Gong *et al.*³⁶ This may be related to the teaching reforms in the schools attended by the participants, including a significant adjustment to teaching content and methods in recent years.^{37 38} In terms of teaching courses, the case teaching and video teaching in our school (Wannan Medical College) provide students with more opportunities to communicate with teachers.³⁹ However, SASP had the lowest score rate, followed by SSSP, for all participants. This may be explained by the fact that the students have been engaged in passive receptive learning and rely on mechanical memory, an inefficient learning technique of rote memorisation, to cope with the exams.⁴⁰ As a result, the academic nature of learning has not been developed. In addition, self-generation of knowledge can

activate deeper cognitive processing and improve long-term retention compared with the passive reception of information.⁴¹ It can enable students to not only acquire content knowledge but also an understanding of inquiry skills.⁴¹ Some new teaching models focus on cultivating students’ SDL and in-depth learning rather than rote learning, which is conducive to improving the quality of teaching and promoting the development of education.⁴² Sahu *et al* reported that the SSSP significantly correlates with subjective happiness and suggested that institutions should promote not only students’ academic development but also their happiness by fostering an appropriate educational environment.⁴³ Although the scores for all subscales indicated positive perceptions among nursing students, there is a need for improvement in all five domains of the learning environment, particularly in the SASP subscale. One possible reason is the individuals’ perceptions and misperceptions of their academic ability. If people could accurately judge their own abilities, then

Table 5 Outcomes of canonical correlation analysis and likelihood ratio test

| | Correlation | Proportion (%) | Cumulative | F | p value |
|---|-------------|----------------|------------|--------|---------|
| 1 | 0.701 | 94.26 | 94.26 | 61.110 | <0.001 |
| 2 | 0.221 | 4.96 | 99.22 | 7.976 | <0.001 |
| 3 | 0.087 | 0.78 | 100.00 | 2.754 | 0.041 |

Table 6 Standardised coefficients of the first and second pairs of typical variables

| SDL ability | Variables | Typical variable 1 | Typical variable 2 |
|-----------------|-----------------------------------|--------------------|--------------------|
| DREEM (X) | SPL (X1) | -0.377 | -0.122 |
| | SPT (X2) | 0.094 | 1.467 |
| | SASP (X3) | -0.350 | -0.491 |
| | SPA (X4) | -0.212 | -0.160 |
| | SSSP (X5) | -0.240 | -0.443 |
| SDL ability (Y) | Self-management ability (Y1) | -0.470 | 1.287 |
| | Information capability (Y2) | -0.299 | -0.004 |
| | Cooperative learning ability (Y3) | -0.357 | -1.309 |

DREEM, Dundee Ready Education Environment Measure; SASP, students’ academic self-perceptions; SDL, self-directed learning; SPA, students’ perceptions of atmosphere; SPL, students’ perception of learning; SPT, students’ perception of teaching; SSSP, students’ social self-perceptions.



Table 7 Multiple linear regression analysis of educational environment on SDL ability among nursing students

| Independent variables | B | S.E. | β | t | p value* |
|-----------------------|--------|-------|---------|--------|----------|
| Constant | 48.820 | 2.659 | | 18.360 | <0.001 |
| SPL | 0.493 | 0.095 | 0.263 | 5.208 | <0.001 |
| SPT | -0.140 | 0.079 | -0.073 | -1.780 | 0.075 |
| SASP | 0.654 | 0.098 | 0.245 | 6.695 | <0.001 |
| SPA | 0.289 | 0.092 | 0.153 | 3.141 | 0.002 |
| SSSP | 0.535 | 0.126 | 0.168 | 4.253 | <0.001 |

*The adjustment factors: gender, age, class, birthplace and planning to pursue this major in the future. B, unstandardised coefficient; SASP, Students' Academic Self-Perceptions; SDL, self-directed learning; S.E., standard error; SPA, Students' Perceptions of Atmosphere; SPL, students' perception of learning; SPT, students' perception of teaching; SSSP, Students' Social Self-Perceptions; β , standardised coefficient.

self-perception would play an important role in the acquisition of education and skills. In order to cultivate the SDL ability of nursing students, the focus in improving the learning environment should be included in the academic perception domain.

To the best of our knowledge, this is the first study to explore the correlation between learning environment and SDL ability among nursing undergraduates. The results of the linear correlation analysis revealed that subscales of the learning environment were positively correlated with those of SDL ability among nursing students, indicating that students with higher scores for learning environment have a better SDL ability. The environment is a major stimulus, providing a strong driving force for educational objects. As we all know, an educational environment affects students' achievements, happiness, motivation and success. Sayed and El-Sayed showed that a collaborative, academic and supportive environment might increase the participation of nursing students, while an environment of competition, pressure or threats might reduce their motivation to learn and weaken their interests in the learning process.⁴⁴ Studies have shown that an SDL environment will produce a learner who is self-directed, which can be a contributing factor to enhancing that individual's quality of life or in learning.⁴⁵ In addition, students' motivation and opportunities for the development of deep understanding are important in creating a positive SDL experience, which can affect SDL ability.⁴⁶ In recent years, colleges and universities have devoted considerable attention to developing educational programmes to promote the SDL capacity necessary to prepare students for lifelong learning. However, traditional academic structures may not effectively promote SDL, and there is growing recognition of the importance of an academic climate or environment for students to learn effectively.^{22 23 47 48} Our findings suggest that students' SDL ability can be improved by changing their learning environment, such as a new

student-centred teaching method. One survey of 4257 college students in research universities demonstrated that effective instructor facilitation can influence both students' self-assessment of learning and their perceived utility of the learning activities, and can improve SPL by improving teachers' teaching ability.⁴⁹ Some studies have highlighted that psychological distress and low peer social support work together to reduce medical students' SASP.⁵⁰ Furthermore, a multiwave longitudinal study of Chinese children demonstrated that contributions by SASP to achievement occurred in a progressive, cascading manner.⁵¹ Therefore, it is suggested that steps should be taken to cultivate positive psychological states and students' sense of achievement to improve SASP. SPL and SASP are positively correlated with self-management ability and cooperative learning ability, suggesting that nursing students with a better perception of learning and academia have a stronger self-management ability and stronger cooperative learning. The above results indicate that changing some aspects of the learning environment can significantly improve the learning enthusiasm and initiative of nursing undergraduates.

The canonical correlation analysis indicated that the learning environment was mainly determined by SPL and SASP, and SDL ability was mainly determined by self-management ability and cooperative learning ability. And then, SPL and SASP are positively correlated with self-management ability and cooperative learning ability, suggesting that students' self-management ability and cooperative learning ability can be improved by changing the environment of SPL and SASP, so as to improve SDL ability. Students reporting high satisfaction with the learning environment have a high sense of happiness, which can improve students' passion for learning.⁵² Teachers can improve students' perception of the learning environment by changing traditional teaching methods to improve students' SDL ability. Alshawish *et al* found that case-based blended teaching can improve students' perception of the learning environment.⁵³ Liu *et al* revealed that the teaching model combining virtual simulation technology and network teaching can effectively cultivate the 'student-centred' autonomous learning ability and promote the development of nursing students' autonomous inquiry learning behaviour.⁵⁴ To actively participate in classroom teaching and master the knowledge points of learning, students consciously engage in preclass and postclass reviews, which can improve their self-management ability.⁵⁵ Zhu *et al* changed the nursing education environment using a case teaching method and fully mobilised students' interest in autonomous learning.⁵⁶ Therefore, teachers should constantly explore new education and teaching methods (such as flipped classroom, seminar and problem-based learning) to stimulate nursing students' learning enthusiasm and promote them to adopt in-depth learning methods, so as to achieve the purpose of ability training.⁵⁷

When nursing undergraduates who have a high thirst for knowledge and actively participate in classroom

teaching encounter difficulties in the learning process, they will acquire knowledge through communication and exchange with classmates and teachers, reflecting their good learning and cooperation abilities.^{58 59} A quasi-experimental study concluded that a training programme based on maker education improved students' creativity, learning interest and cooperative learning ability.⁶⁰ The learning environment directly affected students' learning methods and academic achievements, and satisfaction with the learning environment could in turn encourage students to adopt a more positive approach to learning.⁶¹ Therefore, to improve the SDL ability of nursing students, it is indispensable to create an adaptive learning environment. Comparatively strong infrastructure, experienced faculty, competent administration and leadership, as well as an environment that is student-friendly might have contributed to a better learning environment.⁶² Universities and colleges have been faced with the daunting task of having to grapple with the inevitable change by readjusting and reorganising themselves in preparation for the transformation and reconstruction of the traditional higher education model.⁶³ We suggest the following measures, first, the instructional process is personalised in terms of different instructional parameters such as sequence of tasks and task difficulty, time and type of feedback, pace of learning speed, reinforcement plan, etc. Second, the school can provide more social and the communication opportunity for the nursing undergraduate student in education and teaching. The teachers guide the nursing undergraduates to use the new social platform to strengthen the unity and build a good interpersonal relationship and communication environment. Third, teacher-centredness in the teaching process should be changed, and nursing students should be placed at the centre of education.⁶⁴ Hong *et al* revealed that the application of the combination model of Small Private Online Course and Objective Structured Clinical Examination in paediatric nursing training teaching was conducive to stimulate students' learning interest and improve students' professional comprehensive ability, including interpersonal communication ability.⁶⁵ Teachers should therefore adopt exploratory and innovative teaching methods to change the learning role of nursing students based on 'listening and memorising'. Moreover, to improve students' SDL ability, teachers should maximise the enthusiasm and initiative of nursing students in learning.^{66 67}

LIMITATIONS

When interpreting the findings of this study, some limitations should be taken into account. First, a cross-sectional study approach was adopted and causality cannot be clearly proven. Second, all information was obtained from self-reported questionnaires, which may lead to recall and reporting bias. Third, the nursing undergraduates came from one medical college in Anhui Province and the nationwide generalisability was still limited.

A multi-institutional design from more areas is highly prioritised in the follow-up research. Finally, this study adopted a single quantitative data survey method. Qualitative data derived from focus groups could help explore how nursing students approach SDL, what they value in the learning environment, and why self-perception of academic performance scores was low. A mixed-method study (qualitative interview and quantitative survey) is highly prioritised in the follow-up research.

CONCLUSION

In summary, the SDL ability of nursing undergraduates was not high. SPL and SASP are positively correlated with self-management ability and cooperative learning ability. Nursing educators can improve students' SDL ability by changing their learning environment to include new student-centred teaching methods. A multi-institutional and mixed-method design based in other areas should be highly prioritised in follow-up research.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Ethics Committee of Wannan Medical College (LL-2020BH2086). Participants gave informed consent to participate in the study before taking part.

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Data availability statement Data are available on reasonable request.

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