Latent Profile Analysis of Self-Directed Learning in Nursing Undergraduates in China

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Abstract

Aim: To identify the types of self-directed learning (SDL) ability of undergraduate nursing students, and compare the characteristics of different types of SDL ability in demography and other aspects.

Background: The number of nursing students at the undergraduate level has increased significantly. The importance of SDL in nursing education can be revealed by dividing SDL into homogeneous subgroups.

Method: Three universities in Nantong and Shanghai were surveyed cross-sectionally. In univariate analyses, Chi-square tests, Kruskal-Wallis tests, and multiple logistic regression were conducted, as well as correlation factor analysis using LPA analysis.

Results: Through latent profile analysis, the SDL of 752 nursing undergraduates was divided into low-level group (34.7%), moderate-level group (48.4%), and high-level group (16.9%). Univariate analysis showed significant results for every variable except school, ethnic group, voluntary choice of nursing, and transfer to nursing major. Moderate to high levels of SDL in nursing undergraduates were associated with age, school, choice of arts or sciences, voluntary nursing, satisfaction with nursing major, self-directed learning experiences, and learning difficulties, according to multiple logistic regressions.

Conclusion: It is clear from these findings that SDL levels are heterogeneous among nursing students at the undergraduate level. Identifying students' SDL profiles can help us tailor targeted educational programs to their learning profiles, enhancing their professionalism and building the foundations for their future careers.

Key words: undergraduate nursing students, nursing education, self-directed learning, latent profile analysis

Background

As society evolves and progresses, traditional teaching methods are increasingly inadequate to meet the learning needs of contemporary individuals. Modern education is now characterized by lifelong and self-directed learning. Upon identifying and evaluating their learning needs, learners establish learning goals, assess available resources, select appropriate learning methods, and evaluate the outcomes. This process defines self-directed learning (SDL) [1]. SDL endows healthcare professionals with the flexibility, adaptability, skills, and resourcefulness required to remain integral within an evolving healthcare system [2]. Several elements are involved in SDL, including self-monitoring, interpersonal communication, motivation, planning, and implementation. Nurses must continually acquire new knowledge and techniques. SDL capabilities must be enhanced to enable nurses to adapt to rapidly changing nursing knowledge and meet clinical needs based on their academic training [3]. In addition to advancing professional development, SDL enhances nurses' theoretical knowledge and improves their clinical performance [4]. University-level nursing education aims to cultivate nursing professionals capable of independent learning to meet the evolving needs of the healthcare profession [5].

Students' self-management, responsibility, confidence, and independent learning are essential for lifelong learning. Consequently, SDL is an integral component of professional training. Educators can enhance students' SDL by understanding its influencing factors. The findings of this study are divided into non-modifiable and modifiable factors (such as age [6] and gender [7,8]) as well as modifiable factors (such as type of learning program [9,7], years of study [7,8,10], teaching strategies [11], problem-solving skills [12,13], self-efficacy learning interest and learning attitudes [12,14]). Learning environments and individual learning characteristics interact to enhance and develop SDL capabilities. Researchers have investigated regional differences [10], gender differences [7,8], and associations between SDL and other factors among nursing undergraduate students [15-17]. In addition, two articles have examined the relationship between cultural background and SDL [18,19]. Both agree that there are cross-cultural differences in SDL, especially between Western and non-Western students. In China, the education system and teacher guidance may be the factors that affect SDL [18].

Several methods are available to assess students' SDL abilities, including surveys, interviews, teacher evaluations, and behavioral observations [20-22]. It is important to note that the metrics used to evaluate the SDL abilities of medical students vary, as different researchers have defined SDL differently. Nursing undergraduates are commonly assessed for self-directed learning ability using tools such as self-directed learning readiness scale for nursing education (SDLRSNE) [23,24], self-rating scale of self-directed learning (SRSSDL) [25], self-directed learning instrument (SDLI) [26,4]. In addition to being widely used to assess SDL abilities, these scales have demonstrated high reliability and validity.

Latent profile analysis (LPA) can address important information within individuals and consider individual factors instead of judging nursing students' autonomy level based solely on their total score or critical value. LPA determines patterns of multiple variables within individuals rather than examining individual variables or their interactions. As a consequence, heterogeneous groups of individuals may be divided into subgroups that are smaller and more homogeneous[27], thereby providing valuable insight into hidden information[28]. By applying LPA to undergraduate nursing students with SDL, we can identify homogeneous subgroups which make it easier for us to differentiate between them.

In this population, however, no studies have been conducted to analyze the different profiles of SDL, making it difficult to determine the level of SDL among nursing undergraduates. Providing targeted educational programs for different types of students is the best way to strengthen students' theoretical foundations. In this study, factors associated with SDL were analyzed and different subgroups of nursing undergraduates' SDL were identified using LPA.

Methods

Study Design, Population and Setting

The study conducted convenient sampling at three undergraduate institutions in Nantong and Shanghai from March to October 2023. These universities are representative in the field of nursing education, and the diverse backgrounds of the students provide a rich data sample. Moreover, the educational resources in these areas also offer strong support for the research. This study included 752 nursing students at the undergraduate level.

Inclusion criteria were as follows: (1) full-time undergraduate nursing students, (2) students who provided their own consent and participated voluntarily. The following are exclusion criteria: Absent from the questionnaire due to leave or other special circumstances. Student participation will not affect their research, it was explained to them.

Recruitment

The study involved nursing students enrolled in four-year undergraduate programs at three universities. Through communication and coordination with faculty members, researchers recruited nursing undergraduates in classrooms between March and October 2023.

Variables

The sociodemographic characteristics of the study population were coded using the following variables: Gender (male =2, female =1), school (three universities in Nantong and Shanghai are 1,2 and 3 respectively), division of arts and sciences (liberal arts =1, science =2), voluntary choice of nursing (yes =1, no =2), transferred to the nursing major (yes =1, no =2), satisfaction with nursing major (satisfied =1, dissatisfied =2), knowledge level of self-directed learning (not know at all =1, know a little =2, know a lot =3, know completely =4), self-directed learning experience (have =1, no =2), learning difficulties (have =1, no =2), and scores on the five dimensions of the self-learning orientation scale were continuous variables.

Instrument

As part of the general data questionnaire, we collected information about students' gender, age, ethnicity, and place of origin. To assess learners' level of SDL, the Chinese version of Self-Rating Scale of Self-Directed Learning (SRSSDL) has been proven to be both effective and reliable. Five dimensions are included: awareness, learning strategy, learning activity, learning evaluation and interpersonal skills. Each dimension is composed of 12 items. This method uses a five-level Likert scale. The five points are always, often, sometimes, seldom, and never. Positive scores are given to all items. According to their personal opinions and feelings about learning, students choose the most appropriate answer. Scores range from 60 to 300 points, based on all items in five dimensions. A higher score indicates that students are more capable of SDL. Overall, the CVI is 0.963, and all dimensions are above 0.9, suggesting good content validity for the scale. In the Chinese version of the SRSSDL, all subscales have good reliability which is 0.870~0.900, and the Cronbach's α coefficient is 0.967 for the total scale. This indicates that the total scale has good homogeneity reliability, and the subscales are different across levels.

Data Analysis

SPSS 22.0 was used to analyze statistical data regarding the study population. SPSS 22.0 is a powerful statistical analysis software, widely used in social science research, suitable for processing the large amount of data in this study. Median (M) and quartile (IQR) were used to represent continuous non-normal variables, and frequency (n) and percentile (%) were used to represent categorical variables. By using five items from the SRSSDL as observed variables, Mplus 8.3 performed a latent profile analysis. Mplus 8.3 has significant advantages in latent variable model analysis, enabling more accurate identification and analysis of potential categories of SDL. In order to select the right model, we need to consider the following indicators. With in-

creased number of categories, Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample size adjusted BIC (aBIC) gradually decreases, with smaller values indicating better fit. The P-values corresponding to the Lo-Mendell-l-Rubin likelihood ratio test (LMR) and the bootstrap likelihood ratio test (BLRT) are less than 0.05, indicating that the k category is more suitable for the data than the K-1 category. Entropy is used to evaluate the accuracy of category classification. If entropy is greater than 0.8, it means that the classification is accurate above 90 percent. The above indicators must also be taken into account as well as practical significance and interpretability. The sociodemographic variables and SDL were compared using SPSS 22.0, and the Chi-square test and Kruskal-Wallis test were utilized. The statistically significant indicators related to SDL in nursing undergraduates were analyzed using multiple logistic regression analysis. P-values less than 0.05 were considered statistically significant.

Results

Sample Characteristics

The sample consisted of 752 nursing undergraduates from three public schools in Nantong and Shanghai. In the initial data collection, 820 respondents were included, but this was reduced to 752 participants after excluding invalid respondents and those with missing data that was irregular or had deviations greater than 20%. Of the 752 undergraduates, 91.70% responded. Male respondents were 3.1% and female respondents were 96.9%. The participants were between 19 and 24 years old (M±SD = 20.3±1.10). Table 1 provides demographic information.

Preliminary Analysis

Examining the score distribution of the SDL scale is the first step toward understanding nursing undergraduates' SDL level. Researchers collected general information on respondents prior to conducting the LPA. Each item's mean and standard deviation are shown in Table 1.

Table 1: Sample characteristics

	Total (N/%)	Profile 1	Profile 2	Profile 3	x2/F	P
Gender						
Female	729(96.9)	248 (95)	354 (97.3)	127 (100)	7.379[a]	0.025
Male	23(3.1)	13 (5)	10 (2.7)	0 (0)		
School						
1	111(15.9)	40 (16.1)	59 (18.0)	12 (10.1)	4.183[a]	0.382
2	481(69.1)	173 (69.5)	221 (67.4)	87 (73.1)		
3	104(14.9)	36 (14.5)	48 (14.6)	20 (16.8)		
Ethnic group						
Han ethnic group	742(98.8)	259 (99.2)	356 (98.1)	127 (100)	2.781[b]	0.253
Other	9(1.2)	2 (0.8)	7 (1.9)	0 (0)		
Division of arts and sciences						
Liberal arts	357(47.6)	159 (60.9)	174 (48.1)	24 (18.9)	60.543[a]	<0.001
Science subjects	393(52.4)	102 (39.1)	188 (51.9)	103 (81.1)		
Voluntary choice of nursing						
Yes	459(61)	154 (59)	235 (64.6)	70 (55.1)	4.225[a]	0.121

No	293(39)	107 (41)	129 (35.4)	57 (44.9)		
Transferred to the nursing major						
Yes	73(9.7)	20 (7.7)	37 (10.2)	16 (12.6)	2.543 [a]	0.280
No	679(90.3)	241 (92.3)	327 (89.8)	111 (87.4)		
Satisfaction with nursing major						
Satisfied	540(71.8)	146 (55.9)	291 (79.9)	103 (81.1)	49.793 [a]	＜0.001
Dissatisfied	212(28.2)	115 (44.1)	73 (20.1)	24 (18.9)		
Knowledge level of self-directed learning						
Not know at all	62(8.2)	36 (13.8)	20 (5.5)	6 (4.7)	59.447 [b]	＜0.001
Know a little	630(83.8)	221 (84.7)	316 (86.8)	93 (73.2)		
Know a lot	57(7.6)	3 (1.1)	27 (7.4)	27 (21.3)		
Know completely	3(0.4)	1 (0.4)	1 (0.3)	1 (0.8)		
Self-directed learning experiences						
Have	510(67.8)	109 (41.8)	294 (80.8)	107 (84.3)	124.879 [a]	＜0.001
None	242(32.2)	157 (58.2)	70 (19.2)	20 (15.7)		
Learning difficulty						
Have	520(69.1)	242 (92.7)	237 (65.1)	41 (32.3)	151.667 [a]	＜0.001
None	232(30.9)	19 (7.3)	127 (34.9)	86 (67.7)		
Self-directed learning （x±s，scores）						
Awareness	45.41 5.52	40.44 3.53	46.33 3.34	52.98 3.55	592.725 [b]	＜0.001
Learning strategy	44.62 5.67	39.50 3.44	45.49 3.37	52.66 3.58	650.463 [b]	＜0.001
Learning activity	42.29 5.83	37.56 3.57	43.08 3.54	50.91 4.12	579.537 [b]	＜0.001
Learning evaluation	44.20 5.86	38.88 3.65	45.10 3.33	52.54 3.76	666.455 [b]	＜0.001
Interpersonal skills	46.51 6.01	41.43 4.34	47.31 3.80	54.64 3.58	489.999 [b]	＜0.001

Note: a = x2 test; b = F test

Table 2: The unordered polytomous logistic regression analysis for the latent classes of self-directed learning (Significant results only)

Profile		Variables	B	S.E.	Wald	Exp(B) (95%CI)	P
Moderate-level	**Age**		-0.368	0.129	8.167	0.692(0.538~0.891)	0.004
	School	1	-1.320	0.437	9.125	0.267(0.113~0.629)	0.003
		2	-1.210	0.362	11.190	0.298(0.147~0.606)	＜0.001
	Division of arts and sciences	Liberal arts	-0.428	0.209	4.201	0.651(0.432~0.981)	0.040

	Satisfaction with nursing major	Satisfied	0.962	0.234	16.841	2.617(1.653~4.143)	＜0.001
	Self-directed learning experiences	Have	2.001	0.250	63.903	7.399(4.530~12.086)	＜0.001
	Learning difficulty	Have	-1.790	0.304	4.555	0.167(0.092~0.303)	＜0.001
High-level	Age		-0.625	0.161	15.155	0.535(0.391~0.733)	＜0.001
	School	1	-2.982	0.647	21.244	0.051(0.014~0.180)	＜0.001
		2	-1.628	0.491	10.983	0.196(0.075~0.514)	＜0.001
	Division of arts and sciences	Liberal arts	-1.578	0.322	23.939	0.206(0.110~0.388)	＜0.001
	Voluntary choice of nursing	Yes	-0.787	0.306	6.620	0.455(0.250~0.829)	0.010
	Satisfaction with nursing major	Satisfied	0.882	0.349	6.399	2.416(1.220~4.786)	0.011
	Self-directed learning experiences	Have	2.315	0.424	29.808	10.126(4.411~23.248)	＜0.001
	Learning difficulty	Have	2.896	0.361	64.330	0.055(0.027~0.112)	＜0.001

Latent Profile Analysis

There is a gradual decline in AIC, BIC, and aBIC among the five fitted models in Table 3, the entropy is highest for the profile 1 model, and BLRT and LMR have p-values below 0.05 across all fitted models. The profile 4 and 5 models contain too few people in some profile proportions, and the profile 5 model's p-value of LMR is higher than 0.05, so those two were excluded. There is a slight difference in entropy between profiles 3 and 4 indicating that the profile 4 model is best suited to the situation, but one profile accounts for only a small number of people. It means there will be more dispersal of effective information when there are more profiles. The profile 3 model was selected due to its practical significance as well as interpretability. In Figure 1, the scores of the three profiles are calculated based on the latent profile analysis of the five items of the SRSSDL. As can be seen from Table 4, the average probability of the nursing undergraduates in each subgroup belonging to this profile is 91.4%~95.5%, which indicates that the three profiles are reasonable.
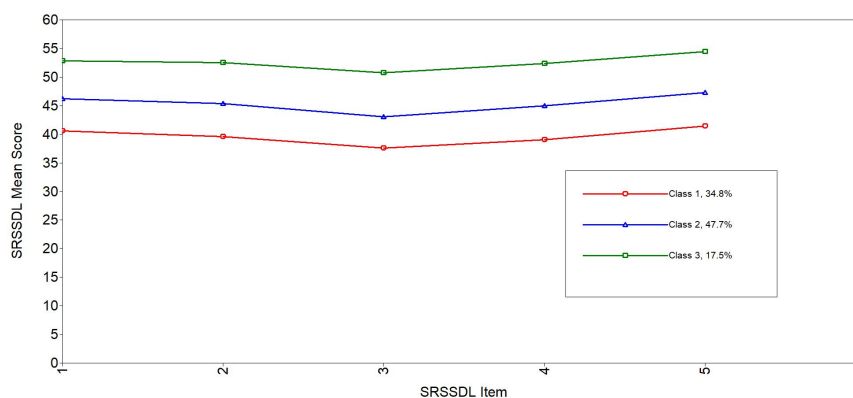

Figure 1: Three self-directed learning profiles for the three categories of best-fit models

Table 3: Model fit indices for One- to Five-Class patterns of SRSSDL subscales and Profile Prevalence (%) from LPA

| Profile	AIC	BIC	aBIC	LMR LR (P)	BLRT (P)	Entropy-1.7	Group size for each profile (n/%)				
							1	2	3	4	5
1 class	23872.660	23918.888	23887.134				752				
2 class	22290.300	22364.264	22313.457	0.0000	0.0000	0.871	484(64.4)	268(35.6)			
3 class	21726.451	21828.152	21758.293	0.0442	0.0000	0.837	261(34.7)	364(48.4)	127(16.9)		
4 class	21426.116	21555.552	21466.641	0.0469	0.0000	0.861	118(15.7)	49(6.5)	215(28.6)	370(42.9)	
5 class	21283.120	21440.293	21332.330	0.4291	0.0000	0.831	280(37.2)	60(8.0)	237(31.5)	131(17.4)	44(5.8)

Note: AIC = Akaike information criterion; BIC = Bayesian information criterion; aBIC = sample size adjusted BIC; LMR = Lo--Mendell-Rubin likelihood ratio test; BLRT: Bootstrapped likelihood ratio test.

Table 4: Probabilities of attribution for each latent profile

Class	Profile 1	Profile 2	Profile 3
Profile 1	0.921	0.079	0.000
Profile 2	0.058	0.914	0.028
Profile 3	0.000	0.045	0.955

Naming of Latent Profile

SRSSDL scores were plotted in Figure 2 based on latent profile analysis results for SRSSDL items. This profile 1 contains 34.7% of the subject, which results in a significantly lower score on each item than profiles 2 and 3. Profile 1 is classified as "low-level" because of its score characteristics; in terms of score characteristics, profile 2 scored between profiles 1 and 3 containing 48.4% of the subject and being classified as "moderate-level"; and the profile 3 contains 16.9% of the subject and scored significantly higher than profiles 1 and 2. Because of its characteristics, this profile was deemed "high-level".
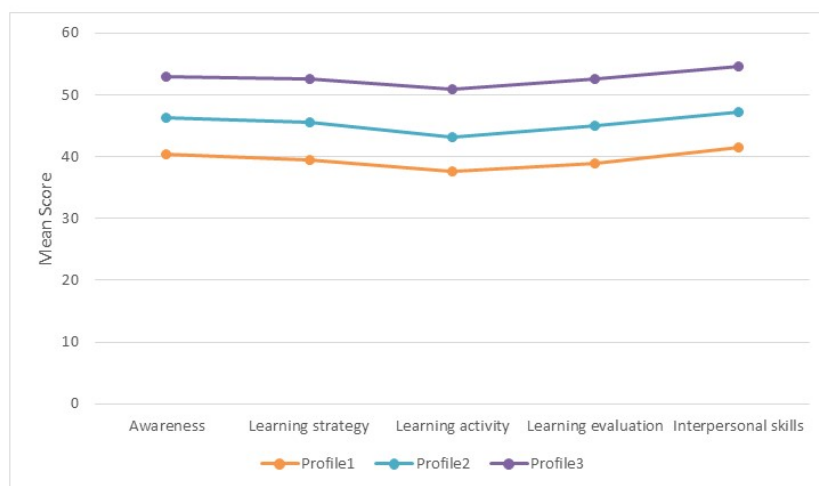
Figure 2: Latent profile model of self-directed learning for nursing undergraduates.

Inter-Profile Characteristic Differences

As shown in Table 1, participants in different profiles had different demographics and SDL abilities. It was found that all variables except school, ethnic group, voluntary choice of nursing, and transfer to the nursing major were less than 0.05 across all comparisons. In all three profiles, the majority of nursing undergraduates were female, the majority were Han Chinese, and

47.6% and 52.4% of the total chose arts and sciences.

Multinomial Logistic Regression of Self-Directed Learning Profiles

Results of unordered multinomial logistic regression for SDL subtypes in Table 2 indicated that compared to cases in the low-level group, participants in the moderate-level group were more likely to be older (OR=0.692, P=0.004) and more likely to be students in school 1 (OR=0.267, P=0.003) and 2 (OR=0.298, P0.001), and they were more likely to choose liberal arts majors (OR=0.651, P=0.040), be satisfied with nursing (OR=2.617, P0.001), have an understanding of self-directed learning, have self--directed learning experiences (OR=7.399, P0.001), and have learning difficulties (OR=0.167, P0.001). Participants in the high--level group were more likely than those in the low-level group to be older (OR=0.535, P0.001), more likely to be students in schools 1 (OR=0.051, P0.001) and school 2 (OR=0.196, P0.001), more likely to choose liberal arts majors (OR=0.206, P0.001), voluntarily choose nursing (OR=0.455, P=0.010), be satisfied with nursing (OR=2.416, P=0.011), have an understanding of self--directed learning, have self-directed learning experiences (OR=10.126, P0.001), and have learning difficulties (OR=0.055, P0.001).

Discussion

This study aimed to classify SDL subgroups among nursing undergraduates and identify factors associated with SDL. Three profiles were selected based on rational criteria: low-level, moderate-level, and high-level. According to the LPA, 34.7% of nursing undergraduates were classified as low-level, exhibiting the lowest scores across all five dimensions. A total of 48.4% of undergraduate nursing students were categorized as intermediate, representing the highest proportion among the three profiles, with overall SDL scores also at an intermediate level. The percentage of high-level undergraduate nursing students was 16.9%, the lowest among the three profiles, yet they achieved the highest average scores across all dimensions. The consciousness and learning strategy subdimensions had the closest scores. Compared to the other four subscales, interpersonal skills received the highest scores across all three profiles, while learning activities received the lowest.

The univariate analysis revealed that gender, academic discipline (arts and sciences), satisfaction with the nursing program, understanding of self-directed learning, self-directed learning experiences, and learning difficulties were significant factors influencing undergraduate nursing students' SDL. Previous research suggests that SDL ability may be influenced by gender. Evidence from studies supports the notion that females possess greater self-evaluation and self-management skills compared to males [29,30]. Females exhibit stronger motivation and self-monitoring abilities, along with more academic self-regulation strategies, a positive attitude toward learning, and clear goals [31,32]. However, the study also found that male nursing students scored higher on SDL than their female counterparts [33]. The inconsistency in research on gender and SDL indicates the need for further studies to determine the impact of gender on SDL among nursing students. This knowledge can inform the development of educational strategies to enhance students' motivation to learn.

Several factors were identified as being related to the categories derived from unordered multinomial logistic regression analysis. High-level students were typically older, enrolled in School 1 or School 2, majoring in liberal arts, satisfied with the nursing program, and had more extensive learning experiences compared to low-level students. However, a significant association was found between high SDL and the voluntary choice of nursing major. Some previous studies have found that SDL and age are significantly correlated [8,34]. Scores on SDL readiness were higher among older students or those at a more advanced academic level [8]. It is plausible that years of study influence SDL. Junior and middle-year students are still adjusting to their majors and may not fully comprehend their learning, whereas senior students have a better grasp of their major and career, enabling them to make more informed career decisions [35,36]. The learning process is also more self-directed for learners with greater life and educational experiences [25]. Consequently, older students may possess a greater ability for SDL from this perspective.

According to national policy, Chinese high school students are categorized as either liberal arts or science students. Nursing students with a science background tend to exhibit greater logical thinking and planning abilities. In this study, the percentages of

liberal arts and science students were 47.6% and 52.4%, respectively. The results of multifactorial analyses indicate that students from different high school divisions exhibit varying levels of SDL. Consistent with previous studies, SDL competency was positively associated with satisfaction in the nursing degree program [37]. Research on gender differences in SDL has been inconsistent, indicating a need for further studies to determine whether such differences exist among nursing students. This will help in developing educational strategies to enhance students' motivation to learn [14,38]. The high-level group was more likely to comprise students who had voluntarily chosen the nursing profession compared to the low-level group. Changing majors can also impact students' enthusiasm and satisfaction with their chosen professional field.

Furthermore, this study concluded that differences in SDL exist among undergraduate nursing students from different institutions. Several studies have correlated undergraduate nursing students' SDL competencies with their learning environment. The learning environment serves as a major stimulus in achieving educational objectives. Nursing students may exhibit higher engagement in learning within a supportive environment, whereas those in a competitive environment may display reduced motivation to learn [39]. Researchers suggest that SDL environments enhance the quality of life and learning conditions, fostering more self-directed learners [40,41]. The study also found that the moderate and high-level groups were more likely to include students with self-directed learning experiences and learning difficulties. Prior learning experiences are more likely to cultivate self-directed learning habits, increased self-discipline, and a clearer understanding of self-directed learning. The pursuit of obtaining a degree motivates students with learning difficulties to exert greater effort.

Nurses at all stages of their education, as well as practicing nurses, have identified SDL as an effective learning method [42]. Various strategies and teaching methods have been proposed to enhance students' SDL abilities, such as web-based learning, mixed methods, group learning, interactive methods, and flipped classrooms [43,44]. Educators should be cognizant of the fact that each generation of nursing students possesses distinct learning styles. Understanding the heterogeneity of SDL among various categories of nursing students aids in the formulation of teaching methods in nursing education. To effectively transfer professional knowledge and enhance students' SDL abilities, educators should integrate a variety of teaching methods. Acquiring SDL skills during their education ensures that nursing students' knowledge and skills remain relevant post-graduation. This long-term benefit extends to the nursing profession.

Limitations

This study is limited by a number of factors. The sample size of this study is moderate for a local descriptive study. As different learning environments and approaches may affect students' SDL, the findings suggest that students differ locally on their SDL. Furthermore, the sample size was primarily female, making it difficult to evaluate gender differences. There is some bias in this data as it was self-reported. The results of this study cannot be interpreted as causal since it is a cross-sectional study.

Conclusion

Nursing educators should focus more on students at different levels of learning in order to achieve the best academic performance. It may be necessary to provide guidance and support at different levels for students at different levels of learning. Students can develop SDL abilities by monitoring their problem-solving skills, developing their learning habits, receiving adequate guidance, and learning according to their interests and abilities. Research using interventions and higher quality methods is recommended in order to better understand the factors that enhance SDL ability in students at all levels.

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Declaration of Competing Interest

None

Authors' Contributions

This study was conceptualized and designed by all authors, and the data was acquired, analyzed, interpreted, and written, revised, and submitted. Additionally, the authors have approved all aspects of the work.

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