Advances in Educational Technology and Psychology (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/aetp.2025.090107
ISSN 2371-9400 Vol. 9 Num. 1

Analysis of the Mediating Effect between Digital Learning Ability and Learning Performance of Online Learning Inputs in an Anatomy and Histology Course for Higher Vocational Nursing Students under the "Three Combinations and Three Forms" Multi-integrated Teaching Model

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Keywords: Higher vocational nursing students; "Three Combinations and Three Forms"; Multi-integrated teaching; Anatomical histomorphology course; Online learning input; Digital learning ability; Learning performance; Mediation effect

Abstract: Based on the "Three Combinations and Three Forms" multi-integrated teaching model, the mediating role of online learning inputs in Anatomy and Embryology course between digital learning ability and learning performance was investigated for higher vocational nursing students. Using the Basic Information Form, Digital Learning Competency Scale, Learning Performance Scale and Online Learning Input Scale for senior nursing students, 813 groups of valid questionnaires were analyzed using SPSS 26.0 software for descriptive statistical analysis, t-test, ANOVA, Pearson's analysis, and Bootstrap analysis of mediation effect. The results showed that the online learning input, digital learning ability and learning performance of the Anatomy and Embryology course were significantly correlated with those of the senior nursing students in the "three combinations and three forms" multifaceted fusion teaching mode.

1. Introduction

Under the instructions of the State Council's Guiding Opinions on Further Promoting the Development of Vocational Education Informatisation and other documents, digital teaching reform in vocational education is in full swing. Learning performance, as a direct indicator for assessing the competence and literacy of higher vocational nursing students, is a factor that runs through the nursing talent training system. Current research suggests that studies on learning inputs of college student

populations have shifted from focusing only on behavioural inputs to cognitive, affective and behavioural levels[1-2]. These three dimensions can have a direct impact on learning performance, and meta-analyses have found[3-4] that the main factors influencing the learning performance of university students taught online include: instructional characteristics, learner characteristics, and environmental characteristics, which include factors such as students' learning engagement. It can be seen that due to the special characteristics of the anatomy discipline, online learning and teaching also have their own special characteristics, which cannot rely on online teaching and cannot be carried out completely in accordance with the traditional teaching, therefore, the research group has developed a "Three Combinations and Three Forms" multi-integrated teaching model based on the characteristics of the anatomy discipline, and initially found that there is a significant correlation between the students' online learning input and the students' digital learning ability, and the students' learning performance. It was also found that students' online learning investment was directly related to their digital learning ability and learning performance in anatomy. However, when it comes to higher vocational nursing students, who are more inclined to vocational skills training, the mediating effect of students' learning input on digital learning ability and learning performance in anatomy and histology course is still vague, and the study lacks focus. And in fact, the factors affecting the competence and literacy of higher vocational nursing students are not only the influence of external environmental factors such as school resources and the degree of teacher education, but also the influence of subjective factors such as the learners' own temperament, self-efficacy, learning satisfaction and affective attitudes [5-6]. This has also been of great concern to scholars at home and abroad, especially at the level of learning engagement [7]. In this study, the learning engagement of senior nursing students in anatomical histomorphology course is cognitive level, affective level and behavioural level interacting and influencing each other. It has a direct positive predictive effect on their learning performance, digital learning ability directly affects learning performance, and there is a significant positive correlation between digital learning ability and learning input. In order to promote the digital transformation of vocational education to the classroom, teachers and students to give further policy support and resources.

2. Information and Methodology

2.1. Subject of the Study

To ensure a minimum sample size for this study, the formula for the minimum size of simple non-return sampling of the sample for a finite overall sample with a 95% confidence interval is as follows:

$$n = \frac{N}{1+\frac{(N-1)}{P(P-1)}(\frac{\alpha}{k})^2} \quad (1)$$

The total number of nursing students in the five higher education institutions in Shanghai from 2021 to 2023 was 8391, from which the minimum sample size required for this study was calculated to be 368 groups. In order to cover a little more of the number of people in each college, this random sampling of more than 800 groups was planned.

2.2. Methods

A stratified cluster sampling method was used to randomly select one class in different grades of nursing majors in five higher vocational colleges and universities in Shanghai, and 813 sets of valid questionnaires were retrieved, including 280 students in the first year of senior high school, 311 in the second year of senior high school, and 222 in the third year of senior high school, with the total number of male students being 351, and that of female students being 462. The students were assessed

on their online learning (including the completion of offline independent study tasks) of the Anatomical and Embryology course between February 2023 and January 2024 when they participated in the "Three Combinations and Three Forms" multi-integrated teaching and learning programme.

This survey used Questionnaire Star to produce electronic questionnaires to be sent to the sampled respondents via WeChat or QQ software by trained enumerators in each school, and each person was issued with 1 set of questionnaires, containing 1 basic information sheet and 3 sub-questionnaires.

The digital learning competence scale for senior nursing students mainly draws on the digital learning competence evaluation scale for college students compiled by Li Yuan [8] et al. to develop and design a scale containing five dimensions, namely, digital learning awareness, digital learning technology application, digital learning behaviour, digital learning management, and digital learning evaluation. In this study, the Cronbach's α coefficient of the digital learning ability scale for senior nursing students was 0.936.

The Learning Performance Scale for Higher Vocational Nursing Students draws on the research scales of Wang Dong (2008) [9] and others on the learning performance of college students. Three dimensions such as quality dimension, behavioural dimension and time dimension were used to define learning performance to form the Higher Vocational Nursing Student Learning Performance Scale. Higher scores of nursing students' learning performance mean better students' learning performance. In this study, the Cronbach's alpha coefficient of the Learning Performance Scale for senior nursing students was 0.905.

The Online Learning Engagement Scale for Higher Vocational Nursing Students mainly draws on the Online Learning Engagement Evaluation Scale for College Students compiled by Jiaxin Li [10] et al. and refers to the Distance Students' Learning Engagement Evaluation Scale (SEM Scale) compiled by Fredericks and the National Students' Learning Engagement Scale (NSSE Scale), and is designed to contain three dimensions of behavioral, cognitive, and affective inputs after translation and item analysis. The Online Learning Engagement Scale for Higher Education Nursing Students. In this study, the Cronbach's α coefficient of the Online Learning Engagement Scale for Senior Nursing Students was 0.898.

2.3. Statistical Methods

Data were processed and analysed using SPSS 26.0 software package. Including descriptive analysis, t-test, Pearson correlation analysis and Bootstrap method of mediation analysis. $p < 0.05$ difference was statistically significant.

3. Results

3.1. General Information

This survey randomly distributed 815 groups of questionnaires to nursing students in five higher vocational colleges in Shanghai area. After testing, 2 invalid questionnaires were excluded, and 813 groups of valid questionnaires were obtained, with an effective rate of 99.75%. The general information of the surveyed higher vocational nursing students is detailed in Table 1.

3.2. Based on the "Three Combinations and Three Forms" Anatomy and Embryology Course for Higher Vocational Nursing Students

The teaching design based on the "Three Combinations and Three Forms", i.e., teaching virtue, teaching morality, teaching ethics, teaching emotions, and various teaching modes such as inquiry, project, group, etc., is an innovative idea of integrating the elements of ideology and politics into the

professional teaching. It is an innovative idea to integrate the elements of Civics and Politics into professional teaching. Among them, "Three Combinations" focuses on integrating moral, reason and emotion elements into the teaching process; "Three Forms" includes three teaching modes of inquiry, project and group, focusing on practice, interaction and cooperation. The model makes full use of advanced teaching tools such as the Digital People STEM 7.0 platform to realise smart teaching both online and offline. In the online part, students' interest in learning is stimulated through the release of pre-study materials and guiding questions; in the offline part, three-dimensional models, virtual anatomy and other functions are used to visually display anatomical knowledge and explain the connotations of Civics and Politics in conjunction with practical cases, thus forming a new paradigm for teaching that is complementary to the online and offline parts of the programme.

3.3. Comparison of Learning Performance of Anatomical Histoembryology Courses of Higher Vocational Nursing Students with Different Characteristics

The results showed (Table 1) that there was a significant difference in the learning performance of nursing students with different genders and from different places of origin ($P< 0.05$). There was no significant difference in the learning performance of students from different teaching year groups, different family incomes, and different acquisition of vocational certificates in the anatomy group embryology course ($P> 0.05$).

Table 1: Comparison of Learning Performance of Anatomical Histomorphology Course among Higher Vocational Nursing Students with Different Characteristics Under the "Three Combinations and Three Forms" Multi-Integrated Teaching Model [N (%), $x \pm s$].

	Form	Distributions	Learning Performance ($x \pm s$)	t/F	P
Distinguishing Between the Sexes	Male	40.25	37.33 ± 8.04	2.330	0.020*
	Women	59.75	35.36 ± 10.33		
Grade Level	Lower Grade	33.25	35.00 ± 7.59	2.134	0.120
	Middle Grade	38.00	37.02 ± 8.18		
	Higher Grade	28.75	36.34 ± 9.31		
Origin of Students	Eastern Part	41.75	35.31 ± 9.36	3.081	0.047*
	Central Part	37.00	37.50 ± 8.23		
	Western Part	21.25	35.47 ± 5.96		
Household Income	Low Income Families	7.00	33.89 ± 7.71	0.968	0.408
	Well-off Family	27.50	36.13 ± 7.60		
	Middle Income Families	49.00	36.17 ± 8.73		
	High Income Families	16.5	37.10 ± 8.72		
Acquisition or Non-Acquisition Certificates	Yes	66.75	36.31 ± 8.63	0.540	0.589
	No	33.25	35.83 ± 7.80		

Note: *P<0.05; **P<0.01; ***P<0.001

3.4. Online Learning Input and Digital Learning Ability of Senior Nursing Students in the "Three Combinations and Three Forms" Multi-Integrated Teaching of Anatomy and Histology Course

In the "Three Combinations and Three Forms" multi-integrated teaching of anatomy and histology course, the behaviour of senior nursing students' online learning input is as follows Behavioural engagement dimension 13.11±3.42 points, cognitive engagement dimension 11.70±3.76 points, emotional engagement dimension 13.02±3.05 points. In this integration of teaching and learning, the scores of the three dimensions of online learning engagement of senior nursing students were in the medium level. The level of behavioural engagement of the subjects is at a medium to high level, and they are able to make positive adjustments in their learning behaviours to participate in online learning. And the emotional engagement dimension was higher than the cognitive engagement dimension, suggesting that although the senior nursing students were able to obtain positive emotions such as pleasure and satisfaction from the online learning of Anatomical Histomorphology, the specific cognitive dimension was lower than the behavioural and emotional engagement.

Digital learning awareness dimension of digital learning competence 12.47±3.46 points, digital learning technology application dimension 12.22±3.58 points, digital learning behaviour dimension 11.50±3.80 points, digital learning management dimension 14.89±2.73 points, digital learning evaluation dimension 10.92±4.18 points. There are 278 cases (30.22%) with poor digital learning ability, 412 cases (44.78%) with moderate digital learning ability, and 230 cases (25%) with good digital learning ability, suggesting that the number of students who can have the ability to ensure the effectiveness of online course learning accounts for a relatively small number.

3.5. Correlation Analysis of Online Learning Input, Learning Performance and Digital Learning Ability of Anatomy and Histomorphology Course for Senior Nursing Students in the "Three Combinations and Three Forms" Multi-Integrated Teaching

Using Pearson correlation analysis, there is a significant correlation between all variables, and the correlation coefficients are all positive, which is positively correlated.

3.6. Effect of Online Learning Inputs on Digital Learning Ability and Learning Performance of Anatomy and Histoembryology Course of Higher Vocational Nursing Students in the "Three Combinations and Three Forms" Multi-Integrated Teaching

"Three combinations and Three forms" diversified fusion teaching, the learning performance total scores of Anatomy and Histoembryology of higher vocational nursing students had a mediating effect on digital learning ability and learning performance (β=0.338, P<0.001), with 95% confidence interval of (0.160) and (0.308) respectively. In the "three combinations and three forms" multifaceted and integrated teaching, the total performance score of senior nursing students in anatomical histopodology had a mediating effect on digital learning ability and learning performance (β=0.338, P<0.001), with 95% confidence intervals of (0.160) and (0.308), respectively.

In this model, the online learning inputs of senior nursing students in anatomical histomorphology exerted partial mediating effects between digital learning competence and learning performance, respectively, with the following resultst, as shown in Figure 1.

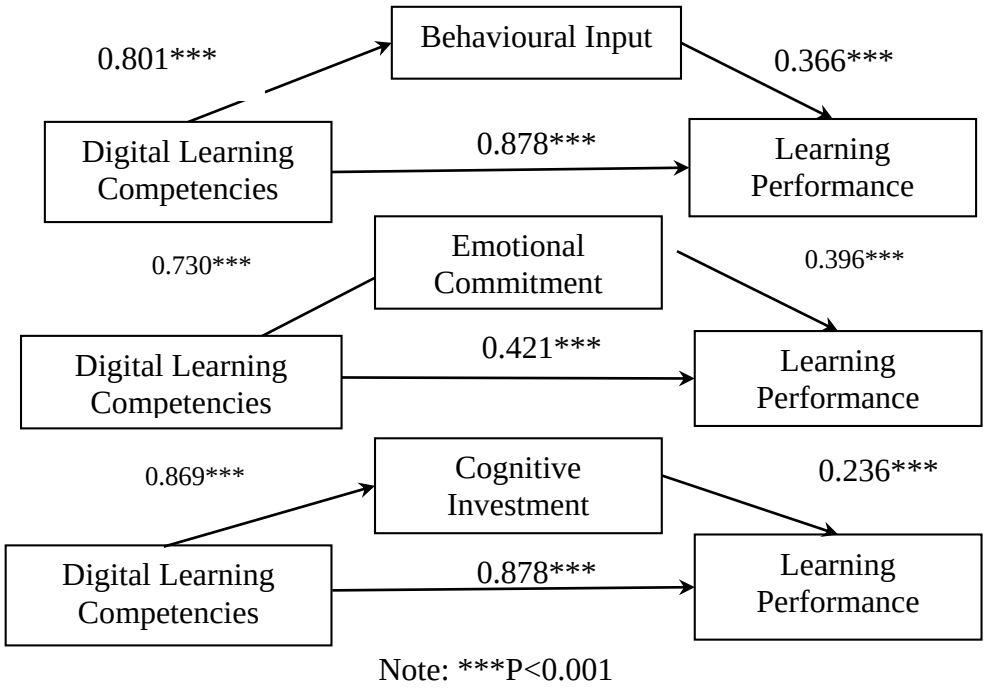

Figure 1: Mediation Effect Model Between Digital Learning Ability and Learning Performance of Online Learning Inputs in Anatomical Histomorphology Course for Higher Vocational Nursing Students Based on the "Three Combinations and Three Forms" Multi-Integrated Teaching.

4. Discussion

4.1. Overall Online Learning Performance of the Anatomy and Histomorphology Course for Higher Vocational Nursing Students Based on the "Three Combinations and Three Forms" Multi-integrated Teaching

In this study, the higher vocational nursing students' own level of commitment to online learning and their level of digital learning ability are important factors influencing their level of learning performance. The level of behavioural engagement of the subjects was in the middle to high range, revealing that the digital resources and teaching tools used in the "Three Combinations and Three Forms" multi-integrated teaching, such as the STEM 7.0, were in line with the "Appetite" of the senior nursing students. On the online learning input of 676 higher vocational nursing students, so teachers should protect the enthusiasm of higher vocational nursing students for learning. Meanwhile, many new anatomical digital educational resources are being widely explored, and it remains to be tested whether they have gained the demand and acceptance of senior nursing students oriented towards vocational skills cultivation [11].

4.2. Predictive Effect of the Level of Digital Learning Ability on the Learning Performance of Senior Nursing Students in Anatomy and Embryology Based on the "Three Combinations and Three Forms" Multi-integrated Teaching

This study found that the level of digital learning ability of senior nursing students significantly predicted the level of their learning performance in the exploration of the new teaching mode of anatomy and embryology. Better digital learning competence of senior nursing students positively predicted better learning performance. And that the exploration of "Teaching with Morality, Teaching with Moral Values, and Teaching with Emotions" should be further consolidated to actively assist

higher vocational nursing students in their learning performance. To further consolidate the exploration of “Moral teaching and Emotional teaching”, we actively help senior nursing students to focus on their own learning strengths, lead them to improve their digital learning ability in active learning, actively explore the digital world, and learn to make use of digital devices with more disciplinary characteristics, such as digital teaching resource libraries, online open courses, and AR virtual simulation and real training systems. Teachers should also design intelligent measurement tools, pay attention to process evaluation and formative evaluation, promote learning through evaluation, build a digital and intellectual three-dimensional talent cultivation environment, and expand the space and time for senior nursing students to learn.

4.3. The Mediating Role of Online Learning Engagement in Anatomy and Histomorphology between Digital Learning Ability and Learning Performance of Senior Nursing Students in the Anatomy and Histomorphology Course Based on the “Three Combinations and Three Forms” Multi-integrated Teaching

The present study found that the online learning engagement of the senior nursing students in this model significantly impacted the outcome of learning performance. Both higher and lower levels of online learning input significantly predicted the learning performance of senior nursing students. Consistent with the findings of Li Shuang's survey on online learning of 433 distance students [12], it also supports the Distributed Cognition Theory that learners' own inputs at the cognitive level, affective level, and behavioural level are important factors influencing their online learning performance, i.e., the students “learn by actively learning about the ways other individuals construct knowledge and problem-solving models” to adapt to the self-directed learning style in cyberspace. In this study, higher vocational nursing students who have more behavioural input into the online learning course on anatomical histoembryology, who integrate the elements of Civics into their professional teaching, and who are more emotionally invested in the course, will show a more positive overall learning state, and therefore will have a relatively higher learning performance. And relative to the behavioural input and emotional input, the cognitive input is more positive. It is recommended to mobilize the teaching staff, objective environmental factors, and peer factors to help senior nursing students to improve the level of online learning input, do a good job of time management and self-regulation in terms of behaviour, pay attention to the effective application of online resources in cognition, and improve the adaptation to online teaching in terms of emotion [13], in order to improve the online learning input of senior nursing students.

5. Conclusion

This study evaluates the outcomes and behavioural mechanisms of digital online learning for senior nursing students from the perspective of senior nursing students based on the application of the “Three Combinations and Three Forms” multi-integrated teaching model in the Anatomy and Histology course for senior nursing students, taking into account the characteristics of the learning performance of senior nursing students, and provides a reference for the intervention of learning inputs for nursing students during online learning in the vocational education stage. It can provide a reference for the intervention of learning input during online learning for nursing students in vocational education stage.

Acknowledgement

Funding: 2025 Shanghai Education Science Research Project[grant numbers(C2025269) ; Famous teachers and Demonstration Courses of Ideological and Political Education in Shanghai Higher

Vocational Colleges in 2024 (kswh2024-xm09); Shanghai Higher Education Association 2024-2026 Annual Planning Project (1QYB24105); The second Huang Yanpei Vocational Education Thought Research Project (ZJS2024YB274).

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