ISSN 2475-529X

Research Article

Journal of Nursing & Healthcare

The Application of "Two-line and Six-stage" Teaching Mode in Teaching Human Anatomy in Nursing

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Submitted: 2023, Aug 08; **Accepted**: 2023, Sep 24; **Published**: 2023, Sep 28

Citation: Xiaofeng, J., Feier, C., Chuanling, W., Kaixuan, D. (2023). The Application of "Two-line and Six-stage" Teaching Mode in Teaching Human Anatomy in Nursing. *J Nur Healthcare, 8*(4), 310-316.

Abstract

Background: *Human Anatomy always causes major hindrances to the learning of nursing students. We designed this study to observe the effectiveness of the "two-line and six-stage" (TLSS) teaching mode based on model making in teaching Human Anatomy in nursing.*

Methods: *One class in the nursing major in Grade 20 was randomly selected as the control group, in which the traditional teaching mode was adopted; while, another class in the same major and grade was selected as the observation group, in which the TLSS teaching mode was adopted. After the course teaching was completed, these students in both groups were compared from the perspective of the final theoretical examination and physical specimen assessment. Besides, the evaluation of the teaching effectiveness of these students from both groups was also investigated.*

Results: *The observation group outperformed the control group in both theoretical examination and physical specimen assessment, which was specifically manifested in six evaluation items, including the novelty of teaching methods, the elimination of the difficult points of the course, the mobilization of the learning enthusiasm, the interestingness of the course teaching, its effects on clinical thinking training, and the interpretation of the knowledge.*

Conclusion: *The TLSS teaching mode based on model making can improve the effectiveness in teaching Human Anatomy.*

Keywords: Anatomy; Medical education; Instructional design

Abbreviations

TLSS:two-line and six-stage; MR: mixed realitytools; 3DR:three-dimensional reconstruction; MOOC: massive open online courses; CT: computed tomography; MRI: magnetic resonance imaging; AR: Augmented reality; 3DP:3D printing; CBL: case-based learning;

Background

Human Anatomy is a fundamental course in nursing education, and nearly 1/3 of medical terms are elucidated in Human Anatomy. This course is mainly involved in the morphological characteristics and location of human organs adjacent to each other. Therefore, a thorough understanding of related knowledge in this course is crucial for nursing students to learn the subsequent clinical courses.

However, the extensive memorization required in the study of anatomy can make it dull and cause loss of interest in learning [1]. The traditional lecture-style teaching mode for anatomy, which aims to construct a systematic knowledge framework, further affects students' learning enthusiasm [2]. Therefore, educators in anatomy are trying to adopt strategies to shift the focus of teaching from knowledge transmission to knowledge construction [3]. To achieve this, anatomists have made many beneficial attempts to explore innovative and attractive teaching methods to increase student engagemeant and consistency with learning objectives [4, 5].

Traditionally, cadaver dissection was considered as an effective method for learning anatomy, providing a better understanding of the three-dimensional relationships between human body structures [6]. However, due to the decreasing availability of donated bodies, it is no longer sufficient to meet the needs of medical education [7]. Therefore, most nursing students in medical schools do not participate in cadaver dissection, which poses higher demands on their three-dimensional spatial imagination when studying this course. To address this issue, anatomical models and specimens became the first teaching aids, which allowed students to understand more easily in a "see and touch" way [8]. With the development of information technology, 3D visualization technology and augmented reality technology have gradually been applied to anatomy teaching, which can help students better understand the anatomy three-dimensional structures [9, 10].

Of course, for nursing students, the main goal of learning anatomy is to apply it in clinical cases. Therefore, how to strengthen students' clinical thinking during basic medical courses has become a major direction for the reform of anatomy teaching. Active teaching models such as flipped classroom are widely adopted to develop multiple teaching modes that highlight the student-centered concept [2, 11, 12]. In teaching practices, jigsaw teaching activities, peer instruction, case-based learning[3], and problem-based learning have all been proven effective [13-15].

With the advancement of Internet technology, an increasing number of means to present information have emerged, and various online learning resources are developed to provide more learning approaches. Research has shown that blended learning, which combines online and face-to-face teaching, is a promising teaching model. Due to the fact of students are also familiar with Internet technology, they have a natural passion and preference for these digital products based on Internet technology. Therefore, it is a significant direction for teaching reforms in colleges and universities to design effective teaching methods and modes according to students' learning characteristics in response to the new learning conditions in the context of the information era [17].

Through analyzing the characteristics of Human Anatomy in detail, it can be concluded that visuo-spatial ability is necessary for the learning of this course. Besides, making 3D anatomical models by using space clay (a material similar to Play-Doh) should be an effective means to enhance students' 3D spatial comprehension of anatomical structures. Based on that, we hope to utilize the information transmission advantages of the internet to extend the learning process from the classroom to fragmented time outside of class.. Based on 3D anatomical model making, the understanding of students can be improved by integrating model evaluation with relevant clinical cases. Thus, anatomical knowledge can be combined with real clinical scenes. The learning content can be further consolidated by means of post-class evaluation and mind mapping. In this way, the basic concept of the TLSS teaching mode is formed. To verify the effectiveness of this teaching model, we conducted this teaching research.

Methods

2. Implementation of Teaching Research

2.1Preparation Stage

(1) Scientific Analysis of Students' Learning Characteristics and Interests

Questionnaires and interviews were performed to investigate and analyze students' learning characteristics and demands, so as to gain an in-depth insight into their cognitive level of Human Anatomy, as well as their learning interests and demands for knowledge related to the human structure.

(2) Identification and Analysis of The Requirements for Knowledge Related to Human Anatomy in Clinical Nursing Positions

We extensively consulted medical and health institutions on the requirements for nursing graduates' basic medical knowledge, especially human anatomy, to determine the teaching focus and guide the development of the course teaching plan.

(3) Preparation of The Teaching Platform and Integration of Teaching Resources

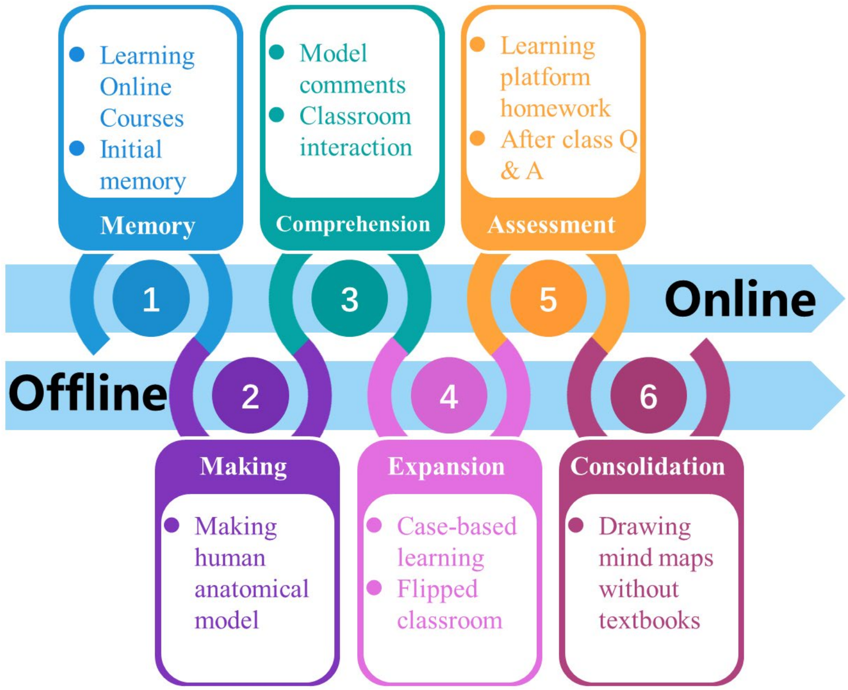
The teaching faculty could proficiently use the Cloud class platform, prepare lessons collectively according to the syllabus, conduct teaching design, discuss teaching plans, prepare clinical cases used in teaching, and compile a database of test questions used before, during and after the lesson.

2.2Teaching Implementation

2.2.1 The Control Group: The traditional lecture-based teaching model was adopted, with pre-class preview tasks assigned to students to familiarize them with the relevant course content. During class, lectures were delivered using multimedia forms such as PPT combined with the Chinese Digital Human Three-dimensional Anatomy software, and actual clinical cases were used to help students understand. After class, students completed corresponding assignments, which were then graded by the teacher.

2.2.2 Observation Group: The TLSS teaching mode was adopted in the observation group.

The TLSS model refers to the online and offline mixed teaching mode, which decomposes the course teaching activities into six stages, including memory, making, comprehension, expansion, assessment, and consolidation (Fig. 1).



(1)Two Lines (Online and Offline Mixed Teaching)

① **Online teaching:** The teaching resources of massive open online courses (MOOC) are utilized to guide students' independent learning. Besides, the Cloud class platform is adopted to realize online Q&A and online assessment before and after class. In addition, various classroom interactions are also carried out in class. Students could use the Mobile 3D Anatomy (an APP) to improve their visuo-spatial ability.

② **Offline Teaching:** The important and difficult questions put by students online could be solved within limited time offline, which achieves effective complementarity between online and offline.

(2)Six Stages

① **Memory:** Before class, students can conduct self-study from MOOC resources, and understand the basic theoretical knowledge in the course with the assistance of the Digital Human Mobile Anatomy (an APP). Meanwhile, some questions raised by students can be answered by the online Q&A, so that students can preliminarily master the knowledge related to the course.

② **Making**: Students work in groups (3-5 students in each group) to make a model of the human body related to the course using space clay according to their preliminary knowledge after learning from the MOOC resources before class. They are asked to reflect the major structures of the anatomical parts in the model. After completing model making, students upload the photos of their models to the Cloud class platform.

③ **Comprehension:** In class, the deviations and errors of cognition reflected in their models are corrected and difficult questions are solved through inter-group assessment and teachers' comments. The key points are then emphasized through the assessment and interaction in class.

④ **Expansion:** In class, the important and difficult points of the course are introduced by combining clinical cases. With the adoption of flipped classroom, brainstorming, and group discussion, students can apply their knowledge of the human body structure to clinical cases based on the knowledge points of the course. In this way, their clinical thinking skills can be cultivated.

⑤ **Assessment:** Post-class assignments are posted on the Cloud class platform to assess students' understanding about the course contents. Targeted post-class Q&A is conducted online based on the assessment results.

⑥ **Consolidation:** After completing the post-lesson assessment, students are asked to independently draw a mind map about the course contents, and then revise and supplement the mind map according to the textbook.

3. Teaching Evaluation Methods

3.1 Process Evaluation System

(1) The control group evaluated students' progress based on their post-class assignments.

(2) The observation group implemented a multi-dimensional evaluation system throughout the entire process of pre-class, in-class, and post-class.

Before the class, these students were tested in terms of the theoretical knowledge learned from the MOOC resources through model making and pre-class tests.

During the class, these students were evaluated in terms of important and difficult points through the cloud classroom test. Various evaluation methods, such as inter-group evaluation and teacher review, were adopted to correct the improper cognition of these students.

After the class, students were evaluated objectively through the cloud class test and self-evaluated by drawing a mind map and making modifications.

3.2 Research Indicators

3.2.1 Final Assessment Results

This section was composed of two parts, namely the theoretical examination and physical specimen assessment. The theoretical examination accounted for 60% of the final closed-book examination. The course group made out unified questions in A and B examination papers according to the course standard. The examination papers were randomly divided by the coin flip method and scored by the anonymous method. As for the physical specimen examination, the random number table method was adopted to draw 40 anatomical parts of 40 specimens, with 40 students in one group. The drawing of each specimen shall be completed within 1 minute during the round-robin examination. The examination was also scored by the anonymous method.

3.2.2 Teaching Satisfaction Evaluation

The teaching quality management platform was used to issue a uniformly designed teaching satisfaction questionnaire, including 10 evaluation items, such as the novelty of teaching methods, the conformity with the teaching schedule, the elimination of difficult points, the logicality of the teaching contents, the conformity of the teaching with students' aptitude, the mobilization of learning enthusiasm, the interestingness of the teaching, the effects on clinical thinking training, the classroom atmosphere, and the interpretation of knowledge. Each item was divided into five options from good to bad, including strongly agree, agree, average, disagree and strongly disagree, corresponding to 100, 75, 50, 25 and 0 points respectively. Finally, the overall average score was calculated.

3.3 Statistical Analysis

SPSS25.0 software was used to conduct statistical analysis. The t-test was conducted, with the measurement data expressed as x±s; the rank data were tested by the rank-sum test; $P<0.05$ was considered statistically significant.

Results

1.The final assessment scores of these students in both groups were compared.

The results demonstrated that the scores of both theoretical examination and physical specimen assessment in the observation group were higher than those in the control group. There was a significant difference between both groups ($P<0.05$) (Table 1).

Group	Number of subjects	Theoretical examination (x± s, score)	Physical specimen assessment (x±s, score)
Control group	55	82.75±6.15	79.55±7.06
Observation group	56	87.08±6.99	85.94±7.59
t		3.469	4.593
P		0.001	<0.001

Table 1. Comparison of final examination results between both groups

2.The teaching effectiveness evaluation of students in both groups

111 questionnaires were distributed in both groups and 111 valid questionnaires were collected, with a valid return rate of 100%. The evaluation results showed that there was a difference between both groups in six evaluation items, including the novelty of teaching methods, the elimination of difficult points, the mobilization of learning enthusiasm, the interestingness of the teaching, the effects on clinical thinking training, and the interpretation of knowledge ($P<0.05$). The mean rank of the observation group was higher than that of the control group, suggesting that the evaluation of the observation group was better than that of the control group. There was no significant difference between both groups in terms of the four evaluation items, including the conformity with the teaching schedule, the logicality of the teaching contents, the conformity of the teaching with students' aptitude, and the classroom atmosphere, as shown in Table 2.

Evaluation projects	Group	Evaluation results (persons)					Average rank order	Z	P
		Strongly agree	Agree	Average	Disagree	Strongly disagree			
The novelty of teaching methods	Control group	40	8	3	3	1	51.18	-2.291	0.022
	Observation group	50	4	2	0	0	60.73		
The conformity with the teaching schedule	Control group	46	6	1	2	0	55.42	-0.302	0.763
	Observation group	48	5	2	1	0	56.57		
The elimination of difficult points	Control group	44	3	4	3	1	52.17	-2.090	0.037
	Observation group	52	3	1	0	0	59.76		
The logicality of the teaching contents	Control group	48	3	4	0	0	56.01	-0.005	0.996
	Observation group	49	3	2	2	0	55.99		

The conformity of the teaching with students' aptitude	Control group	44	5	3	2	1	54.75	-0.608	0.543
	Observation group	47	6	1	1	1	57.23		
The mobilization of learning enthusiasm	Control group	44	4	4	3	0	52.15	-2.105	0.035
	Observation group	52	4	0	0	0	59.79		
The interestingness of the teaching	Control group	44	4	4	3	0	52.35	-1.991	0.046
	Observation group	52	2	1	1	0	59.58		
The effects on clinical thinking training	Control group	42	4	3	5	1	51.77	-2.156	0.031
	Observation group	51	2	2	1	0	60.19		
The classroom atmosphere	Control group	50	2	1	2	0	54.90	-0.796	0.426
	Observation group	53	2	1	0	0	57.08		
The interpretation of knowledge	Control group	42	4	5	4	0	51.80	-2.124	0.034
	Observation group	51	2	2	1	0	60.13		

Table 2. Evaluation of teaching effectiveness by students of both groups

Discussion

Due to the fact that 3D positions of some structures are difficult to understand and the structural terms are relatively close to each other and not easy to remember, Human Anatomy has always been a complicated lesson for most students. In recent years, with the emergence of new technologies such as digitalization and information technology, many useful attempts have been made by medical schools in terms of anatomy teaching methods and approaches. Zilverschoon M et al. used thin-layer images to reconstruct 3D virtual models of the hand and wrist for anatomy teaching [18]. Meulen et al. applied high-fidelity anatomy simulation to the teaching of pelvis and sternum anatomy [19]. Medical imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) are increasingly being used in anatomy courses in order to provide students with a better understanding of various clinical conditions discussed in gross anatomy courses [9]. Augmented reality (AR) technology, which offers a better immersive experience, is also currently being adopted in anatomy teaching related to the application of diagnostic imaging (e.g., point-of-care ultrasound) [20]. 3D printing (3DP) technology is another new way to arise students' interest in learning by scanning and printing the anatomical structures of anatomical specimens. This technique can be employed to construct an organ and model application that allows students to communicate and learn in small groups [21].

In this study, students could understand the 3D location of anatomical structures by making 3D models. Meanwhile, they could obtain the key points of Human Anatomy through six progressive learning stages.

The TLSS teaching mode is designed to improve students' activity in the learning process. This design concept is closer to the so-called "learning pyramid" model, sometimes called Edgar Dale's Pyramid, which has been widely cited in medical education in recent years. Although the model has not been supported by empirical evidence, the idea that active learning is more effective than passive learning has been confirmed by many studies. For example, Freeman et al. showed that active learning can improve the performance of science, engineering, and mathematics students [22, 23]; Metz et al. applied active learning strategies to the teaching of dental physics courses, and also confirmed that students with this strategy can achieve better results compared with traditional teaching methods [24].

Among these six stages, the expansion stage is more like case-based learning (CBL), where clinical cases are incorporated into the teaching process. It can not only arise students' interest in learning, but also help them understand the anatomical structures. As is revealed in some studies, the use of CBL in anatomy courses has shown favorable results in terms of students' examination scores, self-confidence, enjoyment, motivation, and ability to facilitate their anatomical learning [25].

The consolidation stage is based on the Feynman Technique. This learning model is developed by Richard Feynman, a winner of the Nobel Prize in Physics, whose core concept is to guide and develop students to conduct self-study and then interpret complex problems and knowledge to others through plain language. In this study, this concept has been refined as the knowledge output with a mind map. According to some studies, the establishment of relationships between the concepts expressed in the mind map contributes to improving critical thinking skills [26].

Of course, there are some shortcomings in this study. As is revealed from the results of the teaching effect questionnaire, there is no significant difference between both groups in terms of the conformity of the teaching with students' aptitude. This may be due to the fact that teachers pay less attention to and interact with the personalized learning process of students. Fairén's research suggests that students are more concerned with autonomy in the learning process, while teachers tend to favor collaborative learning because it facilitates the sharing of knowledge and experience [27]. This requires us to further refine the teaching process, share out the work and cooperate with one another, in an attempt to construct a more concise teaching model to truly personalize education in the future. Meanwhile, a small sample size and a short observation period may affect the evaluation results. Thus, a larger sample size is needed for further research.

Conclusions

The TLSS teaching mode could effectively stimulate students' interest in learning, cultivate their clinical thinking, transform the learning mode, and improve the quality of teaching.

Of course, in the entire teaching design, we still need to further improve, such as how to fully utilize the data analysis function of the online teaching platform, focus on the learning situation of each student, generate personalized learning profiles, and formulate personalized teaching plans. At the same time, the effectiveness of this model also needs to be further verified and improved in a larger sample size [16].

Funding

This study was supported by Educational Science Planning Project of Zhejiang Province (No.2023SCG277) and Zhejiang Industry Polytechnic College 2023 Campus-level High-level Teaching Development Cultivation Project

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