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Article

Research on online and offline integrated teaching mode of labor education practice for nursing students by integrating mixed reality technology

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Abstract: The traditional teaching mode focuses on the explanation of the theoretical knowledge of labor education, but the medical case knowledge is relatively specialized, while some of the knowledge is highly abstract, the students' practical understanding is low, and the teaching progress is slow. In this regard, the study firstly designed an online and offline integrated labor education curriculum system based on mixed reality technology (MR), and proposed practical teaching in labor education based on virtual classroom and three-dimensional images. Then, the 3D image reconstruction is designed using this technology, and the image schematic is formed using the coordinate system calculation and 3D reconstruction principle. The feature point matching accuracy of MR-based 3D reconstruction technology reaches 86.5%, and the camera trajectory error is small, which ensures the quality of image reconstruction results. Finally, in this paper, 80 students undergoing internship in the Second Affiliated Hospital of Medical University of Province A were selected as the observation objects, and the satisfaction of teaching mode, assessment results and labor literacy of the two groups of students were compared and analyzed. The results show that the teaching mode of labor education for nursing majors based on MR technology can effectively improve teaching efficiency, enhance students' satisfaction, and facilitate the growth of students' assessment scores.

Keywords: Mixed reality technology; coordinate system calculation; three-dimensional reconstruction; labor education

1. Introduction

Nursing labor practice education course is a part of nursing discipline, which has an indispensable role in cultivating students' comprehensive ability, practical experience and sense of responsibility [1-2]. In this course, students have to experience not only the exercise of skills, but also the comprehensive improvement of psychological quality, emergency response ability, and teamwork [3-4]. Through this practical education, students are better prepared to transition to the workplace and face the various complexities that may arise in actual nursing work. With the improvement of social medical care, the demand for nursing talents is increasing, so the training of talents for nursing students' labor education practice has become an important task [5-7]. However, the traditional nursing students' labor education practice adopts the “teacher-centered” teaching mode, which faces the problems of lack of practical operation, single subject knowledge, lack of interaction and personalized teaching, etc., and it is difficult for students to actively participate in classroom teaching [8-10].

With the continuous development of information technology, education is also undergoing revolutionary changes, the combination of mixed reality (MR) technology and online-offline integrated teaching mode has brought a new teaching experience for nursing students [11-13]. Online-offline integrated teaching is the use of network technology, teaching resources, learning activities, communication platforms and other learning resources organically combined together to achieve the coordination of online and offline teaching, with rich learning resources, personalized learning methods and other teaching advantages [14-17]. And labor education practice course as a theoretical and practical subject, online and offline teaching mode can better stimulate students' learning interest and improve the teaching effect by combining MR technology [18-20]. MR technology is a multi-dimensional combination of virtual reality and augmented reality, which is realized through specific equipment such as head-mounted displays, glasses, sensors and so on, and its advantages include immersive experience, real-time information interaction, high degree of visualization, etc. [21-23]. MR technology opens up an efficient and three-dimensional new teaching mode for nursing students, which helps to improve the learning effect of anatomy teaching, clinical practice teaching, case analysis, etc., in labor education practice courses [24-26].

In the field of nursing education, basic nursing technology is an important knowledge and ability that students must master, and how to use MR technology to improve the teaching quality and efficiency of basic nursing technology has always been one of the urgent problems. In this regard, literature [27] reviewed the existing evidence on the application of MR technology in nursing practice, pointing out that current studies have mainly examined a variety of MR applications, including smart glasses and mobile applications, covering different nursing specialty areas. Literature [28] describes how nursing schools are currently integrating MR technology into students' didactic training, with the aim of facilitating students to cope with challenging scenarios in real-world situations and ensuring that they are adequately prepared. Literature [29] analyzed the application of MR technology in the education of nursing students, and pointed out through experiments that MR technology not only increased students' motivation and participation in learning, but also helped to enhance their clinical judgment and develop their ability to observe patients' body signals. Literature [30] pointed out that there are many challenges in the provision of clinical practice, and student clinical placements during the New Crown outbreak became a key moment in facilitating students' engagement in the practical learning experience, and elaborated that in this context, students can utilize hybrid display devices for distance learning.

In addition, literature [31] describes the impact on nursing education of the development and application of virtual reality and augmented reality technologies, the use of which is currently an integral part of the curriculum, and highlights the positive impact of the use of technology on nursing students' learning. Literature [32] examined the use of head-mounted display-based MR technology in nursing education, and the literature review indicated that despite the widespread use of MR technology in nursing education, there is still room for improvement in the relevant theories and the use of this technology. Literature [33] emphasized the use of MR technology in nursing simulation to effectively improve students' practical skills and developed an MR-based nursing intubation simulation system for nursing professionals, which provided an immersive and efficient platform for training in operational skills in nursing education. Literature [34] reviewed the literature on MR nursing education in prehospital emergency care and analyzed the role of MR equipment in prehospital emergency care education, emphasizing that the use of MR equipment in teaching can improve students' motivation and learning efficiency.

With the development of information technology and the popularization of the Internet, online education is gradually concerned, and for the nursing profession, how to effectively integrate online and offline resources to improve the quality of teaching and enhance the learning effect of students has also become one of the hotspots of current research in the field of education. Literature [35] aims to assess the effectiveness of online and offline teaching modes in surgical nursing internship teaching, and points out through comparative experiments that online and offline teaching can improve nursing students' skill performance and independent learning ability more than traditional teaching methods. Literature [36] compared the teaching effectiveness of the traditional teaching mode and the combined online and offline teaching mode, and the results pointed out that the online and offline teaching mode improved students' theoretical knowledge, operational ability and professionalism. Literature [37] pointed out the continuous innovation of surgical nursing teaching methods and proposed the online-offline teaching mode, which was shown to stimulate students' creative learning thinking through virtual surgical nursing scene experiments.

In addition, literature [38] explored the effect of online-offline hybrid teaching mode on students' cognition of mental illness in psychiatric nursing courses, and pointed out through controlled experiments that online-offline hybrid teaching mode significantly improved students' learning effect. Literature [39] aimed to study the blended teaching model and its effects in community nursing, and through a questionnaire survey of students using online and offline teaching, it was emphasized that the teaching model in applicable to the teaching of the nursing profession and can improve the overall competence of students. Literature [40] analyzed the relationship between online and offline teaching modes and the development of cognitive abilities of clinical medical students, and by comparing the experimental results of the two teaching modes showed that the online teaching mode performed better. Literature [41] aimed to compare the effects of online and offline teaching with traditional face-to-face teaching in nursing education in terms of knowledge, skills and satisfaction, and emphasized that the online and offline teaching modes were superior to the traditional mode in terms of knowledge acquisition and skill performance. Literature [42] compared the effects of offline and online learning on the learning outcomes of medical students, and based on the literature review emphasized the advantages of online learning over offline learning in terms of knowledge and skill outcomes.

This paper designs a teaching model for labor education in nursing that involves the application of virtual classroom and 3D imaging. In this regard, the study explores the 3D reconstruction technique based on MR technology. Three-dimensional images are reconstructed using a linear calibration method according to the principle of image presentation. This method can significantly improve the matching accuracy of feature points, and the reconstruction results are of better quality. The reconstruction of the case treatment scene using this technology is conducive to improving the skill level of students and enhancing their labor literacy.

2. Design of labor education teaching mode for nursing majors based on MR technology

2.1. Paths for integrating labor education into the teaching of the nursing profession

2.1.1. Using classroom teaching as a platform to consolidate labor knowledge and skills

In the teaching of nursing labor education courses, to help nursing students establish correct labor values as the guide, digging deep into the elements of human education, so that nursing students are clear that physical labor and mental labor are equally worthy of respect, simple labor and complex labor are not differentiated between high and low, as long as it is diligent and down-to-earth labor that contributes to the development of the community are all honored. Nursing students' professional basic courses and professional core courses are an important part of learning labor knowledge and skills, cultivating labor quality and establishing a correct view of labor.

2.1.2. Enhancement of labor awareness and literacy through apprenticeships and internships

Apprenticeship and internship is the process of nursing students' labor practice in real labor situations such as medical institutions, nursing homes, etc. It serves as the rehearsal for nursing students before employment and is the transition stage for them to move from school to society. Through apprenticeship and internship to understand the nature of labor, labor norms and labor process, familiar with the labor scene, nursing students will learn during the school period of labor knowledge and skills to form a valuable labor experience, not only the labor skills have been exercised, labor awareness has also been strengthened, the correct attitude to labor, improve the ability to communicate, collaboration and psychological quality.

2.2. Design of online and offline integrated labor education curriculum system

2.2.1. Enrichment of online educational resources

The construction of an online and offline integrated labor education curriculum system cannot be separated from the support of rich educational resources. Therefore, teachers in colleges and universities should fully explore the teaching resources in offline teaching materials and online platforms to promote the all-round penetration of labor education curriculum concepts. With the help of the online education platform to create a second classroom, follow the requirements of discipline integration, collect labor education content in other professional disciplines and present it to students to meet students' personalized and diversified learning needs.

2.2.2. Innovative forms of labor education courses

Virtual teaching is a novel and immersive teaching mode in the information technology era. To build an online and offline integrated labor education curriculum system, colleges and universities can be equipped with a special virtual smart classroom with intelligent and integrated teaching equipment, carry out virtual labor education course testing, enter the learning situation of labor education courses of students of various majors into the test indicators, automatically generate test results and improvement suggestions, and provide teachers and students with references for improving classroom teaching [43]. After entering textbook information and students' basic information on the online learning platform, big data will automatically push video materials and case analyses of specialized courses for students according to their preferences and learning habits. In the offline classroom, teachers can answer questions from the side and provide comprehensive guidance for students' learning. Teachers in the online classroom can use catechism, live teaching, remote guidance, online synchronous discussion, etc., while in the offline classroom, they can carry out project-based teaching, experimental teaching, internship training teaching, scenario-based teaching, case study teaching, etc., guiding the students to participate in the activities with the elements of labor education, creating a classroom with humanistic care, and enhancing the effectiveness of education in labor education courses.

2.3. Design of labor education teaching mode for nursing majors

Based on the previous description, to meet the online and offline integrated labor education model of nursing specialty should focus on the combination of theory and practice, enrich teaching resources, and innovate the form of education. In this regard, this paper uses mixed reality technology to design the teaching mode of nursing professional labor education.

2.3.1. Building the virtual classroom

Colleges and universities can use mixed reality technology to build virtual simulation platforms for students and construct virtual classrooms. Students from different regions can access the virtual classroom by using Internet technology for audiovisual learning. Students as well as teachers can do the following when learning in the virtual classroom:

(1) The live image of the teacher can be transmitted to the client in real time, discriminated, tracked, and presented to the students in a three-dimensional state.

(2) Teachers can independently control the virtual scene as well as the courseware during the lecture.

(3) Students and teachers in different locations and regions can communicate with each other anytime and anywhere using the Internet and online platforms to solve students' confusion in learning.

(4) Online students can use the mixed reality technology online teaching platform for online virtual experimental learning, and offline can use the mixed reality technology supporting glasses for virtual and real interactive operation, the teacher's teaching methods are more intelligent and diversified.

(5) Has a good course record function, for teachers, you can watch the playback to improve their teaching skills, for students, they can watch the playback to answer questions and supplement notes.

2.3.2. Establishment of offline virtual laboratories

In order to improve the practical skills of students in offline teaching, teachers can use mixed reality technology to build virtual laboratories for students, medical imaging technology professional equipment and images in the form of 3D stereo in front of the students, which can be used to explain the relevant theoretical knowledge, so that the theoretical learning has become more graphic and vivid. In addition, students in the virtual laboratory, you can carry out animal model operation and a variety of molecular biology basic operation, not only to avoid the waste of animal resources, but also to effectively improve students' practical ability.

3. 3D reconstruction based on MR technology

The teaching model of labor education in nursing designed in this paper involves the application of virtual classroom and three-dimensional images. In this regard, the study used MR technology [44] to reconstruct the image in three dimensions to realize the three-dimensional presentation of the teacher and the image.

3.1. Establishment of the coordinate system

Image three-dimensional reconstruction needs to establish a coordinate system, through the camera positioning to realize the relationship with the real three-dimensional world mapping, that is, through the formation of the coordinate system to make it with the human body layer mapping relationship, so as to establish the three-dimensional graphics, in the whole theoretical derivation process, the image three-dimensional reconstruction needs to make use of the various coordinate systems, including the camera coordinate system, the image coordinate system, the world coordinate system, and the imaging plane coordinate system, the four kinds of coordinate systems are combined with each other. The four coordinate systems are combined with each other.

3.1.1. Image coordinate system

Image coordinate system in grayscale images can be viewed as a digital image, can be composed of two-dimensional digital matrix, formed by the majority of the matrix imaging plane, both each matrix element value is different, and its brightness information is not the same, you can express the data contained in a pair of images. The image plane coordinate system is shown in Figure 1. Where U is the image horizontal coordinate. V is the image vertical coordinate. The image plane coordinate system is built on the basis of digital matrix, and so on, so as to combine with the world coordinate system corresponding to the specific image.

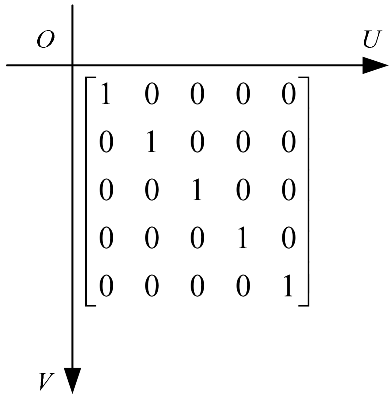

Figure 1. Image plane coordinate system.

3.1.2. Imaging plane coordinate system

The imaging plane coordinate system is shown in Figure 2. Through the matrix pixel coordinates to form the imaging plane coordinate system, in simple terms, the imaging plane covers the imaging plane coordinate system, like the CCD sensing element plane is the digital camera imaging plane, the origin is the intersection of the imaging plane and the optical axis, notated as O_I, and its unit is set to mm.

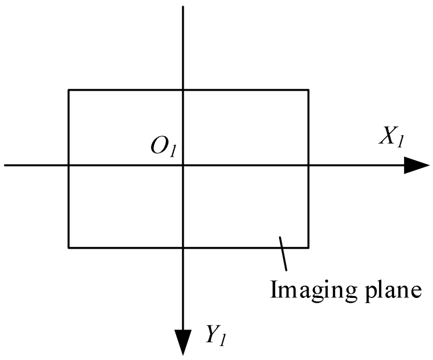

Figure 2. Imaging plane coordinate system.

The imaging plane is based on the light beam formed by the camera's sensing element, which corresponds to the coordinate system in a certain ratio, thus forming an image matrix. In this case, the points of the coordinate system are related to each other, so the relationship between the point (u, v) in $U-O-V$ and the point (x_I, y_I) in the imaging plane coordinate system $X_I - O_I - Y_I$ is shown in Equation (1):

$$u = \frac{x_I}{dx} + u_0, v = \frac{y_I}{dy} + v_0 \quad (1)$$

Where: (u_0, v_0) is the coordinate corresponding to the $X_I - O_I - Y_I$ origin O_I in $U-O-V$. dx and dy are the physical dimensions of the pixels in each image corresponding to the imaging plane

($dx \cdot dy$ (in mm^2) is the area of each imaging plane coordinate system for a pixel in the small cell representation of the image). u is the transverse coordinate of the point (u,v). v is the vertical coordinate of the point (u,v). x_I is the horizontal coordinate of the imaging plane coordinate system. y_I is the vertical coordinate of the imaging plane coordinate system.

Combined with the imaging plane coordinate calculation, Eq. (1) is transformed with the matrix as shown in Eq. (2):

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{dx} & 0 & u_0 \\ 0 & \frac{1}{dy} & v_0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x_I \\ y_I \\ 1 \end{bmatrix} \tag{2}$$

3.1.3. Camera Coordinate System

Based on the principle of the imaging plane coordinate system, the camera maps the camera object on the camera coordinate system $O_C - X_C - Y_C - Z_C$ to form an effective camera imaging, and the relationship between the camera coordinate system and the imaging plane coordinate system is shown in Figure 3. The coordinate origin O_C coincides with the center of projection, similar to the origin translation, and the X_C and Y_C axes are parallel to the X_I and Y_I axes of the imaging plane coordinate system $X_I - O_I - Y_I$, but will be zoomed in or out equivalently. Where the Z_C axis coincides with the optical axis, it can be seen that the camera has a correspondence with the imaging plane, and the distance between O_C and O_I is the focal length of the camera f, which can be presented at a certain distance from the focal length.

Fig. 3 shows the transformation based on Fig. 2, and the presentation relationship can be determined by using Eq. (1), which can obtain the relationship between the object point $P(x_C, y_C, z_C)$ in the camera coordinate system $O_C - X_C - Y_C - Z_C$ and the image point $p(x_I, y_I)$ in the imaging plane coordinate system $X_I - O_I - Y_I$, as shown in Eq. (3):

$$x_I = \frac{f \cdot x_C}{z_C}, y_I = \frac{f \cdot y_C}{z_C} \tag{3}$$

Equation (3) can be transformed into a matrix as shown in equation (4):

$$z_C \cdot \begin{bmatrix} x_I \\ y_I \\ 1 \end{bmatrix} = \begin{bmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} x_C \\ y_C \\ z_C \\ 1 \end{bmatrix} \tag{4}$$

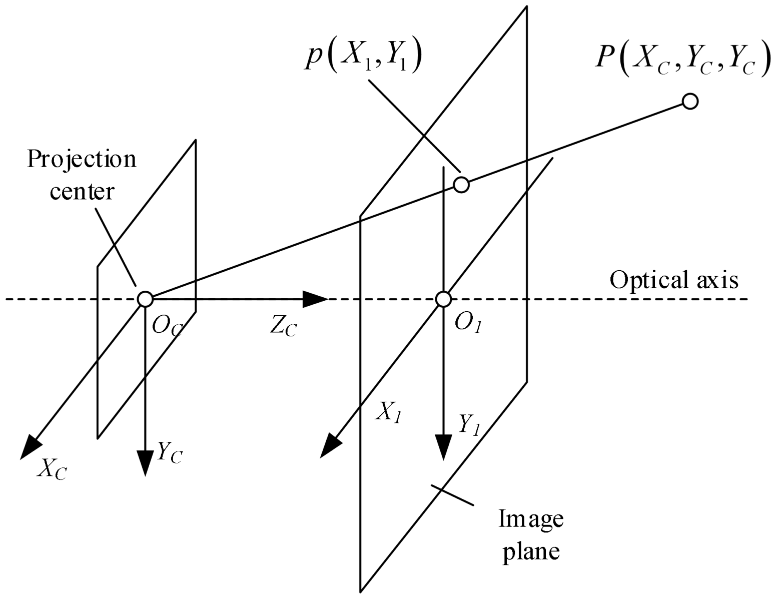

Figure 3. The relationship between camera frame and image plane coordinate system.

3.2. Three-dimensional reconstruction

Based on the above principle of image presentation, the linear calibration method [45] is used for 3D reconstruction, i.e., to understand the relationship between the image coordinates and the world coordinates, to calibrate the mapping relationship using the camera, to stereo match through the image coordinates of the thing, so as to determine the correspondence between the 2 images, and then to calculate the coordinates of the thing in the world coordinates.

Three-dimensional reconstruction can be divided into three-dimensional reconstruction of points, straight lines, planes, curves, and surfaces, which can be distinguished by different processing primitives. The paper focuses on three-dimensional reconstruction of medical images, and to determine its matching primitives, it is necessary to study the principle of three-dimensional reconstruction of its linear calibration method, in order to establish the three-dimensional stereoscopic shape.

The principle of 3D reconstruction is as follows: (x_W, y_W, z_W) as the coordinate system coordinates of the object point, as an unknown number, set the image coordinates, (u_L, v_L), (u_R, v_R) for the object point in the left and right of the 2 cameras in the image coordinate system of the image coordinates of the projected point, M_L , M_R for the 2 camera projection matrix, mainly describes the image of its rendering situation, from the camera projection matrix formula can be obtained from Equation (5), Equation (6):

$$z_{CL} \cdot \begin{bmatrix} u_L \\ v_L \\ 1 \end{bmatrix} = M_L \cdot \begin{bmatrix} x_W \\ y_W \\ z_W \\ 1 \end{bmatrix} = \begin{bmatrix} m_{11}^L & m_{12}^L & m_{13}^L & m_{14}^L \\ m_{21}^L & m_{22}^L & m_{23}^L & m_{24}^L \\ m_{31}^L & m_{32}^L & m_{33}^L & m_{34}^L \end{bmatrix} \cdot \begin{bmatrix} x_W \\ y_W \\ z_W \\ 1 \end{bmatrix} \tag{5}$$

$$z_{CR} \cdot \begin{bmatrix} u_R \\ v_R \\ 1 \end{bmatrix} = M_R \cdot \begin{bmatrix} x_W \\ y_W \\ z_W \\ 1 \end{bmatrix} = \begin{bmatrix} m_{11}^R & m_{12}^R & m_{13}^R & m_{14}^R \\ m_{21}^R & m_{22}^R & m_{23}^R & m_{24}^R \\ m_{31}^R & m_{32}^R & m_{33}^R & m_{34}^R \end{bmatrix} \cdot \begin{bmatrix} x_W \\ y_W \\ z_W \\ 1 \end{bmatrix} \tag{6}$$

Where: m_{ij}^L and $m_{ij}^R \left(i = 1,2,3; j = 1,2,3,4\right)$ are the elements of the i th row and j th column of M_L and M_R respectively.

Eliminating z_{CL} in Eq. (5) and z_{CR} in Eq. (6) yields Eq. (7):

$$\begin{cases}(u_L m_{31}^L - m_{11}^L)x_W + (u_L m_{32}^L - m_{12}^L)y_W + (u_L m_{33}^L - m_{13}^L)z_W = m_{14}^L - u_L m_{34}^L \\ (v_L m_{31}^L - m_{21}^L)x_W + (v_L m_{32}^L - m_{22}^L)y_W + (v_L m_{33}^L - m_{23}^L)z_W = m_{24}^L - v_L m_{34}^L \\ (u_R m_{31}^R - m_{11}^R)x_W + (u_R m_{32}^R - m_{12}^R)y_W + (u_R m_{33}^R - m_{13}^R)z_W = m_{14}^R - u_R m_{34}^R \\ (v_R m_{31}^R - m_{21}^R)x_W + (v_R m_{32}^R - m_{22}^R)y_W + (v_R m_{33}^R - m_{23}^R)z_W = m_{24}^R - v_R m_{34}^R \end{cases} \tag{7}$$

The least squares method [46] can be used to find (x_W, y_W, z_W) by the procedure of writing Eq. (7) in matrix form as shown in Eq. (8):

$$\begin{bmatrix} u_L m_{31}^L - m_{11}^L & u_L m_{32}^L - m_{12}^L & u_L m_{33}^L - m_{13}^L \\ v_L m_{31}^L - m_{21}^L & v_L m_{32}^L - m_{22}^L & v_L m_{33}^L - m_{23}^L \\ u_R m_{31}^R - m_{11}^R & u_R m_{32}^R - m_{12}^R & u_R m_{33}^R - m_{13}^R \\ v_R m_{31}^R - m_{21}^R & v_R m_{32}^R - m_{22}^R & v_R m_{33}^R - m_{23}^R \end{bmatrix} \cdot \begin{bmatrix} x_W \\ y_W \\ z_W \end{bmatrix} = \begin{bmatrix} m_{14}^L - u_L m_{34}^L \\ m_{24}^L - v_L m_{34}^L \\ m_{14}^R - u_R m_{34}^R \\ m_{24}^R - v_R m_{34}^R \end{bmatrix} \tag{8}$$

Simplify Eq. (8) to Eq. (9):

$$AX = B \tag{9}$$

Where A is a matrix. X is a vector. B is a vector.
A, X and B are shown in Eq. (10) ~ Eq. (12) respectively:

$$A = \begin{bmatrix} u_L m_{31}^L - m_{11}^L & u_L m_{32}^L - m_{12}^L & u_L m_{33}^L - m_{13}^L \\ v_L m_{31}^L - m_{21}^L & v_L m_{32}^L - m_{22}^L & v_L m_{33}^L - m_{23}^L \\ u_R m_{31}^R - m_{11}^R & u_R m_{32}^R - m_{12}^R & u_R m_{33}^R - m_{13}^R \\ v_R m_{31}^R - m_{21}^R & v_R m_{32}^R - m_{22}^R & v_R m_{33}^R - m_{23}^R \end{bmatrix} \tag{10}$$

$$X = \begin{bmatrix} x_W \\ y_W \\ z_W \end{bmatrix} \tag{11}$$

$$B = \begin{bmatrix} m_{14}^L - u_L m_{34}^L \\ m_{24}^L - v_L m_{34}^L \\ m_{14}^R - u_R m_{34}^R \\ m_{24}^R - v_R m_{34}^R \end{bmatrix} \tag{12}$$

Equation (13) can be obtained from the least squares method:

$$X = \left(A^T A\right)^{-1} A^T B \tag{13}$$

The least squares method can be used to compute the coordinates of the matching object points of the stereo image in imaging to derive the world coordinate information.

4. 3D reconstruction test and result analysis

4.1. Analysis of feature point matching results

My3d software is used to 3D reconstruct the CT image of the operating room, in order to analyze the feature point matching performance of the methods in this paper - linear calibration method and RANSAC algorithm, the experiment selected a number of sets of data to be analyzed, and the matching rate of the two methods is obtained through the statistics of the number of matching point pairs correctly matching point pairs. The comparison of feature point matching accuracy is shown in Figure 4. It can be seen that the matching rate and efficiency of this paper's method are higher than that of the RACSAC algorithm.The matching rate of the RACSAC algorithm is 86.5%, and the matching rate of this paper's method is 11.7% higher than that of the RACSAC algorithm.

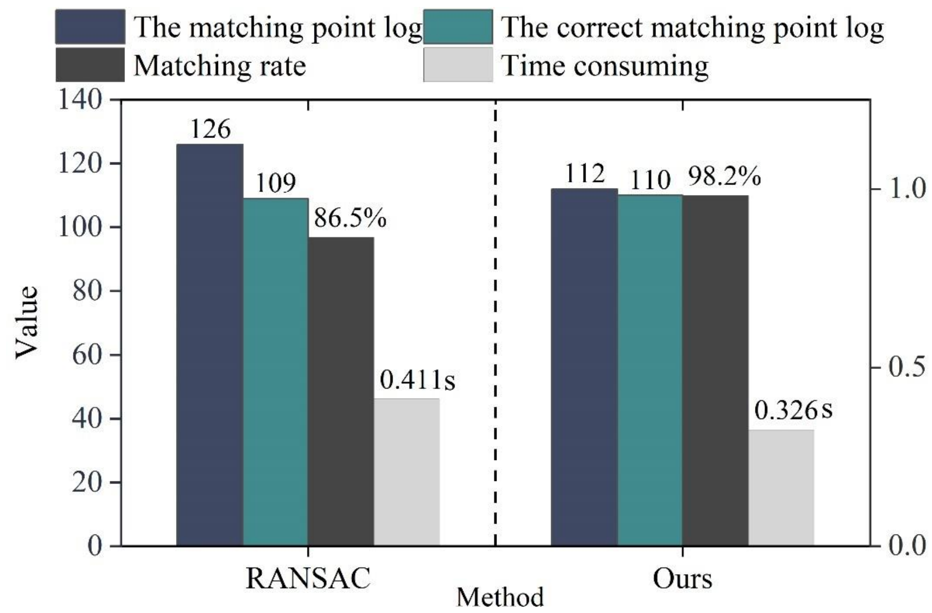

Figure 4. Comparison of feature point matching accuracy.

4.2. Error analysis

The experiments were conducted using the Medlmg database as the data source, which is a comprehensive platform that integrates multiple public sources with a wide variety of medical impact datasets. From it, 6 out of 6 morphological image data are selected from chest X-ray images (D1), brain MRI impact (D2), lung CT images (D3), dermoscopy images (D4), fundus images (D5), and cancer PET images (D6). The root mean square error between the true and estimated camera trajectories of the linear calibration method and the RGB-D SLAM algorithm is computationally analyzed and obtained as shown in Fig. 5. For the selected six sets of data, the camera trajectory estimation results of this paper's method are closer to the real value, and the camera trajectory error results are better. In the experimental results, the largest root mean square error is for the dermoscopic image (D4) dataset, and the root mean square error between the true camera trajectory and the estimated trajectory for this paper's method and the RGB-D SLAM algorithm on the D4 dataset are 0.089 m and 0.081 m. The smallest root mean square error is for the lung CT image (D3) dataset, and the root mean square error for the two methods on the D3 dataset are 0.031, 0.021 m. The method in this paper has better robustness, accuracy and applicability than the RGB-D SLAM method.

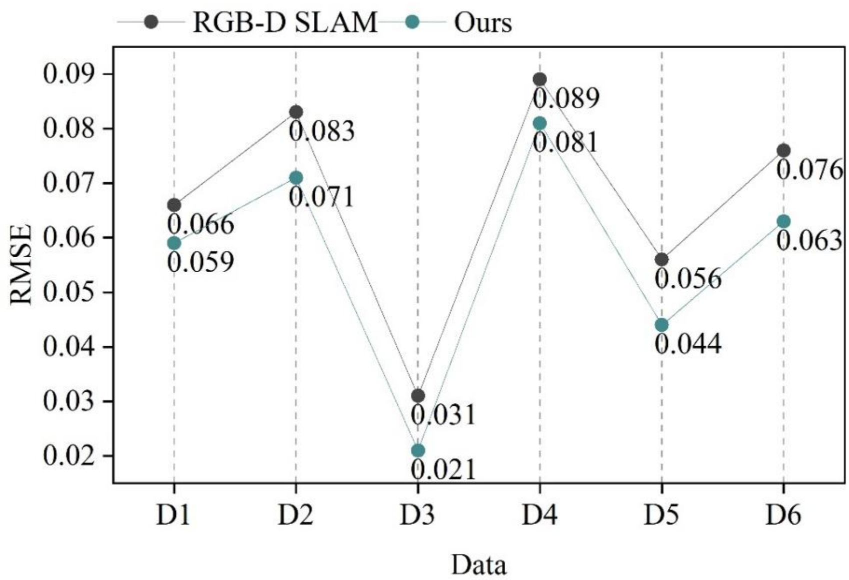

Figure 5. Results of the root mean square error.

5. Analysis of the effect of practical application of the teaching model

This chapter analyzes the effect of the application of MR technology-based labor education teaching model for nursing in teaching from the aspects of teaching satisfaction and practical training skills assessment scores, respectively.

5.1. Research Methodology

In this study, 80 internship nursing students in the Second Affiliated Hospital of Medical University of Province A were selected as observation objects to analyze the actual effect of applying MR technology-based nursing professional labor education teaching mode for labor education in practical teaching. All the students were randomly grouped into 40 students in Group A and 40 students in Group B. Group B was taught in the traditional teaching mode, with experienced physicians acting as instructors, formulating corresponding teaching plans according to the actual learning situation of the students, and carrying out practical teaching at different levels. Group A was taught by the MR technology-based nursing labor education teaching mode, with instructors explaining the theoretical knowledge and practical cases, and the practical exercises were taught by the MR technology-based labor education teaching mode, and the practical exercises were taught by the MR technology-based labor education teaching mode. Group A adopts the teaching mode of nursing labor education based on MR technology, in which the instructor normally explains the theoretical knowledge and actual cases, and applies MR three-dimensional images to reconstruct the case treatment scene for the actual operation practice. At the same time, students can search for theoretical knowledge by using the online education platform. The two groups of students underwent a 3-month internship and were statistically analyzed at the end of the internship.

The general information of the study subjects is shown in Table 1. After comparing the general information of groups A and B, it showed no statistical difference (P>0.05) and was comparable.

Table 1. General information on the subjects.

Project		A (n=40)	B (n=40)	T	P
Gender	Male	23	22	2.354	0.063
	Female	17	18		
Age	Age range	19~26	18~26	-	-
	Mean age	22.23±2.36	22.01±1.36	3.254	0.053
Student degree	Master	9	11	3.172	0.074
	Undergraduate	26	24		
	Junior college	5	5		

5.2. Observation indicators

(1) Satisfaction

A self-administered questionnaire was applied to investigate the satisfaction of all students, which was filled in anonymously. Satisfaction was categorized into three levels, namely: very satisfied, satisfied, and dissatisfied, and the percentage of the number of cases of very satisfied and satisfied students in the total number of cases of students. The total Cronbach's α of the scale was 0.963. 80 questionnaires were distributed in this study, and the effective recovery rate was 100%.

(2) Performance of practical training skills assessment

The specific items were bed-making method, measurement of vital signs, aseptic technique and so on. Practical training skills assessment includes the usual single operation assessment and the final operation sampling test, the usual teaching process of each operation after learning immediately after the organization of the students for the assessment, each full score of 100 points, take the average score of the successive single operation scores. The end of the period of random sampling test 1 operation, the assessment includes assessment, preparation, operation process and quality, end processing, also in the form of a percentage system for scoring. The total evaluation of practical training results = usual operation assessment results × 50% + final operation random test × 50%.

(3) Labor Literacy of College Students

Before and after the course learning, the assessment scale of college students' labor literacy is used for evaluation. The scale contains four dimensions of labor values, labor knowledge, labor skills and innovative labor ability, and adopts five levels of scoring, from “very compliant” to “very non-compliant” in order to assign 5~1 points, and the reverse test questions are scored in the reverse direction, and the higher the score represents the higher level of their labor literacy. The higher the score, the higher the level of labor literacy.

5.3. Analysis of results

5.3.1. Comparison of satisfaction

The statistical results of the questionnaire on the satisfaction of the teaching mode are shown in Fig. 6. 95% of the students in Group A were satisfied, which was significantly higher than 87.5% in Group B ($P<0.05$). It shows that the teaching mode of labor education in nursing based on MR technology is more popular.

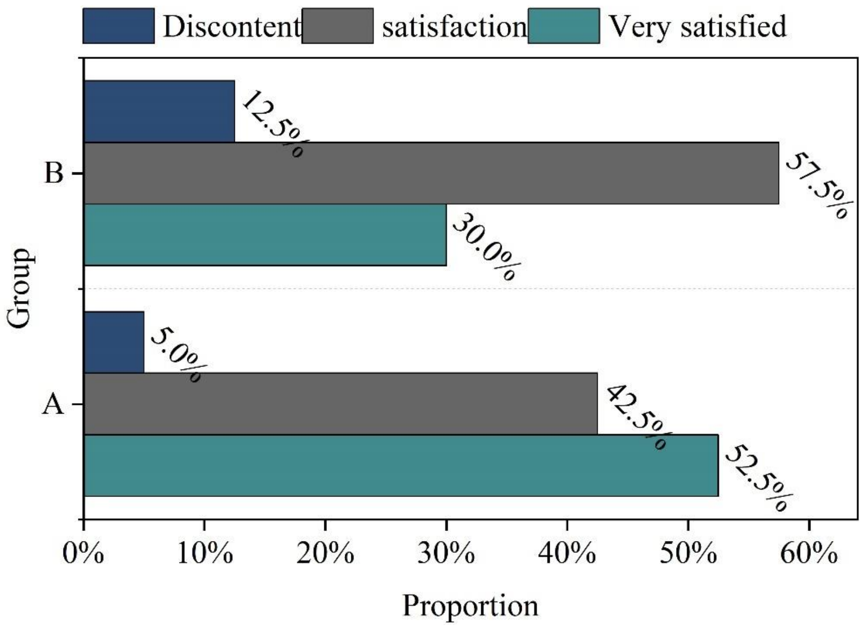

Figure 6. Questionnaire statistics of teaching mode satisfaction.

5.3.2. Comparison of practical training assessment results

The results of the comparison of practical training assessment results are shown in Table 2.The total assessment of practical training results of Group A and Group B were 93.63 and 91.01, respectively, with a significant difference between the results of the two groups ($P<0.001$).There was no gap between Groups A and B in the results of the single practical training, but Group A achieved higher scores in the final practical training results at the end of the final period. It shows that Group A can effectively improve the practical training skills of labor education in nursing by adopting the labor education teaching mode of nursing based on MR technology.

Table 2. Comparison of the two sets of practical training scores.

Group	People	Individual actual achievement	Final grade	General evaluation of physical training
A	40	92.66±3.01	94.63±3.21	93.63±1.55
B	40	92.41±3.04	92.01±2.25	91.01±1.63
T	-	-1.635	-4.635	-4.159
P	-	0.226	<0.001	<0.001

5.3.3. Comparison of Labor Literacy Scores

The comparison of labor literacy scores between the two groups is shown in Table 3. The results of the study showed that the labor literacy level of students in Group A was 3.99 before the internship and improved to 4.19 after the practice, while Group B only improved by 0.01 points. And there was a significant difference between the pre- and post-test scores of Group A ($P < 0.001$), while Group B ($P > 0.05$) had no significant difference. Analyzing the four dimensions, after the internship, the scores of Group A in the four dimensions of labor values, labor knowledge, labor skills and innovative labor ability were higher than those of Group B, with significant differences ($P<0.001$), which indicated that the labor education teaching mode of nursing specialty based on MR technology could significantly improve students' labor literacy.

Table 3. Comparison of the two groups of labor literacy scores.

Group	Labor values		T	P
	Pretest	Posttest		
A	4.16±0.63	4.92±0.42	-6.422	<0.001
B	4.06±0.66	4.16±0.85	-8.634	>0.05
T	0.541	-1.631	-	
P	0.596	0.115		
Group	Labor knowledge		T	P
	Pretest	Posttest		
A	3.64±0.63	4.03±0.41	-6.885	<0.001
B	3.66±0.55	3.86±0.69	-6.547	>0.05
T	0.135	-3.214	-	
P	0.821	0.136		
Group	Labor skill		T	P
	Pretest	Posttest		
A	3.55±0.41	3.96±0.35	-9.254	<0.001
B	3.59±0.34	4.01±0.63	-9.425	>0.05
T	0.123	-0.531	-	
P	0.634	0.013		
Group	Innovative working ability		T	P
	Pretest	Posttest		
A	3.55±0.66	3.97±0.22	-6.558	<0.001
B	3.51±0.69	3.62±0.42	-8.675	>0.05
T	0.156	-0.324	-	
P	0.513	0.001		
Group	Labor literacy		T	P
	Pretest	Posttest		
A	3.99±0.33	4.19±0.63	-5.324	<0.001
B	3.91±0.25	3.92±0.22	-8.542	>0.05
T	0.521	-0.425	-	
P	0.637	0.053		

In summary, this paper practiced the two teaching modes in three aspects, namely, teaching satisfaction, practical training assessment results and labor literacy level. The results show that the labor education teaching mode of nursing based on MR technology is more popular among students and can improve students' practical training skills and labor literacy level.

6. Conclusion

Based on MR technology, this paper designs an online and offline integrated teaching mode for labor education in nursing, and at the same time explores the 3D image presentation method involved in this teaching mode. The feature point matching method proposed in this paper can significantly improve the matching accuracy of feature points, with a correct matching rate of 86.5%, which is 11.7% higher than the RANSAC algorithm. Compared with the RGB-D SLAM reconstruction method, the root-mean-square error between the camera-estimated trajectory and the real trajectory of the proposed method is smaller, and the quality of the reconstruction results is better. Applying this technology in teaching practice, students' satisfaction with the teaching mode based on MR technology reaches 95%, and their performance in practical training teaching is as high as 93.63, and students' labor literacy level is significantly improved. The teaching mode designed in this paper contributes to the cultivation of high-quality skilled personnel, stabilization of the nursing team, and promotion of the sustainable development of nursing.

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