Application of PBL pedagogy based on virtual reality technology in the teaching of sports anatomy

Na Hou[1,2,*], and *Md. Safwan* Samsir[1]

[1]Faculty of Psychology and Education, University Malaysia Sabah, 88400, Kota Kinabalu Sabah, Malaysia
[2]Department of Physical Education, Xianyang Normal University, 712000, Xianyany City, China

Abstract. Purposes To explore the teaching effect and value of virtual reality technology combined with PBL teaching method applied to sports anatomy.Procedures 119 undergraduate students majoring in physical education of Xianyang Normal University were selected as research objects.Randomly divided into experimental group (N=59) and control group (N=60).Methods The experimental group used virtual reality technology combined with PBL teaching method, and the control group used traditional teaching method to teach. At the end of the course, the test scores of the two groups and the evaluation results of self-learning effect were statistically analyzed. Results the test scores of the students in the experimental group were significantly higher than those in the control group (P<0.05); Most of the items in which the experimental students self-evaluated the learning effectiveness were also superior to the control group (P< 0.05), and the difference was statistically significant. Conclusions VR technology combined with PBL teaching method can improve academic performance, enhance students' learning interest and independent learning ability, and cultivate students' ability to find and solve problems. It is a teaching method worth promoting.

Keywords: Virtual reality technology, PBL pedagogy, Sports anatomy.

1 Introduction

Sports anatomy is the main compulsory course for physical education students in various colleges and universities, which occupies an important position in the curriculum system of physical education majors, provides the knowledge base of human morphology and structure for subsequent courses such as exercise physiology, and also provides theoretical support for sports human body science for physical education and sports training. Therefore, the teaching effect of sports anatomy is good or bad, which directly affects the teaching quality of the entire physical education major and the quality of the training of sports professionals. The traditional teaching mode of the sports anatomy course is that the

---
* Corresponding author: houna0918@sina.com

teacher explains the combination of PPT, specimens, wall charts, and the use of models to strengthen the intuitive and image teaching effect, and the teaching process is still dominated by the teacher, that is, the teacher speaks and the student listens to this traditional teaching mode. The teaching method is still to present the structure of the human body to students through the two-dimensional vision composed of PPT pictures and text. As a result, students still do not have a clear understanding of the structure of the human body and the adjacent relationship of various organs after learning, and the learning effect is not good. The main reason is that the teaching method lacks innovative teaching methods and the traditional single teaching methods, resulting in the loss of students' learning interest and learning initiative, and the learning effect is poor. Therefore, how to exert students' subjective initiative in the teaching of sports anatomy and stimulate students' interest in learning is extremely important. With the reform of education and teaching, some new advanced teaching methods have been introduced into China from the West, such as PBL teaching method and TBL teaching method. And with the development of network technology and digital technology, virtual reality technology (VR) appeared and was introduced into the field of education. All these have brought opportunities for the innovation of China's education and teaching mode and the improvement of the teaching quality of undergraduate education. At present, it is not uncommon to apply VR technology to education, and Merchant et al. have found that VR technology generally promotes learning results through meta-analysis of 69 experimental studies in the VR literature [1].In recent years, in the courses of anatomy and physiology in various colleges and universities in China, PBL teaching methods have been widely used and achieved good teaching results. Based on this, this study organically integrates VR technology with PBL pedagogy to observe the teaching effect of this teaching mode applied to motor anatomy. In order to provide reference for the reform of sports anatomy teaching.

2 Overview of related theories

2.1 Introduction to virtual reality technology (VR)

Virtual Reality Technology (VR) is a computer simulation technology that creates and experiences an interactive three-dimensional virtual environment: the virtual environment provides users with multiple sensory stimuli such as vision, hearing, and touch, and the user can achieve natural interaction in the virtual environment through sensor devices such as helmet displays, data gloves, and somatosensory controller [2]. Burdea and Coiffet incorporated Immersion, Interaction, and Imagination as fundamental features of VR technology, also known as 3I features [3].

2.2 PBL pedagogy

PBL (Problem Based Learning), or "Problem-Based Learning," was pioneered in the mid-1960s by Howard S. Barrows, a professor of medicine at McMaster University in Canada, and is a problem-based learning process that encounters problems, solves problems with clinical reasoning skills, identifies learning needs during interactions, and teaches itself. Apply newly acquired knowledge to problems and summarize what you have learned [4]. In the PBL teaching model, the teaching process can be five steps: creating a problem situation and asking questions; dividing groups and analyzing problems; collaborative learning and problem solving; group presentation and summary of reflections, evaluation and feedback, and other steps [5]. The central idea of this pedagogy is to take the student as the main body, the problem as the basis, the teacher as the guide, and the curriculum around

the practical problems. It has great advantages over traditional discipline-centered teaching in terms of cultivating students' cooperative learning, problem solving, and practical thinking skills[6].

3 Research objects and methods

3.1 Research objects

119 undergraduate students of the 2021 class of physical education majoring in Xianyang Normal University were selected as research subjects, 18 female students and 101 male students, with an average age of 18 years old. Among them, there are 59 students in the 1st and 2nd classes as experimental classes, and 60 students in 3rd and 4th classes as control classes. Both the experimental and control groups were guided by the same teacher. Students in all four classes were randomly placed in the same class, and none had a basis in motor anatomy before admission.

3.2 Research methods

3.2.1 Teaching method design and implementation

The control classes still use traditional pedagogy.

The experimental class uses VR teaching technology combined with PBL teaching methods for teaching. The teacher assigns teaching-related content to students two days in advance according to the teaching objectives and plan, and designs relevant questions. The 59 students in the experimental group can be divided into groups of 5-6 people to divide labor and cooperate, comb through relevant materials in advance, such as textbooks, literature, networks, etc., report and discuss in small groups during class, and then give questions, comments, guidance and supplements according to the situation of the nursing report.

Teaching case: "Anatomical analysis of sports movements" is the focus and difficulty in the teaching of motor anatomy and motor systems. In the teaching of this knowledge point, the learning goal is to allow students to flexibly use the theories such as the form of movement of each link during human body movement, the muscles involved in the work, and the working nature of the muscles to analyze the specific actions in the exercise practice, so as to combine the theoretical knowledge of anatomy with teaching and practice. Therefore, when analyzing the one-handed shoulder shooting action, the following questions are designed: (i) In the one-handed shoulder shooting action, what form of movement does the joints of the upper limbs of the shooting, such as the shoulder straps, shoulder joints, elbow joints, wrist joints and hand joints, do?(ⅱ)What are the muscles involved in the exercise? (ⅲ) What is the working nature of the muscles of the movement? Is the primary motility muscle contracted under working conditions? In the process of teaching the course, students are motivated, actively thinking, careful observation, and finally master the relevant anatomical knowledge, and are able to put forward their own different opinions. The PBL teaching model not only cultivates students' thinking ability, but also cultivates the ability to innovate.

3.2.2 Teaching evaluation methods

(i) Evaluation of examination results

After 16 weeks of 64 hours of exercise anatomy teaching, including 54 hours of theoretical classes and 10 hours of experimental classes. At the end of the course, the same test paper is used to conduct a closed-book theory test for both groups of students, and the test score is 100 points.

(ⅱ)Evaluation of learning effect

At the end of the course, students' evaluation of the teaching effect is examined by means of a questionnaire survey. The answer options are divided into "satisfied" and "dissatisfied", and the students answer themselves.

3.2.3 Statistical Methods

Use SPSS 16 for exam results and survey results. 0 Statistical software performs statistical analysis, and the chi-square test is used to compare and analyze the experimental group and the control group. All statistical tests are bilateral, the test level is $\alpha = 0.05$, and the difference between $P<0.05$ is statistically significant.

4. Results and analysis

4.1 Assessment results

It can be seen from Table 1 that the test scores of students in the experimental class who participated in the VR teaching technology combined with PBL teaching method were significantly higher than those in the control class, and the difference was statistically significant ($P<0.001$)

Table 1. Comparison of the results of the two groups (x±s, points).

Group	N	X±SD	t	P
Experimental group	59	78.23±8.51	4.21	＜0.001
Control group	60	83.85±7.53		

4.2 Comparison of teaching effect evaluations between the two groups of students

From Table 2, it can be seen that VR technology combined with PBL teaching method applied to sports anatomy teaching is significantly better than traditional teaching methods in terms of improving students' learning interest and independent learning ability, and the results are very significantly different ($P< 0.01$).It is also superior to traditional pedagogy in terms of effective communication between teachers and students and the mastery and use of knowledge, and its differences are significant ($P < 0.05$）.In terms of cultivating teamwork spirit and problem-solving skills among students, there is no significant difference from traditional teaching methods, $P > 0.05$. This may be related to the fact that the object of our current research is a freshman. Because most of the learning in the primary and secondary education stage before the university adopts the traditional teacher-led traditional teaching method, when the university begins to use the new teaching mode, its ability to find problems and solve problems is difficult to improve for a while, and it takes a long time of training to achieve good results.

Table 2. Comparison of the evaluation of the teaching effects of the two groups of students.

Item	Experimental group (n=59)		Control group (n=60)		χ2	P
	Satisfied	dissatisfied	Satisfied	dissatisfied		
Increase interest in learning	50(84.7%)	9(15.2 %)	29(48.3%)	31(51.7 %)	7.942	0. 005
Improve self-directed learning ability	53(89.8%)	6(10.1 %)	28(46.7 %)	32(53.3%)	13.630	0.0003
Teamwork skills development	38(64.4 %)	21(35.6 %)	28(46.7 %)	32(53.3%)	3.006	0.073
Effective communication between teachers and students	48(81.4 %)	11(18.6 %)	26(43.3%)	34(56.7 %)	4.235	0.038
Effective communication between teachers and students	49(83.1 %)	10(16.9%)	41(68.3%)	20(31.7 %)	4.621	0.03
Ability to discover and solve problems	41(69.4 %)	18(30.6 %)	3761.7%)	23(38.3 %)	.075	0.252

5 Discussion

5.1 Advantages of VR technology combined with PBL pedagogy applied to the teaching of motor anatomy

Sports anatomy belongs to the morphological category, the teaching content mainly includes the morphological structure of important motor organs of the human body and the components of various tissues and organs closely related to movement, the theoretical basis and principle of the analysis of the anatomy of motor movements, etc., the content is large, and there are many conceptual terms. Students are more boring and difficult to remember, and the traditional teaching method is mainly the teacher's explanation plus PPT pictures and text display; and the sports anatomy experimental class time is relatively insufficient, and the university does not invest enough in the laboratory, resulting in fewer laboratory specimen models, and some even no cadaver specimens. All of these factors affect students' interest and enthusiasm in learning motor anatomy, resulting in poor learning results.

PBL is a kind of problem-based learning, is a student-oriented teaching method, PBL teaching method strengthens the teaching interaction between teachers and students, that is, the question answer link requires cooperation and communication between teachers and students, which can not only exercise the communication ability and language expression ability of college students, but also cultivate the team spirit of college students, and at the same time, the student-led teaching mode also greatly improves students' learning interest and independent learning ability.

However, the PBL teaching method or the traditional teaching method still cannot show the structure of the human body to students in an intuitive and three-dimensional mode, and it cannot cultivate students' three-dimensional thinking ability. As a result, students' microscopic structures and adjoining relationships with human organs remain blurred after the end of their studies. With the development of education informatization, teaching methods have also been continuously innovated. The emergence of VR technology and applied to the teaching of motor anatomy, through the virtual simulation software to form a

digital model of human anatomy with three-dimensional effect, intuitively display the spatial structure of human organs for students, enhance the immersion of learning, and increase the interaction between teachers, students and students and the environment.VR technology helps students transfer the anatomy knowledge learned in virtual situations to real sports, which not only promotes the mastery of college students' basic knowledge, but also improves the ability of college students to link sports anatomy theory with sports practice.

5.2 Problems and improvement strategies that arise in teaching practice

In the exploration of teaching practice, there are also some problems, such as some students are resistant to the new teaching mode, believe that it increases their learning burden, and are still accustomed to passively accepting the traditional teaching of knowledge instead of learning knowledge on their own initiative. There are also a small number of students who have insufficient initiative in learning and insufficient preparation before class, resulting in their lack of real participation in the discussion and learning in the classroom, insufficient understanding of knowledge, and weak grasp. In view of the above problems, first of all, it is necessary to let students have the important position and role of sports anatomy in the teaching of sports science, and improve their initiative. Secondly, in the future teaching, it is also necessary to improve the teaching evaluation method, which can increase the performance of classroom discussion, the mutual evaluation of the learning process by group members, chapter tests and debriefing assignments, and include them in the overall evaluation score at the end of the term, so as to improve the active participation of students in the learning process. In addition, due to the emphasis on question-based teaching in the process of VR technology combined with PBL pedagogy, higher requirements are also put forward for teachers. Teachers are required to be prepared to discuss the outline before class, and to be familiar with the syllabus and the actual situation of students; Teachers should also continuously improve their comprehensive quality [7], because the PBL pedagogy requires teachers not only to have solid professional knowledge, but also to master the knowledge of related disciplines and sports practices, and to have good educational and teaching skills in order to answer the questions raised by students well.

VR technology support needs to be further improved, VR system is a multi-sensory interactive system, but for now the most used is vision. Studies have shown that a more comfortable experience can only be achieved when the resolution reaches 4K or even higher, and the resolution of most current VR monitors is far from enough. For young students, long-term wear may cause adverse visual effects. And according to the feedback of many adult users, wearing VR glasses for a long time will produce a sense of vertigo, and the sensing equipment and control equipment also have the phenomenon of slow feedback. All of the above aspects affect the user's sense of experience. However, with the further development of information technology, these problems will gradually be solved.

6 Conclusion

In short, VR technology combined with PBL pedagogy applied to sports anatomy teaching can improve academic performance, enhance students' learning interest and independent learning ability, help cultivate teachers' and students' communication skills and teamwork skills between classmates, and cultivate students' ability to find and solve problems. It shows that this teaching method is worthy of promotion and application in the teaching of sports anatomy.

References

1. Merchant. Z, Goetze.T, Cifuentes.L, et al. Effectiveness of virtual reality-based instruction on students' learning outcomesin K-12 and higher education:a meta-analysis ,Computers & education, **70**, 29-40,(2014)

2. X.Li, L.Zhang, F.zhao, J.Chen, Research on Instructional Design of Hybrid Form under Virtual Reality/Augmented Reality, Electrochemical Education Research, **38,** 20-25(2017) .

3. Burdea.G, Coiffet.P, Virtual reality technology, Digital technology & application, **96**, 663-664,(2015).

4. Albanese M A, Mitchell S.Problem-based learning: a re-view of literature on its outcomes and implementationissues, Acad Med, **68**, 52-81,(1993) .

5. P.Cai, Applied research based on interdisciplinary PBL teaching models, Northwest Normal University ,(2021)

6. Langeloyz.C, Junghans.T,Gunther.N, et al, Prob-lem-based learning for surgery: Increased motivation with lessteaching personnel . Chirurg, 76, 481-486(2005).

7. S.Li,P.Gan, Y.Tian, A comparative study of problem-oriented pedagogy and traditional pedagogy, Chinese Higher Medical Education,**3,**88-89,(2008).