

Online Cooperative Teaching Mode Based on Self-Direction Theory in Method of Sport Science Research

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Abstract—As an important indicator for measuring professional talents, the capacity for scientific research has received more and more attention. The course of Method of Sport Science Research can systematically teach students to learn the theory of scientific research, grasp professional method of scientific research and lay a foundation for cultivating scientific thought and scientific research ability of students of sports specialty. Based on the content characteristics and knowledge foundation of the course, students have not enjoyed this course very much and it has been difficult for them to understand. Besides, it is difficult to achieve good teaching effect because of poor mastery and application of knowledge after learning. On this basis, “12345” online learning mode based on self-direction theory was designed in this study. This process includes 1 thought, 2 mentalities, 3 dimensions, 4 levels and 5 steps. This theory was applied in the smart classroom of Method of Sport Science Research. The online cooperative teaching combined with network interaction technology and integrated with visual exchange technology was conducted. Besides, data analysis advantage of network platform was adopted to record the data of teacher-student interactions. Then, students’ learning was systematically understood through the interaction analysis. Finally, fuzzy C mean was integrated in the above teaching mode to conduct blended group research, implement targeted individual teaching of for Method of Sport Science Research and achieve the target interaction with students according to accuracy of big data analysis. The experimental results show that the teaching mode can fully mobilize students’ enthusiasm, stimulate their learning initiative and enhance learning efficiency.

Keywords—Self-direction theory; online cooperation; fuzzy C mean; scientific research method

1 Introduction

At present, big data technology develops rapidly. Promoting the development of education through network has become a hot spot in the world. The global survey report of American internet survey institution Royal Ping Dom shows the total num-

ber of global network users is as high as 2.1 billion and the total number of global internet websites reaches 550 million. It thus can be seen that the computer has become an important tool influencing people's life [1]. Computer-aided education technology is being faced with a significant and historic revolution. Method of Sport Science Research is one of required courses of sport specialty and also an important course to improve the teaching quality. With strong practicalness and operability, the course requires strong active learning [2]. However, some problems exist in the course, such as limited class time, poor teaching effect and low learning initiative. Meanwhile, some teachers are not aware enough of the new online teaching mode, and individuation of online teaching cannot be fully reflected. The analysis of interaction data on the platform is not deep enough, and targeted teaching cannot be fully embodied. Besides, teacher's teaching modes fail to form a complete system, and the teaching process lacks interaction with students. The insufficient information amount of data cannot reflect the superiority of online cooperative teaching.

Self-direction learning is a core concept of network education research and practice field, and the objective is to cultivate learners to lifelong learners with self-direction learning ability, which highly tallies with the objective of online education. Under the guidance of self-direction learning theory [3], an online course design model based on self-direction learning was proposed by case study of Method of Sport Science Research. In addition, self-direction capability evaluation, learning mode selection, learning ability promotion, resource design, cooperative learning and integrated learning were integrated into the model. In the meantime, we would make a reasonable assessment of students' self-direction capability level, and classify learning modes selected by students to help students improve their learning ability. The rich online education resources contribute to broadening students' horizons and online exchange is beneficial for cooperative learning and integration into classroom learning. Currently, the case teaching mode is widely applied in talent training of economics, management and other specialties, and there are few studies on the application of case teaching mode in Method of Sport Science Research. The teaching experiment in this study was combined with case teaching mode, with the purpose of presenting a new self-direction online course design strategy, effectively improving the learning effect of new open education courses and enhancing learner's self-direction learning ability.

The online cooperative learning mode based on self-direction learning theory was constructed in this study. Meanwhile, the case teaching method was applied, and fuzzy c mean was integrated in the above teaching mode for blended grouping study. A set of new online cooperative learning mode was constructed to let students fast blend in the teaching progress so that students could better absorb knowledge learned in class. The author hopes this study could provide new thoughts for teaching Method of Sport Science Research and contribute to cultivating qualified talents of sports science research.

2 State of The Art

Strongly promoting online learning is one of teaching mode development directions of various countries in the world. Online learning has become a hot field of education technology and teaching theory, and meanwhile it is also a hot new learning method in the field of teaching theory. Foreign online learning develops very fast. The birth mark of network education is the establishment and use of “virtual classroom” in New Jersey Institute of Technology [4]. After American government proposed National Information Infrastructure (NII) and Global information infrastructure (GII) plans, all kinds of network education institutions at all levels continuously appeared and developed across the world [5]. Mark et al. [6] put forward the integration of peer teaching into the online teaching mode. The research team carried out teaching experiment in the physical science course of Open University, UK and designed an online teaching mode applied in the synchronous communication system. Besides, teachers could participate in peer learning tutoring. The results show that the teaching mode could improve students’ learning ability and effect. Limperos et al. [7] applied clear and understandable teaching mode in online teaching and found that multi-mode online lectures were more beneficial to promoting positive experiences between students and teachers as well as perceived and actual learning than the lectures containing only one mode of information. The discussion of these findings focused on teaching design and technology. Like most teaching organizations, American Physiological Society (APS) [8] was exploring an online education method through online resources and projects and constructing a framework of scientific education and physiological education practice community. The team constructed an online learning framework including teaching resources, specialty development, education research and network construction, and gained a satisfactory teaching and learning effect as well as consistent consent of peers. Price et al. [9] provided RN-to-baccalaureate nursing for Bachelor of Science in Nursing (BSN) course based on large online learning platform. The team formed a focus group in which students and teachers joined together on the online learning platform. The themes of teacher focus group included reiteration, students’ commitment and teacher improvement opportunity. The themes of student focus group included participation, usability, encouragement and diversified learning. The teaching practice result showed that such focus group contributed to interactions between students and teachers and improvement of students’ learning ability.

Online learning research of some scholars mainly concentrates on the reference to the experience of developed countries. With technical development and social attention, some preliminary theory systems and teaching methods have been gained gradually during the research on online learning. For the problems of inconformity between experiment and theoretical knowledge and low exchange efficiency between teachers and students in massive open online courses (MOOC), Guo et al. [10] designed and implemented an online experimental platform based on WebRTC and Docker technology as well as provided a unified experimental environment and convenient point-to-point real-time communication platform. The practical test showed that, the platform could well satisfy the needs of teachers and students. Mo et al. [11] conducted practice research on the online course of mechanical engineering and adopted learning

software for online teaching resource integration like courseware, animation, screen recording, teaching program, teaching plan and question bank. In the meantime, Photoshop, Adobe Flash CS6, EV screen recording and Adobe Premiere Pro software were used to edit and clip online materials. It was found that the teaching mode contributed to enhancing students' understanding and mastery of the course and enhancing their learning interest and efficiency. Liu et al. [12] proposed the application of a data visualization method in the online learning mode. The method was implemented through data visualization programming. Teachers could visually express knowledge for students, understand students' learning conditions and carry out targeted classroom teaching and teaching evaluation. Students could form knowledge frame and interconnection system and find out their problems. In practical teaching, the method generated a good practical effect and effectively promoted the development of smart education. However, current online course was mainly designed from the teacher's perspective and lacked the learner-centered perspective. Just because of this, Liu [13] considered that online education had the problems of poor learning control, weak self-direction awareness, single learning strategy and learning evaluation delay. Seeing from the use of online courses, the online course design ignoring learner's subjectivity would also lead to low use rate, thus further lowering learning effect.

Based on the above shortcomings, this study put forward self-direction learning theory based on learner's self-learning, and constructed the online cooperative teaching mode on the basis of this theory. Besides, the theory was applied in the teaching of Method of Sport Science Research, and the new online case teaching method was innovatively combined to analyze learning characteristics of teaching objects. As well, an advanced fuzzy C mean was integrated for blended grouping study. New software sportfire data analysis software was innovatively applied in the teaching of Method of Sport Science Research. Moreover, a set of online cooperative learning mode was constructed for the first time in this study so that the online cooperative teaching mode of Method of Sport Science Research could be closer to teacher's teaching and students could be fast integrated in teacher's classroom pace and better absorb knowledge learned in class. The author hopes this study could provide a new thought for teaching Method of Sport Science Research.

3 Online Cooperative Teaching Mode Based on Self-Direction Learning Theory

3.1 Application of self-direction learning theory in teaching

Self-direction theory aims to cultivate students into continuous learners who can conduct self-directed learning on their own, which adapts to the idea that knowledge is infinite (see Fig.1). "Online cooperative teaching mode design based on self-direction theory in Method of Sport Science Research" was proposed by case study of Method of Sport Science Research under the guidance of self-direction theory. At the same time, we would make a reasonable assessment of students' self-direction capability level, and classify learning modes selected by students to help students improve

their learning ability. The rich online education resources contribute to broadening students' horizons and online exchange is beneficial for cooperative learning and integration into classroom learning. On the basis of self-direction learning theory, “12345” theoretical framework was designed: 1 idea - it is a joy to learn knowledge, review it and practice it; 2 mentalities - accumulate gradually and create soft area; 3 dimensions - skill, attitude and knowledge; 4 levels - creation, broadening, remediation and prevention; 5 steps – think over rules, adjust application, focus on the direction, gain knowledge and practice experience.

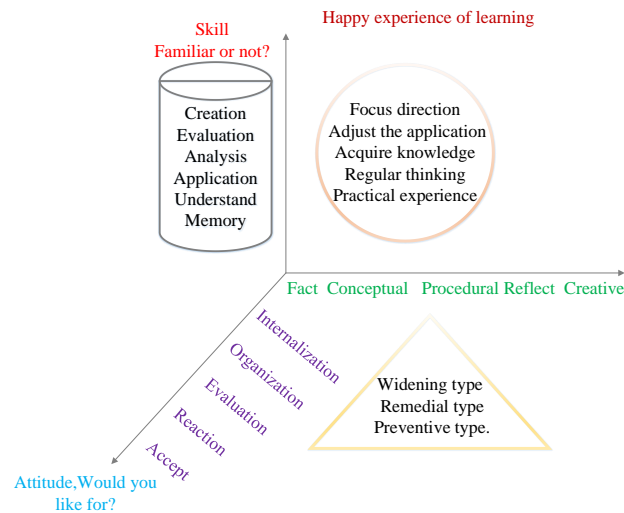


Fig. 1. Frame diagram of self-direction learning theory

Method of Sport Science Research is one of required courses of sport specialty and also an important course to improve the teaching quality. With strong practicalness and operability, the course requires strong active learning, but the class time is limited. The introduction of modern information education mode based flipped classroom is beneficial for students to actively learn before class, in class and after class, and contributes to their independent thinking, problem solving and achievement of deeper understanding of knowledge. According to self-direction theory, the online course design mode based on self-direction learning was designed in this study, as shown in Fig.2.

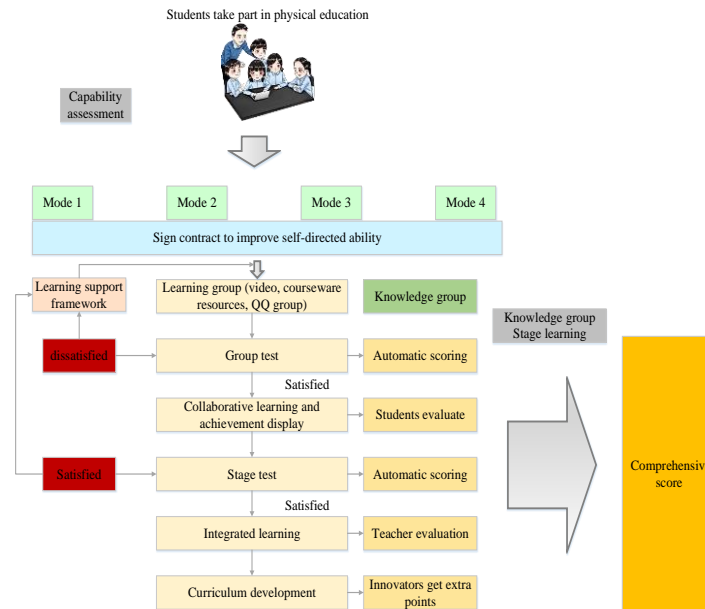


Fig. 2. Online course design mode based on self-direction learning

3.2 Implementation of online cooperative teaching mode based on self-direction learning theory in method of sport science research

The online cooperative learning system was constructed in combination of characteristics and advantages of existing network learning space. Learning environment elements like situation, cooperation and competition should be fully utilized in the system to mobilize students' enthusiasm for participation in cooperative learning in the student-centered teaching design and make students effectively achieve knowledge construction. Additionally, the system should pay attention to the leading role of teachers, and network learning space should be utilized to let teachers guide and organize the cooperative learning. The function module of network technology can be used to effectively support online cooperative learning process and evaluation. The online cooperative learning system constructed for Method of Sport Science Research on this basis is shown in Fig.3. The main components of the system include teachers, students, network learning space and incentive mechanism. Teachers and students exchange and interact mainly through online cooperation, and complete online cooperative learning. The incentive mechanism aims to motivate the sense of competition among each cooperative team so as to facilitate students' more active participation in teamwork and improve the effect of cooperative learning.

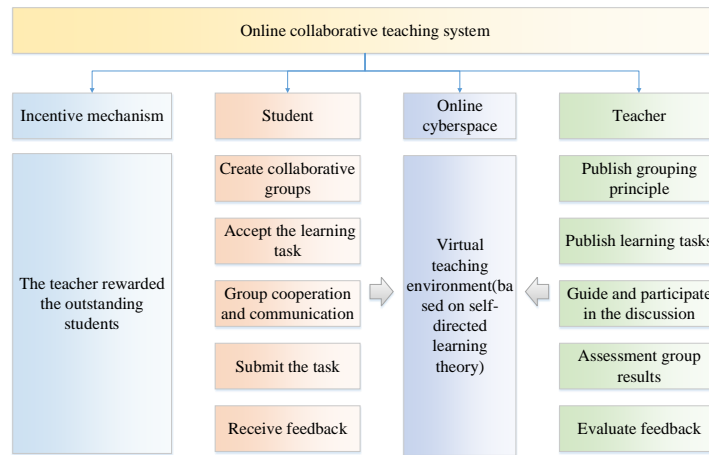


Fig. 3. Online cooperative learning system based on self-direction theory

The successful implementation of case teaching process depends on the cooperation between teachers and students. In the case study of Method of Sport Science Research, it is required to reflect teacher's independent choice space in teaching design and students' learning autonomy. The implementation of case teaching in Method of Sport Science Research mainly involves pre-class preparation of students and teachers, case teaching organization process, summarization and deepening after the implementation of case teaching. In the online cooperative teaching mode of Method of Sport Science Research, the teaching design of combining case teaching method is shown in Fig.4.

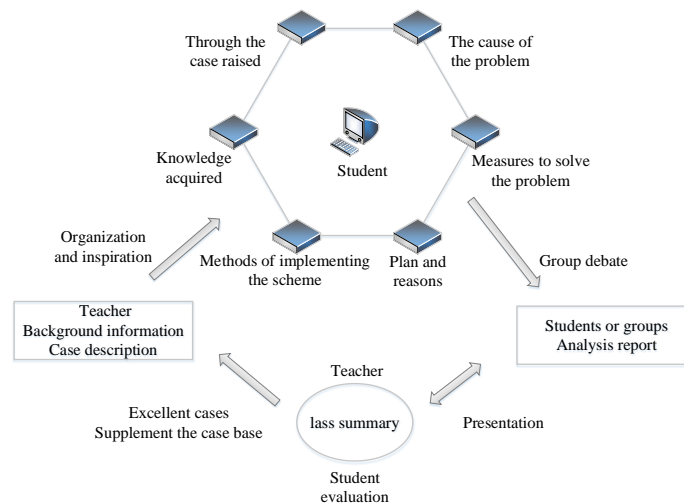


Fig. 4. Online cooperative teaching mode of Method of Sport Science Research based on case teaching method

Meanwhile, new software - sportfire data analysis software was innovatively applied in the teaching mode of Method of Sport Science Research. The software can help the first-line scientific research personnel discover new problems fast according to the situations which have never occurred and make decisions according to statistical data. Firstly, the unique analysis environment of sportfire data analysis software can help researchers make better decisions. For the learners of sport science research, the largest advantage of the data software is that it can help researchers reduce unnecessary time and gain strongly targeted information beneficial for research design. The software has advanced visualized and human-computer interaction interface, and the analysis content ranges from special analysis to interactive report, special technical application, real-time analysis of scientific research experiment and experimental statistical analysis. Considering Spotfire software is a world leading scientific data analysis platform and one of teaching objectives of Method of Sport Science Research is to improve students' scientific innovation ability and cultivate students' scientific research application ability, students were grouped to apply Spotfire software in the cooperative teaching mode of Method of Sport Science Research. The teacher first released a learning task in the online class, grouped students and guided students to apply new data analysis software to complete the learning task online. After completing the learning task, the assignments were submitted to the online learning platform. Then, students carried out mutual evaluation and discussion. In the end, the teacher summarized the main practical problems and displayed the excellent assignments. Fig.5 and Fig.6 show scientific research design and data processing screenshots with the application of Spotfire software.

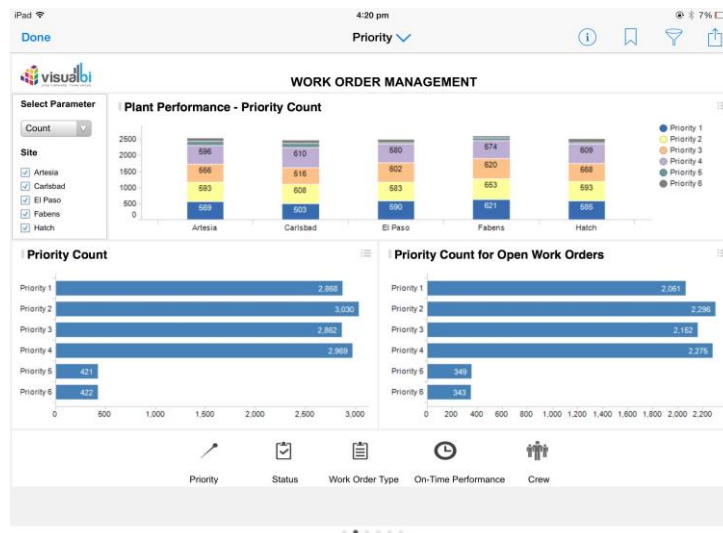


Fig. 5. Research design screenshot with the application of Spotfire software



Fig. 6. Software application scene of students in online cooperative teaching mode of Method of Sport Science Research

3.3 Blended grouping application of fuzzy C mean algorithm in online cooperative teaching mode of method of sport science research

Every student has respective learning modes and strategies, and educators should classify them according to students' learning modes and strategies. In the exam-oriented education, many studies regard students' scores and age as well as learning purpose as the sorting criteria. These criteria are too simple and easily ignore learning deficiencies of some students, thus leading to low learning interest and dissatisfactory teaching effect. Through careful discussion of the research team and consultation of experts in the field, a characteristic model of online cooperative learning was proposed, as shown in Fig.7.

Fuzzy C mean (FCM) algorithm improves early Hard C Means (HCM) method. The algorithm gains the membership degree of each sample point to all category centers by optimizing the objective function so as to determine the generic relation of sample points and finally achieve automatic sorting of data samples. Thus, even if it is very difficult to obviously sort the samples, the better sorting effect can be obtained by FCM algorithm.

The thought of FCM algorithm is to divide the dataset T into c fuzzy groups and then figure out the clustering center of each group for repeated iteration. When the objective function of similarity index reaches the minimum, the element will be assigned to the group with the largest membership degree. The objective function is:

$$\min J_{FCM}(U, V) = \sum_{i=1}^c \sum_{j=1}^n (u_{ij})^m (d_{ij})^2 \quad (1)$$

Wherein, n is the total number of samples; c is number of categories; i is category subscript (i = 1, 2, ..., c); j is element subscript (j = 1, 2, ..., n); U is membership matrix. $U = (u_{ij})$, u_{ij} refers to the membership degree of the ith element subordinate to the jth category, and the following conditions are met:

$$\begin{cases} \sum_{i=1}^c u_{ij} = 1, \forall j = 1, 2, \dots, n \\ 0 \leq u_{ij} \leq 1 \end{cases} \quad (2)$$

$d_{ij} = |v_i - x_j|$ is Euclidean distance between the i^{th} clustering center and the j^{th} data; $m \in [1, \infty)$ is fuzzy weighted index.

The above mathematical programming problem can be solved by Lagrange multiplier method to gain the optimal category center and membership degree for iterative computations, as shown in Formula (3) and Formula (4).

$$V_i^{(k+1)} = \left[\sum_{j=1}^N (u_{ij}^{(k)})^m x_j / \left(\sum_{j=1}^N (u_{ij}^{(k)})^m \right) \right] \quad (i = 1, 2, \dots, c) \quad (3)$$

$$u_{ik} = \left[\sum_{j=1}^c \left(\frac{d_{ik}}{d_{ij}} \right)^{\frac{2}{m-1}} \right]^{-1} \quad (i = 1, 2, \dots, c \quad k = 1, 2, \dots, n) \quad (4)$$

The optimal solution of FCM algorithm clustering is relative to the number of categories c . It is hard to visually determine the number of categories c . Thus, the optimal number of categories is determined by referring to the partition coefficient and clustering validity function.

The units of each index item obtained by experimental statistics are quite different and the data types are also inconsistent. Besides, the influence of variables with large absolute values may submerge the variables with small absolute values. Thus, the due effect of the latter cannot be reflected. To make the variable values in the table have the same status in the analysis, it is necessary to standardize the standard deviation of experimental data before clustering.

The experiment was based on “adaptive learning system of .NET programming course” developed by the research group, and 60 students from PE Department were chosen as the subjects (26 boys and 34 girls). The 60 students were classified into 2 groups, with each group including 30 students. Besides, each group kept the similar male-female ratio. The students in Group 1 (control group) were grouped according to their will, while the students in Group 2 (intervention group) were grouped according to blended grouping algorithm. For Group 2, 9 characteristic component sets $L \in [30, 9]$ of 30 students were acquired by the learning system platform. 9 characteristic component values are expressed with L1~L9. L1~L4 represent component values of 4 learning styles, with the range of $[-11, -9, -7, -5, -3, -1, 1, 3, 5, 7, 9, 11, 13]$. L5 represents knowledge level, with the range of $[0, 100]$. L6 refers to the learning objective, with the range of $[1, 2, 3]$. L7 is the interest, with the range of the combination of any 3 numbers in 1-9. L8 refers to activeness, with the range of $[0, 100]$. L9 represents gender, with the range of $[1, 2]$.

4 Teaching Example and Effect

4.1 Teaching example

Under the guidance of self-direction theory, both teachers and students would apply the teaching mode to learn Method of Sport Science Research. Every teacher has respective teaching mode. This means every teacher has different concerns on students, and the education resources provided for students by teachers are also different, as shown in Table 1. In the first teaching mode, the teacher participated in students' learning content, focused on their learning progress and overall grasped the learning achievements. The fourth mode is the learning mode based on self-direction theory. The teacher only acted as the consultant and only appeared when students needed, which gave full play to students' learning autonomy.

Table 1. Online cooperative mode based on self-direction theory in Method of Sport Science Research

Mode	Stage	Learner	Teacher	Learning process	Resource use
Mode 1	Stage 2	Depend on the teacher	Overall grasp learning	Infuse knowledge in class	Provide resource and process management
Mode 2	Stage 2	Have the interest, but lack ability	Coordinate in learning	The teacher excessively participated in students' learning process	Provide resources and arrange autonomously
Mode 3	Stage 3	Have strong ability, but have no driving force	Supervise learning	The teacher rarely intervened in the learning content, but paid much attention to learning progress	Select resources and independently learn
Mode 4	Stage 4	Learn independently	Learning consultant	Freely learn both in class and after class	Freely use all resources

Tradition online class has rich resources, but it lacks certain pertinence. Students must view a lot of video documents, some cumbersome electronic documents and fragmentary PPT. After completing the learning task, students were required to participate in the examination to test their learning effect. Such method made students lose learning interest, and lower their learning enthusiasm. The author proposed an innovative learning method based on this, in the hope of improving students' learning interest and enhancing their enthusiasm. The specific method is shown in table 2.

Table 2. Online cooperative teaching mode design table of Method of Sport Science Research

	Video	Electronic document	PPT	Picture	Question	
Knowledge point 1	Representative sport event	Running	Document 1	PPT 1	Picture 1	Question 1
Knowledge point 2		Swimming	Document 2	PPT 2	Picture 2	Question 2
Knowledge point 3		Basketball	Document 3	PPT 3	Picture 3	Question 3
Knowledge point 4		Football	Document 4	PPT 4	Picture 4	Question 4
Knowledge point 5		Volleyball	Document 5	PPT 5	Picture 5	Question 5
Knowledge point 6		High jump	Document 6	PPT 6	Picture 6	Question 6
Knowledge point 7		Long jump	Document 7	PPT 7	Picture 7	Question 7
Knowledge point 8		Hurdling	Document 8	PPT 8	Picture 8	Question 8
Knowledge point 9		Gymnastics	Document 9	PPT 9	Picture 9	Question 9
Knowledge point 10		Wrestling	Document 10	PPT 10	Picture 10	Question 10

4.2 Teaching effect

Convenience sampling method was used to choose sophomores who were enrolled to the institute of physical education in 2018. The students were classified into control group (n=30) and intervention group (n=30). The control group was taught according to the traditional teaching method, while the online cooperative teaching mode was used for the intervention group. The experimental period was 8w weeks, and one lesson was given weekly. In the 8th week when the course ended, the investigator surveyed emotional attitude of students in the intervention group. Simple emotional attitude evaluation form for the teaching mode was designed (see table 3) to understand students’ emotional attitude to the mode.

Table 3. Emotional attitude of intervention group to online cooperative teaching mode

Item	n	Percent%
The online cooperative teaching mode of Method of Sport Science Research conforms to students’ actual needs	30	100
Like the online cooperative teaching mode of Method of Sport Science Research	30	100
The online cooperative teaching mode of Method of Sport Science Research contributes to learning	29	96.7
Satisfied with the teacher implementing the online cooperative teaching mode of Method of Sport Science Research	29	96.7
Interested in the online cooperative teaching mode	26	87.7
The online cooperative teaching mode of Method of Sport Science Research contributes to changing learning methods	25	83.3
The online cooperative teaching mode of Method of Sport Science Research contributes to preview and self-learning	25	83.3
It is necessary to change the traditional teaching mode	24	80
It is difficult to learn Method of Sport Science Research	22	73.3
Be able to express opinions on the inline platform, and fully show oneself in class	15	50

It was found that most students in the intervention group presented a positive approval attitude to the teaching mode. The reasons are as below. Firstly, the teaching

mode lays emphasis on improving students' self-direction learning ability. On the one hand, this depends on self-direction learning ability training for learners; on the other hand, the teacher assisted learners in developing a detailed, operable and targeted "learning plan" based on assessment of learners' self-direction learning ability, which contributed to implementing cognitive and metacognitive strategies, improving learners' self-direction learning awareness and enhancing their enthusiasm. Secondly, the traditional teaching mode applied for the control group lacks correspondence among different types of learning resources. Usually, learners are required to view the whole video and carefully read long electronic documents or lots of PPT. After completing learning, learners are often required to join in examinations to test the learning effect. Such design method violates memory rules and reduces learners' happy experience. The case teaching method was applied in the teaching mode, and meanwhile the online cooperative learning mode was combined. Cooperative learning can help learners well share experience and improve learning effect. During learning for the first time, resources are presented as a whole to maintain knowledge completeness. During learning again, the difficult knowledge points can be mainly reviewed according to learners' weak points. Hence, over 80% of students in this study considered the online cooperative teaching mode could improve students' performance, change learning methods, fully mobilize students' enthusiasm, stimulate students' learning initiative, contribute to mastering the knowledge in a short time and enhance learning initiative.

5 Conclusion

Based on self-direction theory, the online cooperative teaching mode that students accepted was designed in this study, and this mode was applied in the teaching of Method of Sport Science Research. In addition, according to the course characteristics and in combination of case teaching method, the teaching effect was assessed by the questionnaire when the experiment ended, and the following conclusions were obtained:

1. The online cooperative teaching mode can effectively utilize the advantage of peer learning, assist students in sharing learning experience and enhance students' sense of joy in learning.
2. The online course under the perspective of self-direction theory has a large quantity of learning resources. Knowledge points and resources should be a one-to-many relation, and multiple choices are provided for learners. Learners may choose one or more for learning according to their characteristics, which contributes to enhancing active learning motivation.
3. The advanced data analysis software applied in this study motivates students' curiosity for knowledge, thus improving scientific research ability and innovation ability. This also prompts that it is necessary for educators to apply advanced and appropriate new software techniques for relevant course teaching so as to keep updating teaching resources.

4. In one word, how to enhance learners' learning effectiveness becomes an objective of online teaching which is explored all the time. Online teaching not just rests on imparting textbook knowledge and experience, but also should help learners form the abilities suitable for the current learning-based society and enhance self-direction learning ability during learning.

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