

Micro-Course Model Based on Precision Teaching Theory

An Exploratory Course on Sports Scientific Research Methods

<https://doi.org/10.3991/ijet.v15i14.14989>

Taotao Su

Henan College of Industry & Information Technology, Henan, China

stthxlw@163.com

Abstract—The course of Sports Scientific Research Methods is mainly designed to help students acquire knowledge on sports scientific research methods in order to lay a good foundation for their engaging in sports scientific research in future. Considering the current teaching system which is not time-efficient, “Internet+”-based micro-course was developed to focus on Precision Teaching model of the Sports Scientific Research Methods. To conduct this study, students’ overall learning process data, classroom teaching process data and teaching affair administration data were collected firstly. Individual-oriented Precision Teaching model was designed by integrating a series of new educational ideas and analysis methods such as Precision Teaching, big data analysis and adaptive learning technology under the context of digital learning. The teaching model was set with Precision Teaching function modules based on “Internet+” technology in the form of micro-course for teachers and students respectively. Lastly, student learning attribute analysis system was built to focus on student attributes for evaluating student learning ability, learning state and task independence. Teaching practice proves that the model is helpful to promote students’ learning interest largely and has enriched the teaching model of the Sports Scientific Research Methods.

Keywords—Precision Teaching; micro-course; scientific research methods; Internet+

1 Introduction

The Sports Scientific Research Methods involves physical education, exercise training and sports management under the guidance of mathematic statistics theories and methods [1]. As a research tool of modern sports science, it aims to help students mastering relevant sports scientific research methods. It will train students to acquire good scientific thinking and research ability by designing teaching content and collecting and analyzing statistical materials with scientific research methods, so that they can possess the capacity required for sports scientific research in future [2]. Usually, traditional teaching mode is adopted for this course. Specifically, the

teaching activities of this course mainly include classroom teaching, written assignment and final examination. This mode is useless for students who don't have a comprehensive understanding and a good command of effective scientific research methods and students usually lack practical ability [3]. In view of this, educators are supposed to continuously reform the teaching mode and teaching methods of this course. The reform goal of the teaching mode and teaching methods of this course can be realized only by differentiated the exact teaching in accordance with students' aptitude. It helps students comprehend the connotation of sports scientific research methods & theories and improve the practical ability of dealing with real problems.

This study aims to explore how the teaching mode and teaching methods of various courses should be reformed in the context of information technology by case study of the Sports Scientific Research Methods. Based on this, a micro-course-based scientific research method course and teaching management system was set and a web-based open course management teaching mode was provided to mainly focus on the learning mode of online course users. Meanwhile, a lot of application scenarios for micro-course mode were developed. The teaching objectives were specified clearly and simply by means of WeChat micro-course, convenient sound or video recording. It was adopted to enable students deeply understand the applications of the course content of the Sports Scientific Research Methods through repeated feedback and exercises. Besides, a new teaching mode for the Sports Scientific Research Methods was formulated under the theoretical guidance of Precision Teaching in accordance with students' learning and cognitive characteristics based on precise student position with a view to provide reference to the educators in teaching of scientific research methods.

2 State of the Art

Currently, the overseas and domestic researches on teaching mode are developing rapidly with the development of information technology and network technology. "Precision Teaching" was proposed based on Skinner's behaviorist learning theory. Precision Teaching refers to a teaching method of meeting the learning needs of individuals and the groups with learning difficulties by planning teaching programs [4]. Strømngren et al. [5] applied Precision Teaching in the teaching of mathematics for 20 minutes a week and 8 weeks a school year and conducted tests before and after the course. The experimental findings showed that the group receiving Precision Teaching had made greater progress than the group receiving conventional mathematics teaching did. Lu et al. [6] tried to apply Precision Teaching in the course of computer programming. To conduct the study, the methods of group design and case analysis were adopted and 10 students were taken as research objects. The result showed that the experimental group comprehended programming problems more accurately and had higher learning efficiency. Kubina Jr et al. [7] found that Precision Teaching is made for improving the educational effect on autistic students and considered Precision Teaching as a method of frequently evaluating student performance, promoting curriculum decision-making and training student fluency.

This is how the teaching methods could be enriched based on the learning characteristics of autistic students. The booming of big data provides opportunities for the development of Precision Teaching in China. For example, Mi et al. [8] discussed individualized teaching in the context of big data and pointed out that information technology was helpful for grasping students' individual needs more accurately. Jiang [9] made analysis by integrating teacher with students developed a harmonious teaching process and improved students' learning interactivity. Yang et al. [10] optimized lesson mode and explored the features and popularization mode of Precision Teaching and individualized education in the context of big data. These literatures all reflect the directions and methods of education in the "Internet+" data era. Fu & Tan [11] constructed a Precision Teaching mode based on big data from the perspectives of establishment of teaching objectives, design of teaching process framework and teaching evaluation and prediction which provides reference for the optimization of the teaching mode referred to herein. Nevertheless, it is also pointed by some literatures that the existing Precision Teaching designs cannot be applied in current teaching design directly with the popularization of digital learning, development of new educational ideas and the gradual maturation of artificial intelligence technology. In addition, there are practical difficulties in respect to data, theory, and analytical technology. Micro-course [12-13] is a teaching mode of developing and improving teachers' teaching skills using modern audiovisual technologies and equipment. In this mode, the teaching process of the "teacher" can be recorded with recording and broadcasting system and the teaching time of 10-15 minutes can help simplifying micro-course. This study aims to explore the performance of the reformed teaching mode, based on big data by focusing on Precision Teaching, supplemented by micro-course technology and innovatively applying it in the teaching of the Sports Scientific Research Methods.

3 Precision Teaching method in scientific research method teaching

3.1 Efficient teaching method based on "Internet+"

Precision Teaching paradigm based on "Internet+": Precision Teaching is mainly applied to individuals and children having difficulties in acquiring some professional skills via programmed instruction. For application in basic education, the mode usually needs to be furnished with clear teaching objectives, courses that can be modularized and monitoring function for evaluating teaching efficiency.

With the penetration of "Internet+" into the educational field, students' learning environment has turned from multimedia environment into digital learning environment and the learning time and space continuously extend and develop. The education units and institutions have built an information environment rapidly and introduce it in elementary and secondary schools via learning platform, mobile APP, digital terminal and wearable devices. The teaching mode based on "Internet+" is based on big data has improved the scientific teaching mode and the intelligence level

of teaching technology in teaching research process, built a data-driven teaching mode in the context of big data and drastically reformed the conventional teaching mode as shown in Fig. 1.

In the experience-imitation teaching paradigm, teacher shows the dominance in the overall teaching structure. Most of the students are passive receivers, teaching content mainly covers booklore, experience and skills teaching media includes paper, pen, book, blackboard, chalk and other conventional teaching aids. Contrastively, in the era where the “Internet+” big data applications become increasingly popular and teaching aids start to evolve into more scientific and personal tools as shown in Fig. 2. It is realizable to build education big data by making full use of big data on education-related fields combining with learner needs and learning progress. Also combining with gathering data on learner status and warning information, make scientific data mining and analysis, and establish individual learning sources of smart teaching preparation to provide necessary conditions for the implementation of Precision Teaching.

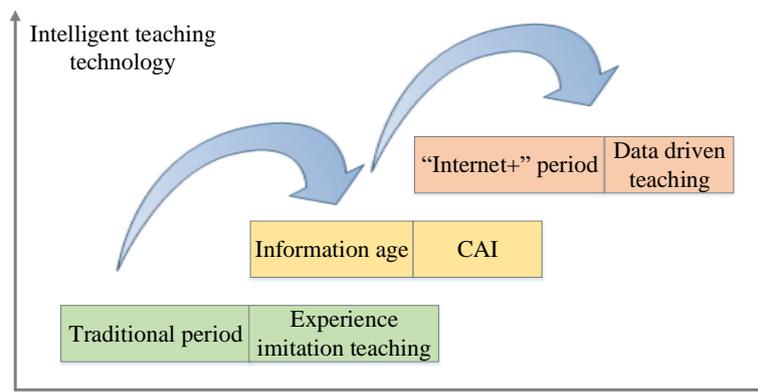


Fig. 1. Progressive diagram of intellectualization of teaching mode reform

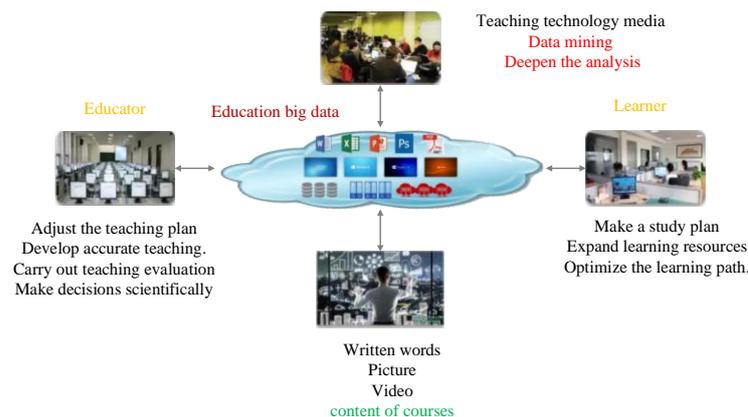


Fig. 2. Intelligent learning mode based on “Internet+”

Precision Teaching method based on “Internet+” : The Precision Teaching mode based on “Internet+” is mainly implemented on the basis of students’ overall learning process data, classroom teaching process data and teaching affair administration data. For example, teacher designs a mode of teaching students in accordance with their aptitude by turning from experience-orientation into exact pattern and analyzing students’ preliminary study performance based on big data analysis. The teaching mode also has been turned from group teaching into customized differentiated and individualized teaching. Promoting individualized learning is good for students to realize multi-dimensional intellectual development and form key competence.

In this teaching mode, the original closed learning environment has turned into a learner-centered open learning environment and is continuously evolving into a learning environment with obvious digitization features supported by data analysis and centered on learners. The learning data throughout the learning process is recorded and the in-depth explorations of artificial intelligence. User modeling and educational data mining technology provide more accurate analysis results for measurement, inference and implementation of learner data. In the context of digital learning, we integrated a range of new educational ideas and analysis methods such as Precision Teaching, big data analysis, adaptive learning technology and designed an individual-oriented Precision Teaching mode as shown in Fig. 3. The mode, taking learner model general and data updating as design core and starting with analysis of student’s personal characteristics and differentiated information. It integrates pre-class learning plan design, learning effect analysis, differentiated in-class teaching interaction guidance, after-class individualized independent study in accordance with the idea of teaching students and in accordance with their aptitude. In its implementation, the main task before class is to design differentiated activities to help students mastering basic knowledge at their cognitive level and the task in class to design differentiated learning objectives based on the completion status of learning content, weak point in knowledge and engagement in activities. In class, it is supposed to select a teaching mode suitable for the course content and design, implement and guide teaching based on the results of analysis of student individual difference and learning evaluation. After class, it is suggested to ask students to conduct independent exercise via adaptive learning platform, so as to further internalize and grasp knowledge via the individualized learning resource pushing and learning path on the platform. Fig. 3 shows a schematic diagram of typical Precision Teaching mode based on “Internet+”. It shows that students’ individual behaviors in learning process are taken as basic data to get detailed information on students’ learning state and included in the teaching mode system as analysis factors. A student model is built on this basis, and evaluation is conducted on student learning ability to further develop Precision Teaching. In the implementation of teaching process, it is also supposed to make full use of detailed learning information of students and teach students in accordance with their individual differences. In this process, relevant information on “Internet+” should be made full use of.

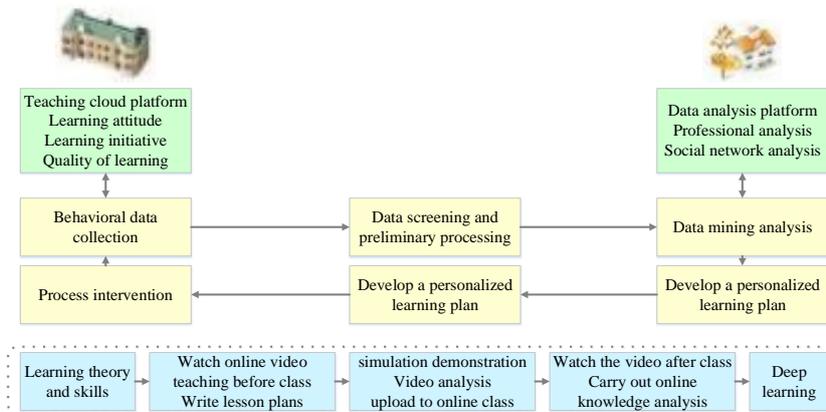


Fig. 4. Precision Teaching function module integrated with micro-course based on "Internet+" technology

Precision Teaching design integrated with micro-course technology: Fig. 5 shows the framework diagram of Precision Teaching mode integrated with micro-course based on the foregoing contents which reflects the information of both teacher and students. Teacher makes full use of micro-course technology in teaching content arrangement, definition of starting point of teaching and teaching design as well as teacher-student interaction and online instruction. Students make full use of micro-course videos and courseware to realize online learning preparation, interactive discussion, advance preparation, in-class internalization, online review and online testing for consolidation as shown in Table 1.

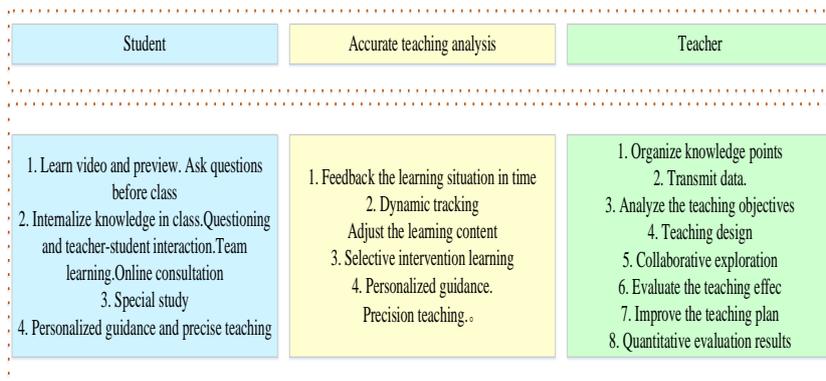


Fig. 5. Precision Teaching design framework integrated with micro-course

3.3 Precision Teaching mode management system of the sports scientific research methods based on “Internet+”

To conduct the study, a teaching management system was established in accordance with RBF network theory of which the basic profile is to map the input of low-dimensional space to higher-dimensional space with hidden unit RBF and fit curve. RBF network is a type of forward network. Its input layer is constituted by signal source nodes, the hidden layer corresponding to it is the second layer and the third layer corresponds to linear output layer. The number of hidden units contained in the hidden layer depends on specific circumstance. Hidden units correspond to RBF radial basis transformation function. The topological structure is as shown in Fig. 6.

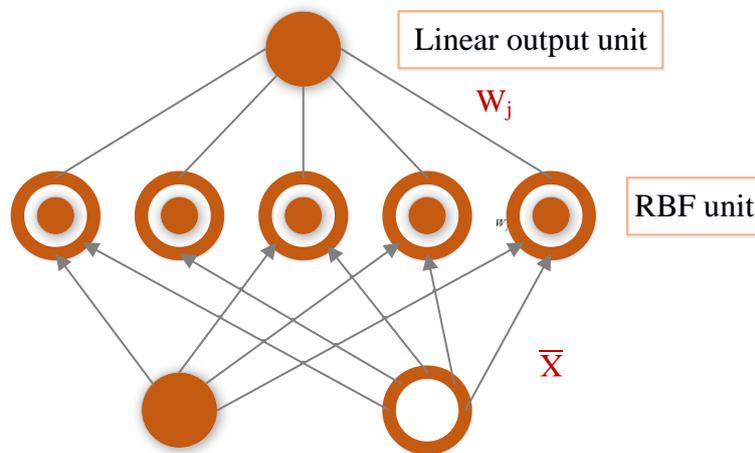


Fig. 6. RBF topological structure

The input node and output node in RBF network model are determined in accordance with the problems to be solved. The number of input nodes is the number of influence factors and the number of output nodes is the level of evaluation result. Hidden nodes usually are determined via clustering algorithm or repeated experiments. The network model by setting n nodes in the input layer, h nodes in the hidden layer and m nodes in the output layer is as shown in Fig. 7.

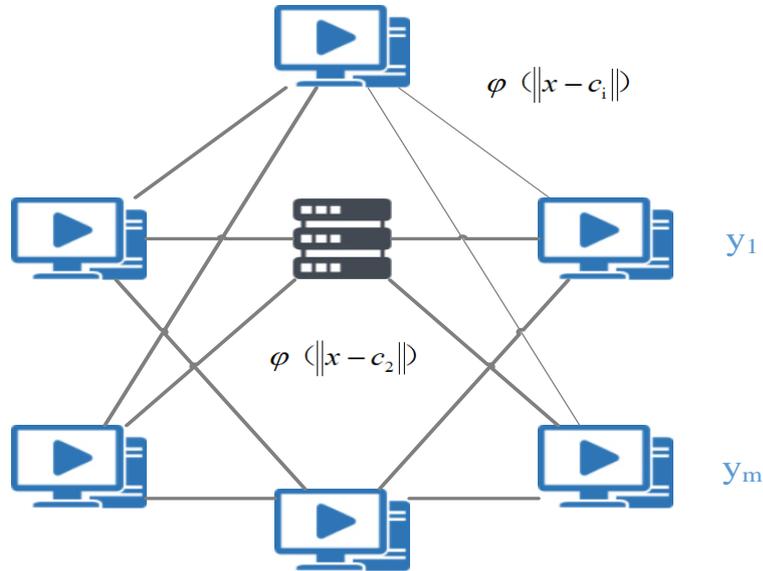


Fig. 7. RBF neural network diagram

The model is featured by fixed hidden layer weight and the input-output relation of the model is as below.

$$y_k = \sum_{j=1} v_{jk} \exp \left(- \frac{\|x - c_j\|^2}{2\sigma_j^2} \right) \tag{1}$$

In this study, a student learning attribute analysis system was established based on student attributes for evaluating students’ learning ability, learning state and task independence as shown in Table 1.

Table 1. Student classroom activeness analysis

Activeness	Classification Standard	Characteristic Value
Highly active	Students’ participation >2	1
Relatively active	1 < Students’ participation < 2	2
Moderately active	0.5 < Students’ participation < 1	3
Low active	0.1 < Students’ participation < 0.5	4
Inactive	Students’ participation < 0.1	5

Student individualized learning characteristics statistical data was established by means of quantitative analysis for building a student learning state analysis model. In this study, a teaching management system was built based on the data analysis model of attention that students should obtain. The specific practice is to take mass student data as sample, extract its characteristic value, take the characteristic value data as the learning data of neural network and automatically output judgement standard on

student learning concentration after neural network training to help establishing a rational teaching management system. The mathematical model of attention that students should obtain meets [A, R, I] indicators. A refers to student activeness, R refers to feedback on learning, and I refers to learning independence. The proportion relation of the indicators is:

$$ARI=A*0.4+R*0.3+I*0.3$$

The ARI values are shown in Table 2. The relation between the attained ARI values and the corresponding attention that students should obtain is shown in Table 3.

Table 2. The ARI values

Indicator	Meaning	Content	Score	Weight
A	Student classroom activeness	Highly active	100	0.4
		Relatively active	80	
		Moderately active	60	
		Low active	20	
		Inactive	0	
R	Task performance quality	High quality	100	0.4
		Good quality	80	
		Medium quality	60	
		Low quality	20	
		Poor quality	0	
I	Degree of learning independence	Highly independent	100	0.3
		Relatively independent	80	
		Moderately independent	60	
		Low independent	20	
		Poorly independent	0	

Table 3. Characteristic value of attention that students should obtain

Attention	Classification standard	Characteristic value
High attention	ARI score < 5	1
Considerable attention	5 < ARI score < 22	2
Moderate attention	22 < ARI score < 58	3
Low attention	58 < ARI score < 80	4
No attention	ARI score > 80	5

Gaussian radial basis function is used to build the neural network analysis function based on this data and the mathematical model was built to facilitate database storage of student individual learning needs, personalized performance and capability of independent learning.

The proper data should be normalized before being input into RBF network. Normalization means normalizing the range of indicator input value into the interval of [0, 1] by operation. To conduct this study, the maximum/minimum method is selected. Both input data and output data were normalized into the interval of [0, 1] with the following formula:

$$X_i^* = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad (2)$$

Wherein X_i is input data, X_{\min} is the minimum of input data and X_{\max} is the maximum of input data.

The below is further analysis of topological structure of fixed network. There are 25 nodes at the input layer of RBF; 5 radial basis function nodes at the hidden layer of RBF and each corresponds to one type; there is one node at the input layer via which evaluation result is output. Before L-M iteration, K-mean clustering algorithm was employed to determine the weight of output layer and set initial value and the center and variance of radial basis function nodes of hidden layer. The basic idea of K-mean clustering algorithm is to minimize total intraclass distance (sum of distances from sample to center in all classes).

$$E = \sum_{j=1}^k \sum_{x_i \in w_j} \|x_i - m_j\|^2 \quad (3)$$

The processing procedure is as below:

1. Initialization: number of clusters k , number of iterations N ; minimum deviation of subsequent iteration δ ; current generation number $t=0$; select k centers at random (usually the first k centers) m'_j .
2. $t = t + 1$, distribute x_j into the class represented by its nearest center m'_j
3. Calculate the new center m_j^{t+1} after distribution and performance indicator $E(t+1)$

$$m_j^{t+1} = \frac{1}{N} \sum_{x_i \in m'_j} x_j \quad (4)$$

(4) If $t > N$ or $\|E(k+1) - E(k)\| < \delta$, stop; otherwise turn to 2, and continue.

In this study, the number of classes is $K=5$, and the number of iterations is 100. The first sample of each class is selected as the initial class center and the minimum deviation is $\delta = 10^{-5}$. The sample center after clustering is as shown in Formula 4:

$$\begin{cases} C_1 = [3.8, 4.1, 4.2, \dots, 3.9] \\ C_2 = [2.7, 3.0, 2.9, \dots, 3.0] \\ C_3 = [2.2, 2.1, 1.8, \dots, 2.0] \\ C_4 = [1.2, 0.9, 1.1, \dots, 1.0] \\ C_5 = [0.1, 0.1, 0.0, \dots, 0.0] \end{cases} \quad (5)$$

The variance is determined with the empirical equation is as below.

$$\sigma^2 = \frac{d_{\max}}{\sqrt{h}} = \frac{\| [4,4,4,\dots,4] - [0,0,0,\dots,0] \|}{\sqrt{5}} = 8.9443 \quad (6)$$

Wherein, d_{\max} is the maximum Euclidean distance among the centers, and h is the number of centers. The weight of the output layer is determined to be random number uniformly distributed in the interval of (-1,1). As in parameters of L-M algorithm, $\mu_1 = 0.1$, the number of iterations is 5000, and the error precision is 10^{-2} .

3.4 Effect evaluation and analysis

The collected 528 sample data relating to the course of Sports Scientific Research Methods was submitted into RBF network for training. Formula 5.6 was applied to make the built model consistent with the questionnaire survey result on graduates for this study to ensure the correctness of the model.

$$\varphi(x) = \exp(- (x - c_i)^2 / 2) \quad (7)$$

In this study, MATLAB functions were used to establish RBF network for analyzing student Precision Teaching analysis model and the Precision Teaching mode model of the course of Sports Scientific Research Methods was obtained finally.

4 Teaching Example and Effect

4.1 Teaching example

The process of the course of sports teaching method implemented herein is provided below. Specially adapted teaching of the course of sports research methods has been conducted in combination with the steps and contents of Precision Teaching method and based on the Precision Teaching analysis model which consists of teaching time allocation and teaching process as shown in Fig. 8. Fig. 9 presents the assignments submitted by students after online learning of the Sports Scientific Research Methods.

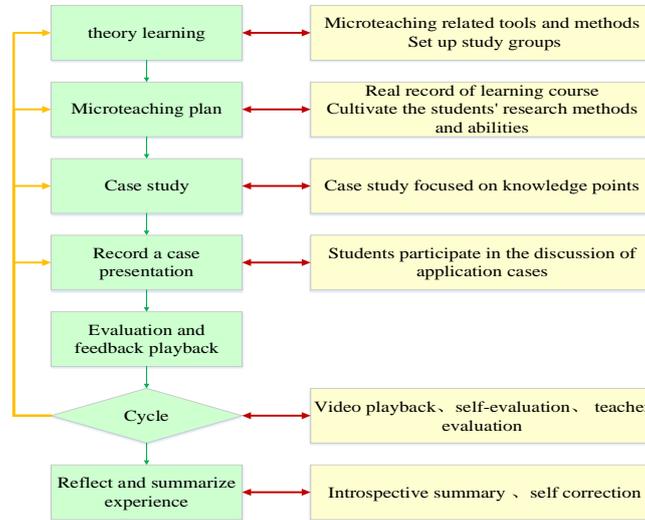


Fig. 8. Process diagram of Precision Teaching of the Sports Scientific Research Methods integrated with micro-course

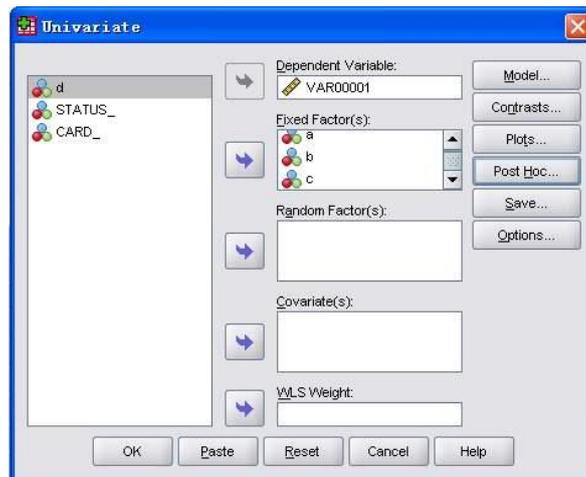


Fig. 9. Content of students' online learning and assignments

4.2 Teaching effect

The teaching results were evaluated based on the theory test scores and usual performance. The online and classroom participation rate of the observation group is 100% on an average. The test scores of the observation group is higher than that of the control group and the difference is of statistical significance ($P < 0.05$). Students' satisfaction with curriculum provision also was surveyed. The survey result shows that the students of the observation group are satisfied with the Precision Teaching

mode of the Sports Scientific Research Methods based on Internet+ in this study as shown in Table 4. Up to 81% students show favor of this teaching mode, 89% students consider the Precision Teaching mode has improved students' independent learning ability largely and 93% students believe it can stimulate learning enthusiasm. In micro-course mode, students can make full use of electronic information products and students are encouraged to contact and use information via the internet to broaden their intellectual field. Students' participation has been improved significantly. 79% students like interactive question and answer session and 81% students think that excellent resources can be obtained via the Internet+ technology.

Table 4. Evaluation of the teaching mode by the observation group/%

Survey content	Strongly agreed	Agreed	General	Disagreed	Strongly disagreed
Way of classroom questioning	55	55	55	55	55
More cooperative with others in classroom	71	71	71	71	71
Course content helps me understand knowledge better	50	50	50	50	50
This teaching mode is helpful to improve communication skills	56	56	56	56	56
I can fully understand the knowledge	12	12	12	12	12
Mobile terminal (cellphone, notebook computer, PAD) helps me in learning	62	62	62	62	62
Good for raising my learning interest	63	63	63	63	63
I like this mode	55	55	55	55	55

5 Conclusion

This study explores the Precision Teaching mode reform integrated with micro-course of this course in combination with the science and technology that promoted in the educational field in the era of “Internet+” big data. The results indicate that the teaching of the course of sports research methods with case teaching method is helpful to raise students' learning interest and enhance students' comprehension of knowledge. It is also helpful for strengthening relations between students and teachers via interactive learning that improves students' skill and level of sports studies and increase the effectiveness of the course of sports research methods. Its main advantages include:

1. Clear and specific learning objectives are set. Teachers decompose the teaching process and start with simple preliminary scientific research methods and skills to make a scientific training plan. Students are informed of the objectives to be achieved at the beginning of teaching so that students can make preparations purposefully.
2. There is no limit in learning time and students show high participation. It is realizable to push learning contents of scientific research methods to students

before, in and after class, so that students can seek guidance from teacher when having doubts, communicate with classmates and submit assignments for summarization. In this way, students can integrate theory with practice well which is good for improving learning effect.

3. Meanwhile, the audio-visual micro-course process can reflect students' knowledge mastery level in time. Teachers can make use of audio-visual technology to present the method design of scientific research methods and operations of statistically software to students visually, so that students can consolidate knowledge via the pictures, videos and audios shared by teachers repeatedly to enhance the teaching efficiency. Besides, students can make discussions via WeChat group through which teachers can make review and guidance to give feedback information to students. Moreover, this eases the teaching burden of teachers to a certain extent and raises teachers' work efficiency.

6 References

- [1] Li, M.L., & Ren, Y.J. A multimedia teaching model for "sports statistics" based on arcs motivation theory. *International Journal of Emerging Technologies in Learning*, 2018, vol. 13(9), pp. 15-28. <https://doi.org/10.3991/ijet.v13i09.8972>
- [2] Ding, S., & Lv, J. Model of evaluation on sports scientific research performance based on grey correlation analysis in universities. *Journal of Computational & Theoretical Nanoscience*, 2017, vol. 14(1), pp. 42-45. <https://doi.org/10.1166/jctn.2017.6121>
- [3] Zhao, M.N., Zhang, H.Q., Yang, J., Shi, Y.K. A Behavioral Research on the Comprehensive Reform of Sports Science Research Methods in Colleges. *Journal of NanJing Sports Institute*, 2019, vol. 2(8), pp. 16-20.
- [4] White, O. R. Precision Teaching—precision learning. *Exceptional children*, 1986, vol. 52(6), pp. 522-534. <https://doi.org/10.1177/001440298605200605>
- [5] Strømngren, B., Berg-Mortensen, C., & Tangen, L. The use of Precision Teaching to teach basic math facts. *European Journal of Behavior Analysis*, 2014, vol. 15(2), pp. 225-240. <https://doi.org/10.1080/15021149.2014.11434723>
- [6] Lu, T.T., Yin, J.T. An Exploration on the Teaching Mode Reform under the Idea of Smart classroom—Taking Computer Science Basics course as an Example. *Journal of Jining Normal University*, 2019, vol. 41(6), pp. 92-96.
- [7] Kubina Jr, R. M., Morrison, R., & Lee, D. L. Benefits of adding Precision Teaching to behavioral interventions for students with autism. *Behavioral Interventions: Theory & Practice in Residential & Community - Based Clinical Programs*, 2002, vol. 17(4), pp. 233-246. <https://doi.org/10.1002/bin.122>
- [8] Mi, C.Q., Deng, Q.Y., Li, X.M., et al. The construction of personalized education method system based on big data. *Computer Education*, 2018, vol. 16(10), pp. 129-131.
- [9] Jiang, Y.F. The cultivation of students' innovation ability in computer teaching in Higher Vocational Colleges. 2016, vol. 23(5), pp. 164-165.
- [10] Jiang, Q., Zhao, W., Li, S. et al. Research on the mining of precise personalized learning path in age of big data: analysis of group learning behaviors based on aprioriall. *e-Education Research*, 2018, vol. 39(2), pp. 45-52.
- [11] Fu, D.J., & Tan, L. Research on the Precision Teaching Model based on Big Data. *Modern Educational Technology*, 2017, vol. 27(7), pp. 13-19.

- [12] Yang, S.X. Teaching Mode of Dance Appreciation Micro-course Based on Primary Teaching Theory. *International Journal of Emerging Technologies in Learning*, 2018, vol. 18(8), pp. 133-145. <https://doi.org/10.3991/ijet.v13i08.9045>
- [13] Gao, N. Construction and Implementation of Teaching Mode for Digital Mapping based on Interactive Micro-course Technology. *International Journal of Emerging Technologies in Learning*, 2018, vol. 13(2), pp. 21-32. <https://doi.org/10.3991/ijet.v13i02.8317>

7 Author

Taotao Su is a Lecturer in the Henan College of Industry & Information Technology, Henan, China (stthxlw@163.com).

Article submitted 2020-04-19. Resubmitted 2020-05-23. Final acceptance 2020-05-24. Final version published as submitted by the authors.