Online Education and Learning Model of Applied Optics Course Based on Artificial Intelligence

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Abstract. In the optoelectronics related curriculum system, the applied optics curriculum focuses on improving learners' ability in practical optical design, while ignoring the online teaching link, so it is difficult to ensure the teaching quality. In order to solve the above problems, a design method of online education and learning model of Applied Optics curriculum based on artificial intelligence is proposed. After determining the design theme, through independent learning and team division, complete relevant data acquisition, optical system optical characteristic calculation, initial structure establishment, evaluation function composition, global optimization process and tolerance analysis, effectively combine artificial intelligence with the learning process, and achieve the learning goal of Applied Optics online teaching. Finally, the experimental results show that the online education and learning model of Applied Optics Based on artificial intelligence is more effective in stimulating learning motivation, improving learning efficiency, enhancing students' design practice and operation ability, and cultivating team communication and cooperation skills.

Keywords: Artificial intelligence · Applied optics · Online education

1 Introduction

In recent years, driven by the progress of information technology, with the proposal of emerging online learning concepts such as large-scale open online courses, online education shows a rapid development trend in market scale and the number of learners. Online education has become a hot field in the Internet industry. It not only brings huge business opportunities, but also may lead to a fundamental change in learning mode in the near future [1]. At present, there is no exact definition of the concept of social media, but what is clear is that it has the characteristics of decentralization. People can use it to create content, share information, and get feedback from others. Most of the online learners are on-the-job adult learners, Therefore, online education not only pays attention to the transmission of knowledge, but also emphasizes the improvement of learners' ability to

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analyze and solve practical problems. The cultivation of practical skills requires learners to participate in practice and learn in practical activities [2]. At the same time, the new online education model emerging in recent years increasingly encourages learners to learn in a collaborative way, promotes the internalization of knowledge and speeds up the mastery of skills through communication with others (other learners or teachers). Social media provides an effective way for collaborative learning in the context of online education. Using social media, learners and teachers, learners and other learners can communicate synchronously or asynchronously. This efficient communication method can improve the learning effect of online education. Aiming at the learning problems in Applied Optics, combined with the characteristics of artificial intelligence, this paper introduces the application of artificial intelligence in online teaching of Applied Optics, and describes the feedback and response of learning model. Combined with the practical characteristics of Applied Optics online teaching, artificial intelligence mode is applied to teaching design as an important learning organization form in different stages of the course.

2 Online Education and Learning Model of Applied Optics Course

2.1 Online Education Management System of Applied Optics Course

The biggest difference between online learning based on social media and traditional classroom learning is the difference in the way of knowledge transmission. Classroom learning is a teacher-centered teaching method, and knowledge is mainly one-way transmission from teachers to students [3]. In online learning based on social media, knowledge can not only come from teachers, but also from learners, and be transmitted among all participants of learning activities. The figure shows the difference of knowledge transmission between the two different teaching methods (Fig. 1).

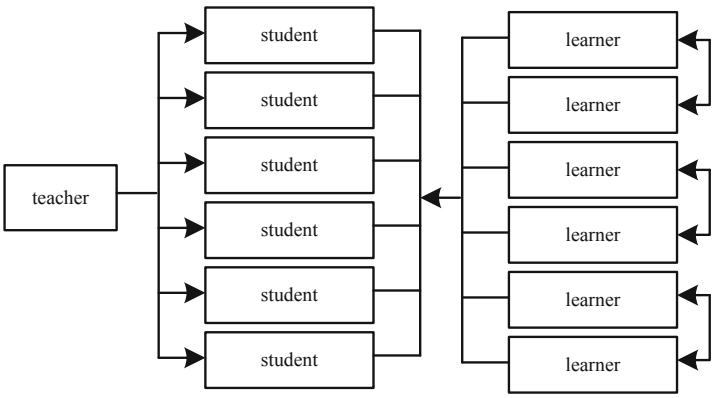

Fig. 1. Knowledge transfer and blending mode of classroom learning and online learning

Considering the learning background and course characteristics, the learning contents will include preliminary aberration theory, application of software tools and practical optical design. The preliminary aberration theory will focus on the study of

monochromatic aberration and chromatic aberration [4]. The learning content of actual optical design will focus on the experience of optical design process, verify theoretical knowledge through software operation, and guide reasonable software operation with theoretical knowledge. Different from traditional classroom education, online education based on network not only needs to impart knowledge and supervise learning, but also needs to provide online teaching resources and environment for learners. Learners need to think independently and explore actively, which requires higher self-consciousness and initiative [5]. With the continuous development of online education and the proposal of personalized learning, there are new requirements for the content and form of learning resources. It is necessary to organize learning resources according to certain norms and standards to make them have structural characteristics, so as to facilitate learners to query, recommend and share learning contents in a wide range [6]. Learning resources refer to all resources that learners can use for learning in the learning environment of teaching system and online education, including teacher guidance, resource information, material content, multimedia equipment and technology. Through the standardized organization and modeling of learning resources, it can meet the new needs of learners for dynamic and retrievable learning resources (Fig. 2).

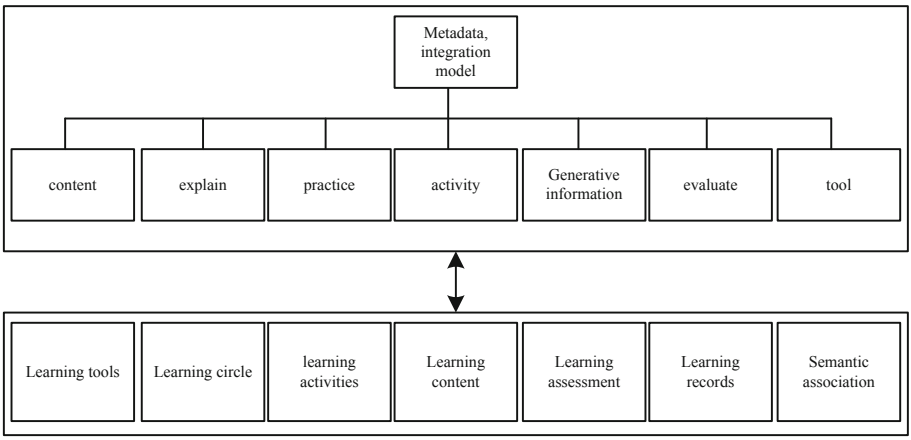

Fig. 2. Elements of online learning elements of Applied Optics Course

Among them, metadata and aggregation models describe the characteristics of learning elements, which are convenient to organize and search for content. Learners mainly learn by obtaining resource content. Practice and evaluation are used to test learners' acquisition and mastery of knowledge. Activity description Standard code of Conduct and operation mechanism of learning Activities Service interface Provides a functional interface for information exchange between learning element and learning service artificial intelligence environment, and provides data information for learning tools, content, activities, exercises and other modules.

2.2 Online Learning Evaluation Index of Applied Optics Course

In order to demonstrate students' problems professionally and typically, ask questions within the limits of teachers, and each group selects a deviation as the problem to be understood and solved. At this stage, the team members are required to collect data and learn the basic function operation videos of the software by themselves, and regularly organize group discussions and share learning experience to prepare for future classroom demonstrations [7]. At this stage, teachers will guide students to master relevant knowledge, discuss core issues, and timely feed back problems in students' learning process. At the same time, teachers should emphasize and guide students not to limit their learning content to the distortion of their own group, and learn all distortions comprehensively (Table 1).

Table 1. AOC learning process based on CPBL model

	The preliminary stage	The intermediate stage	The advanced stage
Learning focus	Primary aberration theory Basic functions of optical design software	Aberration correction strategies	Complex optical system design
Group formation	Students' self-organization	Based on the previous grouping, one person from each group is selected to form a new group	The self-recommendation of the group leader and the group members
Problem arises	Scope limited by the teacher Group self-selection	Taking a simple optical system as the object, determine the optical characteristic parameters by yourself	Find and select optical design problems completely independently
Learning resources	Textbook Literature Video library	Software manual Literature Patent library Website videos	Software manual Literature Patent library Website videos
Activity venue	Smart classroom Group choice	Computer room Group choice	Computer room Group choice
Learning methods	Traditional teaching, Personal learning, Group learning	Personal learning Peer learning Group learning Online and offline communication between teachers and students	Personal learning Peer learning Group learning Online and offline communication between teachers and students
Teacher role	Gradual weakening from the leading role to a supporting role	Supporting role	Supporting role

In the middle stage of the learning process, one student is randomly selected from each group to form a new group on the basis of the previous group, which is conducive to the diversity of aberration control methods mastered by group members. As group members come from different aberration groups, they have different degrees of understanding of different aberrations. Teachers should weaken the role of experts, only play an auxiliary role, actively respond to questions from the students attempt to encourage students to make a different, rather than the default design and operation process, let the team members interact each other and generate dynamic learning resources, and share knowledge and skills, so that the students have more channels to solve specific practical problems, Thus, it is more likely to achieve the best design effect. After the design theme is determined, through independent learning and team division, relevant data collection, calculation of optical characteristics of the optical system, initial structure establishment, evaluation function composition, global optimization process and tolerance analysis are completed, and finally the design objectives are completed. In this stage, the teacher only plays a supporting role, answering the questions raised by the students in time and giving guidance to the mistakes in time, but the focus of this stage is to emphasize the subjectivity of students' independent learning. In the three stages of the learning process, the learning results will be displayed and evaluated in different ways according to the characteristics of the learning stages and the difficulty of the problems, as shown in Table 2.

Table 2. Evaluation indicators of learning results

	The preliminary stage		The intermediate stage		The advanced stage	
Learning outcome exhibit	Group class presentation Questions from other groups Teacher's summary and supplement		The competition between groups The sharing of Paperwork and operating procedure video		Defense group display Adversarial group questioning Paper report	
The role of learning outcome evaluation	Teacher	45%	Teacher	75%	Teacher	45%
	Group members	35%			Group members	25%
	Other groups	10%	Group members	25%	Other groups	25%
	Self-evaluation	10%			Self-evaluation	5%

Multi channel process evaluation and conclusion evaluation are combined to collect learning results. Among them, the subject of learning effect evaluation can be carried out not only by teachers, but also by students in the form of peer evaluation system. In the traditional collaborative recommendation algorithm, the similarity between two users is difficult to calculate because of the lack of common scoring items. However, when the user attributes are similar or even the same, their scores on the same items may also be very close. Therefore, the combination of Pearson similarity and user attribute

similarity is used to measure the similarity of users, so as to alleviate the problem of too sparse scoring matrix (Fig. 3).

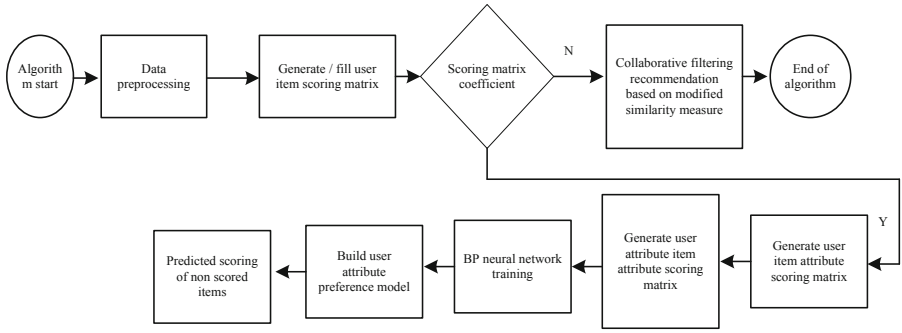

Fig. 3. Online teaching collaborative recommendation algorithm based on Artificial Intelligence

Since the development of students' learning process is related to the design of learning situations and learning strategies, the learning background of this course emphasizes the application of theoretical knowledge to practice; Students combine teacher-student interaction and student cooperation throughout the learning process. In order to effectively combine artificial intelligence with learning process and realize the learning goal of Applied Optics online teaching, the whole learning process mainly includes three learning stages: primary stage, intermediate stage and advanced stage. The framework design and development of online curriculum resources is an important link in the success of the implementation of online teaching mode. It can also be said that the important factor of teaching success or failure is determined by curriculum resources. According to the different functions and uses of information-based teaching resources, our university classifies online course resources into three categories: guiding resources, content-based resources and generative resources. The overall framework design is as follows (Fig. 4):

Guiding resources	Content resources	Generative Resources
Syllabus content design	Curriculum teaching teacher	Online Q & A after class
	Classroom interactive communication	Assignments and exams
	Course live broadcast	Self reflection
	Course supporting materials	Complete the task

Fig. 4. Online education curriculum content structure optimization framework

This stage is the central link of the whole online teaching stage. The quality of classroom teaching directly affects the implementation of the whole teaching mode, and content resources are the key to determine the success or failure of classroom teaching stage. Unlike ordinary online teaching, which uses recorded video courses as course resources, our teaching adopts the way of live video. The so-called teaching behavior should be a real-time process completed by teachers and students. There is a time difference between ordinary video teachers and students when they record it and watch it. The time difference will lead to further estrangement between teachers and students, It is not conducive to the development of Teaching. At this stage, teachers' direct teaching is still the most efficient and direct teaching method. In the process of activities, people prefer to face a living person rather than a cold machine. One advantage of online classroom is that it can carry out more communication between teachers and students. In order to ensure the classroom quality of teaching, students can be arranged to speak on behalf of students after group discussion for many times in a semester, and the students who speak can be scored. When settling the classroom academic results at the end of the term, the system calculates the students who have not spoken or have not spoken enough times, and the score of the project will be discounted or even failed. At the same time, the attendance rate of students can be recorded through the student side camera system. After students log in to the system through their account, the system can monitor students' performance in class. If students leave for no reason, those who leave for more times can be judged as late, early leave or even absenteeism, which is more effective and accurate than taking time to roll call. Du Judai's attendance also saves time.

2.3 Realization of Online Teaching and Learning of Applied Optics Course

With the explosive growth of information resources, it has become difficult for ordinary users to find the content they need from a large number of resources. As information providers, how to make their product information stand out from the multifarious information base and get attention has also become very difficult, hence the emergence of recommendation system. Recommendation system should be based on user needs, interests, preferences, and recommended that may be of interest for the user resources, and provide personalized, differentiated content services for the general information collected by the user personalized recommendation system and modeling module, user behavior records attribute, the recommendation algorithm module and content display interface of these four parts, as shown (Fig. 5).

The user information collection and behavior record module is responsible for obtaining user attributes, scoring information and behavior records from the database and web log, so as to provide data sources for the implementation of recommendation algorithm; User attribute modeling is responsible for analyzing user attributes and their behaviors, extracting effective information, and establishing user attribute preference model: recommendation algorithm is the core module of recommendation system, which needs to generate recommendation results, recommend the content in the resource database to users, meet the personalized needs of users, and the content display interface displays the resource information to users, and in the process of user browsing, Continuously collect user feedback, collect user behavior information, update user needs, and improve system interactivity and real-time. The formulaic definition of recommendation system

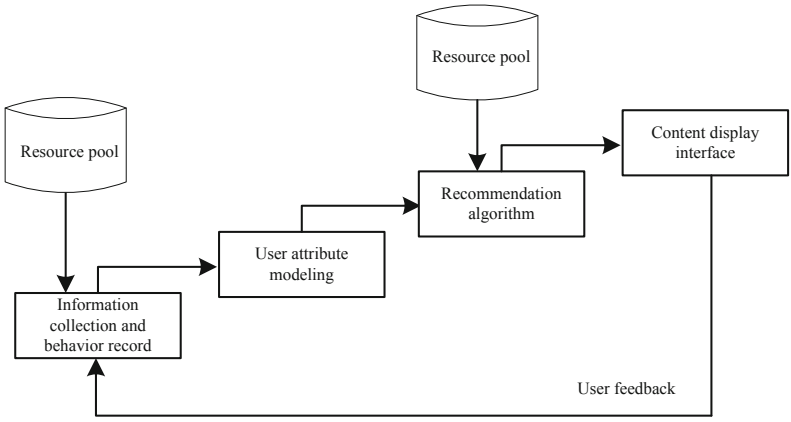

Fig. 5. Online teaching recommendation system of Applied Optics Course

is as follows: in Recommendation System. Let C represent the set of all registered users and A represent the set of all online products. In the actual online system, the number and scale of users and products are usually large, so that the utility function $u(x)$ calculates the evaluation of user C on product s, that is, the liking $u(c, s)$, where R is a totally ordered set. For each user $c \in C$, the recommendation system can help them find the products with the greatest preference, that is:

$$\forall c \in C, \exists s \in A, s' = u(x) - A \arg\max C - u(c, s) \tag{1}$$

At the same time, users can also contain a variety of user information, such as age, gender, specialty and so on. Product s also contains a variety of item information. If it is on the shopping website, it can include the unit price, style, origin and so on. The utility function represents the user's evaluation and preference for the recommended items. Like traditional education, online education also needs a course route process. Teachers also need to prepare lessons before teaching, determine the syllabus and design the course content. On this basis, the system has a set of unique route modules to assist teachers in their course work, as shown in the following figure (Fig. 6):

Preparation before class needs teachers according to the characteristics of the online mode, to determine the content of the syllabus and curriculum, not only is the original PPT courseware to pass on the server, such as over it, and the difference from the online education and traditional education teaching ways, than the general existing online education simply video video lectures, biggest advantage of this system can be taught to broadcast live. The resource display and learning module shows learners the recommended methods to realize the learning resources recommended by the module, and provides supporting functions such as learning browsing. Meanwhile, real-time acquisition of learners' behavior information is carried out. The main users are students and teaching students who can study on the platform according to their own interests and personalized recommendation results. After learning, they can evaluate and discuss, etc. Teachers can upload learning resources, guide students in learning and manage resources and other information. Administrators can perform routine maintenance of the system (Fig. 7).

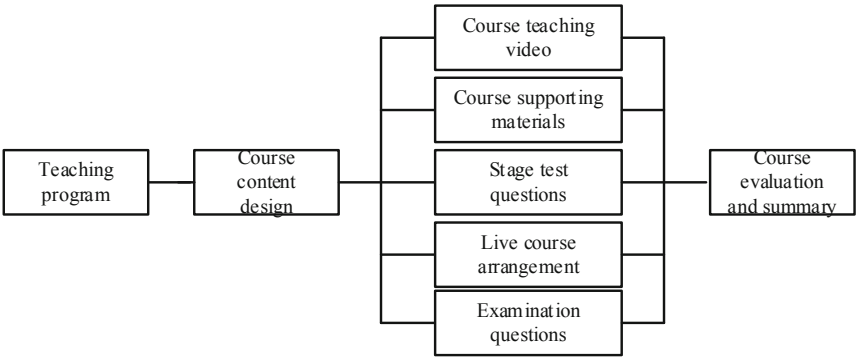

Fig. 6. Online education course route design

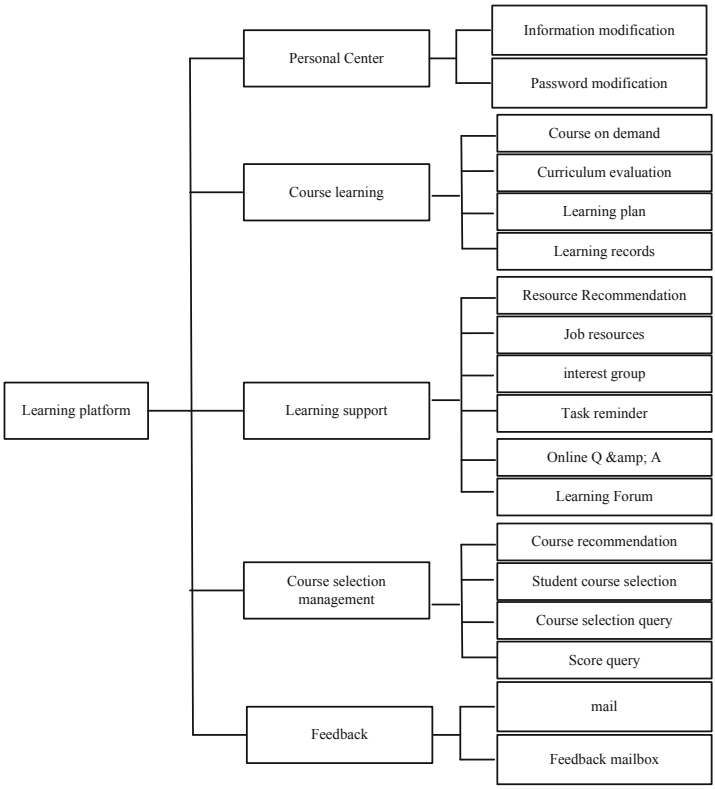

Fig. 7. Function module diagram of learning platform

Based on the learning problems in Applied Optics and the characteristics of artificial intelligence, the application of artificial intelligence in online teaching of Applied Optics is introduced, and the feedback and response of learning model are described. Considering the practical characteristics of Applied Optics online teaching, artificial

intelligence mode is applied in teaching design as an important learning organization form in different stages of the course. In the teaching design, students are gradually familiar with the artificial intelligence mode, give full play to the advantages of the artificial intelligence mode, stimulate students' motivation for autonomous learning, realize the flexible combination of curriculum theory and design practice in the learning process, exercise students' teamwork ability, and finally effectively complete the goal of building curriculum knowledge points based on the network.

3 Analysis of Experimental Results

Function test the personalized resource recommendation module and related modules in the network education and learning platform to verify whether their functions meet the system requirements and design test objects: test the functional modules such as system resource recommendation, resource evaluation and learning support, and evaluate the correctness, reliability and integrity of the functions, And test the interaction and complementarity between the personalized resource recommendation module and the existing functions of the learning platform (Table 3).

Table 3. Deployment and test equipment parameters

Equipment	Model	CPU	Memory/GB	Operating system	Network broadband/M	Quantity
Web server	G2153MT	Inter(R)Core(TM)i7-4780@3.8 GHz	32	Windows XP	120	2
Database server	G2155MT	Inter(R)Core(TM)i7-4780@3.6 GHz	16	Windows XP	120	2
Web client	G2157MT	Inter(R)Core(TM)i7-4780@3.8 GHz	32	Windows XP	120	2

Convergence validity is mainly used to detect the correlation between different problem items in the same construct. It is generally believed that if the standardized factor load λ_i is greater than 0.6, the combined reliability is greater than 0.7 and the average extraction variance is greater than 0.5, the internal convergence of the model meets the requirements. The calculation formulas of 19.1% combined reliability and average extraction variance are as follows, where is the standardized factor load and θ_i is the measurement error of observation variables.

$$CR = s' - \frac{(\Sigma\lambda_i - u(x))^2}{(\Sigma\lambda_i)^2 + \Sigma(\theta_i)} - 1 \tag{2}$$

$$AVE = \frac{\Sigma\lambda_i^2}{\left(\sum {\lambda_i}^2\right) + \Sigma(\theta_i)} - s'u(x) \tag{3}$$

After analyzing and calculating the measurement model of the initial model with amos 17, the test results related to convergence validity are shown in the table (Table 4).

Table 4. Convergence validity test results

Variable	Measurement item	Normalized factor load	Composite reliability	Mean extraction variance
Academic integration	A1	0.768	0.865	0.562
	A2	0.795		
	A3	0.698		
	A4	0.765		
	A5	0.653		
Perceived usefulness (PU)	B1	0.912	0.965	0865
	B2	0.914		
	B3	0.902		
Expected confirmation (EC)	C1	0.856	0.889	0.754

The standardized factor loads of the measurement items were all above 0.6 and passed the significance test, indicating that each measurement item had a strong explanatory ability to the underlying variables to which it belonged. The combined reliability of the six latent variables was also higher than the recommended value of 0.7, indicating that the measurement items in each group had high internal consistency. AVE all meet the standard greater than 0.5, indicating that the measurement items can reflect the characteristics of latent variables. Therefore, on the whole, the measurement model has good convergence validity. By integrating the artificial intelligence model into the course teaching process, the theoretical knowledge module has problems and is specific. Students establish a close relationship between theory and practice by analyzing and solving problems. The success and failure of the design results are precious to students, so the AI model improves students' interest in learning and increases their motivation to learn. Figure 8 shows the results of the student survey on the degree of recognition of artificial intelligence for motivating learning.

Set the experimental environment to intert (R) core (TM) i7479PU@3.60 GHZ, the memory is 8.0 GB, the operating system is windows7, and the implementation of data preprocessing and recommended algorithm adopts pycharm2017 1 and MATLAB r2017b experimental data sets are movielens data sets. This data set is collected and founded by the GroupLens project team of Minnesota University in the United States. It can receive users' scores on movies and provide personalized information recommendations. 3 among them, each evaluation score ranges from 1 to 5. Each user provides its age, gender, occupation and other attribute information when registering, and each movie provides its title, release date Subject type and other characteristic information. In this paper, movielens IM data set is selected and the evaluation diversity is divided into five subsets. The subsets do not intersect. Each subset contains 80.000 scored base data set and 20000 scored test data set. The base data set and test data set complement each other. The sparsity of the base data set is 95%, which is a typical sparse matrix,

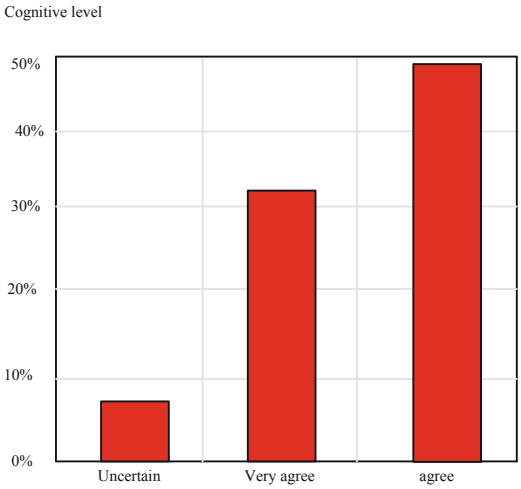

Fig. 8. Survey results of students' cognitive level

which can help verify the improvement of the algorithm in solving the problem of sparse scoring matrix, The number of neighbor user sets is 10, 20, 30, 40 and 50 respectively. The traditional user based collaborative recommendation algorithm and the improved method proposed in this paper are used for comparative experiments. The average absolute error between the prediction score results and the test data set is compared, and the results are shown in the figure (Fig. 9).

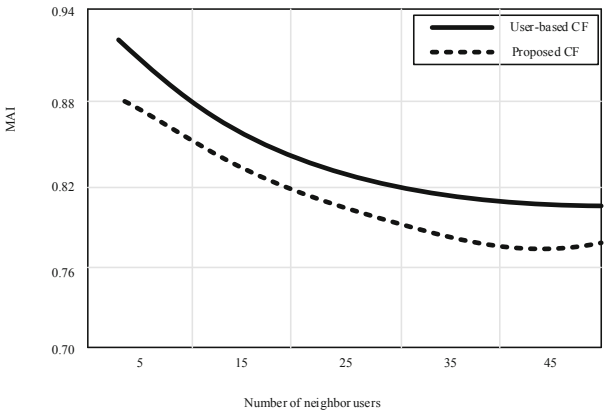

Fig. 9. Comparison of average absolute error of teaching information recommendation

As shown in the above figure, when the number of neighbor users is 40, the minimum average absolute error of the proposed method is 0.77, while the minimum average absolute error of the traditional user based collaborative recommendation algorithm is 0.81. Compared with the traditional method, this method has smaller average absolute error

and better recommendation effect. The improved algorithm simulates the preference model of user attributes based on the dual attribute scoring matrix and adopts artificial intelligence technology to reasonably predict the scoring of non scored items, which alleviates the problem of inaccurate recommendation caused by too sparse scoring data in the traditional algorithm.

In order to verify the effectiveness of this design method, simulation experiments are carried out to test the performance of this design method, and the accuracy of teaching information recommendation is compared with that of literature [2] and literature [3] algorithms. The specific results are shown in Fig. 10.

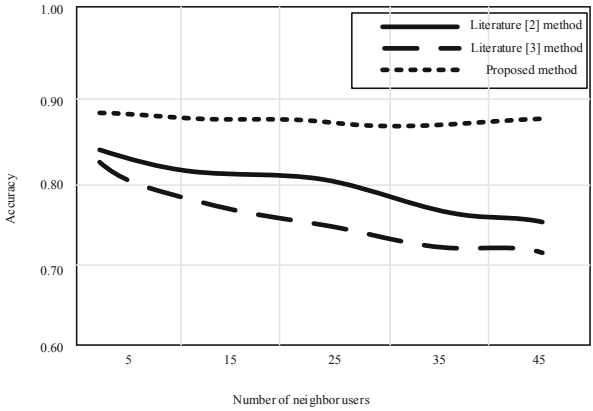

Fig. 10. Accuracy comparison of teaching information recommendation

As shown in the figure above, the recommended accuracy of the proposed method is about 0.90, while the recommended accuracy of the two literature methods is lower than 0.90. Compared with the two literature methods, the proposed method has higher recommended accuracy and better recommended effect. This is because the proposed method emphasizes the subjectivity of students' autonomous learning and combines multi-channel process evaluation with conclusion evaluation to collect learning results.

4 Conclusion

Through the effective integration of artificial intelligence and applied optics online teaching learning process, teachers as coaches gradually guide the learning process, and students experience the learning process by putting forward and solving problems in computer software theoretical learning and practical operation. In the whole learning process, students' learning objectives are clear, and they are motivated to study independently. At the same time, students are encouraged to study independently. Pearson similarity and user attribute similarity are combined to measure the similarity of users, so as to alleviate the problem that the scoring matrix is too sparse. In the teaching design, students are gradually familiar with the artificial intelligence mode, give full

play to the advantages of the artificial intelligence mode, stimulate students' motivation for autonomous learning, and realize the flexible combination of curriculum theory and design practice in the learning process. These practices have proved that the artificial intelligence model has advantages in cultivating students' self responsibility ability and excavating students' autonomous learning motivation, and has a certain reference significance for the development of educational reform.

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