Design of Online Teaching Method for Subject Knowledge of Mathematics Teachers in Higher Vocational Colleges Based on Convolutional Neural Network

Chunyan Yu(✉) and Junyan Wang

College of Humanities and Information, Changchun Technology University, ChangChun 130000, China
yuchunyan2005@163.com

Abstract. Online teaching is developed on the basis of distance education. From the perspective of teacher-student relationship, online teaching should be the unity of five elements: teachers, students, technology, courses and activities. The level of interaction in the process of online teaching affects learners' knowledge construction and learning quality. The existing network education platform focuses on the adaptive learning of knowledge content. Unable to give appropriate feedback based on current learning status. Convolution neural network can reduce the feature dimension, compress the amount of data, reduce the number of network parameters, and prevent over fitting. Therefore, this paper puts forward the design of online teaching method of subject knowledge for mathematics teachers in Higher Vocational Colleges Based on convolutional neural network. Based on the online teaching characteristics, the convolution neural network algorithm is improved, the convolution neural network algorithm structure is optimized, and the loss function is built. Based on convolution neural network algorithm, integrate online teaching materials and optimize the examination system of mathematics online teaching courses in higher vocational colleges. Finally, an example shows that the online teaching method of mathematics teachers' subject knowledge in higher vocational colleges can effectively improve students' performance.

Keywords: Convolution neural network · Neural network · Higher vocational colleges · Mathematics teacher · Subject knowledge · Online teaching

1 Introduction

Nowadays, education has entered the stage of industrialization development. Online learning has become the main way, which is spread in many fields such as educational technology, distance education and library science. In the education industry, the continuous development of Internet technology provides learners with a learning platform that is not limited by region and time. Online education uses the convenient environment of the Internet [1], allowing learners to acquire knowledge anytime and anywhere in new

W. Fu and G. Sun (Eds.): eLEOT 2022, LNICST 453, pp. 751–764, 2022.
https://doi.org/10.1007/978-3-031-21161-4_57

ways, breaking the restrictions of fixed teaching places and fixed teaching time in the past traditional teaching process, So that learners can freely arrange learning time and flexibly choose learning places, which promotes the development of lifelong learning. With the rapid development of information technology in the new century, a new generation of information technology came into being. Many new technologies have also become familiar keywords for the public: big data, cloud computing, Internet of things, artificial intelligence, etc. these new technologies continue to innovate, break through and improve, change all aspects of public life and provide new ideas for the improvement of learning environment.

For teachers, mastering learners' classroom participation and understanding learners' learning experience and learning effect of this section are indispensable links in the teaching process. From the previous online teaching activities, we find that online education is a one-way learning process, and there is almost no direct communication between teachers and learners. This one-way learning process leads to the separation of teaching activities and learning activities [2], and teachers and learners lose communication and communication. The existing online education platforms focus on the adaptive learning of knowledge content. The communication between online education platforms and learners is also reflected in after-school learning evaluation, after-school Q & A, knowledge recommendation and so on. Learners' emotions have not been paid enough attention, educators can not know the emotional changes of learners, and can not give appropriate feedback according to the current learning state. Literature [3] takes the first grade primary school teachers as samples to investigate the relationship between mathematics teaching knowledge and teaching quality. Ten teachers completed the mathematics teaching knowledge (MKT) survey at the end of teacher preparation. In their first year of teaching, three math lessons were recorded and graded using math teaching quality. The results repeat previous studies with more experienced teachers. Literature [4] discusses the relationship between teachers' beliefs and teaching experience. Using the validated MTBs, this study assessed the beliefs of four groups of Chinese high school mathematics teachers with different professional teaching experience: 1–5 years ($n = 25$), 6–10 years ($n = 70$), 11–20 years ($n = 48$) and more than 21 years ($n = 28$). MTBs consists of 26 items, distributed in five sub scales, covering beliefs about mathematics, learning, teaching, students and teachers. Literature [5] aims to understand mathematics teaching by asking questions through the analysis of 22 teaching cases. Teaching mathematics by asking questions begins with the task of asking questions. This study not only provides specific examples of problem posing tasks used in the classroom, but also provides relevant task variables that need to be considered when developing problem posing tasks. This study also helps us to understand how teachers deal with students' questions in class.

Convolutional neural network originated in the 1980s and is one of the first deep learning methods. This method does not need to design classification methods and specific features for a specific class of image sets, so as to achieve the purpose of classifying pictures of different categories in a group of pictures. Moreover, convolutional neural network has been proved to have excellent performance in classification task and regression task [3], which is significantly improved compared with traditional image classification. At the same time, after 2006, with the rise of deep learning, the representation learning

ability of convolutional neural network has been continuously improved with the renewal of numerical computing equipment, so it has been widely valued. Therefore, one of the most important research contents of computer vision in recent years is convolutional neural network. The main content of this paper is to apply convolution neural network technology to the online teaching method design of subject knowledge of mathematics teachers in higher vocational colleges.

2 Improved Convolutional Neural Network Algorithm Based on Online Teaching Features

2.1 Optimizing the Algorithm Structure of Convolutional Neural Network

As one of the classical algorithms of deep learning, convolutional neural networks can be divided into three categories according to dimension. CNN with different dimensions has different application fields. For example, one-dimensional CNN is often used for sequence data processing, two-dimensional CNN is often used for image text recognition, and three-dimensional CNN is generally used for medical image and video data recognition. Nevertheless, the basic structure of convolutional neural networks is the same [4], including input layer and convolutional layer Pooling layer, fully connected layer and output layer. This section introduces the important role of convolution layer, pooling layer and full connection layer in CNN. The convolution layer of the algorithm is one of the most important modules in convolution neural network. The convolution layer consists of multiple feature maps and a set of convolution kernels with learning ability. The feature map is composed of multiple neurons. Each neuron is connected to a small area in the previous layer. This small area with the same size as the convolution nucleus is called the receptive field.

In convolution operation, the existence of redundant parameters will affect the efficiency of convolution operation, so each convolution layer should try to control the amount of parameters in the operation process. In convolutional neural network, there are two ways to reduce the parameters of the network: weight sharing and local perception field. The local perception field can reduce the parameters of the local network to a certain extent [5], but it makes little contribution to reducing the overall parameters of CNN. Weight sharing is an important concept in convolutional neural network, and it is also an effective method to reduce the amount of overall parameters.

The pool layer is the next layer of the convolution layer, which is composed of multiple feature maps and corresponds to the number of feature maps of the previous convolution layer. The input of the pooling layer is the feature map extracted from the previous convolution layer. Its substantive function is to extract the features twice. In addition, it can also reduce the dimension of the features, compress the data, reduce the number of network parameters and prevent the occurrence of over fitting.

Common pooling methods include maximum pooling, average pooling and random pooling. The selection of pooling method is based on the characteristics of feature map [6]. For the separation of very sparse features, the method of maximum pooling should be selected; When the linear classifier is used for classification, the maximum pooling method has better feature extraction performance than the average pooling method.

2.2 Build Loss Function

Currently, target detection algorithms can be divided into two categories according to deep learning methods: one is the two-step detection algorithm represented by FASTR-CNN and R-FCN; Second, SSD and YOLO are typical single-step detection algorithms. RoI pooling layer is a crucial convolution layer in Fast R-CNN network, and its substantive role is to transform RoI features into feature maps of fixed space size. In the operation of RoI pooling, the feature graph with input size of H × W is first divided into h × W size grid (h and W are hyperparameters and set as 7 × 7), and then the maximum pooling operation is carried out for each RoI to further obtain the output feature graph with fixed size [7]. Then, the whole connection layer is processed to obtain two branch vectors. RoI is a rectangular box (r; C, h, w), where (r; C) represents the coordinates of the upper left vertex, and (h, w) represents the height and width. The Fast R-CNN network contains two different output layers, so the loss function adopts the method of multi-loss fusion (classification loss and regression loss). The total loss function is expressed in Formula (1) as follows:

$$L(r,\ c,\ h,\ w) = L_{cls}(r,\ c) + \lambda[h \geq 1]L_{cls}(h,\ w) \tag{1}$$

In the training process, each RoI has an accurate category information and a real boundary regression box, and multi-task loss L is used to conduct joint optimization training for classification and boundary boxes, so that the loss error is smaller, and the trained model has better performance and detection effect.

3 Integration of Online Teaching Materials Based on Convolutional Neural Network Algorithm

The resource integration method based on convolutional neural network mainly consists of two parts. The first part is the technical part, that is, the Arduino device recognition program based on convolutional neural network, which realizes the classification and recognition of Arduino devices [8]. The second part is the learning resources part, learning resources include text, pictures and other resources, through the collection and screening of existing learning resources and making videos, to complete the construction of Arduino device learning resources library. The overall process of resource integration method based on convolutional neural network is shown in Fig. 1:

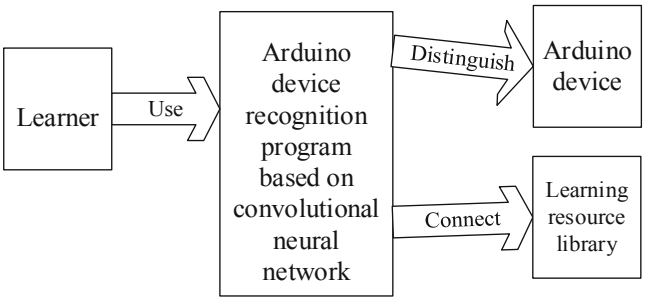

Fig. 1. Overall process of resource integration method based on convolutional neural network

In the learning process, learners use the Arduino device recognition program based on convolutional neural network. The recognition program tells learners the name of the recognized device and pushes learning resources related to the recognized device to learners, including text resources and video resources. Many text resources and video resources form the Arduino device learning resource library, Learners are connected to the learning resource base through the identification program.

The construction process of Arduino device recognition is divided into three parts: data set construction process, model training and generation process and picture classification and recognition process. Next, the construction process is described in detail.

3.1 Data Set Construction Process

The training and generation of deep learning neural network model is based on learning a large number of picture features. Therefore, this study mainly classifies and recognizes images. This paper studies the deep learning model of Arduino device recognition, which is based on a large number of previously selected pictures of 10 Arduino devices [9]. The pictures of all Arduino devices are collected with the same image acquisition equipment to ensure that the resolution of the pictures is the same, so as to build the image data set of 10 devices. After that, the code program will divide the images into three categories: training set, test set and verification set. The number of images in each set will be automatically divided according to the percentage set in the code. The CNN model structure is shown in Fig. 2.

3.2 Model Training and Generation Process

After completing the image acquisition and data set construction, the image format needs to be transformed. In this process, the image file in JPEG format needs to be transformed into a file format that can be recognized by convolutional neural network. In the training process of convolutional neural network model in this paper, the picture is transformed into tfrecord file as the initial data input of the network. After processing the image data, the convolution neural network realizes the output of the network model through multi-layer convolution and pooling operation By comparing the error information between

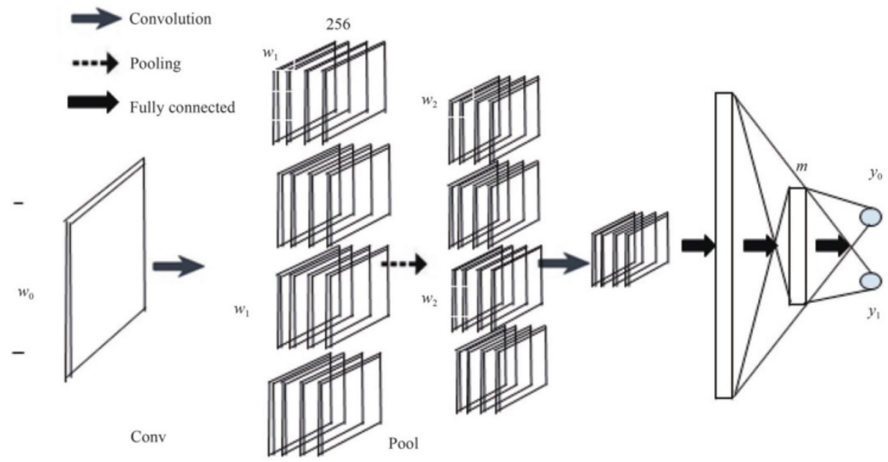

Fig. 2. CNN model structure diagram

the actual output and the expected output, the test accuracy value and error loss function describing the advantages and disadvantages of the model are observed and analyzed. Then, the network parameters of the model are changed. The training phase of the model is a process of constantly changing parameters and optimizing. This process continues until the output data value converges and tends to a stable state or the number of iterations ends, and the model training ends. At this time, a classification model can be obtained and used in the image classification process.

3.3 Picture Classification and Recognition Process

In the process of image classification, the verification image is used to test the network model obtained in the training process. First, the picture must be transformed by format, then the model generated by training will be used to classify and identify the pictures and test the effect of recognition.

In the training process of the whole model, the image data set processed by format is first input into the network as the underlying data. The network will divide the data set into training data, verification data and test data according to the set proportion. The input image is convoluted in the convolution layer to extract image features and generate multiple feature maps. The human nervous system is very complex. In order to simulate the working process of neurons in the human visual nervous system, the convolutional neural network model allows each output feature to be calculated by the activation function and added with a bias value before outputting the features of the image. After passing through 2-layer convolution layer and 2-layer pooling layer, the data is then transmitted to the full connection layer, which completely converts the features into one-dimensional vector output.

The convolution neural network model uses the loss function to describe the parameters to be optimized and the effect of the model. Through the loss function, the gap between the actual output result and the expected result is determined, and then the

network parameters are continuously adjusted through the back propagation algorithm. When the value of the loss function is large, it indicates that the network parameters have not reached the optimum and have to be trained again, return to the beginning of the training and learn the features of the input picture again. When the value of the loss function is small and the network reaches the convergence state, it can be considered that the current state of the network parameters is the optimal state, and then decide whether to end the model training process. The number of iterations of training is also an indicator of whether the model training is completed. When the predetermined number of iterations is reached, the model training will end even if the model has not reached the optimal state, and the model at the end will be output. The final output model is the convolution neural network model constructed by us. The type and feature information of the image extracted through layer by layer operation are saved in this model. The above is a simple process to realize the convolution neural network model. It can be seen that the hierarchical structure of CNN is relatively clear. Each layer has its specific role and responsibility. Through continuous optimization again and again, the optimal model is finally output.

Arduino is a platform for intelligent hardware design and development. It can connect various sensors and set specific coding instructions for products to adapt to different environments and realize specific functions. Arduino is open source, easy to learn, and with little knowledge, you can enter the colorful electronic world and experience the passion and fun brought by DIY. Because of this, there are abundant learning resources related to Arduino, but too many learning resources also make learners don't know what to choose. Through the collection and screening of online learning resources, the author constructs the Arduino device learning resource library. The resource library mainly contains video resources. Video resources are the process of using Arduino device recorded by the author, and each step is accompanied by explanation. The Arduino device recognition program based on convolutional neural network will push the learning resources related to the identified device in the learning resource library after the successful recognition of the device.

4 Optimizing the Examination System of Mathematics Online Teaching Courses in Higher Vocational Colleges

Online teaching has created a new teaching space for college teachers. In the past, face-to-face knowledge transfer has become an exchange on the Internet. Therefore, the previous offline teaching methods are not suitable for online teaching. In the process of online teaching, we need to give full play to the advantages of the Internet [10]. Teachers need to combine the characteristics of network teaching, focus on the network, and explore the characteristic content suitable for students' listening habits. The teaching contents should keep pace with the times and the teaching methods should have network characteristics, so as to attract the attention of college students. By exploring the production of characteristic content, arouse students' interest and improve learning efficiency. The design of teaching courseware needs to highlight the system design. A complete system design can bring the completion of the learning process and improve students' learning experience. Therefore, schools and teachers need to combine the advantages of

the Internet and pay attention to the production of high-quality teaching content, which will be more practical in network teaching. Exploring the production of characteristic content also requires the state's policy support for schools to promote the production of characteristic content in the process of internet teaching through financial support. Based on convolution neural network algorithm, this paper constructs loss function, integrates online teaching materials, and optimizes the online teaching course examination system of higher vocational mathematics. Through the whole process assessment, students do not dare to slack off in the classroom. They will treat online learning with a more focused attitude and maintain a high degree of concentration at all times. However, teachers can not give students too much pressure, improve the teaching effect by turning the classroom, and borrow domestic high-quality educational resources to improve students' interest in learning. Promoting cooperative learning among students can cultivate students' team consciousness and improve their interpersonal skills in the process of cooperation. For some contents that students can master through self-study, teachers can also let students experience the feeling of being a teacher and let them deepen their understanding of knowledge through classroom teaching. In terms of course homework, teachers can arrange more cooperative homework, enhance the communication between students, improve their practical ability, break the limitation of their single thinking in the process of cooperative learning, and let more ideas collide in the communication to produce new sparks. Learning motivation is an important factor affecting students' learning. In the process of basic education in China, middle school students have a strong utilitarian learning goal, that is, in order to enter a better university and find a better job in the future. In the process of interview, the author found that some students lost their learning motivation after entering the University. Some courses won't listen carefully in offline class and online. The loss of clear learning objectives leads to their laziness and laziness in the process of learning, resulting in low learning efficiency. Although it has been advocated that teaching should focus on "student-centered", there are still many phenomena of teachers' teaching and students' passive learning in the process of classroom teaching in Colleges and universities. In the process of learning, students need to think about what their motivation is and what they study for. Preview in advance can better integrate into the learning environment. Students should be the subject of learning, not dominated by the outside world, and gradually clarify their learning motivation through independent exploration and self thinking [11]. In the offline teaching process, teachers and students coexist in the same specific learning environment. In this relatively closed learning space, students can feel a particularly strong sense of learning immersion in the learning process. Therefore, it is particularly important to create a classroom with active atmosphere and clear learning objectives. Teachers can cause students to interact by assigning tasks and asking questions, so that students can maintain a high degree of concentration and have a strong sense of learning immersion in the learning process. Teachers can add diversified elements in the process of curriculum design, such as flipped classroom design. First, let the students group freely online, put forward open questions, have interactive discussions between different groups, comment on the performance of each group, and encourage students to carry out inquiry learning. Second, make use of the advantages of the network to communicate with students online. Students are "digital natives", who are more accustomed to the expression methods on the

network. Teachers can interact with students through expression packs and catchwords, and conduct different interactions through the unique "like" and "bullet screen" of the online teaching platform. The third is to increase the presentation of short videos in classroom content. Short videos have a fast rhythm and can attract students' attention. Making full use of the application of short video in classroom teaching can improve students' learning concentration.

Empathy is a psychological concept, which refers to the ability to understand their emotions and intentions from the perspective of others and express them accurately. In the critical period of epidemic prevention and control, there are differences in students' region, background and learning conditions. Building a empathic classroom is conducive to promoting the development of teacher-student relationship and improving students' learning effect. First, teachers need to integrate thoughts and emotions into teaching activities and design rich and attractive teaching contents. Empathy classroom has built a good communication platform between teachers and students. If teachers want to better integrate empathy into teaching practice, they need to flexibly adopt teaching methods and observe students' learning enthusiasm and attitude, so as to improve the "temperature" of the classroom. Secondly, teachers should increase the process of interaction with students, trigger students' thinking by asking questions, let students hear their own voice and the voice of others in the process of learning, and produce empathy in research and discussion. Realizing mutual learning and inspiration between teachers and students through empathy classroom is not only conducive to the transmission of knowledge in the teaching process, but also conducive to helping students shape a sound personality. Students constantly improve their ideological realm in the process of learning and communication. Such a empathy class will be more warm and deep.

5 Case Analysis

The online teaching method of mathematics teachers' subject knowledge in Higher Vocational Colleges Based on convolutional neural network designed in this paper is applied to practical teaching, and its application effect is verified.

5.1 Analysis of Current Teaching Situation

Although higher mathematics in higher vocational education plays an irreplaceable function and role in vocational education and talent training, it is difficult to effectively integrate the two. It is unable to improve students' mathematical ability according to the development demands of vocational education, so that the quality of mathematics teaching in higher vocational education can not be effectively improved. The main reasons are the following two aspects. First, the deviation of educational concept. Due to the obvious differences between higher mathematics and professional education in teaching content, teaching methods, teaching objectives and teaching system, higher vocational colleges ignore the relationship between the two in principle, mechanism and logic, which leads to the separation of mathematics teaching from the category of vocational education. The mathematical ability contained in mathematics teaching has not been "taken care of" and "set off" in the talent training system of higher vocational colleges, resulting

in the lack of close relationship between mathematics teaching and talent training. This "lack of connection" or "loose connection" stems from the deviation of the concept of vocational education. If we can enhance the relationship between the two at the macro level and top-level design, we can effectively improve the value of Higher Vocational Mathematics Teaching in vocational education and talent training.

Secondly, the demand of enterprises for talents with logical reasoning ability, thinking ability, spatial imagination, mathematical operation, logical analysis and material generalization ability is not obvious, which makes higher vocational colleges pay more attention to the cultivation of teamwork ability, problem-solving ability, practical ability and learning ability, and the value of mathematics teaching in talent cultivation is not obvious. The teaching design of mathematics in Higher Vocational Colleges usually takes teachers as the guidance and students as the object, which is difficult to stimulate students' initiative and enthusiasm in mathematics teaching, ignores the emotional communication between students and teachers, students and students, makes knowledge teaching the main body of mathematics teaching, and weakens students' development and emotion in mathematics learning. In addition, due to the obvious textbook standard problem in higher vocational teaching design, teachers' understanding process of teaching plans and teaching materials replaces students' understanding and experience process, which affects the role of mathematics teaching in the cultivation of thinking ability, spatial sense and data generalization ability, and can not help higher vocational colleges better connect mathematics teaching with vocational education. In order to solve these problems, we need to take the modern educational concept as the starting point, take the students as the guidance, innovate the traditional teaching design content, process and form, and make the mathematics teaching design better reflect the professionalization, informatization and application characteristics of higher vocational education. In addition, we should make changes and innovations in the teaching process, teaching methods and teaching modes. Only in this way can mathematics teaching really meet the needs of vocational education and talent training.

5.2 Application Process and Results

Because each dimension of the current situation of learning investment and each dimension of influencing factors are continuous variables, product moment correlation is adopted. If the correlation coefficient is positive, it indicates that they are positively correlated, and if the correlation coefficient is negative, it indicates that they are negatively correlated. The absolute value of the correlation coefficient indicates the strength of the correlation. The greater the absolute value of the correlation coefficient is, the stronger the correlation is, and the smaller the absolute value of the correlation coefficient is, the weaker the correlation is. Analyze the relationship between students' learning input, and the analysis results are shown in Table 1:

Table 1. Analysis results of influencing learning input

Dimension	Overall learning engagement	Study preparation	learning motivation	learning environment	Learning organization and management
Overall learning engagement	1	–	–	–	–
Study preparation	0.445	1	–	–	–
learning motivation	0.468	0.547	1	–	–
learning environment	0.512	0.525	0.541	1	–
Learning organization and management	0.560	0.538	0.562	0.554	1

The data analysis shows that there is a significant positive correlation between the influencing factors (learning preparation, learning motivation, learning environment, learning organization and management) and learning investment, P The values are less than 0.01, and the correlation coefficient is between 0.445 and 0.562. In addition, from the absolute value of the correlation coefficient, the correlation from strong to weak is learning organization and management, learning environment, learning motivation and learning preparation. There is also a significant positive correlation between the influencing factors of learning investment, P All values are less than 0.01.

Convolution algorithm is applied in online learning, which is an optimization algorithm for data set training. The main problem solved by the algorithm is that it can reduce the imbalance between positive and negative samples during training. By suppressing a certain number of negative samples, the loss curve converges faster and the training model is better. The core idea is to screen according to the loss of input samples, that is, to screen out the negative samples that have a great impact on classification and detection, and then train the model of the screened positive samples through stochastic gradient descent (SGD). The advantages of the algorithm are mainly reflected in two aspects: one is the online selection of negative samples, which is more targeted to the imbalance of data categories; Second, with the increase of data set samples and categories, the detection effect of the algorithm will be improved more obviously. The architecture of the algorithm is shown in Fig. 3:

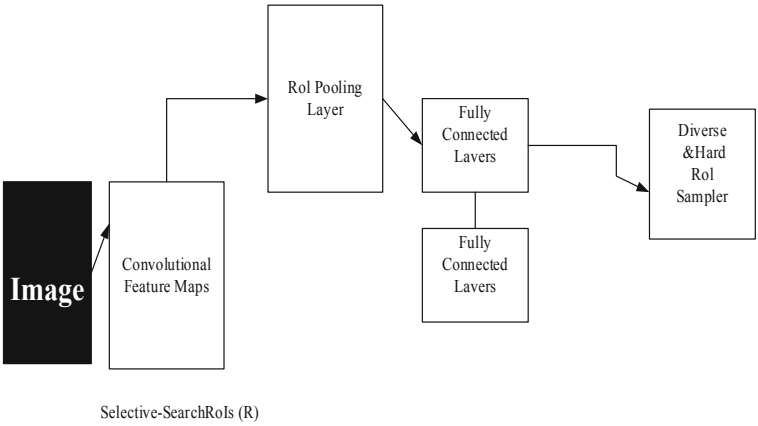

Fig. 3. Architecture of algorithm

As shown in Fig. 2, in order to test the practicability of the teaching method, the above algorithm is used to identify the students' classroom performance. The hardware equipment of the experiment is a GTX 1080ti independent graphics card server with Intel Xeon CPU, 32 GB RAM and 11 GB video memory. The software device is Ubuntu 16 under Linux 04 operating system, the deep learning framework used is Darknet, and the image display function is realized by calling opencv and related libraries. There are two experimental data sets: one is a self built student behavior data set, which includes five kinds of behaviors: raising hands, listening, answering, sleeping, writing (hand. Listen. Answer. Sleep, write); The other is the standard voc2007 + 2012 dataset. The data set includes two subsets of voc207 and voc2012, which are a benchmark set for image classification, image recognition and target detection. The comparison of students' scores before and after using this teaching method is shown in Table 2:

Table 2. Application results

Experimental class	Before application	After application
Class A	72.14	86.12
Class B	74.23	87.45
Class C	75.14	88.52

The application results are shown in Table 2. After applying the teaching method designed in this paper, the scores of the three classes have been significantly improved. It shows that the method designed in this paper has the effect of improving students' performance.

In order to verify the convolution neural network algorithm proposed in this paper, the methods in literature [2] and literature [3] are used as comparison methods for comparison experiments. The comparison results are shown in Table 3.

Table 3. Comparison results of academic achievements

Experimental class	Convolutional neural network algorithm	Literature [2] method	Literature [3] method
Class A	86.20	70.01	76.15
Class B	90.35	74.51	73.14
Class C	89.94	73.04	72.84

It can be seen from table 3 that after the application of the teaching method designed in this paper, the scores of the three classes are more than 85, while the scores of the two literatures are less than 80. The results show that compared with the two literature methods, the scores of the three classes are higher after the application of the teaching method designed in this paper.

6 Conclusion

This paper grasps the opportunities brought by online teaching and bravely meets new challenges. It improves the efficiency of online teaching. Through the early large-scale online teaching practice, it has accumulated many problems in online teaching. This paper can seize the opportunity brought by online teaching with a more open mind. Based on convolution neural network algorithm, this paper constructs loss function, integrates online teaching materials, and optimizes the online teaching course examination system of higher vocational mathematics. Through the integration of Internet and education, we can realize more advanced, more human and more perfect educational ideas, and help us better deal with the challenges from the future. In the future development, this paper discusses the application of artificial intelligence technology and advanced teaching methods in the design of online teaching methods for Higher Vocational Mathematics Teachers' subject knowledge, and discusses the distance teaching methods.

Fund Project. Jilin Province Vocational Education Research Project: Research on the Ways to Improve the Subject Knowledge and Teaching and Research Ability of Mathematics Teachers in Higher Vocational Colleges (2021XHZ043).

References

1. Bragg, L.A., Walsh, C., Heyeres, M.: Successful design and delivery of online professional development for teachers: a systematic review of the literature. Comput. Educ. **166**(6), 104158 (2021)
2. Martínez, S., Guíñez, F., Zamora, R., Bustos, S., Rodríguez, B.: On the instructional model of a blended learning program for developing mathematical knowledge for teaching. ZDM Math. Educ. **52**(5), 877–891 (2020). https://doi.org/10.1007/s11858-020-01152-y
3. Santagata, R., Lee, J.: Mathematical knowledge for teaching and the mathematical quality of instruction: a study of novice elementary school teachers. J. Math. Teach. Educ. **24**(1), 33–60 (2019). https://doi.org/10.1007/s10857-019-09447-y

4. Xie, S., Cai, J.: Teachers' beliefs about mathematics, learning, teaching, students, and teachers: perspectives from Chinese high school in-service mathematics teachers. Int. J. Sci. Math. Educ. **19**(4), 747–769 (2020). https://doi.org/10.1007/s10763-020-10074-w
5. Zhang, H., Cai, J.: Teaching mathematics through problem posing: insights from an analysis of teaching cases. ZDM Math. Educ. **53**(4), 961–973 (2021)
6. Zahner, W., Aquino-Sterling, C.R.: Are the words as important as the concepts? Using pedagogical language knowledge to expand analysis of mathematics teaching with linguistically diverse students. Math. Educ. Res. J. **34**, 457–477 (2020). https://doi.org/10.1007/s13394-020-00352-9
7. Ndlovu, M., Ramdhany, V., Spangenberg, E.D., Govender, R.: Preservice teachers' beliefs and intentions about integrating mathematics teaching and learning ICTs in their classrooms. ZDM Math. Educ. **52**(7), 1365–1380 (2020). https://doi.org/10.1007/s11858-020-01186-2
8. Pan, J., Wen, L., Qi, L., Xing, D., Zhao, Y.: Integrated reform of electronic technology courses in higher vocational colleges based on the OBE concept. J. Contemp. Educ. Res. **5**(9), 20–25 (2021)
9. Zhang, X.: Teaching reform and research on art design majors in higher vocational colleges under the background of "double high plan." J. Contemp. Educ. Res. **5**(1), 4 (2021)
10. Jiang, L.: Analysis and enlightenment of daily education and training of student party members in higher vocational colleges. The Science Education Article Collects (2020)
11. Mi, Q.C., Zhao, H.M., Lin, L.P.: Unstructured data annotation based on multichannel convolutional neural network. Comput. Simul. **38**(6):400-404 (2021)