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**Analysis of the influencing factors of
students' vocational ability based on joint
improvement of convolutional neural
network and multimodal data**



Abstract: - Students' professional ability includes innovation and entrepreneurship ability, independent ability, quality ability, professional ability and adaptability. The school's practical training teaching and professional setting, as well as the unique talent training model have a profound impact on training and development of students' professional ability. The continuous progress and development of society indicates that the competitiveness of occupational positions in the future will continue to increase. The talent market will also put forward newer and more difficult requirements for the quality of students. In study and life, cultivating students' good professional ability is the fundamental purpose of colleges and universities. Employers tend to pay more attention to overall quality of candidates when selecting employees. Whether students can enter the society smoothly after graduation has become an important task. It can be seen that it is very important to analyze the cultivation of students' professional ability and the influencing factors of professional ability. This work combines convolutional neural network (CNN) with the analysis of factors influencing students' vocational ability. First, this work proposes an improved residual block (IRB). It increases the width of the residual network by adding a residual connection channel to learn richer features. Second, this work proposes an improved attention module (IAM). It combines channel attention with spatial attention to improve model performance. Third, this work combines IRB and IAM to propose an SVAIFANet. The model can be applied to the analysis of factors influencing students' vocational ability. Fourth, this work conducts various experiments for proposed method, experimental data verify correctness for this method.

Keywords: Influencing factor; Vocational ability; CNN; Attention

1. Introduction

Due to the different perspectives of researchers, the concept of professional ability has different interpretations. The relevant sector, the International Labour Organization, has defined the term professional competence. They believe that the ability of an individual to keep the job that he has obtained and make continuous progress in the job, and to be able to actively deal with the changing factors that may arise in the work, is called vocational ability. The Employment and Education Commission of the United States interprets vocational ability as the self-confidence of individuals in the labor market to realize their potential by fully marketing employment opportunities. In China, the ability of students to achieve their own employment ideals through the knowledge and comprehensive quality acquired by students after graduation is vocational ability. Therefore, vocational ability

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is a comprehensive ability related to employment. With its individual characteristics and a series of characteristics that can be combined to ensure that workers keep their jobs and have the possibility of promotion. More companies pay more attention to the comprehensive quality of students when conducting employment assessment, have made higher specific requirements for comprehensive quality of graduates. Vocational ability training in colleges and universities focuses on cultivating students' professional ability to adapt to social front-line labor production such as management, service, construction and production. The direction of its training and the professional orientation of the society often make a specific positioning for the training direction of professional talents [1-5].

For colleges and universities, it is very important to be able to cultivate special talents and a unique talent quality training model. The traditional education model makes teachers lack the process of inducing students to carry out education and lack of interaction in the teaching process. This often ignores the cultivation of students' innovative as well as entrepreneurial spirit. This leaves students with insufficient innovation ability and insufficient vocational skills. Professional ability is embodied in professional emotion, professional habits and professional ethics. Often schools with characteristic talent training models and students who can accept the training of characteristic talent models are more favored by the society. This requires schools to pay more attention to the cultivation of characteristic talents in the process of cultivating students. Only by cultivating high-quality technical and all-round talents that are different from other colleges and universities can they improve their employment and competitiveness in the employment market after graduation [6-10].

The average school only pays attention to the teaching of students' professional knowledge and implementation of training. Teamwork spirit and problem-solving ability are often neglected, which leads to insufficient professional ability of students after graduation. Colleges and universities not only require students to master theoretical knowledge flexibly and solidly, but also teach students to integrate the knowledge they have learned in real practice. Among them, the cultivation of ideological and cultural quality is the most important. As an important foundation of quality, ideological quality not only affects the growth trajectory of students in the cultivation of vocational ability, but also affects the process of comprehensive formation of students' quality in all aspects. And in the work, must be full of hard-working and cooperative spirit. After learning occupational knowledge and mastering occupational skills, the work of school students should focus on mastering occupation, discipline, occupational ideals and occupational responsibilities. In the process of cultivating high-precision and cutting-edge applied technical and technical talents, the practical training teaching among the educational factors is very important. Internship training not only determines the direction of students' personalized vocational training, but also has a very important impact on students' professional setting direction and employability [11-15].

Students are often subtly influenced by social relations, educational environment and curriculum system in their daily study and life. These educational factors often determine the personality and psychological characteristics of students. If this kind of mandatory preaching and guidance is inappropriate, students will have a strong rebellious psychology. This has created a huge obstacle for college students to cultivate students' professional ability. Invisible curriculum will teach students the experience of education in various designed specific situations subtly. This allows students to unknowingly accept learning and educational experiences of various vocational

abilities in a relaxed and pleasant learning atmosphere. This effect often has lasting characteristics, making this kind of professional ability knowledge and educational experience have a lasting effect in students' learning and life. The learning nature of this course makes the requirements for teachers very strict. The arrangement of the school's innovation and entrepreneurship ability training curriculum system also needs to be more rigorous. This enables the teaching experience of sound science to have a lasting effect and accompany students throughout their lives. The improvement of the school's innovation and entrepreneurship ability curriculum system not only affects the students' vocational ability education in terms of educational factors. It also plays a good guiding and normative role in the campus atmosphere, teacher-student communication and the school's material environment in vocational colleges [16-20].

This work combines CNN with the analysis of factors influencing students' vocational ability. First, this work proposes an improved residual block. It increases the width of the residual network by adding a residual connection channel to learn richer features. Second, this work proposes an improved attention module. It combines channel attention with spatial attention to improve model performance. Third, this work combines IRB and IAM to propose an SVAIFANet model. The model can be applied to the analysis of factors influencing students' vocational ability. Fourth, this work conducts various experiments for proposed method, experimental data verify correctness of this method.

2. Related Work

Literature [21] believes that professional ability is the professional potential, which is the behavioral performance when completing a certain task. Learning is a process in which learners actively construct internal mental representations, which is a generative process. Learning not only includes structural knowledge, but also includes a large amount of experience background, so vocational ability is situational comprehensive ability. Literature [22] believes that professional ability is the key ability. This ability plays a key role in personality development and career development, and is an ability for individuals to adapt to career changes. The key capabilities specifically include basic capabilities, career development capabilities, information acquisition and processing capabilities, and era-related capabilities. Reference [23] proposes that human action ability is the core of key capabilities. It is mainly the ability to act in the sense of things, the ability to act in the sense of society, and the ability to act in the sense of value. Literature [24] proposed that vocational ability is comprehensive vocational ability. This is a subjective condition for a person to survive and live in modern society, engage in professional activities and achieve all-round development. It includes occupational knowledge and skills, ability to analyze problems, ability to receive and process information, management, social interaction, and continuous learning. Literature [25] believes that vocational ability is comprehensive vocational ability. It refers to the performance of an individual performing, completing a professional activity, and successfully adapting to the special circumstances that occur in the professional activity. This ability will be affected by motivation, but the individual can freely control it, which is the externalization of the professional quality that people have. This can be specifically decomposed into professional ability, method ability, social ability and practical ability to engage in professional activities. Literature [26-27] believes that the connotation of professional competence evolves with the task of work. It interprets professional competence as competence for job tasks. The content of professional competence is

determined by work tasks, and professional competence and work tasks correspond to each other, and work tasks should be used to define professional competence. Reference [28] proposes that professional ability refers to the ability of professionals that cannot be objectified, or is difficult to be objectified. This ability goes beyond the requirements of current professional tasks and aims to solve and deal with future problems. It further elaborates that professional ability is the ability of people to solve comprehensive problems as a whole in a real work situation, and it is a necessary ability to engage in a profession.

Literature [29] proposes that the vocational ability evaluation mainly includes the skills assessment system, the enterprise internal skills assessment and skills identification system, the office-based skills assessment system, the elderly care service skills assessment system, and the handling skills assessment system. Reference [30] relies on many core skills assessment and certification agencies, and mainly assesses three skills of communication, digital application and information technology. The assessment methods mainly include three forms: self-assessment, internal assessment and external assessment. At the same time, it will closely coordinate the evaluation of students' professional ability with the professional qualification framework to ensure the level of students' professional ability. Reference [31] adopted the requirement of defining the level of learning outcomes to guide the transition of the vocational education quality control paradigm from input-oriented to result-oriented. This prompted the field of vocational education to think about how to ensure the quality of vocational education more scientifically. Reference [32] carried out a professional ability assessment for secondary vocational students, higher vocational students and teachers. The project analyzes the influencing factors of vocational ability based on assessment data. This provides a data basis for decision-making in vocational education and a certain degree of technical support for curriculum and teaching reform. Literature [33] proposes that the use of vocational ability assessment methods can help students make career plans. This promotes the effective conduct of career education and enables students to understand their own abilities. This can also enable students to understand the specific requirements of different occupations, clarify their goals, and establish a career development direction. Literature [34] proposed that there are many factors that affect the cultivation of vocational ability of higher vocational students. However, it is mainly manifested in people's lack of understanding of the connotation of professional ability, the differences in the quality of college students themselves, and the fact that higher vocational teachers do not pay attention to practical teaching. Literature [35] believes that the influencing factors of vocational ability are composed of two parts: vertical and horizontal. One is the part of influencing factors, and the other is the part of cultivation forming factors. And the influencing factors of culture formation will affect the influencing factors of composition. Literature [36] investigates and analyzes the influence of students' part-time job on their professional ability and the current situation of part-time job. It draws the current situation of part-time job of vocational students and the influence of part-time job on their professional ability, and puts forward corresponding suggestions and opinions on part-time job of vocational students according to the survey results. Literature [37] proposed that the background factors affecting the vocational education process are mainly the psychological characteristics, basic concepts, and age characteristics of vocational colleges and enterprises, as well as individual students. Literature [38-40] conducts research through questionnaires and individual interviews. It is concluded that the experience of student cadres in school plays a very important role in improving college students' professional abilities such as teamwork, interpersonal communication, innovative practice, and comprehensive

employment.

3. Method

First, this work proposes an improved residual block. It increases the width of the residual network by adding a residual connection channel to learn richer features. Second, this work proposes an improved attention module. It combines channel attention with spatial attention to improve model performance. Third, this work combines IRB and IAM to propose an SVAIFANet model. The model can be applied to the analysis of factors influencing students' vocational ability.

3.1. CNN Algorithm

CNNs are characterized by local receptive fields and weight sharing. The local receptive field means that each neuron in CNN is only connected to some neurons in adjacent layers. Therefore, the partial field of view of the data is obtained, and the partial field of view of each part of the data is obtained by continuously sliding the window, and finally it is spliced into a whole. Weight sharing means that the same convolution kernel uses the same weights when processing data. In this way, a certain type of characteristics of the original data can be obtained, and the influence of special data individuals or parts on the characteristics can be reduced.

As a crucial component of convolutional neural network models, convolutional layers are essential. The parameters of the convolution kernel are multiplied by the data at the corresponding point, making the convolution kernel the central component of the convolution layer. The result of the product is the output, and the output obtained after traversing the entire input is the feature map. The weight parameters of the convolution kernel are different, and the information represented by the features obtained after convolution is also different, so different convolution kernels can be adapted to different tasks.

$$x^l = f(\sum_i x^{l-1} w_i^l + b_i^l) \quad (1)$$

Where x is input, w is weight, b is bias.

To minimize the data volume in space, CNNs often incorporate a pooling layer in between convolutional layers at regular intervals. This minimizes the size of the convolutional neural network and its associated computing requirements. Additionally, it can prevent the neural network from becoming overly specialized. Since the input has feature invariance, after the pooling operation, although the dimensionality of the data is reduced, the interference noise in the feature information is eliminated. But this does not lose information about the overall characteristics of the data. At the same time, because the pooling reduces dimension of feature information, spatial size of the data volume is greatly reduced. Convolution processing on the pooled feature information significantly speeds up the convolution operation.

The neuron takes as its input the value produced by the preceding neuron in the neuron node's higher layer, and outputs that value to the layer below. The activation function is the particular functional relationship between the output of a given upper layer node and the input of the next layer node in a deep neural network. For a given neuron, the input and output are linear functions if no activation function is applied to the neuron. The output of a neural network is always a linear combination of the inputs, regardless of the number of layers in the network.

The neural network's approximation ability is severely constrained, making it equivalent to the most basic perceptron. The neural network can approximate practically any function when a nonlinear function is given as the activation function.

$$\text{Sigmoid} = 1/(1 + e^{-x}) \quad (2)$$

$$\text{ReLU} = \max(0, x) \quad (3)$$

Where x is input.

BN is widely used in deep learning models to normalize the data before training starts. This can eliminate the adverse effects caused by individual prominent sample data and improve the convergence of the network model. When the number of layers of the network model is shallow, the model parameters are slightly updated during the training process, the output layer usually does not change drastically, and the training process can be performed stably. When the network model has a large number of layers, even if the input data is normalized and preprocessed, the small-amplitude update of the parameters will still produce large-scale oscillations through multi-layer conduction. When the batch normalization layer is introduced, the batch normalization layer calculates the mean and standard deviation of the output of the network layer on the batch scale and normalizes the output of the intermediate layer. This keeps the input of the next layer in a relatively stable distribution space, which accelerates the convergence of the neural network.

In the convolutional neural network, when using the dropout connection method, the network will mask a certain number of neurons according to a certain probability. Masked neurons do not participate in the training of the network, so using dropout connections can reduce the complexity of the network. This reduces the dependence on some specific neurons during neuron training, thereby effectively avoiding the overfitting phenomenon of convolutional neural networks.

All neurons in the fully connected layer have weight connections, and the fully connected layer is usually at the back end of the neural network. It expands the feature matrix obtained by the convolutional layer and the pooling layer into a single-dimensional vector, and loads the vector into the output layer for classification. All weight parameters of the fully connected layer are all connected to the input neurons. This integrates local information in the feature map and reduces the influence of feature location on classification results.

3.2. Improved Residual Block

When the data signal is directly input, it is necessary to increase the number of network layers to enhance the ability to extract the deep features of the input signal. This obviously increases the network structure and parameter quantity, computational complexity and computational resource consumption, and also easily leads to gradient disappearance or gradient explosion. Deep residual networks solve the above problems and are successfully applied in the CNN domain. When training a deep learning network, since its initial weights are generally close to zero. Shallow parameters may not be updated, which is prone to the problem of gradient disappearance. With the deepening of training, redundant network layers learn parameters that are not identity mappings, resulting in degradation. ResNet can make network information flow across layers, reduce the loss of original features caused

by multi-layer nonlinear transformation, and give full play to the powerful learning ability of deep CNN. A residual network converts a complex function fitted by multiple nonlinear layers into a residual function.

$$H(x) = x + F(x) \tag{4}$$

Where x is input, H is nonlinear transformation.

The residual block of the traditional residual network has only one residual connection channel to input the features of the low-level network to the high-level network. When the error is back-propagated, the residual block does not have enough weights to learn the features. Most residual blocks can only share a small amount of information, which results in reduced feature reuse. This work designs an improved one-dimensional residual block (IRB) whose structure is demonstrated in Fig. 1.

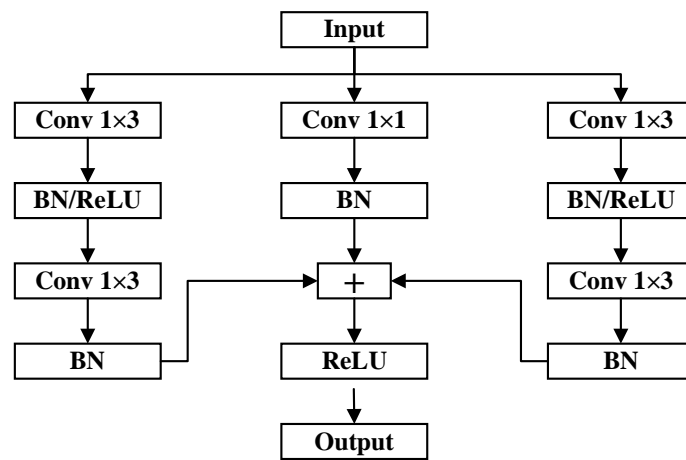


Fig. 1. IRB structure.

Compared with the traditional residual block, the convolution kernel of this IRB is one-dimensional, and a residual connection channel is added. Therefore, the residual block can effectively reduce the amount of network parameters and improve the efficiency of network training. In addition, the widened network structure enables each layer of the network to obtain richer features. Therefore, the network performance can be improved without increasing the number of residual blocks.

3.3. Improved Attention Module

This new and better attention module By focusing on what matters most, ignoring what doesn't, and enhancing neural network communication, IAM helps operations succeed. A channel attention module and a spatial attention module form its backbone. Key channel position information and key space position information of the feature are obtained with the use of the channel attention module and the spatial attention module, respectively. This performs better adaptive refinement of the data features of each sample.

The channel attention module focuses on the features in the channel dimension and creates an attention map based on the channel relationship between the features. The channel attention component uses a max pooling layer and an average pooling layer to characterize one-dimensional input. The features aggregated through the average pooling and max pooling layers are then fed into a shared network composed of MLPs. The corresponding

elements of the two feature maps after passing through the shared network are summed to combine the output feature vector, and then the Sigmoid function is used to activate the combined output feature to obtain the channel attention weight coefficient. Multiply the weight coefficients with the original to get the output features refined by channel attention.

$$F_c = \sigma \left(W_1 \left(W_0(F_{avg}) \right) + W_0 \left(W_1(F_{max}) \right) \right) * F \tag{5}$$

Where W_0 and W_1 are weight, F_{avg} and F_{max} are feature.

For feature vectors of different channels, the channel attention weight coefficient can be regarded as a feature detector. Each channel in the feature map is assigned a weight using the channel attention weight coefficient. Which channel brings more useful information, the greater the corresponding weight.

The spatial attention module takes into account the spatial relationship between features to create a spatial attention map. The spatial attention module, in contrast to the channel attention module, draws focus to the regions of the spatial attention map that contain the most useful information. By fusing together cross-channel and geographical data, convolution processes can extract useful characteristics. Finding the spatial location information of key features is essential for feature categorization, as different places on the feature map reflect different feature information. To create new features, the input features are first compressed by the average pooling layer and the maximum pooling layer in the spatial attention module. The feature map is obtained by joining two one-dimensional channel feature maps and then compressing them using a convolution check, one for each dimension of the combined feature maps. The spatial attention weight coefficient reflects the importance of different regional features. Not all regions in the feature map are equally important for the recognition task. The regions related to the recognition task deserve more attention, and these regions should receive larger weights.

$$F_s = \sigma(f(F_{avg}, F_{amax})) \tag{6}$$

Where f is convolution, F_{avg} and F_{max} are feature.

IAM is composed of channel attention and spatial attention in parallel, and its structure is demonstrated in Fig. 2.

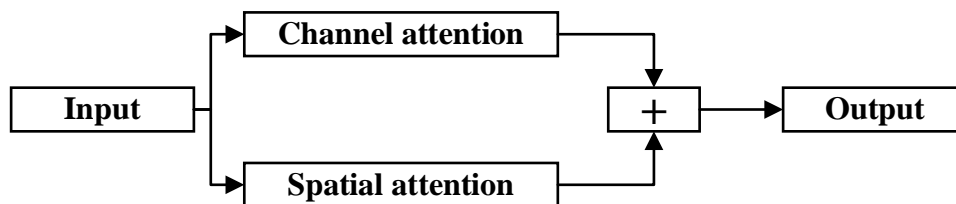


Fig. 2. IAM structure.

First, the features are input into the channel attention mechanism to get the channel weight coefficients. Multiply it with the input feature to get a feature map that can better reflect the key channel information of the feature. Second, the original features are used as the input of the spatial attention module, and the spatial weight coefficients are obtained. Multiply it with the original features to get a feature map containing spatial location information. Finally, the two feature maps are combined to obtain the final features.

3.4. SVAIFANet for Influencing Factor Analysis of Vocational Ability

This work uses the improved residual block as the basic feature extraction unit, and then uses the improved attention module to strengthen the features. This work is based on IRB and IAM to design SVAIFANet to analyze the influencing factors of students' vocational ability. The input is the corresponding student vocational ability data, and the output is the corresponding vocational ability influencing factor. The structure of SVAIFANet is demonstrated in Fig. 3.

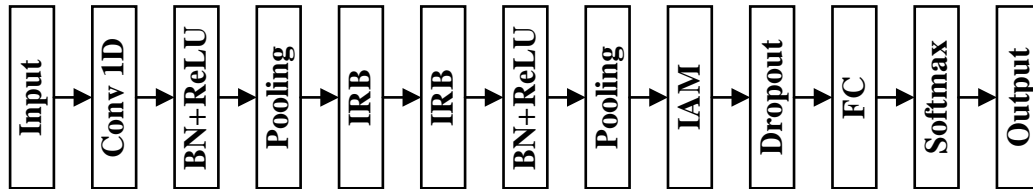


Fig. 3. The structure of SVAIFANet.

The input first goes through a one-dimensional convolution layer, which consists of a large convolution kernel. The wide convolution kernel can effectively extract the short-term features of the signal. The activation function is ReLU, and a BN layer is added to reduce the impact of data distribution, and then a maximum pooling layer is passed. It then goes through two modified residual blocks to extract deep features, while using BN normalization, ReLU activation, and max pooling after the second residual block. Next, the output is enhanced through IAM, and the enhanced features are classified through FC layer and Softmax to obtain the final result.

4. Experiment

4.1. Experimental Detail

This work collects the corresponding student vocational ability data as the input of SVAIFANet. The input feature are demonstrated in Table 1. To match the network input, this work replicates and stretches it. The label corresponding to each sample is the influencing factor of students' vocational ability. The evaluation indicators used in this work are the accuracy and recall, which are calculated as:

$$Acc = (tp + tn)/(p + n) \tag{7}$$

$$Recall = tp/(tp + fn) \tag{8}$$

Table 1. The input feature of data sample.

Code	Feature
c_1	Professional ability
c_2	Method ability
c_3	Social ability
c_4	Survival ability
c_5	Specific ability
c_6	General ability

4.2. Different Method Analysis

This work proposes SVAIFANet to analyze the influencing factors of students' vocational ability. In order to verify the superiority of this method, this work compares it with other methods, and the comparison data is demonstrated in Fig. 4.

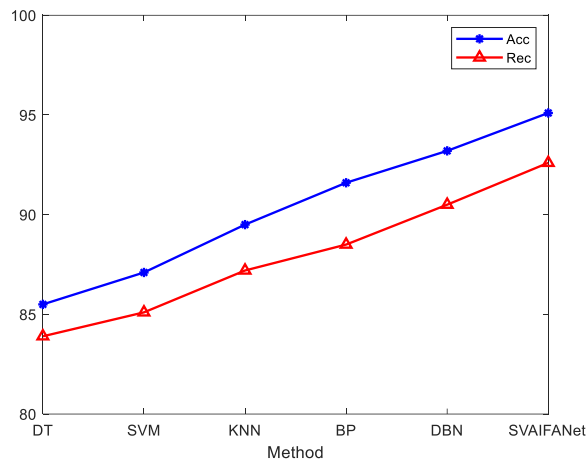


Fig. 4. Comparison of different method.

Compared with other machine learning strategies, the SVAIFANet designed in this work can achieve the highest accuracy and recall rates. This verifies the feasibility of SVAIFANet for the analysis of the influencing factors of students' vocational ability.

4.3. IRB Analysis

SVAIFANet uses an improved residual block, which can extract more discriminative features. To verify the superiority of the IRB strategy, this work compares the network performance when using traditional residual block (TRB) and IRB, as demonstrated in Fig. 5.

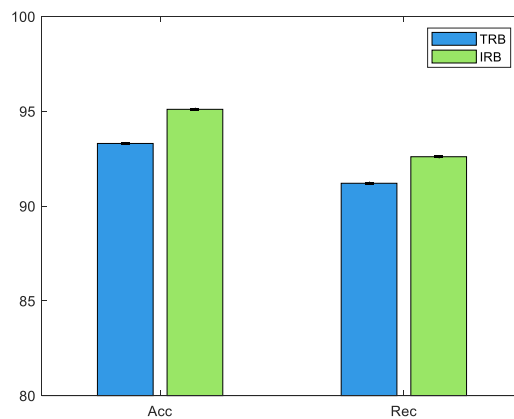


Fig. 5. Comparison of TRB and IRB.

Compared with using TRB, after using the IRB strategy, the accuracy of SVAIFANet is increased by 1.8%, and the recall rate is also increased by 1.4%. This corroborates the feasibility and superiority of using the IRB strategy in this work.

4.4. IAM Analysis

SVAIFANet uses an improved attention module, which can enhance deep feature. To verify the superiority of IAM strategy, this work compares the network performance when using traditional attention module (TAM) and IAM, as demonstrated in Fig. 6.

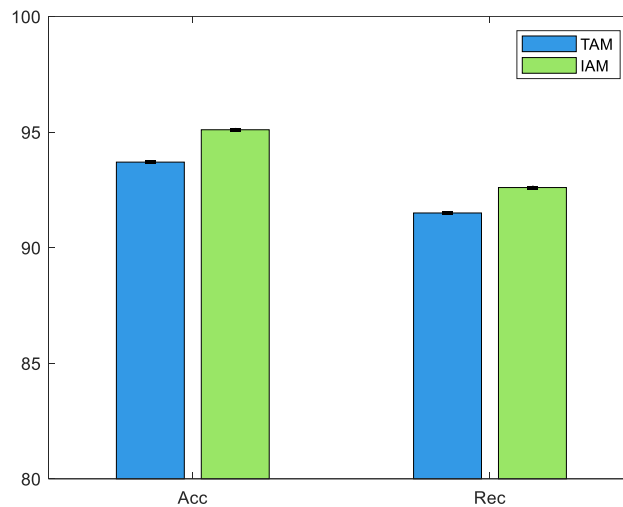


Fig. 6. Comparison of TAM and IAM.

Compared with using TAM, after using the IAM strategy, the accuracy of SVAIFANet is increased by 1.4%, and the recall rate is also increased by 1.1%. This corroborates the feasibility and superiority of using the IAM strategy in this work.

4.5. BN Analysis

This work uses BN layer to normalize the features. To verify the feasibility of BN, this work compares the performance without BN and when BN is used, as demonstrated in Table 2.

Table 2. BN layer analysis.

Layer	Acc	Rec
No BN	93.9%	91.6%
BN	95.1%	92.6%

Compared with the network performance without using the BN layer, after using the BN layer, both the correct rate and the recall rate have been improved to a certain extent. This corroborates the feasibility of using BN layers.

4.6. Dropout Analysis

This work uses Dropout strategy to increase the network sparsity. To verify the feasibility of Dropout, this work compares the performance without Dropout and when Dropout is used, as demonstrated in Table 3.

Table 3. Dropout analysis.

Layer	Acc	Rec
No Dropout	93.5%	91.1%
Dropout	95.1%	92.6%

Compared with the performance without Dropout, after using this strategy, the accuracy rate is increased by 1.6%, and the recall rate is increased by 1.5%. This proves the feasibility of the Dropout strategy.

5. Conclusion

Under the background of the emergence of new science and new technology, the demand for talents in all walks of life has changed. The society has begun to pay attention to the optimization of the talent structure, and a large number of high-level professional talents with professional skills are needed. At the same time, in the context of promoting the transformation of local colleges and universities, the transformation of talent training is the focus of transformation. Therefore, it is necessary to pay attention to the current situation of students' professional ability development, analyze the influencing factors of ability development, achieve the goal of talent training, and meet the needs of social talents. Vocational ability refers to the synthesis of multiple abilities that must be possessed to engage in a certain occupation and that are manifested in the occupational activities. It is very important to analyze the cultivation of students' professional ability and the influencing factors of professional ability. This work combines CNN with the analysis of factors influencing students' vocational ability. First, this work proposes an improved residual block. It increases the width of the residual network by adding a residual connection channel to learn richer features. Second, this work proposes an improved attention module. It combines channel attention with spatial attention to improve model performance. Third, this work combines IRB and IAM to propose an SVAIFANet model. The model can be applied to the analysis of factors influencing students' vocational ability. Fourth, this work conducts various experiments for proposed method, and the experimental data verify the correctness of this method.

Data availability statement

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflict of interest

The authors declared that they have no conflicts of interest to this work.

Funding statement

This work was supported by A research of the integrated development of labour education and aesthetic education in majors related to Tourism in higher vocational education- taking the cluster of Hospitality Management and

Digital Operation as an example. (No. 2022ly34).

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