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ORIGINAL RESEARCH ARTICLE

Design and application of performance evaluation model of school education informatization based on artificial intelligence mode

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ABSTRACT

Educational informationization is an important part of educational reform. The performance evaluation of educational informationization plays an important role in promoting the development of informationization. Therefore, a performance evaluation model of school education informatization based on artificial intelligence mode is put forward. First, the current situation of school education informatization evaluation is briefly described, summarizing the artificial intelligence technology. The evaluation model of education informatization based on artificial intelligence is established, the performance evaluation index of school education informatization analyzed in detail. The index meets the requirement of input data through quantification and normalization, and the process of performance evaluation is designed. Feasibility and stability of the evaluation method are confirmed by the performance evaluation of school education informatization and the error analysis of the test results.

***Keywords*:** education informatization; artificial intelligence; neural network; performance evaluation

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1. Introduction

At present, with the continuous improvement of social informationization, computer technology has penetrated into every aspect of human life, and the concept of human thinking is constantly changing[1]. Computer technology is also applied in the field of education, and has achieved great results, greatly promoting the development of education. The application of computer technology in the field of education not only has a great impact on the educational model, but also has an impact on the teaching methods and educational concepts[2]. School education informatization is based on computer technology. In recent years, in order to promote the construction of education informatization, the Ministry of Education has given strong support and pointed out the development goals, which has played an important role in promoting education equity[3].

The major universities in China have basically realized the informationization of education, but there are many obvious differences in the overall level of construction, often encountering various problems[4]. For example, the communication between developers and managers is poor, database standards are not uniform, and resources are duplicated. With the increase of campus network users, how to maximize the function of educational informatization has become a difficult problem to be faced[5]. The performance evaluation of school education informatization can not only discover

the shortcomings of information technology and the problems in the development of information resources, but also provide more references for management departments. It can also provide scientific basis for education informatization and reduce the blindness of later informatization development[6]. Therefore, in the construction of education informatization, performance should be used to evaluate the results, which are used as guidance to improve the level of construction decision-making. In the research and analysis, artificial intelligence technology is used to achieve the performance evaluation of school education informatization.

2. Related work

Artificial intelligence (AI) has a long history and has been put forward in the 1940s. British scientists have raised the question of whether machines can think[7]. At present, there is no clear concept of AI, which can be simply understood as a branch of computer science, mainly serving for intellectualization[8]. After more than a century of development, artificial intelligence has gone through several stages. Since the birth of artificial neural network technology, artificial intelligence has become an independent discipline. By the year 1950s, all kinds of theories and methods of artificial intelligence were emerging and developed in an all-round way[9]. With the advent of the Internet and the era of big data, AI technology, constantly emerging in various application sites, has been constantly combined with other technologies[10]. There are common scenes in the current society such as biometrics, language processing, with AI technology applied[11]. **Figure 1** is the application of AI.

Figure 1. Application of artificial intelligence.

At present, there are three directions for the development of AI technology. The first direction is to solve some complex problems by software programming, such as problem solving, information retrieval[12]. The second direction is artificial neural network, which is a kind of current research and application. The third direction is multi-agent research, more advanced[13]. From the point of view of these studies, the

contents that AI has been studying can be divided into weak AI and strong AI. The first is weak. This research refers to the use of software or algorithms to solve some practical problems, such as neural networks, fuzzy intelligence, to intellectualize complex problems[14]. In the research and analysis of the article, artificial intelligence refers to weak artificial intelligence. The application of artificial intelligence in some fields has been mature, such as Microsoft has applied it to image recognition and speech recognition in the research, and formed mature software[15]. Skype can recognize speech and translate in real time, and can serve 100 million people every day. In terms of infrastructure, AI has been used to build super cloud computers[16].

3. Performance evaluation design of school education informatization

3.1. Performance evaluation based on artificial intelligence

From the analysis of the research situation of education evaluation, there are many contents involved in the performance evaluation of education informatization, including quantitative indicators and qualitative analysis indicators. Generally speaking, it is a non-linear comprehensive evaluation[17]. In the evaluation of informationization performance, many methods need to be used. Among many AI methods, artificial neural network is a new type of technology, which simulates the brain nerve to transmit information, distributing the processing results in the matrix, and achieves mapping relationship[18]. Compared with traditional methods such as analytic hierarchy process (AHP) and fuzzy comprehensive evaluation (FGM), artificial neural network (ANN) has strong learning and fault-tolerant ability, so it can replace many traditional algorithms and is closer to human brain in information processing. It has strong self-adaptability, which can find internal relations according to the data, with incomplete data processed. Each factor will not affect each other, reducing the influence of subjective factors on the evaluation results[19].

AI neural network is a multi-layer sensor. In the process of signal forward transmission, the input and output of hidden layer nodes are not expressed by *net* and *Y* respectively. The formulas are as follows:

$$net_i = \sum_{j-1}^{M} w_{ü} x_j + \theta_i \tag{1}$$

$$y_i = \varphi(\sum_{j-1}^{N} w_{ü} x_j + \theta_i) \tag{2}$$

The output value of the output layer node is expressed as:

$$a_k = \varphi(\sum_{i-1}^{a} w_{ki} y_i + a_k) \tag{3}$$

Learning algorithm is used to minimize errors, and error gradient descent method is used in learning training. The error of the output layer is used to estimate the error of the former layer, and then it is pushed forward step by step to get the error value of each layer. Therefore, the error value can be obtained along the opposite direction of signal transmission. Assuming that the error function of sample *P* is also expressed by *E*, the formula is:

$$E_p = \frac{1}{2} \sum_{k-1}^{L} (T_k - 0_k)^2 \tag{4}$$

The total error of training samples is as follows:

$$E = \frac{1}{2} \sum_{j-1}^{p} \sum_{k=1}^{L} (T_k^p - 0_k^p)^2 \tag{5}$$

Δw_{ki} represents that the output layer weight is corrected, Δa_k the output layer, and Δw_{ij} the hidden layer. The formula is:

$$\Delta w_{ki} = -\eta \frac{\partial E}{\partial w_{ki}}, \Delta a_k = -\eta \frac{\partial E}{\partial a_k}, \Delta w_{ij} = -\eta \frac{\partial E}{\partial w_{ij}} \tag{6}$$

The formula can be further deduced.

$$\begin{aligned} \Delta a_k &= \eta \sum_{p=1}^{p} \sum_{k=1}^{L} (T_k^p - 0_k^p) \cdot \varphi^{/}(net_k) \\ \Delta a_k &= \eta \sum_{p-1}^{p} \sum_{k-1}^{L} (T_k^p - 0_k^p) \cdot \varphi^{/}(net_k) \end{aligned} \tag{7}$$

Finally, the error signal is obtained:

$$\delta_{pk} = (\mathrm{T}_{pk} - 0_{pk}) \cdot 0_{pk} \cdot (1 - 0_{pk}) \tag{8}$$

When training, the weights and thresholds are given randomly, and the Sigmoid function is selected by the response function. According to the function, the hidden layer and output layer unit error is obtained, the adjusted weights finally obtained. Artificial intelligence neural network (AINN) technology also has some shortcomings, such as slow convergence speed, low efficiency, and training may fail[20]. In the research, improvement based on adaptive error signal is proposed. There are many kinds of error signals. The common error signals contain Sigmoid function derivatives. When the output tends to zero or 1, the error signal will be wireless close to zero. After modifying the derivative, it can automatically adjust the signal and speed up the convergence:

$$\begin{aligned} (\delta_{pk})_{MBP} &= (T_{pk} - o_{pk}) r \cdot \exp[o_{pk}(1 - o_{pk})] \\ (\delta_{pk})_{MBP} &= (T_{pk} - 0_{pk}) r \cdot \exp[0_{pk}(1 - 0_{pk})] \end{aligned} \tag{9}$$

The error signal can obviously correct the weight and the training will not enter the saturation area. In the construction of the performance evaluation model of school education informatization, the most critical link is the determination of the number of hidden layers, as well as the input layer and output layer neurons. In the performance evaluation of school education informatization, there are many evaluation indicators. Assuming there are *n*, the number of neurons in input layer is *n*, and the number of neurons in output layer is 1. The hidden layer number is generally set at 1, avoiding excessive scale. The number of neurons in the hidden layer should be carefully selected. If too few, the learning accuracy is low and the fitting is poor. Generally speaking, the more numbers there are, the higher the accuracy. However, it will also affect the ability of input without learning and increase the training time. The formula for determining the range of general neurons is:

$$L = \sqrt{m+n} + a \tag{10}$$

In the formula, *a* is between 1 and 10, *m* is the input neuron, and *n* is the output neuron. According to this formula, the number of hidden neurons is determined to be 5 according to the evaluation content of school education informatization. **Figure 2** is the performance evaluation network structure of school education informatization.

The attribute values of evaluation indicators are processed to form input, which is then input into the network to directly output the evaluation results. As long as the sample data is enough, more realistic output results can be obtained. The numerical value of the model after training is correct knowledge. The value of the measured attribute is input into the evaluation system, and the qualitative and quantitative analysis is realized in combination with subjective judgment, which ensures the heterogeneity of the evaluation result. **Figure 3** is the flow chart of school informatization performance evaluation.

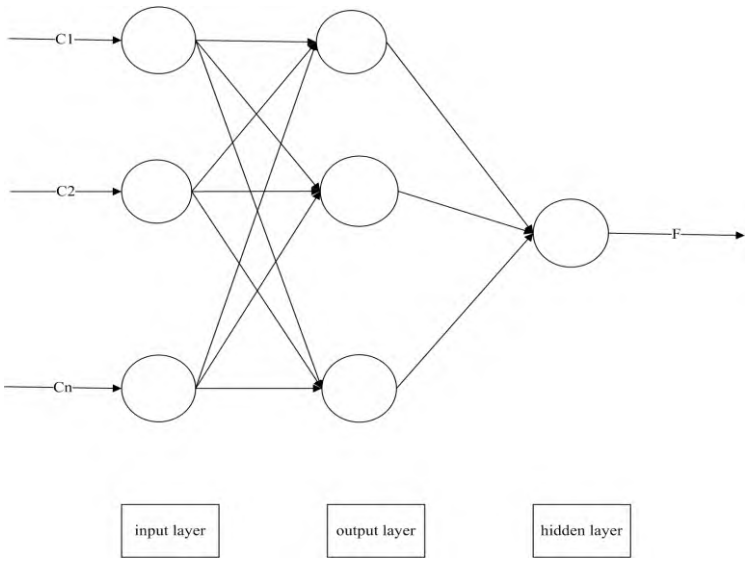

Figure 2. Performance evaluation network structure of school education informatization.

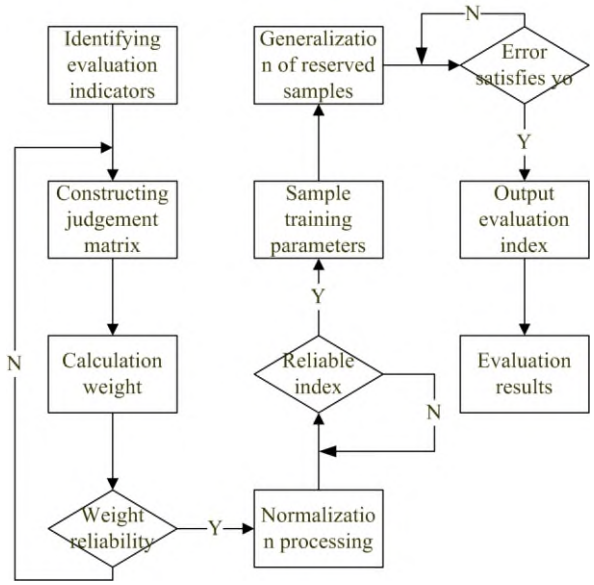

Figure 3. Flow chart of school informatization performance evaluation.

In data analysis, it is necessary to normalize the evaluation index, which is also the most common method. First, the basic unit of measurement needs to be unified, and the neural network is used to predict the probability in statistical samples. Normalization processing refers to the distribution of calculation probability between [0, 1]. When all sample inputs are positive, the weights of the input layer and the first hidden layer show the same change, and increase or decrease together. In this case, the algorithm is slow. The normalization of input data can avoid this situation and speed up the process. Normalization accelerates the convergence of the network, so the sample data need to be normalized. The technology used in the study is artificial intelligence neural network technology, which is a non-linear technology. The selection of initial values will affect the learning accuracy and training time. Therefore, in the application, the output value of initial weights should be wireless close to zero to ensure that the weights of neurons can be adjusted in the excitation function. In the analysis, the initial weight is set at [0, 0.1], and the initial threshold is set at [0, 0.2], so as to avoid prolonging the convergence time caused by improper initial weight or threshold setting.

3.2. Educational informatization performance evaluation index system

Schools around the world are constantly building education informationization, but there are not many studies on the performance evaluation of education informationization. In the performance evaluation, it is

necessary to determine the evaluation indicators. In the establishment of evaluation indicators, the principles of comprehensiveness, unity and comparability should be followed. The data source of the index is reliable, which can be recognized by people and can reflect reality. The indicators of the evaluation system should be comparable, and the informatization of education can be obtained through measurement. In data resource acquisition, the independence of each index should be accurately obtained. In this study, the performance of school education informatization is mainly evaluated. Previous research results are combined and qualitative and quantitative indicators are synthesized. In the performance evaluation of school education informatization, the evaluation contents are divided into four aspects: informatization design, informatization content, operation level and other contents. Then the four aspects are divided into four parts to form an index system. **Figure 4** is the performance evaluation index system of school education informatization.

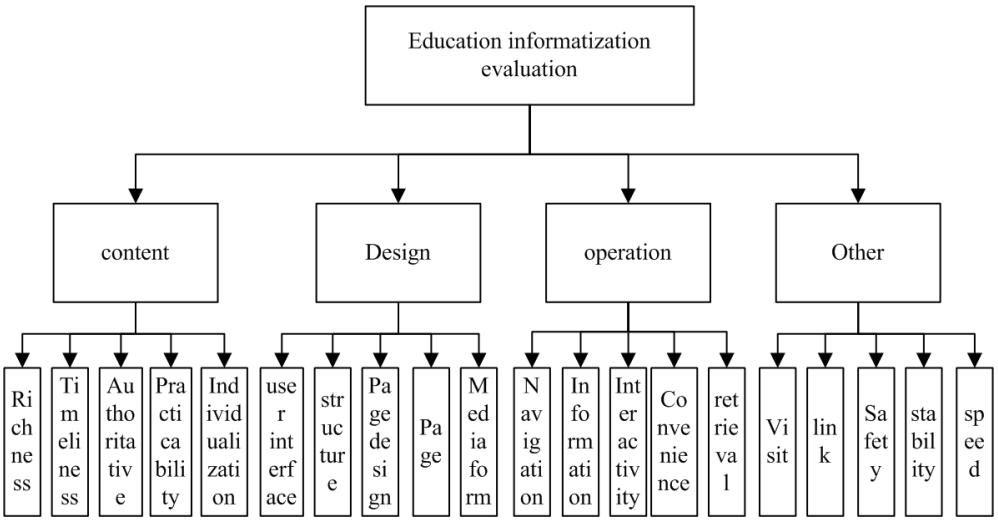

Figure 4. Performance evaluation index system of school education informatization.

The content indicators of school education informationization include richness, timeliness and authority. School education informationization should be able to provide users with real and reliable information. Richness includes the quantity and content of information education resources, which can reflect the scale of information construction to a certain extent. Timeliness refers to the real-time information provided by school education informationization, which can update the information in time, remove the worthless information and maintain the content in time. The information design of school education is also one of the important contents of evaluation, including interface design, overall structure, page level and layout design. Operational usage refers to the application effect of educational informatization, including navigation, information organization, interaction and so on. Users can quickly determine the information they need to find by navigation. Interactivity refers to the design and improvement of educational informatization, and to invite users to participate.

Other contents include visits, network connection, information security, stability, etc. Visits can reflect the degree of familiarity of campus informatization by students and teachers, and also reflect the application of campus informatization, which is an important indicator to evaluate the performance of informatization. Links, can influence the information construction to a certain extent, are very important for a campus website. The number of links is large, which means that users can visit it very quickly and conveniently. If many websites can connect to the school education information network, it means that the construction has certain authority. Security inspects the security situation of school education informatization, including anti-virus software, firewall, intrusion detection and so on. Stability means that in the application of school education informatization, resources should be continuously stable, especially the information they have, and resources should be released in time. Response speed refers to the time users get information.

After the completion of the evaluation index system of school education informatization, the judgment matrix is established, the eigenvectors are calculated, and then the consistency test is carried out to get the composite weight. Specifically, the judgment matrix A-B is first established. **Table 1** is the judgment matrix. The CI = 0.06, CR = 0.067 are calculated, and the maximum feature is 4.118. Then other judgment matrices are constructed, eigenvectors and eigenvalues are calculated, and consistency checks are carried out. By calculating the weights of each index, the comprehensive weights of each index are obtained. **Table 2** is the result of synthetic weight calculation of each index.

Table 1. Judgement matrix A-B.

A	B_1	B_2	B_3	B_4	W
B_1	1	1/3	1/5	1/7	0.06
B_2	3	1	1/3	1/5	0.12
B_3	5	3	1	1/3	0.26
B_4	7	5	3	1	0.56

Table 2. Calculation results of synthetic weights of each index.

First level index	Two level index	Synthetic weight
Website content	Richness (0.038)	0.210
	Timeliness (0.026)	0.145
	Authoritative (0.12)	0.067
	Applicability (0.17)	0.095
	Individualization (0.07)	0.039
Website design	user interface (0.21)	0.055
	Overall structure (0.35)	0.091
	Page hierarchy (0.29)	0.075
	Layout (0.09)	0.023
	Media form (0.06)	0.016
Operation and use	Navigation system (0.43)	0.052
	Information organization (0.27)	0.032
	Interactivity (0.10)	0.012
	Convenience (0.09)	0.011
	Retrieval function (0.11)	0.013
Other	Amount of access (0.27)	0.016
	Connection situation (0.38)	0.023
	Safety (0.10)	0.006
	Stability (0.10)	0.006
	response speed (0.15)	0.009

3.3. Index score

In the performance evaluation of school education informationization, the designed index system contains both qualitative and quantitative indicators, so different methods are needed to score. Website visits, security, response speed and other indicators are quantitative indicators, the data of these indicators can be directly obtained. In the research, Alexa website data is used to measure website visits. Safe Scanner measurement tool is widely used in the market, and it is widely used in finance, education and e-commerce. In the application, testers input instructions and create clients, which can realize the detection of servers and support multiple browsers. The response speed is realized by testing website. In the application, testers input

instructions and create clients, which can realize the detection of servers and support multiple browsers. The response speed is realized by testing website. Qualitative indicators are measured by questionnaires, divided into four grades. Excellent score is 0.9–1.0, good score is 0.8–0.9, qualified score is 0.6–0.8, and unqualified score is less than 0.6. In the survey, students are randomly selected as the subjects. Questionnaires are sent out and collected on the spot. The effective rate of questionnaire recovery is 96%.

4. Result analysis

4.1. Experimental data

According to the artificial intelligence model established to evaluate education informationization, the samples are divided into two parts: testing and training. The data of 10 schools in one area are selected as the research objects. The first five sets of data are used as training samples and other data as test samples. The two parts of the data covers output values and expectations. The output value refers to the scores of 20 indicators in the performance evaluation of education informatization, and the expected value refers to the overall score of the survey of each evaluation index. An evaluation questionnaire is issued. According to the split sample test method, the data are divided into two groups, one group as learning samples, the other as testing data. The sample data are scored, and experts are invited to score. **Table 3** is the survey of some universities.

Table 3. Part of university survey.

	Undergraduate	**Graduate student**	**Doctor**	**Teacher**
doctoral point	40	30	15	15
No doctoral point	50	20	0	30

According to the established artificial intelligence model, the program is called by using MATLAB software package, and quantified according to statistical data and expert scores. The training sample selection function is an adaptive gradient function with a maximum of 10,000 training times, and the error of the objective function is limited to 0.0001. The network is trained by the data obtained. **Figure 5** is the relationship between the number of training samples and the error. It can be seen from the figure that the selected function training can meet the accuracy requirements. At the end of the training, it takes 1 minute, and the overall error meets the requirements.

The data of the school informationization questionnaire are normalized and processed. The results are taken as learning samples. Then training samples are input into the AI evaluation model. The relationship between input and output values is fitted through repeated learning until the weight network value of learning accuracy reaches 0.0001. In order to avoid the defects of traditional algorithm, trainlm function to train the network is use. **Table 4** is a learning sample.

Then other school data are selected as the test sample set, the scores are aggregated, the data are normalized, and the performance is tested. **Table 5** is the test sample.

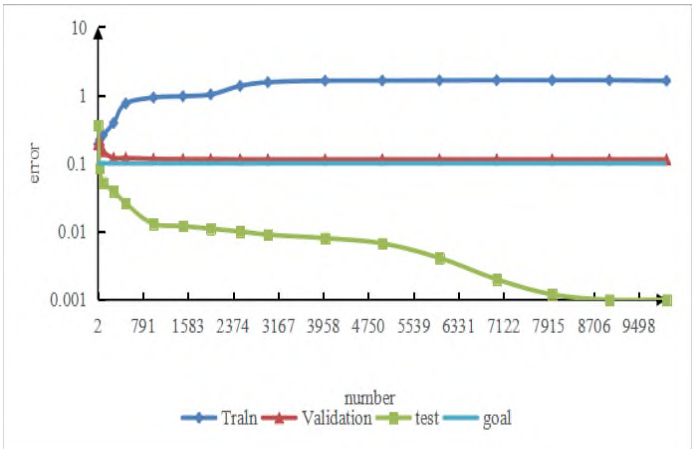

Figure 5. Relationship between sample training times and errors.

Table 4. Learning samples.

Evaluation index	School 1	School 2	School 3	School 4	School 5
Richness (0.210)	0.71	0.73	0.93	0.94	0.96
Timeliness (0.145)	0.71	0.72	0.94	0.93	0.94
Authoritative (0.067)	0.72	0.71	0.93	0.93	0.95
Applicability (0.095)	0.70	0.72	0.92	0.93	0.97
Individualization (0.039)	0.72	0.71	0.88	0.87	0.89
user interface (0.055)	0.73	0.74	0.90	0.91	0.91
Overall structure (0.091)	0.69	0.72	0.91	0.90	0.90
Page hierarchy (0.075)	0.75	0.70	0.91	0.92	0.93
Layout (0.023)	0.65	0.71	0.87	0.85	0.91
Media form (0.016)	0.69	0.76	0.88	0.86	0.88
Navigation system (0.052)	0.70	0.71	0.91	0.90	0.91
Information organization (0.032)	0.71	0.72	0.90	0.91	0.92
Interactivity (0.012)	0.68	0.73	0.87	0.89	0.89
Convenience (0.011)	0.70	0.71	0.88	0.88	0.89
Retrieval function (0.013)	0.71	0.72	0.89	0.87	0.96
Amount of access (0.016)	0.72	0.73	0.91	0.92	0.98
Connection situation (0.023)	0.70	0.71	0.90	0.90	0.92
Safety (0.006)	0.71	0.70	0.91	0.92	0.94
Stability (0.006)	0.68	0.72	0.90	0.90	0.91
response speed (0.009)	0.70	0.71	0.91	0.91	0.93

Table 5. Test samples.

Evaluation index	School 6	School 7	School 8	School 9	School 10
Richness (0.210)	0.71	0.92	0.70	0.91	0.68
Timeliness (0.145)	0.75	0.91	0.73	0.90	0.70
Authoritative (0.067)	0.74	0.90	0.70	0.90	0.71
Applicability (0.095)	0.72	0.89	0.70	0.88	0.71
Individualization (0.039)	0.73	0.84	0.72	0.86	0.70
user interface (0.055)	0.75	0.87	0.66	0.86	0.71
Overall structure (0.091)	0.74	0.88	0.68	0.88	0.70

Table 5. (*Continued*).

Evaluation index	School 6	School 7	School 8	School 9	School 10
Page hierarchy (0.075)	0.73	0.87	0.68	0.89	0.71
Layout (0.023)	0.74	0.84	0.74	0.85	0.66
Media form (0.016)	0.72	0.86	0.68	0.87	0.73
Navigation system (0.052)	0.73	0.87	0.72	0.88	0.67
Information organization (0.032)	0.75	0.87	0.77	0.86	0.73
Interactivity (0.012)	0.76	0.88	0.73	0.87	0.65
Convenience (0.011)	0.72	0.87	0.71	0.86	0.71
Retrieval function (0.013)	0.71	0.87	0.73	0.86	0.72
Amount of access (0.016)	0.72	0.87	0.68	0.89	0.65
Connection situation (0.023)	0.73	0.87	0.70	0.87	0.71
Safety (0.006)	0.74	0.90	0.69	0.89	0.67
Stability (0.006)	0.72	0.90	0.71	0.90	0.71
response speed (0.009)	0.71	0.88	0.72	0.89	0.67

4.2. Analysis of test results

The test sample data are input into the network to test. **Table 6** is the result of the test. The expert error in the table refers to the absolute error ratio between the score and the survey. The network error refers to the absolute error ratio between the network score and the survey.

Table 6. Determination results (part).

Evaluation index	School 6	School 7	School 8	School 9	School 10
Richness (0.210)	0.71	0.92	0.70	0.91	0.68
Timeliness (0.145)	0.75	0.91	0.73	0.90	0.70
Authoritative (0.067)	0.74	0.90	0.70	0.90	0.71
Applicability (0.095)	0.72	0.89	0.70	0.88	0.71
Individualization (0.039)	0.73	0.84	0.72	0.86	0.70
user interface (0.055)	0.75	0.87	0.66	0.86	0.71
Overall structure (0.091)	0.74	0.88	0.68	0.88	0.70
Page hierarchy (0.075)	0.73	0.87	0.68	0.89	0.71
Layout (0.023)	0.74	0.84	0.74	0.85	0.66
Media form (0.016)	0.72	0.86	0.68	0.87	0.73
Navigation system (0.052)	0.73	0.87	0.72	0.88	0.67
Expert error	1.35	1.14	2.82	1.16	1.39
Network error	0.51	1.68	1.67	0.24	0.76

Sample training results and actual evaluation results are analyzed, and relative errors are calculated. The actual evaluation results analyzed refer to the survey results. The result of training refers to the evaluation result. From the data in the table, it can be seen that the errors of the evaluation results of the test samples are small, and the accuracy can exceed 95%. In the test samples, most of the expert errors of the samples are greater than the network errors can be seen.

The trained artificial intelligence model is used to test, and five test samples are input. **Table 7** shows the test results. In AI evaluation model, the model is usually used to measure the sample, and then the relative error is calculated. If the error is acceptable, the evaluation result is considered to be effective. Test samples are put into artificial intelligence model for testing. By comparing the test results with the training

results, it is found that the maximum error value is 2.11%, which is less than 5%. This shows that the evaluation model is effective.

Table 7. Artificial intelligence model for testing results.

	1	2	3	4	5
Actual evaluation results	6.00	6.00	8.00	7.00	5.00
Training results	6.12	5.92	8.15	7.10	8.08
Relative error (%)	2.11	1.18	1.86	1.47	1.60

5. Conclusions

The performance evaluation of school education informatization can provide accurate direction for the development of education departments, as well as data support for decision-making of education informatization. In the research, the artificial intelligence model is introduced into the performance evaluation of school education informatization. Because there are many AI technologies, the current mature AI neural network technology is used to carry out performance evaluation. Combining qualitative analysis with quantitative analysis, the indexes of information design, website content, operation, use, security and stability are selected, and the weights of each index are calculated by analytic hierarchy process. And indicators are quantified and normalized. Through data training and testing, the results show that the error can be controlled within 5%, which confirms the accuracy and stability of the evaluation results. It should be pointed out that school education informatization itself is a complex system. There are differences in the construction of education informatization in different regions. The performance evaluation indicators proposed are subjective, which needs to be further studied.

Author contributions

Conceptualisation, ZZ, NGW and SBS; methodology, NGW; software, ZZ; validation, ZZ, NGW and SBS; formal analysis, ZZ; investigation, ZZ and SBS; resources, ZZ; data collation, ZZ; writing—original draft preparation, ZZ, NGW and SBS; writing—review and editing, NGW and SBS; visualisation, ZZ; supervision, SBS; project management, ZZ. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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