Hindawi
Mobile Information Systems
Volume 2022, Article ID 6953082, 7 pages
https://doi.org/10.1155/2022/6953082

Research Article

Evaluating the Scientific Research Abilities of Colleges and Universities Using an Improved Neural Network

Jiasheng Lai[1] and Yinjun Zhang[2]

[1]*Office of Research Administration, Guangxi Science and Technology Normal University, Liuzhou, China*
[2]*School of Mechanical and Electrical Engineering, Guangxi Science and Technology Normal University, Liuzhou, China*

Correspondence should be addressed to Yinjun Zhang; zhangyinjun@gxstnu.edu.cn

Received 26 April 2022; Revised 10 July 2022; Accepted 29 July 2022; Published 24 August 2022

Academic Editor: Mian Ahmad Jan

Scientific research ability (SRA) is now the main technical index used to assess comprehensive strength of a university. At the same time, it will have an impact on college and university rankings as well as enrollment. However, at the moment, college and university evaluation standards for research capacity are not unified, and there are various evaluation criteria, making it impossible to measure with unified standards. The main reason is that the evaluation factors are not consistent. Based on the characteristics of Guangxi Normal University of Science and Technology (GNUST), this paper develops the evaluation system of GNUST and introduced an improved neural network to assess the SRA of the faculty and the staff of GNUST. The simulation results show that the 15 technical indicators used in this paper are effective.

1. Introduction

Many factors are currently used to measure the overall strength of a university, including the number of professors, doctors, master's and doctorate programs, national or provincial key laboratories, and scientific research capability. The most complex one is the evaluation of scientific research ability. Because other indicators can be quantified, there is no quantitative standard for scientific research ability. Currently, the quantitative standard of the SRA of college teachers is the number of papers, paper grades, undertaking vertical and horizontal topics, etc., but they not only violate the current national evaluation of college teachers but also do not promote teacher growth. In most cases, a scientific study evaluation of a teacher is a system that includes a number of elements, such as an evaluation of a teacher's ability to instruct. The evaluation of a teacher's teaching ability is generally completed by experts with rich teaching ability, but there are too many subjectivities. Therefore, many colleges and universities also have some subjectivity in evaluating teachers' scientific research abilities. However, in order to avoid the trouble brought by subjective evaluation for teachers, some scholars have put forward expert evaluation methods, fuzzy evaluation methods, multilevel evaluation methods, and so on. The advantage of these evaluation systems is that they can use quantitative and qualitative methods to comprehensively evaluate the scientific research abilities of teachers, and they have achieved certain results; however, there are many imperfections. Therefore, our evaluators are required to evaluate the scientific research abilities of teachers from many aspects, namely, objectivity, scientificity and safety, comprehensiveness, and operability.

These indicators cannot cross each other. However, they must have their own independence, and the evaluation system cannot include any subjective aspects. Therefore, the traditional evaluation method makes it challenging to determine the relative importance of the components, because the judgment includes defects such as inefficiency and objectivity. This is one of the main problems that will be discussed in this paper.

The SRA of colleges and universities is generally dynamic, which generally includes the following factors.

1.1. Information Processing Capability. Nowadays, information is the primary productive force of science and technology. An excellent scientific researcher must be able to process information, which requires our teachers to receive and process various cutting-edge information in the fastest way in today's information explosion era and strive to master the latest scientific and technological information and the latest development trend at the first time.

1.2. Knowledge Accumulation and Reserve Capacity. Scientific research is an extremely complex process. The subject becomes more interdisciplinary as it becomes more advanced. If it is not adequately prepared in a timely manner, it will fail. Therefore, one of the fundamental qualities of scientific researchers is the ability to reverse knowledge.

1.3. Scientific Innovation Ability. The emergence of any new affairs and any high technology cannot be separated from our scientific researchers. Therefore, it requires our scientific researchers to actively create new knowledge, new concepts and technologies, new methods, and so on. As a result, innovation ability is the most important factor to be evaluated. From the perspective of university managers, first of all, we should formulate rules in line with our own school because if we directly use the evaluation system of other schools, it would not accord with the characteristics of our teachers. So, we first investigated the SRA of all teachers in our school by means of questionnaire, then referred to the evaluation system of similar universities, and finally combined the two to form their own evaluation system.

2. Related Work

Teachers can teach students about the subject of [1] through training, which can support them increase their fundamental competitiveness by integrating theoretical and practical knowledge, fostering innovative thinking and increasing their competence in scientific research development and practice. Tian et al. [2] summarized the reform achievements in postgraduate education in terms of research project selection, teaching method development, teacher level, and student level and proposed new ideas such as by what method to increase students' innovative consciousness and SRA. Based on an investigation of the current situation [3], it is observed that there is a growing trend of younger basketball instructors in academies such as school, colleges, and universities that the percentage of teachers with professional designations is low, that the SRA of teachers is weak, that scientific achievements in research are few, and that the opportunities for teachers for further research studies are insufficient, so that college and university administrators can correct the present problems and intensify the development of basketball instructors to effectively meet the requirements of students. Under these circumstances, Man et al. [4] integrated the cultivation of logical thinking into teaching. Using the AHP approach, the hierarchical structure based on the above characteristics and other elements was developed by [5]. On the basis of this current situation, Cui et al. [6] proposed to strengthen awareness-rational position-training platform-evaluation mechanism four-in-one ability cultivation system. Comprehensive, planning, and experimental-based research projects have been established to investigate the teaching restructure of the experiment with optical fiber sensors, improve students' inventiveness in learning and collaboration ability, and promote their innovative perception, independent SRA, and rigorous attitude of research in science [7]. Other influential work includes [8–10].

3. Prosed Evaluation Method of SRA of Colleges and Universities Based on Improved Neural Network

3.1. Scheme for Estimate Index. The SRA of students in colleges is impacted by both external elements such as the research area offered through college and fundamental elements such as their scientific research literacy. The architecture of college students' genuine SRA is depicted in Figure 1. The genuine SRA of college students is divided into three sequential dimensions: scientific perception, scientific exercise, and scientific creative capabilities.

Chinese colleges primarily generate a study environment through 2 techniques: building labs on their own and collaborating with corporations and research institutions to form cooperative experiment training camps, economic science zones, and technology marketplaces. However, not every college in every location has access to the research environment's idea development circumstances and size. Scientific research is an experimental and creative group or individual activity for college students to explore new information in their area and resolve disputes between established scientific assessments and empirical findings. Figure 2 shows the complete process of college students conducting scientific research, which consists of 6 stages: subject selection, experimental investigation, hypothesis creation, practical exam, theoretical system construction, and findings in transformation. A full scientific research control strategy must support and comprehensively plan each step. Unfortunately, not every college in every area has such a system.

Based on the findings of the previous investigation, a hierarchical assessment catalog scheme for college students' academic research capacity was developed, concerning the present status and current assessment index systems for science investigation amongst college students.

3.2. Establishment of Evaluation System. A fair, just, and comprehensive evaluation system is the compass to ensure our teachers' enthusiasm for scientific research. This evaluation system requires a scientific, systematic, objective, and normative evaluation, and this evaluation system should also be dynamic, which should be dynamically adjusted according to the actual situation of the school at any time. Only in this way can teachers' scientific research motivation be stimulated. When it develops to a certain period, when some indicators in the indicators are no longer suitable for

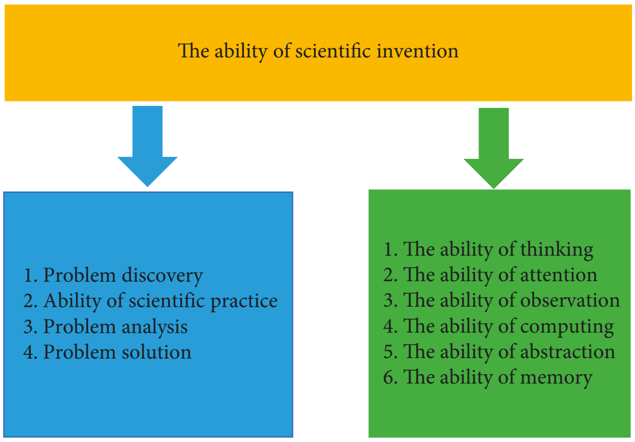

FIGURE 1: Architecture of college students' genuine scientific research capacity.

evaluation, they should be deleted in time. Therefore, according to the above requirements and the characteristics of our teachers, we have constructed the following evaluation indicators, including explicit indicators and implicit indicators, as shown in Table 1.

3.3. Improved Neural Network Establishment. A feed-forward neural network is a BP neural network. The characteristic of this neural network is obvious: information is transmitted between all neurons in a forward direction, but the error is reversed. As shown in Figure 3, the input signal travels from the input layer to the output layer via the hidden layer, and the signal is output layer-by-layer. The hidden layer can be multilayered among them. The lower layer is influenced by the upper layer. If the output layer's expectation is not satisfied, the output error is sent to the reverse layer, which adjusts the network weight and makes the BP neural network approach the expected output continually. This is the most traditional BP neural network.

This paper improves the BP neural network by including a fuzzy model. The fuzzy characteristics of things are described, studied, and dealt with using fuzzy mathematics. Mathematics refers to the research method, whereas fuzzy refers to the research object.

The most basic concepts in fuzzy mathematics are membership degree and fuzzy membership function. The membership degree refers to the membership degree of element "u" belonging to fuzzy subset "F". $f(u)$ denotes a number between [0, 1]. The closer $f(u)$ gets to 0, the less u belongs to the fuzzy subset F. Otherwise, the closer it gets to 1, the more u belongs to F. Fuzzy membership function is a function used to quantitatively calculate the membership of elements. Fuzzy membership function generally includes trigonometric function, trapezoidal function, and normal function.

Takagi-Sugeno (T-S) fuzzy systems are a kind of fuzzy system with strong adaptive ability. The most remarkable feature of this model is its dynamic nature. It can dynamically update the membership function of subsets. It has the following mathematical expression:

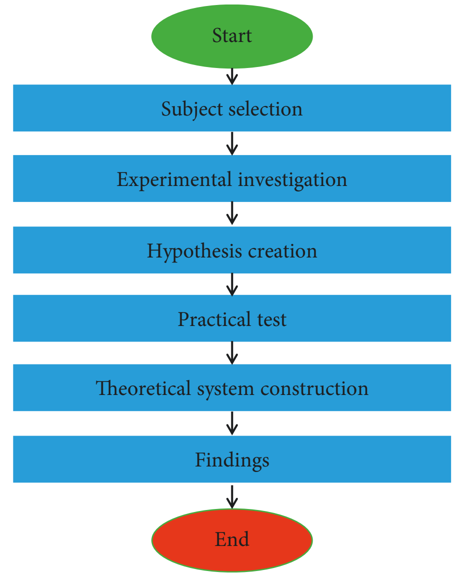

FIGURE 2: Complete process of college students conducting scientific research.

$$R_i\text{: if } x_1 \text{ is } A_{1i}, x_2 \text{ is } A_{2i}, \ldots\ldots, x_k \text{ is } A_{\text{ki}}, \quad \text{then } y_i = p_{0i} + p_{1\text{ix}_i} + \cdots\cdots + p_{\text{kix}_k}, \tag{1}$$

where A_{ki} is the fuzzy set of fuzzy system, p_{ki} is the parameter of fuzzy system, and $k = 1, 2, \ldots, n, i = 1, 2, \ldots, n, k, n$ are the input parameter and the number of fuzzy subsets, respectively. y_i is the output obtained according to fuzzy rules, the input part (i.e., if part) is fuzzy, and the output part (i.e., then part) is determined. The fuzzy reasoning indicates that the output is a linear combination of inputs. Assuming that for the input quantity $x = [x_1, x_2, \ldots, x_k]$, first calculate the membership of each input variable x_k according to the fuzzy rules as follows:

$$uA_{\text{ji}} = \exp - x_i - 2c_{\text{ji}} b_{\text{ji}}, \tag{2}$$

where c_{ji} and b_{ji} are the center and the width of membership function, $j = 1, 2 \ldots, n$, respectively. The fuzzy operator is the continuous multiplication operator, and the fuzzy calculation is performed for each membership degree. It is given as follows:

$$\omega_i = uA_{j1x_1} \times uA_{j2x_2} \times \ldots \times uA_{\text{jkx}_k}. \tag{3}$$

According to the fuzzy measurement results, the output value y_i of the fuzzy model is calculated as follows:

$$y_i = i = 1n\omega_i \frac{\left(p_{0i} + p_{1\text{ix}_1} + \cdots + p_{\text{kix}_k}\right)}{i = 1n\omega_i}. \tag{4}$$

T-S fuzzy neural network has four layers: input layer, fuzzification layer, fuzzy rule computation layer, and output layer. The input layer is connected to the input vector x_k, and the number of nodes is the same as the dimension of the input vector. The membership function in (2) is used by the fuzzy layer to fuzzify the input value and obtain the fuzzy membership value (u). The fuzzy multiplication formula in

Table 1: Evaluation system.

Index attribute	Primary index	Secondary index
Dominance	Basic information	Academic degree Continuing education Foreign language level Computer level
	Working ability	Knowledge and ability update Current hot spots Is it a key laboratory
	Scientific research achievements	Scientific research papers Research longitudinal subject Horizontal scientific research topics Scientific research award There are master's and doctoral students
Recessive	Personal characteristics	Affinity Logical thinking Professionalism

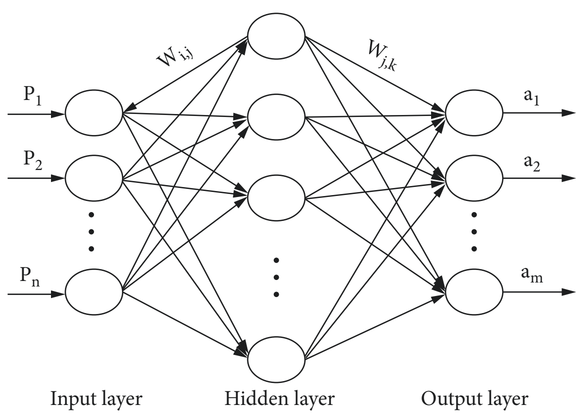

Figure 3: Classical BP neural network.

(3) (ω_i) is used to calculate the fuzzy rule calculation layer. The output layer calculates the output of the fuzzy neural network using the formula in (4). The learning algorithm of fuzzy neural network is as follows:

(1) Derivation of error

Using equations (1), (2), and (3), the error can be derived as follows:

$$e = 12\left(y_d - y_c\right)2, \tag{5}$$

where y_d, y_c, e are the expected output of the system, the real output, and the error, respectively.

(2) Coefficient modification

$$\begin{aligned} p_{\mathrm{jik}} &= p_{\mathrm{jik}} - 1 - \alpha\partial e\partial p_{\mathrm{ji}}, \\ \partial e\partial p_{\mathrm{ji}} &= y_d - \frac{y_c\omega_i}{i = 1m\omega_i x_j}, \end{aligned} \tag{6}$$

p_{ji} is the coefficient of neural network and α is the network learning rate, which determines how quickly the model adapts to the situation. α is the input parameter, x_j is the network input parameter, and ω_i is the continuous product of the membership degree of the input parameter.

(3) Parameter correction

$$\begin{aligned} c_{\mathrm{jik}} &= c_{\mathrm{jik}} - 1 - \beta\partial e\partial c_{\mathrm{ji}}, \\ b_{\mathrm{jik}} &= b_{\mathrm{ijk}} - 1 - \beta\partial e\partial b_{\mathrm{ji}}, \end{aligned} \tag{7}$$

where c_{ji}, b_{ji}, and β are the center, the membership function width, and the input parameter, respectively.

4. Analysis of Simulation Results

We can see from the above analysis that there is still a certain deviation in the evaluation of college teachers. However, our goal is to minimize our error because numerous components are often overlapping and cannot be quantified to standardize it. We use the trained T-S neural network to evaluate the SRA of teachers. Table 1 shows the data of 20 teachers for each year between 2012 and 2021. The evaluation results are presented in Figure 2. It is clear from Figure 4 that the SRA of teachers improved to some extent in 2012 and 2013, and it also improved in 2015 and 2016, which may be related to the possibility that the university may be transformed to an undergraduate university. Other times, however, the difference is essentially insignificant.

As shown in Figure 3, we also counted the periods from 2012 to 2021 and then estimated the SRA of 20 GNUST teachers from 2021 to 2030. Figure 3 shows that if the current scientific research system is maintained with all conditions essentially unaltered, the SRA of teachers will not change significantly, so we may need to modify the basic scientific research system first. Simultaneously, we provide additional possibilities for instructors to engage in active scientific research. It is also a good idea for

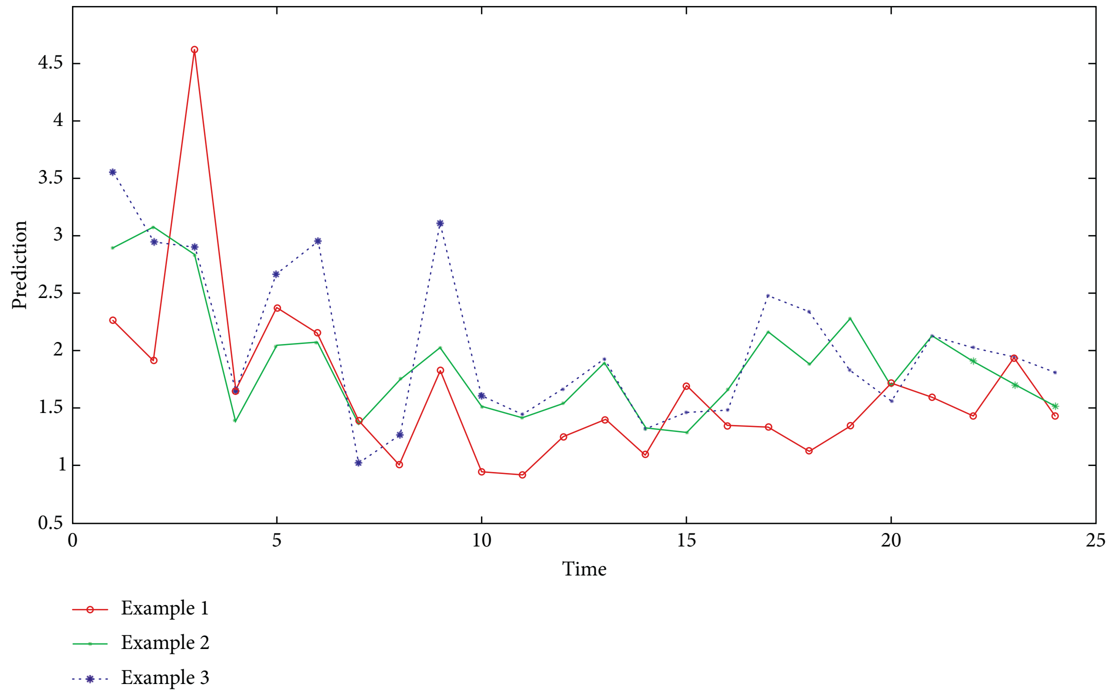

Figure 4: Evaluation curve of teachers' SRA from 2012 to 2021.

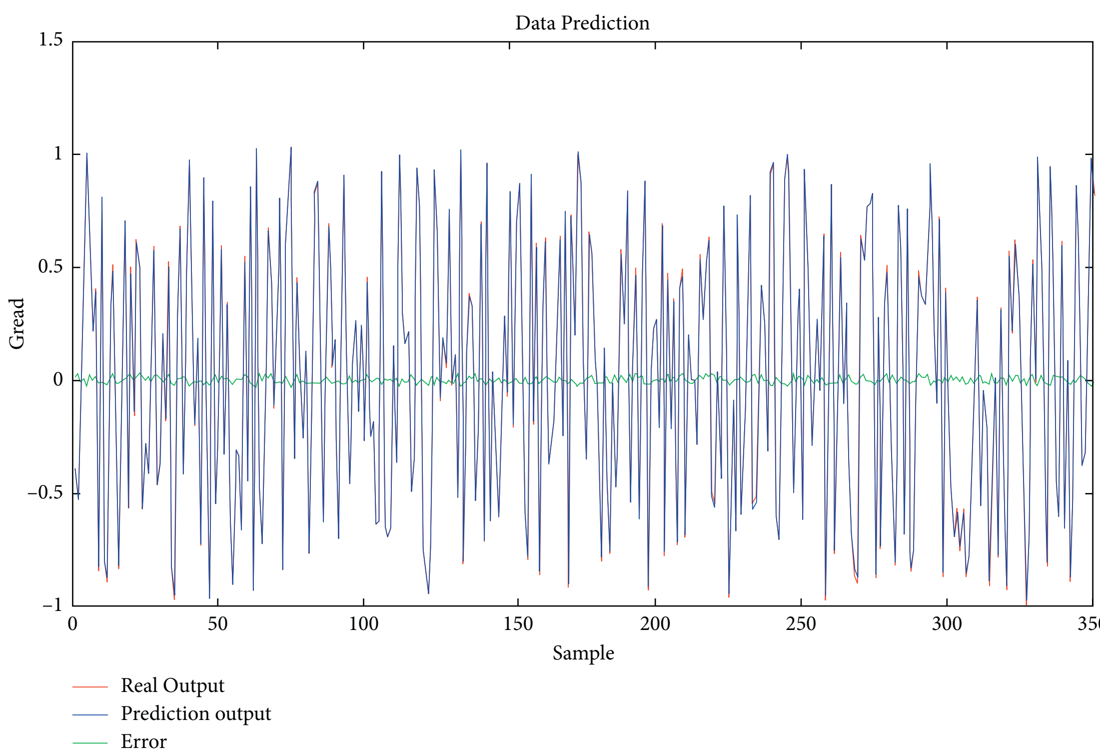

Figure 5: Prediction curve of teachers' SRA from 2012 to 2021.

teachers to go out and study while establishing conditions. Figure 5 also demonstrates that the error is almost a straight line, indicating that the predicted and actual outputs are in a related state over time, implying that the current method is unable to drive our teachers' enthusiasm for scientific inquiry.

Figure 6 shows that the SRA of our teachers is higher than that of the similar colleges and institutions, although it is only by 5% higher. Nevertheless, this only applies to our evaluation indicators. If we replace the evaluation indicators of other colleges and universities, these data are meaningless. However, the SRA of our teachers is still

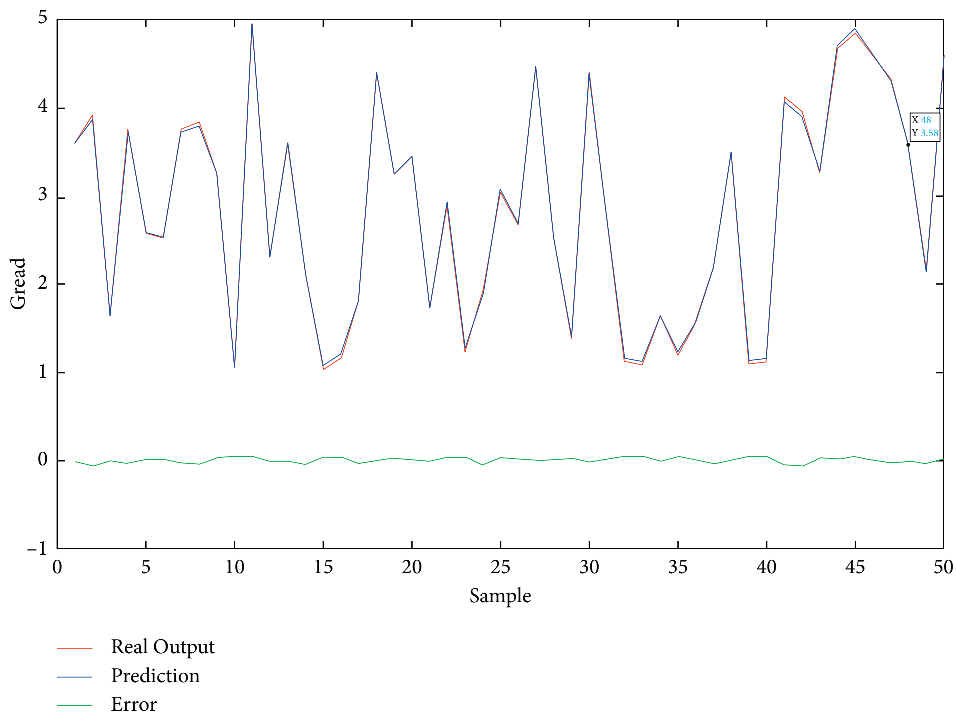

FIGURE 6: Comparison of teachers' SRA with other similar colleges and universities from 2012 to 2021.

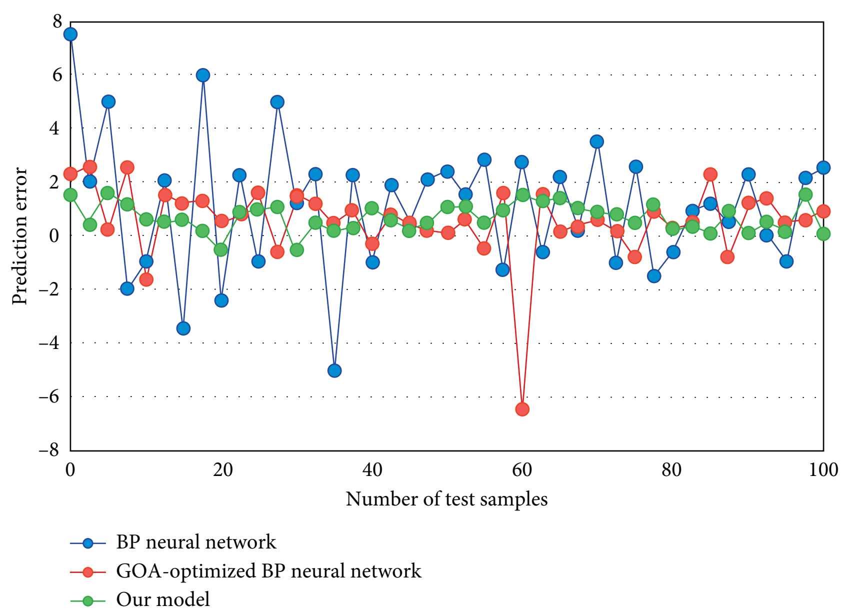

FIGURE 7: Comparison of prediction error line of 3 models.

better under the existing system (Figure 6). To test the efficacy of our GOA enhancement, a standard BP neural network, a BP neural network with GOA optimization, and our system, in that sequence, were used to assess the scientific research capacity of college students. The estimated error of the 3 models is presented in Figure 7. In terms of prediction error, the model that consists of it, differed significantly, as seen in the graph. The assessment findings of both the standard BP neural network and a BP neural network with GOA optimization exhibited mutations, resulting in a significant error. The prediction error of our model, on the other hand, changed less considerably and alternated around zero. In terms of prediction error, our model exceeded both the GOA-optimized BP neural network and the standard BP neural network.

This suggests that our model can assess the SRA of college students in a very realistic manner.

5. Conclusions

Based on the simulation results, the improved fuzzy neural network we designed can better evaluate the SRA of teachers in our school under its own evaluation system. However, it should be noted that these evaluation indexes were developed by us and do not cover all of the evaluation standards; only the current curve is obtained under this evaluation system. Based on our findings, we can conclude that the SRA of our teachers, particularly publications and scientific research projects, needs to improve under the current evaluation system. Our model shows better results than a BP neural network with GOA optimization and the standard BP neural network in terms of prediction error.

Data Availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The paper was supported by the School Level Key Project Support of Guangxi Science and Technology Normal University (GXKS2021ZD003) and Teaching Reform Project of Guangxi Science and Technology Normal University (2021GKSYGA01).

References

[1] Q. Li, Z. Li, Y. liu, D. Wang, and W. Song, “The exploration for strengthening the scientific research ability of laboratory medicine students in the implementation of scientific research projects,” *CHINESE JOURNAL OF MEDICAL EDUCATION RESEARCH*, no. 12, pp. 657–661, 2018.

[2] Lu Tian, Y. Lv, H. Ren, Y. Zhao, Z. Zhou, and P. Lin, “Discussion on postgraduate education and management in colleges and universities, proceedings of the 2019 5TH international conference on social science and higher,” *Education*, 2019.

[3] L. Liu, “Research on the development of college basketball teachers from the perspective of modern education theory, proceedings of the 1ST international symposium,” *ON EDUCATION, CULTURE AND SOCIAL SCIENCES (ECSS 2019)*, pp. 363–366, 2019.

[4] X. Ma, C. Fan, S. Li, and Y. Jia, “Research on the teaching reform of programming courses based on robotics education in high school,” *Creative Education*, vol. 11, no. 11, pp. 2305–2326, 2020.

[5] C. Zhao and Z. Sun, “Study on the evaluation of scientific research ability of university teachers based on the mathematica software, 2021 2ND international conference on big data and informatization,” *Education*, pp. 334–338, 2021.

[6] J. Cui, J. Pan, X. Gao, L. Zhang, and S. Wu, “Exploration of the scientific research ability cultivation of major basic course teachers in military science and technology universities,” *BCP EDUCATION & PSYCHOLOGY*, vol. 3, pp. 61–65, 2021.

[7] H. Jiayu and G. Bo, “Experimental teaching reform of optical fiber sensing based on the cultivation of innovative communication talents,” vol. 19, no. 4, pp. 92–95, 2021.

[8] T. Dongdong, “Chen yafei; strategies for improving scientific research ability of private colleges and universities in the new era,” vol. 2, no. 11, 2019.

[9] M. Sunmi, “application of PBL can improve the teaching quality of professional degree graduate students in hepatobiliary surgery,” vol. 11, no. 12, pp. 2609–2616, 2020.

[10] Y. Fen, “Cultivation of scientific research ability of undergraduates based on the incubation of competition results,” *CREATIVE EDUCATION STUDIES*, vol. 8, pp. 432–436, 2020.