Research Article

Construction and Application of a Task-Based Teaching Model of College English Based on Random Matrix Theory

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Society is in urgent need of English talents with high comprehensive English application ability and strong independent learning ability. Task-based language teaching has always been an effective way to improve English talents, but the shortcomings of traditional task-based language teaching in teaching practice are beginning to emerge, such as insufficient classroom time, lack of real-time monitoring, and scientific evaluation mechanisms. Therefore, the traditional task-based language teaching cannot meet the new requirements of society for the cultivation of English talents. Random matrix theory uses the principles of statistical mechanics to model the interaction of complex systems in multiple mathematical domains to improve the teaching effectiveness. Random matrix theory has been widely used in theoretical neuroscience and optimal control. This paper is based on teaching task-based language and analyzing the data from the teaching process with big data so as to give timely feedback and suggestions to teachers. This paper constructs a model of college English teaching based on random matrix theory using a task-based teaching model. Since the teaching model of college English is a typical high-dimensional nonlinear function problem, a network model of deep confidence network is used to determine the implicit relationship between input and output. To verify the effectiveness of the model, this paper conducts a practical study of the constructed model. The study shows that the task-based teaching model of college English based on random matrix theory improves college students' English expertise and English language usage ability and also greatly enhances students' enthusiasm for learning English.

1. Introduction

The emergence of task-based language teaching, educator N. Prabhu conducted the Bangalore Project (an experiment in strong communicative teaching) in southern India, in which students were asked to complete designed communicative tasks to achieve language teaching goals, allowing the task-based language teaching method to appear in front of the public for the first time and receive the attention of a wide range of scholars [1]. Since then, many scholars have studied this new teaching method and famous scholars. It was introduced to China in the late 1990s, and nowadays, task-based language teaching has influence in the field of language teaching.

Today’s university English teaching model cultivate highly qualified and complex talents who not only have rich English expertise but also have the ability to use English to conduct research or teach-related professional applications [2]. Task-based language teaching emphasizes the concept of “learner-oriented” and “People-oriented” [3], which translates the basic principles of language use into practical classroom teaching methods. It has long been regarded as an effective way to teach language and is highly regarded in the English language education community. However, the shortcomings of traditional task-based language teaching in practice, such as insufficient classroom time, lack of real-time monitoring, and scientific evaluation mechanisms, have aroused the concern of many domestic scholars [4]. Meanwhile, the integration of education and technology has become a major trend in higher education. The teaching requirements for college English courses promulgated by the Ministry of Education in 2004 pointed out that “in view of the rapid growth of the number of college students in Chinese universities and the relatively limited educational
resources available, we should make full use of the opportunities brought by the development of multimedia and network technologies and adopt a new teaching mode to improve the original single classroom teaching mode, which is mainly based on teachers’ lectures [5]. The new teaching model should be supported by modern information technology, especially network technology, so that English teaching can develop in the direction of personalized learning, learning not limited by time and place, and active learning” [6]. The issuance of this document showed a path to the majority of university teachers, and since then, scholars have continued to combine the traditional way of teaching English with modern information technology, and task-based language teaching is one such path.

Random matrices first originated in the field of mathematical statistics, the landmark work being a distribution of elements of Wishart matrices and the joint distribution of eigenvalues. Physicists introduced the theory of random matrices into atomic physics due to the need to develop the physical discipline [7]. The analysis of high-dimensional data has become more and more important, thus also attracting a large number of statisticians to devote themselves to the study of high-dimensional data analysis. For high-dimensional data, one usually needs to use dimensionality reduction methods; however, unfortunately, this method has to lose information containing the original data [8, 9]. Random matrices have rushed to be one of the many tools to deal with high-dimensional data. Specific engineering applications of random matrices include wireless transmission channels, learning and neural networks, and capacity of Hoc networks [10]. As for most of the standard techniques in multivariate statistical analysis: principal component analysis, standard correlation analysis, multivariate analysis of variance, discriminant analysis, and other analyses are based on the eigenvalue analysis of covariance matrix; therefore, the methods of random matrix theory play an important role in multivariate statistical analysis [11].

Task-based teaching is a teaching model introduced from the West [1]. It is based on teaching objectives, combined with teaching content, designed a variety of tasks for students to complete the teaching method. These tasks are closely related to the teaching materials, and the purpose is to enable students to master various knowledge related to the teaching materials, such as the writing background of the text, the introduction of the author, and the culture, customs, stories related to the text, so that students can better grasp the language rules and improve the ability of language practice [12]. Task-based teaching takes the completion of specific tasks as the driving force or motivation of learning, the process of completing tasks as the process of learning, and the way of displaying the results of tasks to reflect teaching achievements, rather than using the test scores of students as traditional teaching. Because task-based teaching sets many tasks related to teaching materials, it helps to stimulate students’ interest in learning, promote students to actively participate in language exchange activities, and inspire imagination and creative thinking. In task-based teaching, students are divided into groups or double activities, and everyone has tasks to complete, so that teaching can face all students and expand the coverage of teaching influence. The content of teaching activities covers a wide range and a large amount of information, which helps to broaden students’ knowledge. Cultivating students’ interpersonal, thinking, decision making, and adaptability is conducive to the all-round development of students. Although the task-based English reading teaching model has the above advantages, it also has many shortcomings [13].

The rest of this paper is organized as follows: the second part discusses the development of task-based English learning models and the construction of task-based learning models after incorporating random matrix theory. In the third part, the data screening algorithm based on PSO-DBN reactive optimization strategy is investigated. The fourth section presents the learning outcomes of students after using different teaching methods under the same conditions. The final part of the paper concludes the whole paper.

2. The Construction of a Task-Based Teaching Model Based on Random Matrix Theory

2.1. Design of Task-Based Teaching Model. Emphasis is placed on human-centeredness, and everything is aimed at being able to help students solve real-world problems and improve their ability to use language [14]. Teachers design tasks based on the above educational philosophy. When designing tasks, they should pay attention to the need to design a series of microtasks and try to ensure that the tasks are as authentic as possible. Teachers should encourage students to use as many forms of communication as possible naturally to complete the tasks to achieve the effect of learning the language [15]. Task-based language teaching emphasizes the authenticity of the tasks, hoping that students can use English to solve real tasks in real situations, so that they can have a high level of English proficiency. The core of task-based language teaching is the “task,” which is the goal of completing the task, the learning process, and the basis for the final evaluation of teaching. Excellent teachers, textbooks that keep pace with the times and authentic learning environment are all indispensable English learning resources. Cloud computing platform is a virtual education system without boundaries. The creation of a cloud platform teaching environment that “takes efficient use of time as the starting point, students’ dominant position as the center, interactive and hybrid teaching mode as the main line, and multi-dimensional teaching evaluation as the support” breaks through the limitations of the traditional teaching mode and provides students with the choice of learning time and learning methods.

The process of implementing the task-based language teaching method is divided into three parts: pretask activities, task-loop activities, and language focus [15]. Its architecture is shown in Figure 1.

Pretask. First, the teacher takes the students through a new topic and gives them a task and explains what they need to know to complete the task, the requirements and the steps. Then, the teacher teaches the students new knowledge, including language points and vocabulary of the text and background knowledge, with an emphasis on background
knowledge to stimulate students’ existing background knowledge in order to build knowledge and also to stimulate students’ learning frenzy for English, providing a good atmosphere for future learning and forming a virtuous cycle.

Task-cycle activities (task cycle): students are grouped according to certain factors, form teams to complete the task, and report back. The teacher is a helper in the whole process of completing the task. When designing the task, the teacher splits the whole task into a series of minitasks to form a task chain, so that students can receive the knowledge points from shallow to deep, in this process, making students understand the objectives to be achieved by completing the task, and to instruct students to make task plans and task reports, to conduct task. The report can be in various forms, such as each group elects a representative to make a report presentation. The task chain can be divided into:

Task—Students perform a task. A set of microtasks with real-life characteristics is designed to form a task chain, and students are conditionally grouped to work in teams to complete the tasks.

Planning—Each group member develops a task reporting format, program, and plan.

Reporting—Students select representatives to report back to the rest of the class on the completion of the task.

Language focus.

Analysis—Analysis of the results of each group’s task completion, with the teacher providing guidance.

Check—Including students’ self-assessment, intergroup assessment, and teacher’s summative assessment.

Practice—The teacher finally helps the students summarize the key points of learning, and the students practice the language.

Characteristics of task-based language teaching.

1. Emphasis on process rather than outcome. The result of learning is not the focus of task-based language teaching, but rather the process of learning, the extent to which students can use their initiative and their ability to use language knowledge.

2. Emphasis on authenticity. The design of tasks should be related to personal experiences and real external happenings, and classroom language should be combined with language outside the classroom.

3. Equal emphasis on language form and meaning. In the beginning, task-based language teaching tended to focus on the learning of meaning and completely ignored the learning of language form, but it has been proven through long practice that this is not true.

Finally, in the teaching ecosystem, information technology is no longer an auxiliary means of teaching, but as an essential factor. Then, cloud computing technology, as a new network resource, is enough to support and maintain the balance of the English teaching ecosystem.

2.2. Design Based on Random Matrix Theory and Task-Based Teaching Model. To make English learning more convenient for users, online classes and related English resources have emerged, and English teaching has evolved from a fixed classroom model to a freer and more convenient distance learning model. In recent years, new e-learning classes have been created based on user needs, and students’ e-learning and online communication for these classes have generated a huge amount of data records, which are useful for reference in choosing English learning.

As shown in Figure 2, through big data collection, students’ questions and discussions in e-learning are recorded, and through more detailed analysis, students’ mastery of the corresponding knowledge can be determined. Teachers can also flexibly develop teaching contents based
on the above big data analysis results and take different tutorials for different students in a targeted way, and all these have a significant role in improving the efficiency of distance English education. The cloud computing-assisted instruction platform has built a platform for teachers and students to communicate and cooperate and has broken through the limitations of time and space. Students can use their extracurricular time to master the basic learning content by watching microclasses and can carry out communication activities with peers through the auxiliary platform, discuss, and interact with peers according to their own blind spots, so as to broaden their horizons, learn from each other, and complete the construction of knowledge structure.

Application in classroom education: in addition to distance education, big data are also widely used in classroom education, the most important of which is to improve students’ English learning performance and practical application effect. By collecting and analyzing students’ homework, daily learning behavior, and other information, we can find out the aspects of English classroom teaching mode and method that can be improved and provide personalized attention for students of different levels. At the same time, it can also monitor students’ English grade 4 and 6 scores, attendance rates and other information to effectively identify the factors that cause students’ poor performance and provide effective information for teachers to conduct targeted teaching.

Application in examinations: big data have a great reference role in the comprehensive examination of students’ English proficiency, and the scientific and reasonable arrangement of the examination content is made. After the examination, through the integration and analysis of students’ answer results and class results, we can get a summary of students’ English knowledge reserves and the difficulties of the test paper, which can provide reference for the setting of test questions and the selection of the focus of course lectures afterwards. The embedding of big data technology in the exams is very helpful for students to check and fill in the gaps.

3. Research on Task-Based Teaching Model Based on Random Matrix Theory

3.1. Random Matrix Model Capable of Computing System Tasks. A matrix with random variables as elements is called random matrix theory (RMT), which is a set of data analysis-driven mathematical tools that enable effective analysis of complex systems and massive amounts of data [16].

There exists a square matrix $A$ of order $n$. Suppose that an $n$-dimensional nonzero vector $a$ and a real number into satisfy such that the equation

$$A\alpha = \lambda a \ (a \neq 0),$$

holds, then the $n$-dimensional nonzero vector $a$ is said to be an eigenvector of $A$ and its corresponding eigenvalue is $\lambda$. At this point, the system of chi-square equations $(\lambda E - A)a = 0$ has nonzero solution $a$. To this end, the $n$ eigenvalues 1 of the matrix $A$ can be obtained by solving the system of chi-square equations $|\lambda E - A| = 0$, after which the system of solutions underlying the equation $(\lambda E - A)a = 0$ can be calculated to obtain the $n$ linearly independent eigenvalues $\lambda_i$, corresponding to the eigenvectors.

Now suppose two nth-order square arrays $A$ and $B$, if there exists an $n$-dimensional nonzero column vector $a$, a real number into which makes the equation

$$A\alpha = \lambda Ba \ (a \neq 0).$$

Then a generalized eigenvalue of matrix $A$ with respect to matrix $B$ is $\lambda$.

The linear eigenvalue statistic is a distribution of the eigenvalues of a random matrix in characteristic specific form of expression, and the linear eigenvalue statistic is defined as

$$N_n(s) = \sum_{i=1}^{n} \varphi(\lambda_i).$$
In (3), \( s \) is the value of the mapping corresponding to the statistical function. \( \lambda_i \) \((i = 1, 2, \ldots, n)\) are the eigenvalues of the random matrix. \( \phi(\bullet) \) is a linear eigen statistical function, and different linear eigen statistics can be obtained with different choices of linear statistical functions.

3.2. Research on Teaching Method Based on PSO-DBN Algorithm. The DBN is constructed by a multilayer restricted Boltzmann machine and the outermost BP network, as shown in Figure 3.

Optimize the model parameters in the network to achieve local optimization. The reverse fine-tuning of the parameters is to use the last layer of the DBN model as the input and fine-tune the parameters of the whole DBN network model from the bottom up using the BP neural network.

As a branch of probabilistic neural network, RBM is mainly composed of visual layer and hidden layer. The visual layer \( \mathbf{v} = (v_1, v_2, \ldots, v_n) \) and the joint probabilistic energy function of the hidden layer \( \mathbf{h} = (h_1, h_2, \ldots, h_n) \) is

$$E(\mathbf{v}, \mathbf{h}|\theta) = -\sum_{i=1}^{m} a_i v_i - \sum_{j=1}^{n} b_j h_j - \sum_{i=1}^{m} \sum_{j=1}^{n} \omega_{ij} v_i h_j. \quad (4)$$

In (4), \( \theta = \{\omega, a, b\} \) are the parameters related to the RBM network model; \( v_i \) and \( a_i \) are the current states of the neurons in the visual layer and the bias of the network in that layer, respectively; \( b_j \) and \( h_j \) are the current states of the neurons in the hidden layer and the bias, respectively, and \( \omega_{ij} \) are the weights of the required connections between each layer.

After the RBM parameters of each layer are adjusted, it is difficult to ensure that the overall DBN parameters are optimal. Therefore, the BP algorithm is needed to fine-tune the parameters of the whole DBN network, and the specific fine-tuning process is to update the weights using the inverse error, thus obtaining the best network parameters of the overall DBN.

In the parameter tuning process, the last layer of the RBM training is used as input, and the training error generated during the RBM pretraining process is passed to the RBM layer from the bottom up using the BP algorithm, thus adjusting the whole DBN network and greatly reducing the training time. The parameter update formula in the reverse fine-tuning process is

$$\begin{align*}
\Delta \omega_n &= m \Delta \omega_{n-1} + \eta \omega_{n-1}, \\
\omega_n &= \omega_{n-1} + \Delta \omega_{n-1}.
\end{align*} \quad (5)$$

In (5), \( \omega_n \) is the weight between each layer of the network; \( n \) is the number of RBM update iterations; \( \eta \) is the learning rate; and \( m \) is the momentum coefficient.

At the beginning of establishing DBN model, the initial weights of DBN network are derived by random assignment, and if the assignment is not appropriate, the DBN model will have local convergence in training, so the initial weights of DBN network are optimized by particle swarm algorithm.

As a heuristic algorithm, the particle swarm optimization algorithm itself is updated by the velocity \( V \) and position \( x \) of each particle, and the optimal solution is obtained when the end condition is satisfied.

Traditional particle swarm optimization (PSO) is prone to fall into the local optimal solution. So there are many ways to improve it. At present, most scholars mainly use methods such as adjusting weights and limiting learning factors to improve the particle swarm algorithm.

The main use of the improvement of the inertia weights, through the linear weight decreasing method, the specific formula is

$$\omega = \omega_{\text{max}} - \frac{(\omega_{\text{max}} - \omega_{\text{min}})}{T} k, \quad (6)$$

where \( \omega_{\text{max}} \) and \( \omega_{\text{min}} \) are the maximum value and minimum value and \( T \) is the sampling interval.

The flow chart of PSO-DBN reactive power optimization is shown in Figure 4, and its specific optimization steps are as follows.

Step 1 Construct a stochastic matrix of the system from historical data.

Step 2 Extract the 40 historical feature indicator sets according to the feature indicator extraction method described in the previous section, normalize them, and obtain the sample.

Step 3 Determine the number of layers of the hidden layer and the number of neurons in the hidden layer in the DBN network in order to make a determination of the particle dimension.

Step 4 Setting each parameter of the particle population, i.e., population size, learning factor, inertia weight, and maximum number of iterations of the particles, and the connection weights between the layers in the DBN network are used as the vectors of PSO.
Step 5 Calculate the fitness function value \( f \) of the particles. Its function is

\[
f = \sum_{i=1}^{N} \sum_{j=1}^{m} \left( p_{ij} - t_{ij} \right)^2 / N
\]  \( (7) \)

The \( f \) and the individual extreme value \( P \), etc., are compared, and if \( f > P \), the current fitness value is replaced, otherwise the individual extreme value is kept.

Step 6 if \( f > P_{\text{best}} \), the current fitness value is replaced, otherwise the population extreme value is kept.

Step 7 updating the velocity as well as the position.

Step 8 uses the values of each dimension of the population extremes obtained after PSO optimization as the initial weights of the DBN network. Then the DBN model training and parameter fine-tuning are carried out until the DBN training is finished, and the network model of DBN is established to obtain the reactive optimization strategy.

4. Analysis of the Results of Teaching Practice

This study adopts different methods to collect data from the above three groups of subjects. Among them, the questionnaires of students in school are distributed and collected through the voting questionnaire function of blue ink cloud class to complete statistics. For the collected interview records and the teaching logs and reflections written by the teachers, this study uses the qualitative data analysis software nvivo11 to sort out and analyze. In qualitative research, the text analysis of interview transcription, field observation records, etc. generally includes the following steps: coding, theme extraction, theme correlation, and putting forward opinions. First of all, we encode the text data, summarize and integrate the data through sentence by sentence reading, and extract the key concepts; then summarize and refine the theme of the high-frequency words and sentences that appear repeatedly in the coding process; further classify and correlate the topics; based on the relationship between topics, this paper puts forward a view, that is, to summarize what tasks learners need to complete at present and in the future, the specific situation of the task, and what language skills they need to possess to complete these tasks and what language barriers they need to overcome.

The particle swarm parameters of this experiment are initially set as \( C_1 = 2 \), \( C_2 = 2 \), \( \omega = 0.7298 \), \( N = 500 \). The running environment of this experiment is python3.7, numpy1.13.1, pandas0.20.3, and tensorflow1.2.1. The four-layer structure of DBN is 3-35-100-5.

The experimental part is arranged as follows: (1) the experimental group and the control group are statistically analyzed to remove interference; (2) this paper analyses the application of the task-based teaching model of College English based on random matrix theory and observes the students’ mastery of knowledge points; and (3) the reliability of the algorithm is verified by comparing and analyzing the communication ability, organization ability, self-study ability, and English interest of the class.

4.1. Conditions and Preparation for Teaching Practice. The experiment was conducted in classes 51552p, 51523p, and 51541p. Class 51552p is the experimental class 1, class 51523p is the experimental class 2, and class 51541p is the control class. The experimental class 1 had 40 students and applied the task-based teaching model of college English based on random matrix theory using DBN optimization. The students were evaluated on the basis of their scores in the third level of college English, with a score of 100 out of 100, and stratified by every 10 points. There were 39 students in Experimental class 2, and the SPOC-based college English teaching model was applied. The class was evaluated by the
score of University English Level 3, which was 100 points, and stratified by every 10 points.

In the control class, there were 48 students, and the traditional teaching mode was applied to evaluate the students’ performance in English III. The number of students in each stratum and the specific scores of the experimental class 1 and the control class were randomly selected in the 90–99 mark range, 1 in the 80–89 mark range, 11 in the 70–79 mark range, 7 in the 60–69 mark range, 4 in the 50–59 mark range, 5 in the 40–49 mark range, and 2 in the 30–39 mark range. Thirty-one students from each class were selected as the sample of the experimental class 1 and the control class. The two classes each had 31 students as the sample of Experiment 1 and the control class.

Table 1 shows that the English levels of the experimental and control groups are similar, and there is no significant difference between the three groups before the experimental treatment. From the conclusion analysis, it can be seen that the evaluation conclusion obtained from the random matrix model can not only evaluate college students’ English teaching and education from a qualitative point of view but also quantitatively study the evaluation object in the process of evaluation, digitize some abstract concepts and convert them into specific quantities for evaluation, so that the evaluation conclusion is more based than the ordinary qualitative evaluation method. The evaluation process is clearer and more reasonable, and the evaluation results are more scientific and credible.

4.2. Verification of the Superiority of the Algorithm. Students are the main subjects in educational activities, and the amount of knowledge that they master directly reflects the teaching methods used by the teacher. The effectiveness of students’ learning under different teaching modes was responded to by means of periodic testing of the class during the experiment. The results are shown in Figure 5.

It can be seen from the graph that the overall learning of the two classes with the same situation is better than that of the control class. It can be seen from the figure that the amount of knowledge mastered by students in all three classes increased as the teaching program was implemented. The students in Experiment 1 class mastered the fastest growth in knowledge points, followed by the students in Experiment 2 class, and the control class grew the slowest. Due to the old teaching method used in the control group, students reached the bottleneck period quickly in the learning process, and the growth of students’ knowledge points became significantly slower, while the bottleneck period came later for students in the two experimental classes. Among them, the students in the experimental class 1 grew slightly faster than those in the experimental class 2,
which we believe is because the teacher could identify and compensate for the missing knowledge points of the students in time through the diagnostic system based on the random matrix theory.

The last is an investigation of the impact of the task-based teaching model of college English based on the random matrix theory on students, as shown in Figure 6. It can be seen that the traditional teaching method has less impact on students’ interest in learning, and students are not highly motivated in the learning process. Due to the introduction of the random matrix theory, the teaching method proposed in this paper has a greater impact on students’ motivation and better effect in the learning process. In total, 65% of the students think that the execution of various communicative tasks and various discussions have exercised their communication skills in the whole learning process, and 62.5% of the students believed that online autonomous learning and offline communication learning in the task-based learning process improved their autonomous learning ability.

5. Conclusion

Task-based language teaching based on random matrix theory has theoretical support, policy support, environmental support, and complementary advantages. In this paper, we constructed a task-based teaching model of college English based on random matrix theory, and we applied the constructed new model to three classes of our university. Furthermore, we assessed the students in the off-class, while the random matrix theory collated and analyzed the data collected from the online platform to provide guidance for the teachers’ next teaching. In the classroom, teachers act as facilitators to guide students through tasks and ask questions for communication. Through the mutual coordination between classes and the analysis of the teaching effects after practice, we found that the new model has better teaching quality compared with the traditional model and makes students interested in learning English; meanwhile, the new model strengthens the interaction between students and teachers, overcomes some shortcomings and drawbacks of traditional task-based language teaching, and has more obvious teaching effects. The Task-based College English teaching task established in this paper is a comprehensive evaluation model based on DBN, and there are many other mathematical theories and methods to establish teaching. In the future work, we should make progress in examining the Task-based College English teaching model established by different mathematical methods, in order to seek a more scientific mathematical modeling method.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

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