Advances in Computer, Signals and Systems (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/acss.2025.090216
ISSN 2371-8838 Vol. 9 Num. 2

Intelligent English Teaching System and Method Based on Human-Computer Interaction Technology

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Keywords: Human-Computer Interaction, Intelligent English Teaching, Artificial Intelligence, Teaching Experiment

Abstract: At this stage, the advancement of artificial intelligence (AI) technology has facilitated technological innovation in many fields, not only bringing new guidelines for the optimization of English classrooms in the curriculum field, but also providing new support for English language understanding and learning. However, the intelligent English teaching system also has problems with low modernization and low synchronization. In view of this situation, this article integrates the human-computer interaction (HCI) technology with the intelligent English teaching system. First, the definition of HCI technology was introduced. Then the evaluation of the intelligent English language teaching system from students, teachers and parents has been collected by means of a questionnaire. Finally, an experiment was carried out on the intelligent English language teaching system and method under the human-computer interaction technology. Through experiments, it was found that the current English teaching system could not meet the teaching needs, but the introduction of human-computer interaction technology into intelligent English teaching could fulfill the requirements of customers to the greatest extent. The teaching efficiency has increased by 5.36%, and the student's English proficiency has been extremely enhanced.

1. Introduction

Related research findings on intelligent English teaching systems and methods have been very rich. English teaching based on the application of computer-assisted instruction or the computer-based learning system facilitates the enhancement of the quality of English instruction, expanding teaching knowledge, and strengthening the frequency of teacher-student communication. For this reason, Wen H was committed to using computer-aided teaching to design solutions for studying intelligence education system [1]. Yao N proposed a web-based teaching management system design method that uses intelligent algorithms to analyze big data to understand how to arrange and control access to English learning management resources [2]. For more effective intercultural English teaching, Zheng J built an intercultural O2O English teaching system with the support of AI emotion recognition and neural network algorithm, which has the function of intelligent recognition and management. The system was stabilized and data processed using neural network algorithms. In accordance with the actual requirements, the overall O2O English teaching model was constructed, and the corresponding teaching process was formulated [3]. Depending on the academic achievements of university students, Zhang W introduced the basic knowledge of data mining and the status of implementation of data mining technology in the scope of education. He used data mining technology to deepen the in-depth research on databases [4]. Liu G built an English intelligent writing system based on artificial intelligence on the foundation of mechanism learning and herd effect algorithms. He proposed an improved swarm particle walking path optimization algorithm for the drawbacks of the conventional model and the feature of English writing intelligently [5]. Yu L provided essential figures for studying and examining with foreign language support systems [6]. In order to developing English proficiency in English writing for English majors in vocational institutions, Wang J was committed to the research of intelligent computer automatic composition evaluation system [7]. Through the above research, it can be learned that a number of academics have investigated intelligent English instruction systems, but the research results combining with human-computer interaction technology are relatively few.

Due to the rapid development of human-computer interaction technology, many people have studied it. Gamboa H described a new behavioral biometric technology based on HCI, a system designed to capture user interaction through pointing devices, which uses this behavioral information to authenticate individuals [8]. As a gesture recognition system can serve as a more desirable and usable way of human-computer interaction, Azad R proposed a face and gesture recognition system capable of controlling computer media players [9]. Han Q proposed a non-contact HCI method based on human electrostatic current for game control [10]. The approach of Kinect marks the arrival of the era of somatosensory interaction. Teng introduced Kinect from the aspects of composition, working principle, function, and development mode [11]. As HCI is the interface between residents and smart cities, it plays a pivotal function in bridging the gap in the utilization of the informational technologies in modern cities, and gestures have been widely recognized as a promising method for human-computer interaction. Qi J studied linear discriminant analysis and extreme learning machines in gesture recognition systems [12]. Sudarma M designed an integrated academic management information system (IAMIS) with the concept of HCI. An inductive analysis approach was used to systematically reveal the data so that the discovered usability and functionality of the IAMIS system could perform well [13]. Jianfeng deeply discussed the common situation, background and utilization of HCI, proposed a one-hand gesture recognition method under the HCI mode, and analyzed various principles and methods of vision-based gesture localization, tracking, segmentation and recognition [14]. Human-computer interaction technology has attracted the attention of the extensive list of professionals and scholars, and scholars in various fields have studied it.

2. Intelligent English Teaching System Based on Human-Computer Interaction Technology

(1) Intelligent teaching system of human-computer interaction technology

Due to the fast update speed of computer technology, modern HCI has made great progress compared with traditional human-computer interaction, as shown in Figure 1. Due to the improvement of technology and the update of hardware, the way of human-computer interaction has also become more direct, including touch, gestures, facial expressions, voice and other more natural and everyday forms [15]. In a sense, the distance between the user and the computer is getting smaller, and the user's experience will be smoother and more realistic, just like the interaction in the real world, so human-computer interaction technology has a favorable perspective in the world of education [16].

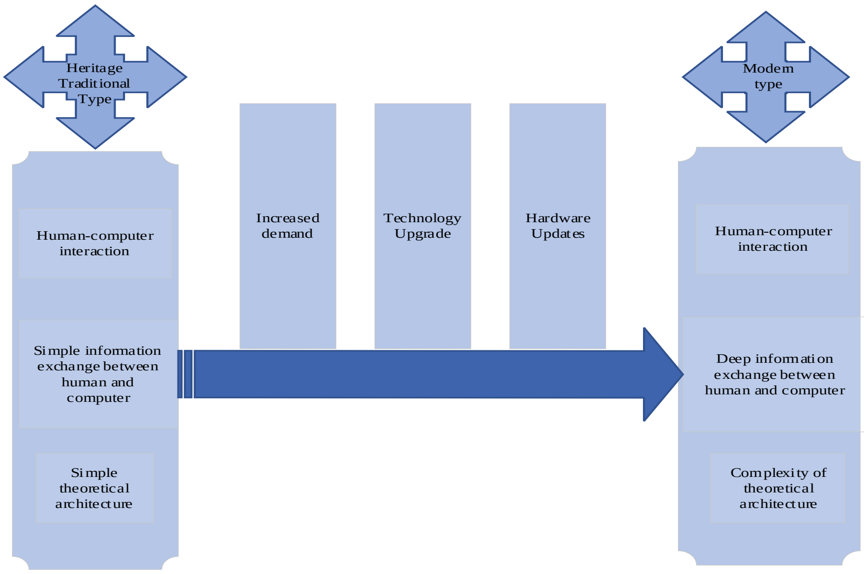


Figure 1 Difference between Modern Human-Computer Interaction and Traditional Human-Computer Interaction

(2) Interactive mode for personal experience

From the perspective of individuals, this paper analyzes the research content of human-computer interaction based on personal experience according to the basic principles of human-external interaction in the natural environment, as shown in Figure 2. Figure 2 outlines the main research contents of human-computer interaction in personal experience. Human psychology is essentially divided into two levels: visual and interactive. The hand is the most flexible part of the human body, and the natural gesture interaction is very convenient for people to operate the machine. The body is the main body of human movement, and the interaction of body movements can bring fun to the interaction and make users more willing to interact in English. In the spirit of improving the user's personal experience in the interaction process, the human-computer interaction of personal experience should meet the following four characteristics:

1) To be designed according to the actual situation of the user, a good interactive experience must put the service for the user in the first place.

2) Direct three-dimensional interaction: Traditional desktop interaction must map the information to be expressed into two-dimensional tools, which seriously affects the naturalness of interaction. Most of the activities in users' daily life are done in 3D space, and direct interaction in 3D space can reduce the cost of user interaction [17].

3) Understanding user interaction needs: During the interaction process, users often encounter situations where their personal preferences are contrary to the actual situation, which can negatively affect the interaction experience.

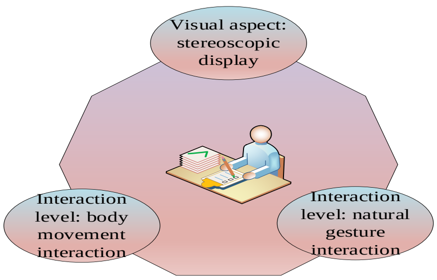


Figure 2 Interaction Research Content for Personal Experience

4) Protecting the patience of user: When the error rate in the interaction process is too high, and there are too much interfering information unrelated to the task, it may cause the user to be impatient, with a negative impact on the user, even making the user lose patience and be unwilling to interact anymore. Therefore, the accuracy of interaction must be guaranteed in the interaction design of personal experience, and the content of the context environment should also be reasonably designed to protect the user's interaction patience, as shown in Figure 2.

(3) Teaching process of intelligent system

As shown in Figure 3, the teaching mode of the intelligent English teaching system is the TAD teaching pattern. Taking the English teaching of senior one as an example, the teaching process is as follows: During the teaching process, the system first provides students with the corresponding pre-class preview content and corresponding teaching videos. In the classroom, the teaching of key knowledge is completed through the system, and students are required to complete the supporting exercises after class [18]. Each unit tests the students' learning status, and actively collects students' feedback information to solve the problems encountered by students in the process of learning in a timely manner.

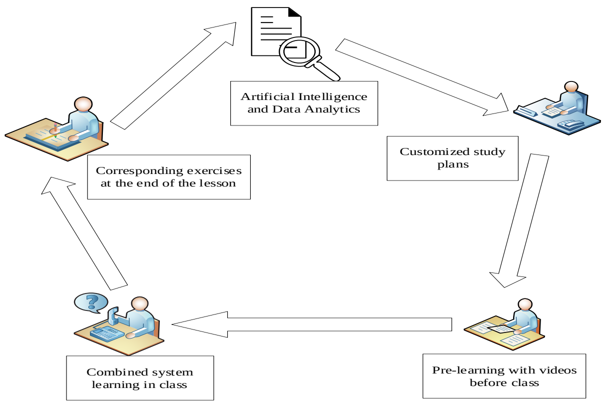


Figure 3 "On Answer" Manual System Learning Mode Cycle Diagram

3. Human-Computer Interaction Technology Algorithm

At present, the main development directions of human-computer interaction technology algorithms include "multi-Kinect", "MTBM", voice-activated interaction, action interaction and intelligent interaction. This paper mainly studies the "multi-Kinect" algorithm and "MTBM" algorithm.

(1) Algorithm based on "multi-Kinect HCI technology"

Multi-Kinect HCI technology is to use multiple Kinect somatosensory applications to obtain relevant data of real scenes and users, and to design and develop somatosensory interaction technical algorithms in the virtual world. The calculation steps of this algorithm are as the followings:

1) Target pixel points $Zixwe$, $Zixwe-X$, $Zixwe-Y$ and depth information $Zixwe-Depth$ are established;

2) The depth thresholds are set to Min_V and Max_V respectively, and the maximum depth of Kinect is Max_D;

3) The depth image is explored in a pixel area of $3*3$. The obtained pixel depth value (gray value) $Depth$ is compared with the depth threshold, and the coordinates $Zixwe-H$ and $Zixwe-W$ of the pixel are recorded;

4) If there are 3 or more pixels, and their depth values all satisfy the condition " $Depth > Min\_V$

And $Depth < Max\_V$ ", it is determined as a valid pixel, and the following operations are performed and the operation continues, as shown in Formulas 1-4:

$$Zixwe+=4 \tag{1}$$

$$Zixwe-Y+=4 \tag{2}$$

$$Zixwe-X+=4 \tag{3}$$

$$Zixwe-Depth+=4 \tag{4}$$

In Formulas 1-4, $Zixwe-Y+=4$ represents $Zixwe-W$ pixels. $Zixwe-X+=4$ means $Zixel-H$ pixels. $Zixwe-Depth+=4$ means $Depth$ pixels.

5) After the operation is completed, if $Zixwe=1$, $Zixwe-X$, $Zixwe-Y$, and $Zixwe-Depth$ are all set to 1, and X, Y, and Z all represent the coordinates of the center point. If $Zixwe>1$, the following parameters of the target object are obtained, as shown in Formulas 5-7:

$$X = Zixwe-X / Zixwe \tag{5}$$

$$Y = Zixwe-Y / Zixwe \tag{6}$$

$$Z = Max\_D - Zixwe - Depth / Zixwe \tag{7}$$

6) The depth image is calculated in a loop, and the variables are initialized immediately after the loop ends.

(2) Human-computer interaction algorithm based on MTBM

The HCI algorithm based on MTBM is shown in Figure 4. This paper is an artificial intelligence algorithm based on MTBM to determine repetitive functions of robot experience in human-robot interaction system, which uses advanced radial basis neural network for unsupervised training of robot motion domain and functional interaction characteristics [19]. The human-computer interaction training response based on MTBM can also achieve minimal system resource utilization without affecting the network training effect and network performance.

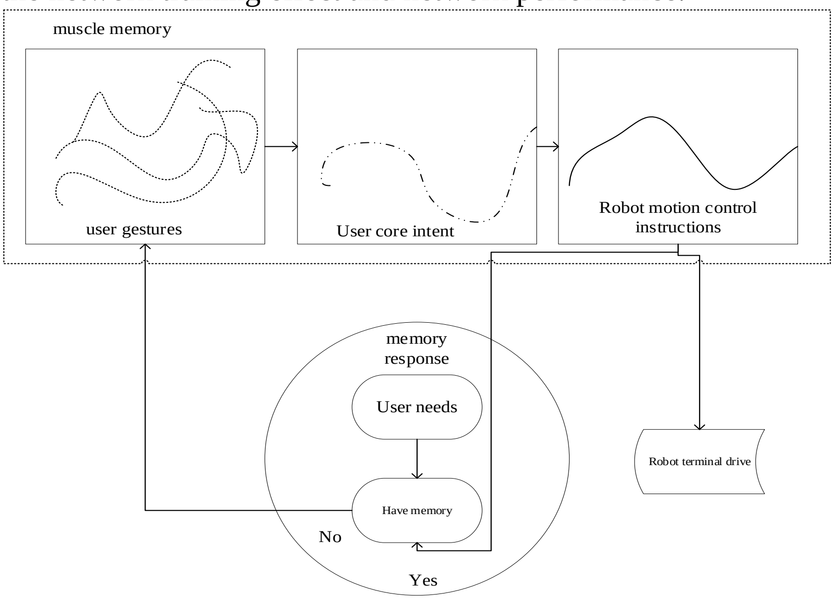


Figure 4 MTBM-Based Training to Respond to Human-Computer Interaction

The objective function of constructing the MTBM memory response algorithm based on the improved radial basis neural network is shown in Formula 8:

$$f(p_m) = \theta_0 + \sum_{h=1}^{h} \theta_h ext(-\frac{1}{\delta^2} \| p_m - c_h \|^2) \tag{8}$$

In Formula 8, $f(p_m) = (x^d, y^d, z^d; task^d(m_1 m_2 m_3)^n$ represents the expected movement of the robot executor and the respective action features. These action features refer to each feature recorded by the algorithm during human-robot interaction, and then gesture-based robot control is performed for each action. $P_m = p_m(x, y, z; task(m_1 m_2 m_3)$ indicates the motion information and action attributes of the robot end effector. h represents the number of hidden layer units, and the initial value of h is set to 0. c_i and δ_l represent the center and width of the h-th hidden layer respectively, and θ_l represents the density of the h-th hidden layer.

In the course of HCI, the functional characteristics and movement patterns of the robot are constantly changing. That is, if the current network strength is not enough, new hidden elements are added [20]. The current network power setting is defined as Formula 9:

$$W_m = \max\{W_{\max} Y^n, W_{\min}\}, (0 < Y < 1) \tag{9}$$

Among them, the different values of Y can be controlled by $\|P_n - o_n^n\|$, and the specific values of $Y, W_{\min}$ and $W_{\max}$ in practical applications are affected by the complexity of data input and the accuracy of network processing. If Formula 9 holds, this indicates that the present internet is not fluent enough, and the rule for adding hidden nodes is defined as Formula 10:

$$\begin{cases} o_{d+1} = p_m \\ \delta_{d+1} = \vartheta \| P_m - O_m^m \| \\ \theta_{d+1} = e_n \end{cases} \tag{10}$$

In Formula 10, O_n^n represents a hidden node that is nearest to the input data object's center p_n. ϑ is a coefficient of controlling parameter to control the dimensions of the newly hidden cluster nodes. If Formulas 9 and 10 cannot be established at the same time, it implies that the fluency of the present internet can meet the usual training and education needs, and it is not necessary to integrate new hidden elements. However, some weights $(c_1, \delta_l, \theta_0, \theta_h, ...)$ in the web must be forecast and kept up to date. The update calculation method is as Formulas 11-13:

$$G_m = [Ib_1(p_m) Ib_h(p_m)(2\theta_h / \delta_h^2)(P_m - O_1)^T b_1(p_m)(2\theta_h / \delta_h^3) \| p_m - o_h \|^2 \tag{11}$$

$$b_h(p_m) Ib_h(P_m)(2\theta_h / \delta 2_h^2)(P_m - O_h)^T b_h(p_m - o_h)^T b_h(p_m)(2\theta_h / \delta_h^3) \| p_m - o_h \|^2 \tag{12}$$

$$K_n = C_{m-1} G_m (V_m + G_m^T C_{m-1} G_m)^{-1} \tag{13}$$

In Formulas 11-13, C_n represents the gradient table. K_n represents the gain of the Kalman filter gain matrix. b_l represents the basic operation of radial basis neural network. C_{n-1} and V_n are the covariance matrices representing the noise variance and Kalman filter systematic error respectively. The covariance matrix is updated as Formula 14:

$$C_m = (I_{wxw} - K_m G_m^T) C + \partial I_{wxw} \tag{14}$$

Among them, C_n represents the initial value of the newly added hidden interface parameter. w_1 represents the number of parameters that need to be adjusted for newly added hidden nodes.

The excitation noise matrix of the Kalman filter system is as Formula 15:

$$C_m = \begin{pmatrix} C_{m-1} - 0 \\ 0C_0 - I_{WXW} \end{pmatrix} \tag{15}$$

The method of updating the noise matrix in the Kalman filter system is defined as Formula 16:

$$\begin{cases} h_m = h_{m-1} + K_m\{f_m(p) - f_m(p)\} \\ h_m = \theta_0^T \theta_1^T 0_1^T \delta_1 - \theta_m^T O_m^T \delta_m \end{cases} \tag{16}$$

The contribution of every concealed session to the network export is discovered, and hidden elements that consistently contribute to the network output are removed online. Output of the implicit network nodes is first calculated as Formula 17:

$$ou_m^h = \beta_m^h ext(-\frac{1}{\delta_l^2} \| p_m - c_h \|) \tag{17}$$

Second, the maximum value $\| ou_{\max} \|$ of the hidden node output parameters is calculated, and then the typical output value of each hidden node is calculated as Formula 18:

$$\delta_m^h = |\frac{ou_m^h}{ou_{\max}}| \tag{18}$$

Eventually, the concealed nodes that contribute more to the network outcome are counted by calculation and comparison. If the standard output value of an implicit node S_n^l of n times does not meet the condition $\delta_m^h > W_m$, the implicit node is retained and the dimensionality of the extended Kalman filter is optimized. If the standard output value of an implicit node S_n^l of n times meets the condition $\delta_m^h > W_m$, the implicit node is removed, and the dimensionality of the extended Kalman filter is decreased. Therefore, the advantage of the MRAN-based memory response algorithm is reflected in the flexibility and automation of the network, which can retain and delete hidden nodes in the network online.

4. Experiment of Human-Computer Interaction Technology in English Teaching

Table 1 Students' Cognition of Human-Computer Interaction

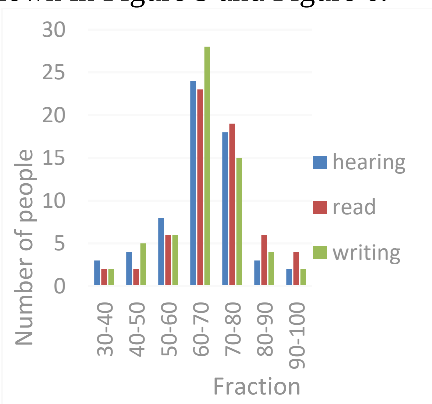
Response Type	Have you heard of human-computer interaction technology?	Do you understand human-computer interaction technology?	Do you have a deep understanding of human-computer interaction technology?	Are you interested in human-computer interaction technology?
Yes	35	25	12	41
No	24	33	48	19
Uncertain	3	4	2	2

Students and teachers should not rely on the intelligent tutor system blindly, but should make reasonable use of it. Teachers and students and the artificial intelligence system support and complement each other to achieve the optimal teaching effect. Based on this, this paper applied human-computer interaction technology to intelligent English teaching, and conducted a six-month experiment of intelligent English teaching based on human-computer interaction technology in two senior first grade classes with 62 students each. The overall English level of the students in these two classes was roughly the same. One of the classes used an intelligent English teaching system based on human-computer interaction technology for teaching, and this class was an experimental class. Another class continued to use the intelligent English teaching system for teaching, which was the control class. Before the teaching experiment, the students in the experimental class were given a questionnaire to understand their interest and cognition of human-computer interaction technology, as shown in Table 1.

It can be seen from Table 1 that more than half of the students have heard of HCI technology, and nearly half of them had some understanding of human-computer interaction technology, but only a few students had a deep understanding of HCI technology. Therefore, it is very necessary to apply HCI technology to intelligent English teaching and play the role of HCI technology to improve students' English level.

5. Experimental Design of Human-Computer Interaction Technology in English Teaching

With an attempt to improve the accuracy of the experimental results, the students of the two classes were also tested for their English proficiency before the experiment, including three abilities of English listening, reading and writing. The full score for each ability was 100 points. The test results are shown in Figure 5 and Figure 6.



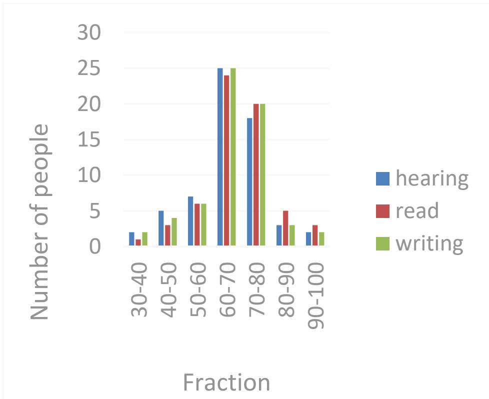


Figure 5 English Proficiency Test Results   Figure 6 English Proficiency Test Results

It can be seen from Figure 5 and Figure 6 that the English level of the experimental class and the control class was basically the same. Most students had scores between 60-70, but there were too few students in the 80-100 segment, and there were not a few students with scores below 60. This teaching experiment was dedicated to increasing the number of students in the 80-100 segment and reducing the number of students who scored below 60.

(1) Comparison of students' English scores before and after the experiment in the experimental class

After six months of teaching experiments, the English proficiency of the students in the experimental class using the intelligent English teaching system based on HCI technology has been greatly improved. Although the English proficiency of the students in the control class using the intelligent English teaching system has also improved, compared with the experimental class, the improvement effect was not obvious. After the teaching experiment, students in the experimental class and the control class were tested for their English proficiency, and compared with the English proficiency before the experiment. The comparison results are shown in Figure 7.

It can be clearly seen from Figure 7 that after using the intelligent English teaching method based on human-computer interaction technology, the students' English level has been greatly improved. The number of students who scored below 60 in listening, reading or writing dropped significantly. Especially in reading and writing, no student has scored below 50. In addition, more than one-third of the students have improved from the previous 60-80 points to more than 80 points, and the number of students with more than 90 points has increased from the previous single digits to more than ten.

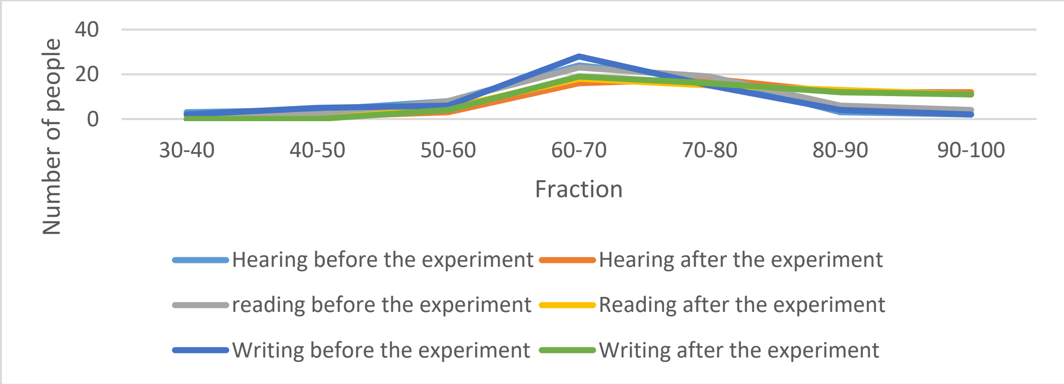


Figure 7 Comparison of the English Level of Students in the Experimental Class Before and After

(2) Comparison of students' English scores before and after the experiment in the control class

In order to make the results of the experiment more convincing, this paper also made a comparison chart of the English scores of the students in the control class before and after the experiment, so as to compare with the students in the experimental class. The comparison results of the English level of the students in the control class are shown in Figure 8.

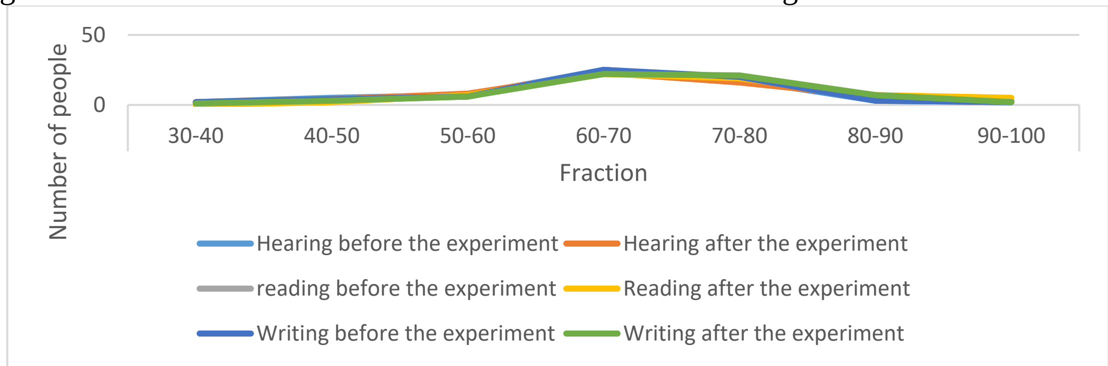


Figure 8 Comparison of the English Level of Students in the Control Class Before and After

It can be seen from Figure 8 that the number of students with listening scores of 80-90 increased by 3. Students with a score of 90 and above increased by 1. Students with reading scores of 80-90 increased by 2. The number of students with a score of 90 and above increased by 2. Students with writing scores in the 80-90 range increased by 4. There was no increase for students with scores above 90. From the analysis of the above data, it can be clearly seen that after using the intelligent English teaching method to teach, although the students' English scores have changed, the effect of improvement was minimal. Moreover, this method only helped individual students improve their English scores, and most of the students' English scores were still at the level before the experiment.

6. Experimental Results of Human-Computer Interaction Technology in English Teaching

The advantages of intelligent English teaching systems and methods based on human-computer interaction technology in improving students' English level are far greater than those of intelligent English teaching methods. In order to further determine whether human-computer interaction can be applied to English teaching, after the teaching experiment, students in the experimental class were asked to rate the intelligent English teaching system and intelligent English teaching method based on human-computer interaction technology. The scoring items include likeness, applicability, improvement effect, and acceptance. The full score for each item was 100 points. All students in the experimental class were asked to score the average value, as shown in Figure 9. The abscissas 1, 2, 3, and 4 represent the degree of love, applicability, improvement effect, and acceptance respectively.

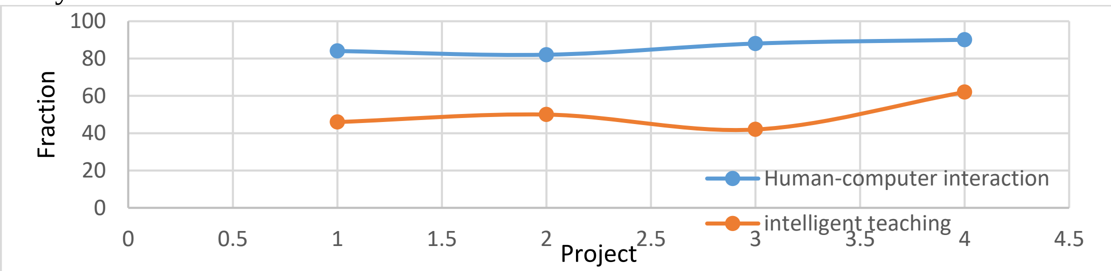


Figure 9 Comparison of Scores between Human-Computer Interaction Technology and Intelligent Teaching System

According to Figure 9, it can be clearly seen that the students' scores for the intelligent English teaching system and method based on human-computer interaction technology were much higher than the intelligent English teaching method. Some students were also interviewed in the process of collecting the scoring results. Some students thought that the intelligent English teaching method was too mechanical, and students and teachers could not be well linked. As a result, the problems encountered by students in the process of English writing may not be raised to the teacher in time, and the teacher may not be able to understand the students' learning states in time. Thus students' English scores have not been improved, and they have lost interest in English, so more students chose human-computer interaction technology.

7. Conclusions

There is no doubt that human-computer interaction technology supported by science and technology is the trend of future education development. Human-computer interaction technology can not only effectively solve the problems existing in students' English learning process, improve the practicability of teachers in English teaching, but also improve the interaction and interest between teachers and students by using HCI technology. Human-computer interaction technology also has great development potential in English education and learning, and the research and development department should upgrade it according to the educational needs of different communities and students.

Acknowledgement

This work was supported by The 2022 Annual Project of the "14th Five-Year Plan" for Educational Science in Shaanxi Province.

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