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Research on Adaptive Algorithm and Interaction Design for English Translation Teaching in Flipped Classroom Mode

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ABSTRACT

The flipped classroom relies on a smart platform to assist the implementation of English translation teaching, combining the smart platform with the students as the core to realize the efficient interaction of English translation teaching and enhance the students' interest in English translation learning. This paper develops an easy-to-use interactive system for English translation teaching in flipped classroom based on Fine Report, and utilizes MySQL database to store the relevant data generated in the process of use. In this system, the BERT model trained by matrix masking strategy is used as the basis, and the neural machine translation model that assists teachers in English translation homework correction is established by combining the NMT model. Then the K-Means clustering algorithm is optimized by the adaptive K-value selection method, and the students' learning data on the system is clustered by using the improved K-Means, and the student performance evaluation model is established by combining the CART decision tree. A pedagogical comparison experiment was carried out for the feasibility of the interactive system for teaching English translation in the flipped classroom. The BLUE value of machine translation using the BERT-NMT model was always above 30, and the average accuracy of student performance prediction of the K-Means-CART model could reach 84.85%. The English translation performance of the students in the experimental class was significantly improved after the teaching experiment, and the overall satisfaction of the students with the interactive system for teaching English translation was 4.038 points, which was between the satisfied~very satisfied level. Fully combining intelligent technology to assist teachers in teaching English translation under the flipped classroom can help to enhance the quality of cultivating English translation talents in colleges and universities.

Keywords: teaching interactive system; BERT model; NMT model; K-Means; decision tree; English translation

1. Introduction

With the rapid development of network information technology, education has also gained a brand new development opportunity. Flipped classroom, as a brand new teaching mode, makes full use of information

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technology and is more suitable for the needs of modern education. English translation teaching in colleges and universities has always been an important part of cultivating students' intercultural communication ability [1-2].

With the continuous promotion of information technology teaching, the flipped classroom has been widely used in the field of education, which has brought a positive impact on English translation teaching in colleges and universities [3]. Under the background of the new era, English translation teaching in colleges and universities gradually favors students' independent learning, and teachers play a synergistic and auxiliary role in teaching to help students carry out learning activities better [4]. Flipped classroom has the characteristics of diversified teaching subjects, shared teaching resources and three-dimensional teaching carriers, which can be applied to English translation teaching in colleges and universities to fully stimulate the enthusiasm of teachers and students, and effectively improve the effectiveness of English translation teaching [5]. At the same time, to a large extent, it has brought the distance between teachers and students closer, avoiding the problem of less interaction and communication between teachers and students in traditional classroom teaching. The effective application of the flipped classroom teaching mode can make students devote themselves to English translation learning, which is of great help to the improvement of students' English translation standard [6]. In addition, the cultivation of translation ability is one of the important goals of English learning, and the very important college English four or six level exams at the university level include translation part, and the English translation teaching in colleges and universities under flipped classroom can help more students pass these English level exams [7].

Flipped classroom, also called inverted classroom, refers to a new type of teaching mode relying on network information technology, which reasonably adjusts the time inside and outside the classroom, transforms the classroom subjectivity of teachers and students, and the students take the initiative of learning, prompting students to carry out double learning in and out of the classroom. Altemueller, L et al. introduced the flipped classroom as a teaching mode and concluded that the teaching mode can help enhance students' motivation, help teachers master the teaching rhythm, and promote students' feedback, which is of positive significance for improving teaching effectiveness [8]. Long, T et al. tried to examine teachers' perception and adaptation to the flipped classroom teaching mode based on the experimental case of flipped classroom teaching and pointed out that teachers' interaction with their experience of flipping the classroom is helpful for teachers to better adapt to the flipped classroom teaching mode [9]. Cheng, L et al. systematically reviewed the research literature related to flipped classroom teaching strategies and confirmed that flipped classroom is effective in enhancing students' learning outcomes, and this enhancement is more significant in the disciplines of mathematics, science, social sciences, engineering, arts and humanities, health, and business [10]. Shi, Y et al. examined the feasibility of the flipped classroom teaching model based on the meta-analysis method, combined with related research on the mathematical information extraction and research, as well as Review Manager 5.3 software for meta-analysis, the pedagogical methods adapted to the flipped classroom teaching model significantly affected the effectiveness of the flipped classroom [11]. Wasserman, N. H et al. conducted a two-semester comparative investigation of a calculus classroom based on the flipped classroom teaching model and revealed that the flipped classroom promoted the improvement of students' performance on conceptual exams, but it has also been argued that the flipped classroom has less effective instructional time and more interaction between students than the traditional classroom [12]. Most of the studies on flipped classroom are explorations and researches on its teaching effect and feasibility, while there are fewer reflections on the design of flipped classroom teaching methods and optimization of the teaching mode, so it is necessary to focus more on the direction of research on the optimization and improvement of the flipped classroom teaching mode.

English translation teaching in colleges and universities itself has strong practicability and applicability, and also has certain difficulties. For many students in colleges and universities, it is not an easy thing to master translation skills.Yang, Y studied the English translation teaching mode based on interactive reading theory, and designed the corresponding teaching process reproduction according to the process

and stage of the modality, pointing out that compared with the traditional English translation teaching courses, English translation teaching based on the reading theory has a better teaching effect [13]. Gu, S et al. optimized English translation teaching by combining computer-aided technology and verified the feasibility through teaching practice, and the study provided a perfect translation teaching system for English translation teaching, which is conducive to the improvement of students' translation ability [14]. Sun, H integrated a SPOC English translation teaching model called Rain Classroom with WeChat platform and multimedia intelligent teaching tools, and carried out teaching evaluation, which confirmed the effectiveness of the proposed approach and could provide some references for the reform of English translation teaching [15]. Li, Z et al. introduced the BP optimization algorithm into the traditional English translation teaching evaluation method to improve the accuracy of English translation teaching evaluation, which is conducive to the design optimization and methodological innovation of English translation teaching [16]. Wang, X elaborated the significance of English translation teaching for the improvement of students' English speaking level, and proposed that English translation strategies should be actively and reasonably utilized in English teaching practice, which can not only improve students' comprehensive language ability, but also facilitate the efficiency of English teaching [17]. Numerous scholars have studied the optimization of the methods of English translation teaching as well as the effect of English translation teaching methods, and all these researches have to some extent promoted the innovation of English translation teaching design and mode reform.

Relying on the intelligent teaching platform to carry out flipped classroom teaching, the adaptive recommendation of English translation teaching resources is realized based on students' learning behaviors, so as to enhance students' motivation to learn English translation. The article proposes an interactive system for English translation teaching under flipped classroom, which mainly relies on intelligent technology and Fine Report for webpage construction. In order to enhance the interactive performance of English translation teaching, this paper utilizes the matrix masking strategy to train the BERT model as the basis, combines with the NMT model to establish a neural machine translation model, and applies it to teachers to correct students' English translation assignments. In order to analyze students' learning performance on the system, the K-value selection of K-Means clustering is optimized by using adaptive algorithm, and the student performance evaluation model is established by combining with CART decision tree. For the feasibility of the interactive system for teaching English translation in the flipped classroom, the School of Foreign Languages of a university in Province T was chosen as the research object, and a teaching experiment was set up to carry out quantitative analysis of the data.

2. Interactive System for Teaching English Translation in Flipped Classroom

In today's rapid development of science and technology, education informatization has been listed as a major national strategy. With the deepening of the new round of English curriculum reform, how to build a network education platform and how to make full use of the advantages of the online and offline flipped classroom teaching mode have become the focus of attention of the majority of educators. The Flipped Classroom English Translation Teaching Interaction System established by relying on informatization technology empowers teachers and students with more diversified interaction methods, helps students better enhance their interest in learning English translation, and provides reliable facility support for realizing the teaching reform of English curriculum and improving the quality of cultivating English translation talents.

2.1. Instructional system design

Under the perspective of education informatization, it is necessary to realize the innovation of English translation teaching, which is fundamentally relying on the intelligent platform to carry out flipped classroom teaching, truly student-centered, so as to realize the improvement of the quality of English translation teaching, and to cultivate English translation talents who meet the needs of the society.

For the design of English translation teaching system, it needs to focus on intelligent learning, intelligent assessment and scientific evaluation [18]. First of all, the fundamental purpose of the platform is to meet the needs of English translation teaching and students' learning. Smart learning based on information technology must provide support for mobile learning, interactive learning, independent learning, personalized learning and virtual simulation learning. Secondly, the effectiveness of students' learning needs to be examined through intelligent assessment, including voice assessment, writing correction, grade testing, subject competitions, online proctoring and so on. Finally, students' assessment data and daily performance, etc. need to be scientifically evaluated and given feedback on their intelligent learning, so as to form a complete closed loop of teaching and promote the optimization of the whole teaching activities and the enhancement of teaching effect.

The interactive system of English translation teaching under the flipped classroom teaching mode is shown in Figure 1, which is mainly divided into six functional modules: user rights management, translation assignment release, translation assignment response, translation situation analysis, communication and discussion, and corpus evaluation collection.

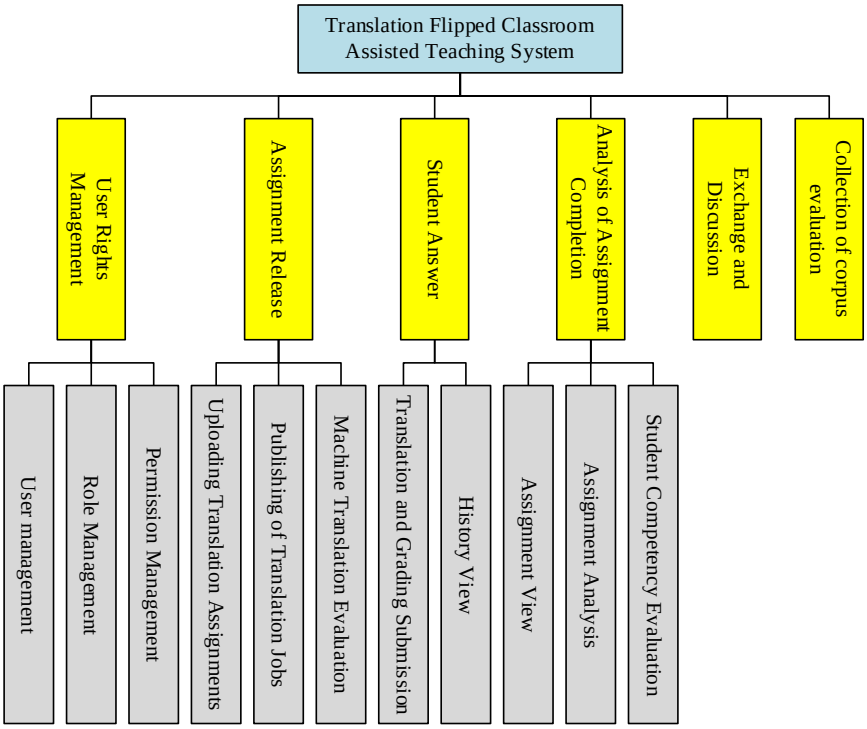

Fig. 1. English translation teaching interactive system

This system adopts Fine Report for the construction of web pages, makes full use of its own user and permission management functions, quickly develops an easy-to-use interactive system for teaching English translation, and uses a MySQL database to store the information generated in the process of using the system, including the bilingual corpus and the manual evaluation of machine translation.

2.2. System workflow

The workflow of the interactive system of English translation teaching in flipped classroom is shown in Figure 2, and its main process is expressed as "Teacher → Machine Translation Model → Student Performance Evaluation Model → Student". During the teaching process, the teacher implements the collection of students' English translation data, combines the neural machine translation model and the quality evaluation model to understand the students' English translation learning situation, so as to formulate corresponding English translation teaching strategies.

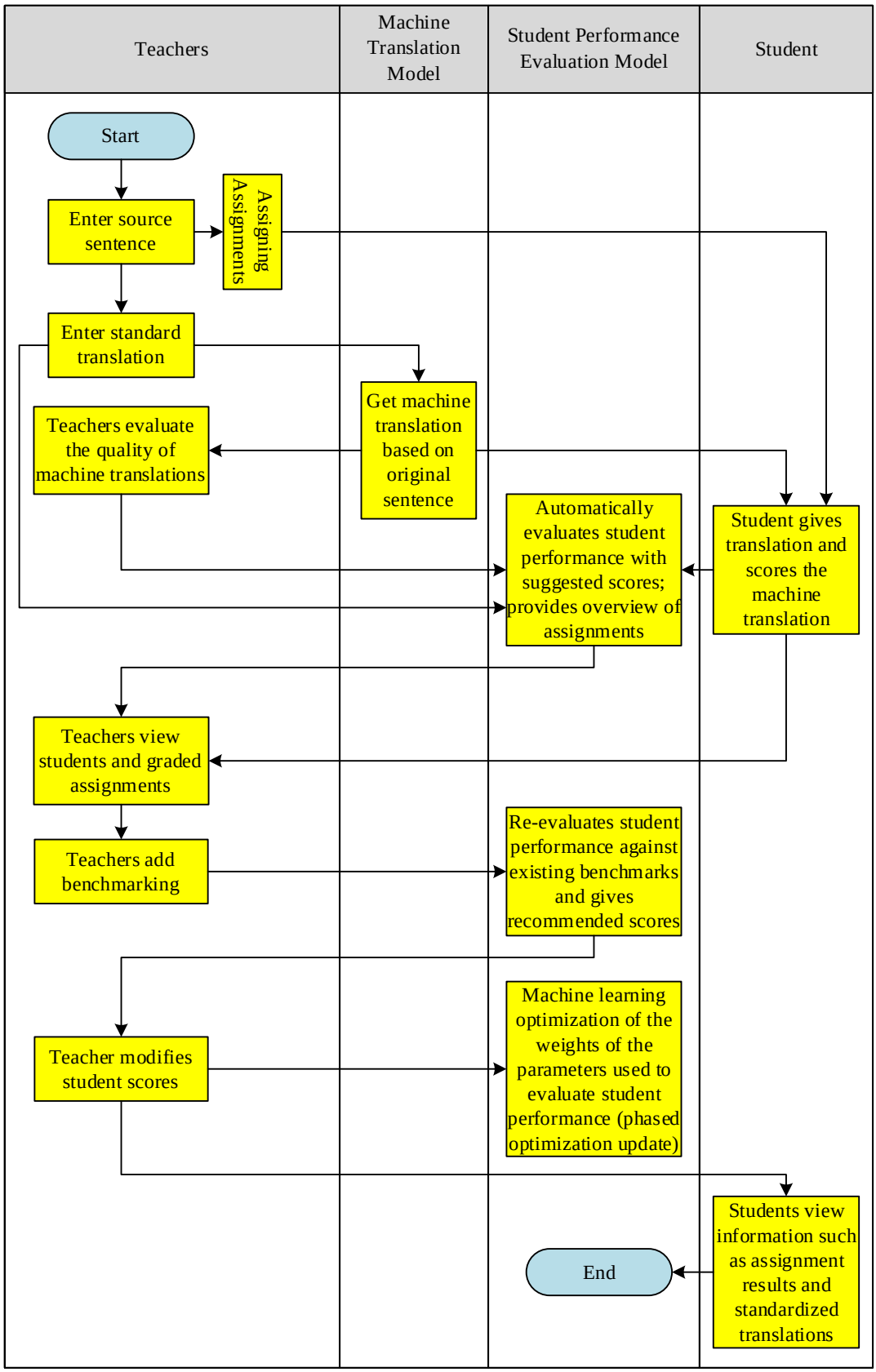

Fig. 2. The workflow path of the English translation teaching interaction system

Teachers can open the webpage of the Flipped Classroom English Translation Teaching Interactive System through the browser, verify the account password and then upload translation assignment tasks through the Translation Assignment Publishing Functional Module, the uploading method can be filled in the page or imported by using the form. Teachers can submit multiple original sentences and

translations as a task group to the system, the machine translation model will automatically give the machine translation results, and teachers can evaluate the machine translation results. The teacher assigns translation assignments to the attributed students through the translation assignment release function module, sets the assignment deadline, supports releasing to a single student or a group of students, and the students can be grouped according to classes or roles. After the deadline for collecting assignments, the automatic analysis module of the system starts to evaluate and analyze the assignments submitted by students. Teachers can view students' responses through the Assignment Viewer module of Translation Situation Analysis and view the system's analysis through the Learning Situation Analysis module after the system finishes analyzing.

Students can open the webpage of Flipped Classroom English Translation Teaching Interactive System through the browser, verify the account password, and then they can answer the assignment and grade the machine translation through the function of answering the translation assignments, and the students' dialectical thinking can be cultivated through the students' grading of the machine translation. After the teacher announces the answers, students can check their own answers and grading through the history homework view function.

2.3. Translation Teaching Interaction

Interaction is one of the characteristics of the interactive system for teaching English translation in flipped classroom. It is able to realize the interaction between system users, the interaction between users and system content, and the data interaction of the system itself. The specific interaction modes of the system include operational interaction, information interaction, and conceptual interaction.

1) Operational interaction is the most direct and specific interaction mode, the interaction behaviors of teachers and students with the system interface belong to operational interaction, and its role is to make basic preparations for students' subsequent information interaction and conceptual interaction.

2) Information interaction is based on the interaction behavior of the system database information. It can be divided into data and information interaction between teachers and students, data and information interaction between students and students, data and information interaction between teachers and teachers, and data and information interaction between teachers and students and learning resources.

3) Conceptual interaction mode is the highest and most abstract interaction mode, and the ultimate purpose of operational interaction as well as information interaction. The ultimate purpose of the interaction between teachers and students through the system is to complete the teaching of English translation, that is to say, to achieve the intermingling of new and old English translation knowledge. For students, it is to realize the interaction of new and old knowledge at the cognitive level within their own minds, and for teachers, it is also an interaction between teachers' new and old teaching experiences.

3. Neural Machine Translation and Translation Evaluation Modeling

Adhere to the core concept of deep integration of information technology and education teaching, adhere to the basic policy of application-driven and mechanism innovation, establish a sound mechanism for the sustainable development of education informatization, and build a networked, digital, intelligent, personalized and lifelong education system. The core of the interactive system of English translation teaching in flipped classroom lies in building an online teaching platform with the help of digital technology and information technology, assisting students to learn English translation-related contents through adaptive algorithms, and evaluating the translation quality of students in a timely manner, so as to provide support for teachers to optimize the translation teaching strategy.

3.1. Neural Machine Translation Model

3.1.1. BERT and NMT models:

1) BERT pre-training model. The BERT model is proposed based on the Transformer model architecture, which is constructed by adopting the coding structure of bidirectional Transformer, and the pre-trained BERT model generally referred to on the web is the model trained by using a large number of corpus datasets in Wikipedia. The pre-trained model shows a strong ability to learn generalized information under different real-world scenarios. Since its structure is mainly stacked by Transformer encoders, the overall structure of BERT is also composed by using only multiple models of self-attention mechanism and based on this mechanism to better learn semantic representations in text [19].

There are two main tasks in the application of the BERT model, the first one is Mask-based Language Modeling (MLM). That is, by randomly masking or replacing characters in a text sentence, i.e., letting one of the characters transform another character and letting the model predict that character, and then iterating the model with continuous optimization based on the loss function between the predicted text and the actual text. The specific method of this process is to randomly extract 15% of the characters to be replaced, the extracted characters have a probability of 80% to be replaced by [Mask] characters, 10% to be replaced by random other characters, and 10% to have their characters remain unchanged, the use of masking allows the model to predict the characters based on the contextual information, and thus learn the representations in the text.

The second task is to make a prediction of the next sentence, the input of two sentences at the same time, and add the special characters [SEP] and [CLS] as symbols marking the end and the beginning of the sentence, so as to determine whether the relationship between the two sentences is contextual or not.

2) Neural Machine Translation Model (NMT). NMT uses neural networks to model machine translation directly between text sequences in natural language to learn the correspondence between source and target texts. Among them, natural language is the target of NMT, while the object of language model (LM) is mainly sentences in natural language and constructs probabilistic models for them. Neurolinguistic model (NLM) is basically based on neural networks, with the LM of the next word in the prediction window as a background, and gradually developed into an autoregressive model to model the process of sentence probability generation [20].

Assuming that there is a source language sentence $x=\left(x_1,\cdots,x_{|x|}\right)$ and a target language sentence $y=\left(y_1,\cdots y_T\right)$, NMT aims to match the translation of a sentence in the source language with the translation in the target language by learning from a bilingual parallel corpus, and this translation probability can be expressed as:

$$p\left(y,x;\theta\right)=\prod_{i=1}^{T+1}p\left(y_t\left|y_{0:t-1},x;\theta\right.\right) \tag{1}$$

where θ is used to describe the NLM parameters and the NLM typically uses an encoder-a-decoder system that converts the original input sequence into an output sequence.

The encoding and decoding system first generates vectors for each Chinese source and then uses a coding network to generate the coded representation of the entire Chinese sentence. The decoder then translates the English sentence based on the coded representation of the source language and the decoding is done word by word and ends when the terminal is displayed at the end of the sentence. Where each English word created expands the capacity of the decoding process and helps to create the next word to be translated by providing a rich translation context for the next translation step. The encoder-decoder system is the most common example of NMT, in which the encoder and decoder modules can be implemented in separate neural networks, in which the parameters of the encoding and decoding models are updated simultaneously. At each time instant of each training segment, the corresponding reference translation term is used as a control signal to guide the training of the model.

3.1.2. The BERT-NMT translation model. In the interactive system of English translation teaching in flipped classroom, the teacher relies on the neural machine translation model of the system to judge the quality of students' English translation, so as to better assist students in English translation teaching. In

this regard, this paper combines the BERT pre-training model with NMT, and pre-trains the BERT through the mask matrix strategy, so as to enhance the system's ability to detect the quality of students' English translation.

In the case of BERT, for example, its l st Transformer block consists of 6 linear layers $W^l \in \left\{W_K^l, W_Q^l, W_V^L, W_{A0}^l, W_I^l, W_0^l\right\}$. The first four linear layers W_K^l, W_Q^l, W_V^L, W_{A0}^l, compute and output the self-attention between words in the sequence fed by the model. The last two linear layers W_I^l, W_0^l, pass the word sequence representations to the next Transformer block. Then:

$$K = XW_k, Q = XW_Q, V = XW_V \tag{2}$$

$$Attention(Q,K,V) = Soft\max\left(\frac{QK^T}{\sqrt{d}}\right)V \tag{3}$$

where X is the representation of the input word sequence which is a vector of size $(N \times D)$ (N is the sentence length and D is the hidden layer dimension size). After computing the attention by the above formula, the result is transformed by W_{AO} and subsequently passed to the next Transformer block by W_I and W_o.

Each linear layer W^t of the l st Transformer block is associated with a real-valued matrix M^l. Each matrix is randomly initialized from a uniform distribution and has the same size as W^l. During training, backpropagation continually updates the matrices M^l with the loss values of the downstream tasks.The forward propagation process, which first passes M^l through an element-wise inter-level value function, yields the binary mask M_{bin}^l used for the current linear layer then:

$$\left(m_{bin}^l\right)_{i,j} = \begin{cases} 1, if m_{i,j}^l \geq \tau \\ 0, otherwise? \end{cases} \tag{4}$$

where $m_{i,j}^l \in M^l$, i, j denote the coordinates of the two-dimensional linear layer and τ is a global threshold hyperparameter.

This M_{bin}^l is then used to multiply with the current linear layer w^l to get the updated linear layer $\hat{w}^l$, which is equivalent to letting the model choose for itself the portion of the parameters that are needed to pre-train the model without updating the parameters; multiplying with 1 is the needed parameter and multiplying with 0 is the discarded parameter. Then:

$$\hat{w}' := w' \; e \; M_{bin}^l \tag{5}$$

After the training of the BERT model is completed, the BERT-NMT neural machine translation model is constructed in combination with NMT as shown in Fig. 3. Since the Masking-BERT model is also the Transformer encoder, we adopt it as the encoder of NMT. The source language is first encoded by Masking-BERT, and then it is used as the input to the Transformer decoder side to generate the translation of the source language.

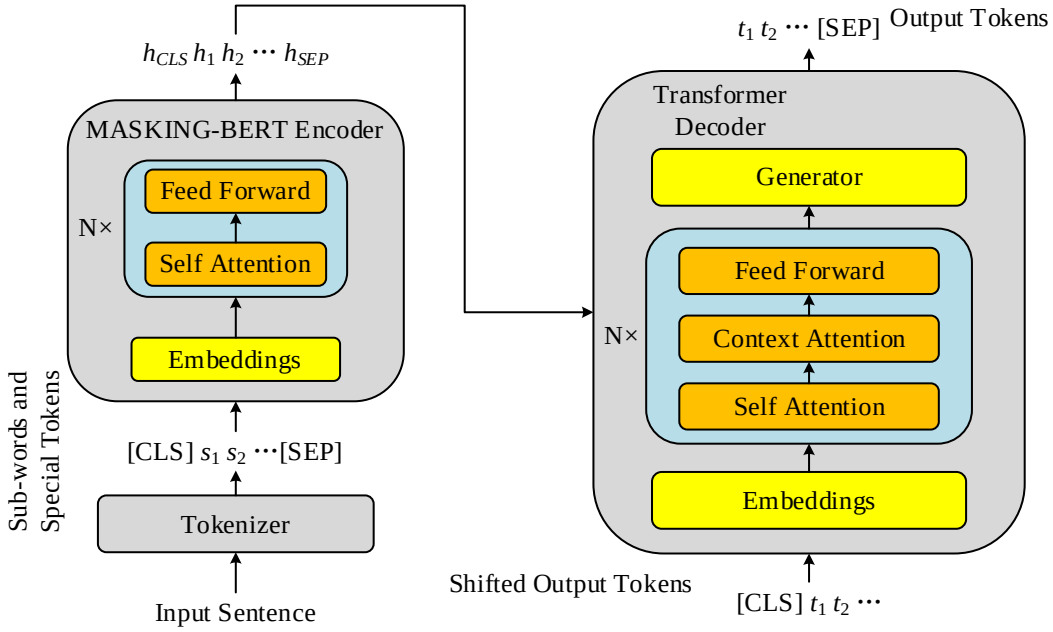

Fig. 3. BERT-NMT Model

In the process of backpropagating the model according to the translation task loss function L, we cannot backpropagate through the binary because the element-level threshold function described above is a hard thresholding operation, for which the gradient of M^l is zero almost everywhere. Similar to the approach used in, we use $\frac{\partial L\left(\hat{w}^l\right)}{\partial M_{bin}^l}$ as a noise estimator for $\frac{\partial(\hat{w}^l)}{\partial M^l}$ to update M^l, then:

$$M^l \leftarrow M^l - \eta \frac{\partial L\left(\hat{w}^l\right)}{\partial M_{bin}^l} \tag{6}$$

where η is the step size. Thus, the whole structure can be trained end-to-end.

3.1.3. BERT-NMT Validation Analysis:

1) Validation of word vector generation. Crawler technology was used to crawl 65,000 sentences of Chinese-English parallel corpus on the Internet and pre-process them, including performing the segmentation process on Chinese and obtaining the word vectors of each Chinese word, and performing the morpheme-slicing operation on English and calculating the word vectors of each English word. Subsequently, the dataset is built and divided into training set and testing set according to 8:2. The number of layers in the BERT network is set to be 14, the number of polytopes of attention is set to be 10, and the dimension of the hidden layer in the BERT network is set to be 512. Also, the maximum length of each experimental sentence is set to be, 00, and the maximum number of training iterations is set to be 500. The learning rate is set to be 0.0001, and the parameter optimizer is chosen to be Adam.

For the word vector generation ability of BERT model, the control models of this paper's experiments are CNN, LSTM, TextCNN, Word2Vec, and BiLSTM, and the six algorithms are trained and tested respectively, and the evaluation indexes of their test results are compared and analyzed. For the evaluation indexes of word vector generation, the accuracy, precision, recall and F1 value are mainly chosen. Figure 4 shows the test results of the word vector generation model.

As can be seen from the figure, the accuracy of all six word vector generation models is above 80%, indicating that all six models are able to extract text information to generate word vectors more effectively, but the precision of the control group is average, between 81% and 90%, not exceeding 90%, indicating that the accuracy of word vector feature extraction is poor. On the other hand, the accuracy and precision

of the BERT model trained with the mask matrix strategy in this paper are 93.49% and 92.17% respectively, which are 4.36% ~ 6.76% higher than the five models in the control group on average, indicating that the model is more suitable for use as a word vector generation model for Chinese-English machine translation.

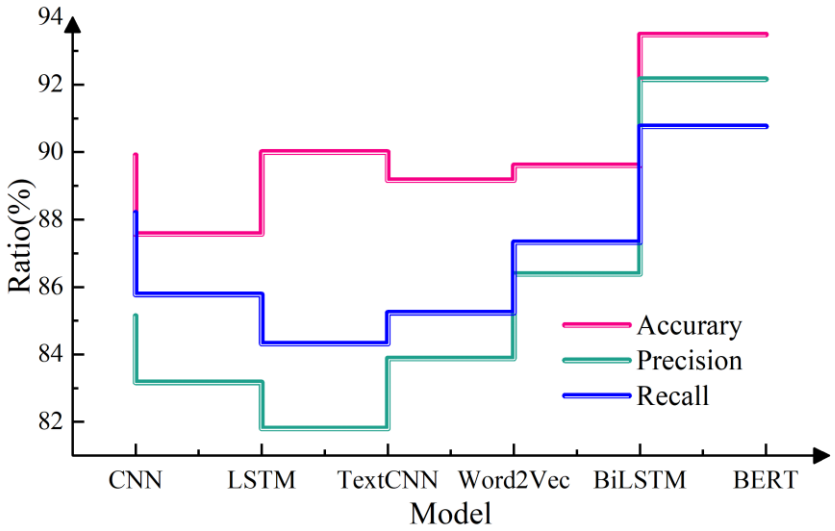

Fig. 4. Test results of the word vector generation model

In order to further verify the performance advantages and disadvantages of the BERT model, this experiment was carried out on six models for iterative training, the maximum number of iterations was 500 and the F1 values during the iteration process were recorded for comparison, and the test results and comparison results are shown in Table 1. With the increasing number of iterations, the F1 values of all six models show an increasing trend, indicating that the performance of the models is getting better and better with the continuous iterative training. However, the F1 values of the five models in the control group did not exceed 0.86, with a maximum of only 0.85, indicating that their word vector generation performance is average. The F1 values of the BERT model designed in this paper, which is trained based on the matrix masking strategy, are all above 90% and can be maintained at about 94%, indicating that the model has better performance and is more stable.

Table 1. Model F1 value comparison results

Model	100	200	300	400	500
CNN	0.75	0.81	0.82	0.81	0.82
LSTM	0.81	0.82	0.83	0.82	0.81
TextCNN	0.83	0.83	0.84	0.83	0.83
Word2Vec	0.82	0.84	0.85	0.84	0.84
BiLSTM	0.85	0.82	0.85	0.84	0.84
BERT	0.92	0.93	0.93	0.94	0.94

2) Comparison of Translation Effect of Different Machine Translation Models. For the feasibility of applying the BERT-NMT model designed in this paper in the interactive system of English translation teaching in flipped classroom, this paper chooses the most commonly used BLEU value as the evaluation index of the neural machine translation model.The BLEU value is based on the n-gram algorithm, and the similarity between the machine translation result and the actual answer is calculated by using the n-gram matching method, and the higher the similarity represents the higher quality of the machine translation. Higher quality of machine translation. Teachers evaluate students' translation assignments through the neural machine translation model on the teaching interactive system, so as to compare the quality of

students' translations and provide data support for teachers to optimize English translation teaching strategies.

In this regard, this paper chooses Transformer model, Word2Vec-CNN model, and BERT-ML model as the comparison models to analyze whether the method of linguistic feature extraction for the sentences to be translated is feasible. Figure 5 shows the comparison of the translation effect of different machine translation models.

As can be seen from the figure, with the increasing number of training times, the translation effect of the models is gradually enhanced, and their BLEU values are all above 20, indicating that all four models are suitable for Chinese-English machine translation with better results. However, the highest BLEU values of machine translation based on the basic Transformer model, Word2Vec-CNN model, and BERT-ML model are 27.23, 31.14, and 32.46, respectively, while the BLEU value of machine translation optimized by the BERT-NMT language model after pre-training of the matrix masking strategy has been maintained at more than 30 and the highest value is up to 33.75. This indicates that the four models are suitable for Chinese-English machine translation with good results. This indicates that the neural machine translation model based on BERT model and NMT proposed in this paper has better performance and better translation effect. In the interactive system for teaching English translation in flipped classroom, teachers use the model to compare students' translation assignments, so as to compare the differences in translation contents and provide students with better guidance on English translation-related skills.

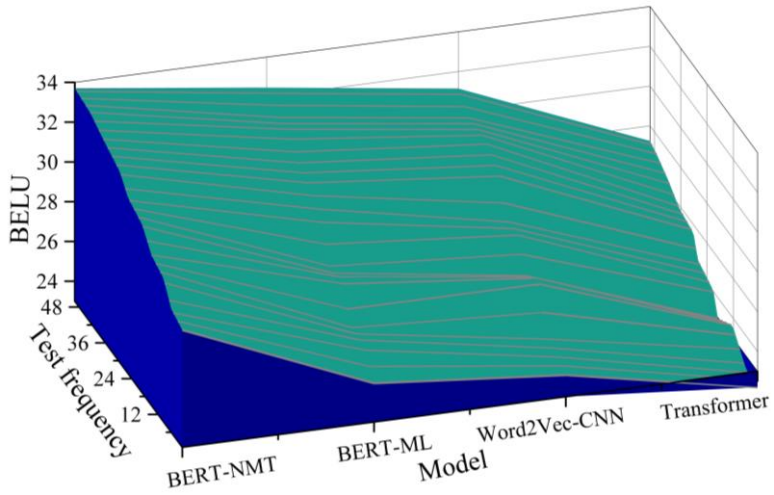

Fig. 5. The translation effect of different models is compared

3) Grading of Translation Compositions. In order to further illustrate the effectiveness of the BERT-NMT model in assisting teachers to correct students' English translation compositions, 500 students' English translation compositions data were randomly selected from the interactive system of English translation teaching in flipped classroom to conduct manual correction experiments, with each composition scored out of 20 points. In order to compare the error correction comparison between the BERT-NMT model and manual grading, Figure 6 shows the comparison results of composition translation scoring.

From the figure, it can be seen that the average score of the teacher's assessment of students' English translation compositions in the flipped classroom English translation teaching interactive system using the neural machine translation BERT-NMT model is 16.74, while the average score of the teacher's manual grading through the paper is 16.85, and the difference between the two is only 0.66%. This indicates that the BERT-NMT model of neural machine translation can help teachers to complete the effective grading of English translation assignments on the teaching interactive system, and help teachers to reduce the corresponding amount of assignment correction. It can also assist teachers to better find out the problems of students' English translation compositions, so that teachers can make learning plans for students in a targeted way, and provide reliable data support for improving students' English translation level.

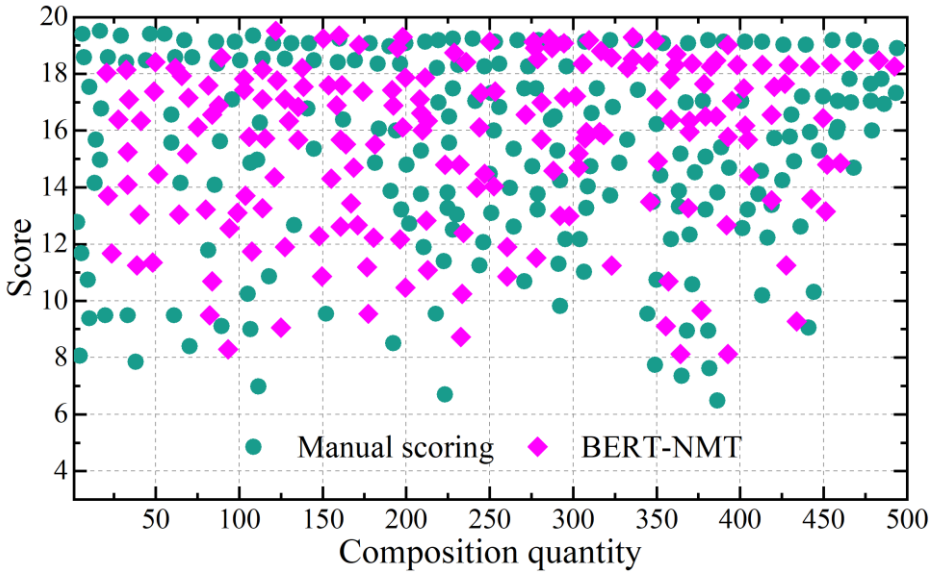

Fig. 6. The comparison results of the translation of the translation

3.2. Model for evaluating student performance

3.2.1. K-Means clustering of student data. In the interactive system of English translation teaching in flipped classroom, teachers can obtain the relevant English translation assignments submitted by students, and analyze them by using the neural machine translation model to generate student translation scoring data. In order to further explore the quality of students' English translation, this paper introduces the improved K-Means clustering algorithm for data clustering.K-Means, as a classical clustering algorithm, mainly realizes the different division of dataset categories through the iterative process, and the algorithm has the advantages of simple anisotropy and scalability.The K-Means algorithm firstly selects K samples arbitrarily as the initial clustering centers from sample set S. The K-Means algorithm then selects K samples as the initial clustering centers. Then according to the rule algorithm for the distance between data objects, through the obtained data object grouping situation iterative calculation until the center does not change, to get K clustering results [21]. The specific implementation process of the algorithm is as follows:

1) In $K-Mean$ clustering algorithm, set the algorithm input sample set to include n data objects and K number of clusters.

2) Based on the clustering samples clustering, calculate the distance between each sample and the center, and then reclassify the objects based on the minimum calculated distance obtained. Set the Euclidean distance between two P-dimensional data points $x_i=\left(x_{i1},x_{i2},\cdots,x_{ip}\right)$ and $x_j=\left(x_{j1},x_{j2},\cdots,x_{jp}\right)$. I.e:

$$d\left(x_i,x_j\right)=\sqrt{\left(x_{i1}-x_{j1}\right)^2+\left(x_{i2}-x_{j2}\right)^2+\cdots+\left(x_{ip}-x_{jp}\right)^2} \tag{7}$$

Determine the average distance for all samples:

$$Meandist\left(S\right)=\frac{2}{n\left(n-1\right)}\times\sum_{i\neq j,i,j=1}^{n}d\left(x_i,x_j\right) \tag{8}$$

3) After recalculating to obtain the mean value for each sample, return to step (2) until the objective function value is unchanged or less than the specified threshold. Determine the squared error criterion function for the objective function as:

$$\sigma_i=\sqrt{\frac{\sum_{i=1}^{n_i}\left(x_i-c_i\right)^2}{\left|C_i\right|-1}} \tag{9}$$

where c_i is the center of mass point of the same class of data, and Definition c_i is calculated as:

$$c_i = \frac{1}{|C_i|}\sum_{x_i \in T_i} x_j \tag{10}$$

where $|C_i|$ is the number of class C_i data objects; c_i denotes the i th cluster center.

4) Ends and K clusters are obtained.

In K value selection, the range of clusters is limited by an adaptive algorithm, i.e., assuming that the number of clusters K ranges from (m,n), the $K-means$ traditional algorithm is carried out $n-m$ times and the optimal number of clusters is selected as the optimal clustering tree from multiple clusters, and the Euclidean distance of each node of the cluster ministries from the center is set to be:

$$V = \frac{d_{Integration}}{d_{External\ cohesion}}, \left(d_{Integration} = \sum_{i=1}^{K}\sum_{j=1}^{n_i}\left(x_{ij} - c_i\right)^2 \right.$$
$$\left. d_{External\ cohesion} = \frac{1}{k(k-1)}\sum_{i=1}^{K}\sum_{j=1}^{K}\left(c_i - c_j\right)^2 \right) \tag{11}$$

From Eq. It can be seen that the outer distance is the sum of the distances of the centers $\frac{1}{k(k-1)}$. When the ratio of cohesion and externality is the smallest it indicates high degree of cohesion within the clusters and low degree of coupling between the clusters, which indicates that the number of clusters is the optimal solution.

In the initial point selection, the centroid mutual distance is required to be maximized and the points around the initial center must be dense. For the center point mutual distance is:

$$d = \frac{1}{k(k-1)}\sum_{i=1}^{K}\sum_{j=1}^{K}\left(c_i - c_j\right)^2 \tag{12}$$

d as the mean of the sum of distances of all center points, which gives a better representation of the overall situation of the cluster centers' distance from each other. For the density of each elemental point in the clusters, it is calculated as:

$$p_i = z_i \Big/ \sum_{1}^{n} z_k \tag{13}$$

Where p_i point x_i the degree of denseness around the point, the larger the value the greater the density, the more points around. Where z_i is the distance between the sample points, so the use of p_i can better reflect the degree of density around the i point to determine the calculation of z_i. That is:

$$z_i = \sum_{j=1}^{n}\left(x_i - x_j\right)^2 \tag{14}$$

3.2.2. Decision Tree Prediction Modeling. After the K-Means clustering algorithm is completed for clustering the student translation data, this paper uses the decision tree algorithm to construct a prediction model to realize the evaluation of student translation quality [22]. The decision tree modeling process is a recursive process with the following basic steps:

1) Load the sample data first.

2) Choose appropriate feature selection criteria according to the sample characteristics.

3) Begin to consider all records as a node.

4) According to the feature selection criteria, traverse each segmentation method for each variable to find the best segmentation point.

5) Split into two nodes N1 and N2.

6) Continue with steps 3)-5) for N1 and N2, respectively, until each node is sufficiently "pure".

The decision tree algorithm is trained on a large number of data set samples to construct a tree structure to describe the classification rules. The tree structure is the key to determine the attributes of each layer of the tree, provided that the feature selection criteria are determined.

For the CART decision tree algorithm uses the Gini index to select the division attributes, the Gini value represents the impurity of the data classified according to a feature attribute. A smaller Gini value indicates that the set is more pure and vice versa the set is more impure. Then:

$$G(D)=1-\sum_{k=1}^{K}p_k^2 \tag{15}$$

where there are K classes in dataset D, k denotes the category, and p_k denotes the probability that the sample belongs to the k th category.

For feature A, the set D is divided into $D1$ and $D2$, and the Gini index $G(D,A)$ represents the uncertainty of the set D after the division by feature A with the following formula:

$$G(D,A)=\frac{|D_1|}{|D|}G(D_1)+\frac{|D_2|}{|D|}G(D_2) \tag{16}$$

where $|D|$, $|D1|$, and $|D2|$ denote the number of samples in datasets D, $D1$, and $D2$, respectively.

3.2.3. Predictive evaluation of student performance. In this paper, we utilize K-Means clustering algorithm to cluster students' data in the interactive system of English translation teaching, and use the clustering results to construct and train the decision tree model, so as to predict students' English translation learning performance. For the effectiveness of the prediction model, this paper uses MATLAB software to simulate and analyze it, and takes the data of 40 students on the interactive system of English translation teaching in flipped classroom as an example to predict their English translation learning performance. The clustering results are utilized to train the decision tree model, which is brought into the test set after training, and the output simulation evaluation results and actual evaluation results are obtained as shown in Figure 7.

The data in the figure shows that the student performance prediction model that combines the K-Means algorithm with the decision tree is able to predict the students' performance more accurately than the conventional CART decision tree. The average prediction accuracies of the model and CART in this paper are 84.85% and 81.43%, respectively. That is to say, the English translation student performance prediction model integrating the K-Means algorithm and decision tree can predict the students' translation performance through teaching, which is helpful to judge whether the interactive system of English translation teaching in flipped classroom is suitable for English translation teaching, help teachers make timely translation teaching adjustments, and further enhance the level of English translation teaching in colleges and universities. The student performance evaluation model combining the K-Means algorithm and the decision tree has a high prediction accuracy and at the same time has a fast response speed and a low CPU occupancy rate. The combination of machine learning algorithm and English translation teaching will realize the progress of technology and benefit the English translation teaching in colleges and universities.

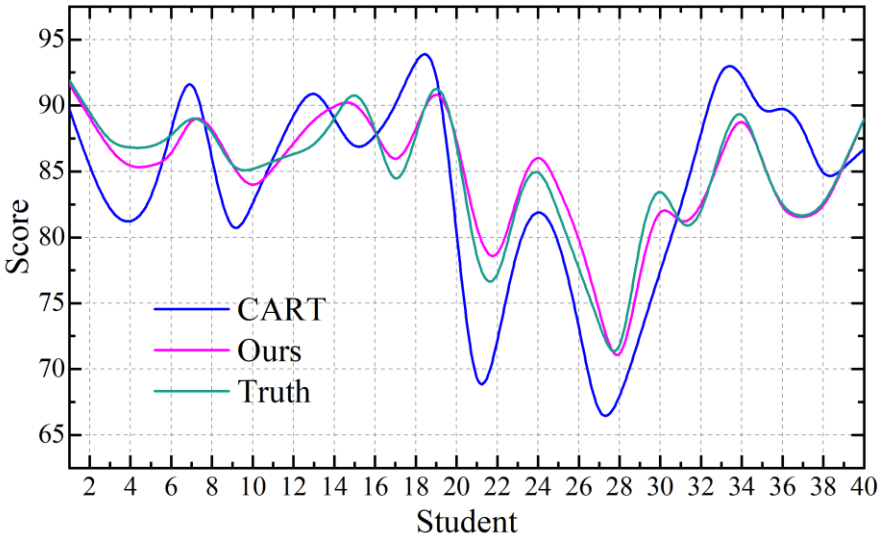

Fig. 7. Students' English translation performance prediction results

4. Application of English Translation Teaching Based on Teaching Interactive System

With the rapid development of network information technology, education has also gained a brand new development opportunity. Flipped classroom, as a new teaching mode, makes full use of information technology and is more suitable for the needs of modern education. English translation teaching in colleges and universities has strong practicality and applicability, and there is also a certain degree of difficulty. For many students in colleges and universities, it is not easy for them to master translation skills. The flipped classroom can maximize students' sense of independent learning, stimulate their interest in learning, and is very important for the improvement of the quality of students' translation learning.

4.1. Experimental design for teaching English translation

In this section, the flipped classroom English translation teaching interactive system designed in the previous section is used as a specific tool for English translation teaching to verify the specific effect of the flipped classroom English translation teaching interactive system on enhancing the quality of English translation teaching through teaching comparison experiments, so as to provide a reliable basic support for cultivating English translation talents.

4.1.1. Selection of research subjects. In this study, two classes of English 1 and 2 students in the second year of university in the College of Foreign Languages of a university in Province T were selected as the subjects of the study. There were 50 students (28 male and 22 female) in class 1 and 52 students (29 male and 23 female) in class 2. A total of 80 students were randomly selected as subjects out of 40 each in both classes based on their grades. (By analyzing and comparing the scores of the 60 selected subjects in the recent English IV level examination for college students, the difference in the mean scores is not significant and the scores of the two groups of subjects are normally distributed. (That is, the dispersion of the two scores of the two groups of students did not differ much). The study was conducted over a period of one semester, from September 2023 to February 2024 an experimental study was attempted on them under the same conditions. Set class 1 as an experimental class (EC), in which the interactive system of teaching English translation in flipped classroom is adopted to teach English translation. Class 2 is set as the control class (CC), in which the traditional teaching mode is still dominated for English translation instruction. The learning materials are university English textbooks of Foreign Language Research Press. During the experiment, the same unit teaching time, the same lecturer and the same content were set as control variables. The teaching mode was the independent variable, and the interest in learning English translation and the achievement of English translation level were the dependent variables.

4.1.2. Selection of research tools:

1) English translation test questions. The English translation test questions in this study come from the real questions of the University English IV Exam 2022, with the University English Final Exam 2022 questions as a supplement. In order to maximize the validity of the test, the pre-test and post-test papers came from the same source and had the same type of questions. Students' scores were recorded as research materials for final comparison. Since only English translation is taught by the English Translation Teaching Interactive System in this teaching experiment, in order to verify the experimental results more effectively, the test questions are designed to examine students' English translation ability.

2) Questionnaire. Before the experiment, a questionnaire was distributed once in the experimental class. The pre-test questionnaire had a total of 20 multiple-choice questions, and the questionnaire was designed to understand the subjects' current general situation in English translation learning, including the dimensions of students' attitudes towards English translation learning, their interest in English translation, students' learning strategies, and the application of grammar in translation. At the end of the experiment, the questionnaire was again distributed in the experimental class, and the post-test questionnaire consisted of 30 questions, the first 20 questions were exactly the same as the pre-test, comparing whether there was a significant improvement in students' interest in learning, students' learning strategies, and students' attitudes toward learning English translation, etc., and the last 10 questions were to investigate the satisfaction of the students in the experimental class with the flipped classroom model.

4.1.3. Design of the research process. The core of teaching with the Flipped Classroom English Translation Teaching Interactive System lies in the flexible utilization of offline and online modes. When teaching with the system, teachers should avoid the heavy and lengthy offline teaching format and use concise and condensed language to clearly express the teaching content. When teaching online, teachers should give full play to their guiding role and take students as the center. Based on this concept, the author has designed the English translation teaching classroom.

1) Teaching program aspect. The 1st week is a pre-test week, during which the teacher organizes the students' statistics on CET-4 scores and conducts a pre-test on students' performance, including listening, reading, writing and translation parts. Weeks 2-15 were the practice phase of mixed-mode classroom teaching, during which teachers and students cooperated with each other to make full use of the flipped classroom. Weeks 8-16 the teacher utilized the conceptual CET-4 translation and writing questions to assess the subjective quality of the students, with the aim of discovering the advantages under the use of the blended classroom and some problems in the teaching by means of students' self-testing and the teacher's subjective assessment. The objective assessment of students' translation and writing ability is based on the CET-4 scores that students take in each semester. When the students' new round of CET-4 scores come out, the teacher conducts statistics and data analysis of the scores as a way to assess the effectiveness of the teaching implementation.

2) In the teaching class carried out by the Flipped Classroom English Translation Teaching Interactive System, teachers should divide the class time reasonably. Considering the long time of university classroom, teachers should arrange a little time as a break during the exchange of online and offline teaching.

3) In teaching, offline classroom is mainly for theoretical teaching. The online classroom is mainly for students' special training, and the abstract concepts learned offline should be trained flexibly in the online classroom, and teachers are required to combine the online assessment mechanism to make objective judgments. Through the online classroom, students can follow up the paragraph translation training in time after the sentence translation training, and then complete the writing training.

4.2. Analysis of the Effectiveness of English Translation Teaching

4.2.1. Comparison of English translation scores:

1) Analysis of English Translation Achievement. Flipped classroom English translation teaching interactive system is mainly used to carry out English translation teaching, combined with the English translation teaching test designed in the previous section, the data of students' English translation achievement in the pre-test, mid-test and post-test of the study are compared by SPSS, and the opposing samples T-test is carried out on them. Table 2 shows the results of the difference analysis of the English translation scores of the students in the experimental and control classes.

Before the beginning of the teaching experiment, the average English translation scores of the experimental class and the control class were 67.41 and 67.38 respectively, and the T-distribution value of the English translation achievement test was -0.335, and the significance Sig (two-sided) value was 0.749, which is greater than 0.05. It indicates that there is no significant difference in the English translation achievement of the students in the experimental class and the control class. Therefore, the difference between the English translation scores of the two subject classes in the pre-study stage is small, which is in line with the research expectations and allows for a controlled study of teaching.

In the first study mid-test the writing scores of the experimental class and the control class were 69.59 and 67.53 respectively, compared to the pre-test scores, the English translation scores of the experimental class and the control class were improved by 2.18 and 0.15 respectively, although the scores of the two classes were improved, the English translation scores of the experimental class and the control class did not reach the level of significance. In the second mid-study test, the English translation scores of the experimental and control classes improved by 2.68 and 0.41 points respectively compared with the first mid-study test, and the T-distribution value of the test was 4.953, corresponding to a significance Sig (two-sided) value of 0.003, which is less than 0.01 to reach the level of significance, which verifies that there is a significant difference between the English translation scores of the experimental and control classes. It can be seen that after 12 weeks of English translation teaching in the experimental class based on the interactive system of English translation teaching in the flipped classroom, the students' English translation scores have been significantly improved. And they gradually distanced themselves from the control class, so that the gap between the average scores of the writing scores of the two classes, which were originally at a comparable level, gradually became larger. This shows that the English translation teaching mode based on the flipped classroom English translation teaching interactive system is of practical significance for improving students' English translation level.

In the test at the end of the teaching experiment, the English translation scores of the students in the experimental class and the control class were 85.95 and 68.76 respectively, and the English translation scores of the experimental class were 25% higher than those of the control class. And the T-distribution value of English translation scores is 7.596, corresponding to the significance Sig (two-sided) value of 0.000, which is less than 0.01 to reach the significance level. This indicates that after 16 weeks of teaching research, the English translation scores of the experimental class and the control class are significantly different, which further verifies that the English translation teaching mode based on the interactive system of flipped classroom English translation teaching can significantly improve the students' English translation scores.

Table 2. Analysis of differences in English translation achievements

Test	Class	Means	STD.	T value	Sig. (2-tailed)	95% CI	
						Lower	Upper
Pre	EC	67.41	2.631	-0.335	0.749	-1.316	0.879
	CC	67.38	2.549				
Medium1	EC	69.59	2.324	0.738	0.394	-0.634	1.428
	CC	67.53	2.675				

Medium2	EC	72.27	2.133	4.953	0.003	1.528	3.947
	CC	67.94	2.637				
Post	EC	85.95	1.462	7.596	0.000	2.647	6.752
	CC	68.76	2.558				

2) Verification of Students' Independent Learning Ability. The purpose of English translation teaching using the flipped classroom English translation teaching interactive system is to enhance students' English translation ability and promote students to realize efficient independent learning on the teaching interactive system. In this regard, this paper carries out the verification of students' independent learning ability before and after the teaching experiment by designing a test questionnaire to collect students' independent learning ability, with a total score of 100 points, which is tested before, during and after the teaching experiment. The collected test results of independent learning ability were entered into SPSS and independent samples t-test was conducted to get the results of the comparison of the differences in students' independent learning ability as shown in Table 3.

Before the beginning of the teaching experiment, the independent learning ability scores of the students in the experimental class and the control class in the English translation course were 69.51 and 7028 respectively, and the Sig (two-sided) value of the T-test results was 0.445>0.05, indicating that there was no difference in the overall level of the independent learning ability of the students in the two classes. The validation was carried out in the middle of the teaching, at which time the Sig (two-sided) value of the T-test was 0.017<0.05, indicating that the teaching of English translation by means of the flipped classroom English translation teaching interactive system can increase the students' independent learning ability. At the end of the teaching experiment, the independent learning ability score of the students in the experimental class is 86.43, which is 16.92 points higher than that before the experiment, and the score is 18.85% higher than that of the control class after the experiment. And the sample t-test value is 8.953, and the significance Sig (two-sided) value is 0.001<0.01. This reflects the feasibility of the flipped classroom English translation teaching interactive system in assisting teachers and students to carry out the teaching of English translation, which can effectively improve the students' independent learning ability, and help teachers to better plan the English translation teaching courses.

Table 3. The difference between the ability to learn

Test	Class	Means	STD.	T value	Sig. (2-tailed)	95% CI	
						Lower	Upper
Pre	EC	69.51	9.432	0.279	0.445	-1.276	0.153
	CC	70.28	10.815				
Medium	EC	73.94	4.175	2.814	0.017	0.953	1.998
	CC	70.67	9.528				
Post	EC	86.43	2.941	8.953	0.001	1.385	3.279
	CC	72.72	5.267				

4.2.2. Satisfaction with teaching English translation. In order to further understand students' satisfaction with the English translation teaching mode supported by the flipped classroom English translation teaching interactive system, this paper sets up a questionnaire to carry out data collection, which is mainly analyzed in six dimensions, including learning resources (T1), translation interaction (T2), translation evaluation (T3), result sharing (T4), class discussion (T5), and group mutual evaluation (T6). The questionnaire was quantified using a five-point Likert scale, with 1~5 representing total disagreement~total agreement. A total of 40 questionnaires were distributed and 40 were effectively recovered. Entering the questionnaire data into SPSS software and analyzing the sample t-test from the perspective of male and female students, the satisfaction of students of different genders with the English translation teaching mode supported by the Flipped Classroom English Translation Teaching and

Learning Interactive System was obtained as shown in Figure 8, with *** in the figure representing the statistically significant significance at the 1% level.

Overall, the mean value of students' satisfaction with the English translation teaching mode supported by the flipped classroom English translation teaching interactive system is 4.038 points, and the satisfaction of male and female students with the English translation teaching mode shows a significant difference at the 1% level in all dimensions. In addition, the overall satisfaction mean of male students is about 7.2% lower than that of female students, which is mainly due to the fact that female students have stronger self-planning ability, while male students may not be able to adapt to the teaching mode of self-directed learning as well as the machine translation to help them correct their English translation assignments for a while. Overall, most students recognized the rich resources and practice opportunities brought by the Flipped Classroom English Translation Teaching Interactive System for English translation teaching, and also affirmed that the platform's testing and teaching mutual evaluation functions are helpful for translation learning. The English translation teaching mode supported by the Flipped Classroom English Translation Teaching Interactive System can effectively improve students' classroom concentration and make full use of the neural machine translation model to stimulate students' interest in learning translation courses. Thus, the English translation application ability of students can be improved, and a solid foundation can be laid for universities to cultivate high-quality English translation talents.

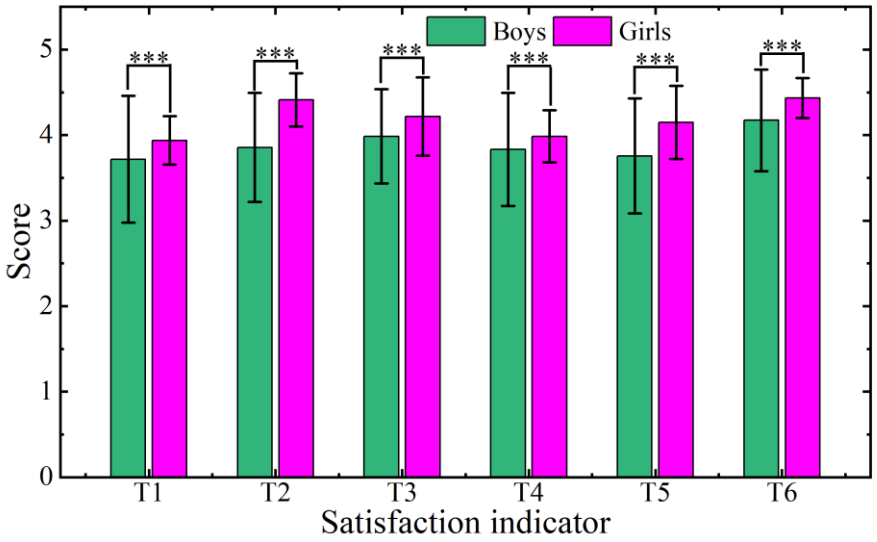

Fig. 8. English translation teaching satisfaction

5. Conclusion

The article relies on information technology and Fine Report to build an interactive system for teaching English translation in a flipped classroom, and utilizes neural machine translation and student performance evaluation models to assist teachers to carry out flipped classroom teaching of English translation. The BLEU value of the BERT-NMT model pre-trained with matrix masking strategy for machine translation is maintained above 30, and the average accuracy of the student performance prediction model integrating K-Means clustering with adaptive K-value selection and CART decision tree can reach 84.85%. In the teaching experiment conducted using the flipped classroom English translation teaching interactive system, the English translation performance of the students in the experimental class was improved by 18.54 points and by 25% compared with the performance of the control class after the experiment. The students' overall satisfaction with the teaching mode supported by the English translation teaching interactive system is 4.038 points, which recognizes the teaching interactive function of the teaching interactive system and the evaluation method of machine translation. The flipped classroom English translation teaching interactive system provides a new paradigm for English translation teaching in

colleges and universities, which helps to enhance students' independent learning ability and fully enhances the quality of English translation teaching in colleges and universities.

Although this study has obtained certain research results, the selected research samples are small and may not be generalizable. Therefore, the selection of research samples will be further expanded in the subsequent research to further optimize the intelligence level of the interactive system for teaching English translation in flipped classroom, and VR technology can be introduced to enhance the real-time interactive performance of the system to provide a more perfect intelligent system for cultivating students' English translation ability.

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