AHP-BP-Based Algorithms for Teaching Quality Evaluation of Flipped English Classrooms in the Context of New Media Communication

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ABSTRACT

Big data analytics constitutes a key component in the pursuit of enhancing educational efficiency. This study defines the concept of the flipped classroom in the context of new media communication, evaluates the state of audiovisual instruction in higher education, and advocates for the use of this methodology to enhance college students' English listening and speaking skills. Utilizing multiple linear regression and a conditional quantile model, this research quantifies the range of impact of flipped instruction on college students' acquisition of a foreign language. To address the deficiencies in the current evaluation process for flipped classroom teaching, it proposes a teaching quality evaluation model based on the AHP and BP neural network. The AHP constructs the teaching quality evaluation index system for the flipped classroom and ascertains the combined weights of the indices. The simulated experiment's results show that utilizing the proposed evaluation model to assess flipped classroom instruction enhances objectivity, efficiency, and precision in the evaluation process.

KEYWORDS

AHP, BP neural network, English teaching, flipped classroom, new media communication

INTRODUCTION

The proliferation of new media and the internet, as well as the ongoing development of cutting-edge information technology, have led to a shift away from the more conventional model of higher education found in colleges and universities (Abdullah et al., 2021; Huo X., 2019). Multiple channels and dimensions of English knowledge have a significant impact on how the language is taught to students. Baker was the first person formally to propose using flipped classrooms in the year 2000. Khan and the Khan Academy have actively promoted and expanded this model since then. Now, the term more commonly refers to the use of short videos and other resources to assist students in preparing for class by reviewing previously taught fundamental concepts.

Teachers presented audio or video learning resources, had students read along and do exercises while listening, then revealed the answers, discussed the concepts, and played the materials again. In

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non-English-speaking countries, this method taught English. Practice and review end learning. Course exercises reinforce subjects. English curriculum updates address this. Teachers should encourage student participation and knowledge development with mobile devices. Mobile gadgets can boost student involvement and knowledge. Flipped classroom students need free time and a clean space. Outside of class, students should study as they please. Traditional education does not allow subject choices. Students use mobile devices for group tasks and research. Flipped mobile classroom for English hearing and speaking.

Flipped classrooms can facilitate student learning, provide teachers with a higher sense of accomplishment, and foster student creativity and analytic abilities. According to certain research, flipped learning can improve the English skills of college students. Evaluation of English instruction in the context of new media communication is a thorough procedure comprising numerous levels, aspects, and indicators. AHP is the most popular evaluation approach, but, owing to cognitive differences among experts in a particular professional field, experts will increase the weight of the indications differently, resulting in an unfair weighting calculation of the entire indicators. Some researchers have coupled the AHP method with the BP neural network method, trained and tested the AHP weighting results using the BP neural network algorithm, and created an enhanced AHP-BP teaching evaluation model with favorable assessment findings.

As a result of the proliferation of new forms of media communication, English is now ubiquitous in many aspects of daily life. In order to improve the convenience of teaching evaluation of similar practical courses, BP neural network was constructed by taking single index data of practical course evaluation as input samples and teaching evaluation results as output samples, and finally, a teaching evaluation model with practical courses as the main body was established. As a result of these implications, language education is significantly affected. This paper examines the impact of flipped teaching on college students' foreign language acquisition through a statistical analysis of the distribution of learners' linguistic competence and individual differences. This paper begins with a discussion of the flipped practice of college English in a provincial university. The interaction between them will be examined in greater detail in the near future. In addition, this paper develops an AHP and BP neural-network-based teaching evaluation model to improve the objectivity, speed, and accuracy of evaluations.

RELATED WORK

Flipped Classroom

Regarding high-level learning and training, including teacher–student interaction, task teaching, and other methods (Kolomiets et al., 2020, Irianti, 2020, Aprianto & Purwati, 2020), it can enhance its ability to apply knowledge to new contexts. Academics favor this method of teaching. Many educational institutions are known for developing innovative foreign language teaching methods. Academics generally support flipping foreign language classrooms (Agustini et al., 2021; Xu et al., 2018, Zhang & Zhang, 2018). They believe the flipped classroom can make learning easier for students, give instructors a greater sense of fulfillment, and foster students' creative and analytic development (Zainuddin et al., 2019).

Theoretical research implies that a flipped classroom can lessen students' cognitive burden and improve second-language acquisition. Empirical research on flipped instruction and college language acquisition is scarce. Differentiations must be made. Flipped learning enhances college students' English results, according to several studies (Tang et al., 2020, Singh et al., 2018, Alkhawaldeh & Khasawneh, 2021, Zen et al., 2019). This research helps academics comprehend the flipped classroom approach to teaching foreign languages, but methodological and experimental limitations remain. Researchers employ widely available samples and related classes in uncontrolled trials (Rachayon & Soontornwipast, 2019; Wang, 2020). Studies of flipped classrooms show that demographic and early academic performance variables influence blended learning more than thought. Flipping classrooms helped. A group of academics studied the flipping model in economics classrooms. The OLS model takes socioeconomic status and academic performance into account. Midterm and final scores are three percentage points higher for the experimental group.Student's performance has been improved after flipping class. (Zakaria & Yunus, 2020).

Teaching Evaluation

The evaluation of English teaching in the context of new media communication is a comprehensive process involving multiple levels, factors, and indicators, and relies on users' empirical judgments based on their perceptions of using the database, whereas the AHP method has the advantage of using less information to mathematize and systematize expert thinking, tacit knowledge, and experience in order to solve such a complex multi-level, multi-factor decision-making problem. Therefore, it has been widely utilized in the field of evaluation. To make the evaluation results more objective and convincing, the weights of evaluation experts must be determined scientifically and rationally (Chu et al., 2018; Yuan & Li, 2021).

Although some scholars have used the simple average method or empirical assignment method to assign weights to the evaluation experts, due to differences in cognition between experts in a certain professional field or when the evaluation experts have a strong personal preference for certain evaluation indexes, the experts will increase the weights of the indexes they are concerned with, resulting in an unfair calculation of the weights of the whole index (Jiang & Wang, 2020). The subjective assignment method relies solely on the subjective judgment of the presiding judge, who may be influenced by subjective and objective factors; consequently, these methods cannot be used to determine the weights of experts in a reasonable manner. Some researchers combined the AHP method with the BP neural network method, trained and tested the weighting results obtained by AHP through the BP neural network algorithm, and obtained the improved AHP-BP model for teaching evaluation (Jin et al., 2021).

The AHP-BP Method

The AHP-BP method has gained attention as a powerful approach for decision-making and analysis in a wide range of fields. Previous studies have shown that the AHP-BP method can effectively address complex decision problems, particularly those involving multiple criteria and factors. For instance, Li et al. (2020) used the AHP-BP method to analyze the risk factors associated with construction projects, demonstrating that the method could effectively prioritize the most critical factors and provide accurate predictions of risk outcomes. Similarly, Zhang et al. (2021) applied the AHP-BP method to optimize the selection of materials, showing that the method could significantly improve the accuracy and efficiency of the decision-making process. Other studies have explored the effectiveness of different variations or adaptations of the AHP-BP method, such as integrating fuzzy logic or artificial neural networks into the framework (Liu, 2018). Overall, the literature suggests that the AHP-BP method can offer a robust and flexible approach to addressing complex decision problems and has the potential to be widely applied in various fields.

THE EFFECT OF FLIPPED TEACHING ON ENGLISH ACQUISITION

The flipped classroom paradigm inverts the standard classroom setting to fit student learning styles and schedules better. The flipped classroom model for teaching academic English includes online pre-class, offline in-class, and online post-class. Pre-class online instructional videos, in-class practice and application, and post-class evaluation and progress convey subject knowledge. The model's organic blending of online and offline and in-class and out-of-class training improves student English skills and literacy. All pedagogical framework components are interconnected. This pedagogical framework's components are interrelated.

Traditional classrooms use problem-based, heuristic, discussion-based, inquiry-based, and project-driven teaching tactics to enable students to draw on existing knowledge and experience to answer questions and solve issues. Using heuristic, seminar, and inquiry pedagogies, teachers conduct group discussions, debates, and fake international conference speeches. Problem-oriented education helps pupils consolidate pre-class knowledge. Teachers can use the project-driven teaching method, which is highly praised by academic English teaching practitioners, to guide students to search literature, find real topics worthy of research, complete the project through group cooperation, form a written research report, and report the research process and results via PPT or posters in class. Teachers may apply this strategy within the appropriate unit theme. Students enhance their English and academic literacy by working in small groups to solve challenges. In a flipped classroom, student participation and engagement are essential to learning. This applies to online, in-person, before, during, and after-class collaboration and interaction.

This study evaluates flipped education for boosting college students' target language ability. It compares standard and flipped instruction. A university randomly divided six Computer Science 2020 sessions into experimental and control groups. These university students are in their second English semester. Both groups took the CET-4 before flipping. Students took the CET-6 test in June, during the 17th week of flipped classroom teaching. Researchers uploaded micro-videos and learning task booklets based on "New Horizons College English." This course covers vocabulary, grammar, reading, listening, writing, and translating. The experimental intervention included films and listening, writing, and translation activities.

Students in the flipped classroom experiment as a group must check in to the online self-learning laboratory each week, view the teaching micro-video, and then complete the task book. This is in addition to weekly class time. Full-time lecturers and four postgraduate teaching assistants answer students' inquiries, and timer software tracks internet use. During the experiment, each participant averaged 120 minutes on the network platform (these findings indicate that the participants used the platform even when they were not engaged in an independent study).

For control group pupils, the institution provided an online independent study environment. These students did not get micro-videos or workbooks. A full-time teacher and graduate student taught on the platform. Control group students could utilize the site without assignments. To decrease the influence of the disembodied environment on experiment and control group students, most learning settings were kept the same throughout the course. The variables selected in this paper are shown in Table 1, and the mean values of the variables in the experimental group and the control group are shown in Figure 1. The comparison of gender and profession is shown in Figure 2.

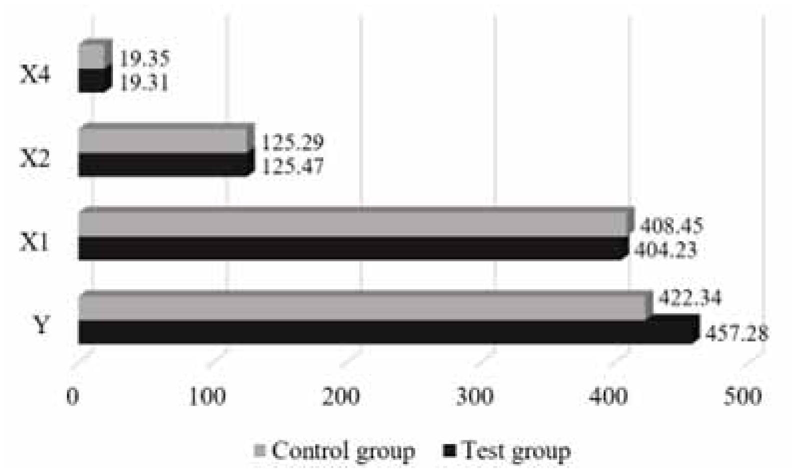
Further, to establish a regression equation to study the relationship between the flipped classroom and foreign language ability:

$$\ln\left(Y_i\right) = b_0 + \alpha F + aX_1 + bX_2 + cX_3 + dX_4 + eX_5 \tag{1}$$

Table 1.
Variables and their interpretation

Variable	Meaning
Y	Later comprehensive level
X1	Early comprehensive level
X2	Foreign language level of the college entrance examination
X3	Gender
X4	Age
X5	Profession (arts or science)

Figure 1.
The mean difference between the experimental group and the control group for different variables



where $F = 1$ in the experimental group and $F = 0$ in the control group.

We use the preceding formula, which is similar to a mean regression, to examine how the categorical variable F affects the conditional expectation of linguistic competence Y. Since the formula resembles a mean regression, we employ it. Regarding a student's learning capacity and cognitive aptitude, however, there is a wide range of variation among the student body. Due to the aforementioned reason, conditional distributions are notoriously difficult to capture with simple mean regression fully.

The regression results of the above formulas are shown in Table 2. It shows that flipped teaching has a greater impact on the comprehensive level of foreign languages, and the influence coefficient is 0.245. The early comprehensive level also has a significant impact on the later foreign language level. Similarly, the foreign language level of admission Similar to the early comprehensive level, it

Figure 2.
Comparison of differences in age and profession between experimental and control groups

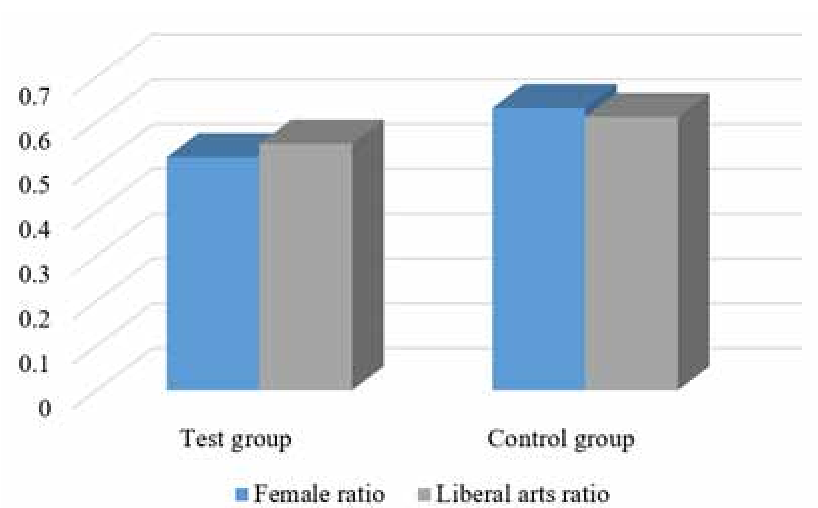


Table 2.
Table of regression analysis results

	F	$X1$	$X2$	$X3$	$X4$
Y	0.245***	0.172***	0.165***	0.08	0.07
R_2	0.767	0.569	0.442	0.103	0.869

also has a significant impact on the later foreign language level. Age, gender, and major have little effect on later foreign language proficiency.

MODEL EVALUATION

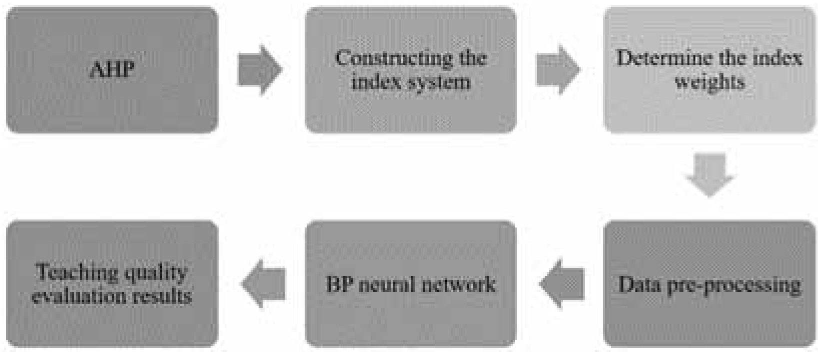
Despite the fact that many conventional universities and vocational colleges are currently engaged in vigorously implementing flipped classroom teaching reform activities and that many teachers and related scholars are engaged in the application practice and research of flipped classroom teaching mode, there is a paucity of research results on the evaluation of the quality of flipped classroom teaching. This is despite the paucity of research findings regarding the evaluation of the quality of flipped classroom instruction. Consider utilizing a fuzzy analytic hierarchy process, as well as creating an evaluation index system and evaluation system, for instruction using a flipped classroom. In the existing research on evaluating the effectiveness of teaching in flipped classrooms, the emphasis is more on theory than on empirical research findings. The majority of studies have solely focused on developing an index system for evaluating instructor performance. The flipped classroom teaching quality evaluation system is an example of a systematic project characterized by nonlinearity, a significant time lag, and uncertainty. In terms of the content of teaching evaluation, the evaluation subject, the evaluation object, and other aspects continue to expand, but the classroom pays more attention to the evaluation of teachers' practical teaching ability, which needs comprehensive evaluation from multiple dimensions. Using the conventional evaluation strategy in a flipped classroom makes it challenging to make a fair, objective, and accurate assessment of the quality of instruction in that setting.

This paper applies the AHP to the flipped classroom as a case study to establish a backpropagation neural network for flipped classroom instruction. After using the flipped classroom as a case study, this step is taken. We use the improved particle swarm algorithm to optimize the initial weights and thresholds of the network and the improved backpropagation algorithm to train the backpropagation neural network evaluation model in order to evaluate the flipped classroom's teaching quality in a more scientifically sound, efficient, and objective manner. This will determine the effectiveness of instruction delivered in flipped classrooms.

The AHP weights were used to determine the evaluation scores of practical course teaching. The original data 13 sub-indexes were taken as input samples and the evaluation scores of practical course teaching were taken as output samples to construct BP neural network. A total of 40 teaching evaluation data sets of a practice course are extracted from the school, among which 30 sets of data are used as training samples and 10 sets of data are used for simulation prediction. When the training is completed, the sample data to be tested can be directly input to obtain the prediction results.

The AHP and BP neural network-based teaching quality evaluation model used in flipped classrooms is depicted in Figure 3. Then, we present our findings. The enhanced BP algorithm is used to train the BP neural network, after which the relevant index data is chosen as training samples, the optimal initial weights and thresholds of the network are chosen, and the trained BP neural network is then evaluated using the training samples. The AHP total score is used as the expected output of the BP neural network, and the deviation between the AHP total score and the actual output of the

Figure 3.
Flow chart of teaching quality evaluation model based on the AHP and BP neural networks



BP neural network must fall within the allowed error accuracy range for the neural network to be deemed accurate. Through the organic integration of the AHP and BP neural networks, it is possible to overcome and avoid the subjective and human factors that arise during the evaluation of the quality of flipped classroom instruction. This will result in more accurate, objective, scientific, and fair outcomes.

In line with the findings of the relevant research, the pertinent indicators of the evaluative quality of teaching are 17. The aim of this paper is to prevent the standard BP algorithm from entering local minima and possibly oscillating while it is learning and being trained. This is accomplished by introducing an improved version of the BP algorithm that is based on momentum and adaptive learning. It is possible to prevent the oscillation and even the divergence of the system that can result from a learning rate that is either too high or too low and a convergence speed that is too slow by introducing an adaptive learning factor in order to adjust the learning rate. This is accomplished by introducing an adaptive learning factor to adjust the learning rate (Yuan & Li, 2021).

$$w_{ij}\left(t+1\right)=w_{ij}\left(t\right)+\beta\left(t+1\right)soft\max\left(t\right)x_{i}\left(t\right)+R \quad (2)$$

$$R=\varepsilon\left|w_{ij}\left(t\right)-w_{ij}\left(t-1\right)\right| \quad (3)$$

where $w_{ij}\left(t+1\right)$ is the weight matrix of time $t+1$, R is the momentum term, $\beta\left(t+1\right)$ is the learning rate of time $t+1$. When $\left[\beta\left(t+1\right),=x_{i}\left(t-1\right)\right]>0$, we have:

$$\beta\left(t+1\right)=k_{1}\left[Soft\max\leq\left(t\right)x_{i}\left(t\right)\right] \quad (4)$$

When $\left[\beta\left(t-1\right),x_{i}\left(t-1\right)\right]<0$,

$$\beta\left(t+1\right)=k_{2}\left[\beta\left(t\right)x_{i}\left(t\right)\right] \quad (5)$$

When $\left[\beta\left(t-1\right),x_{i}\left(t-1\right)\right]=0$,

$$\beta\left(t+1\right)=\beta\left(t\right)\left[Soft\max\left(t\right)x_{i}\left(t\right)\right] \quad (6)$$

Further, this paper normalizes the data:

$$x_i^{'} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \tag{7}$$

The evaluation indicators for the teaching quality of flipped classrooms rely heavily on students' own subjective assessments of their level of achievement. Before the data can be used in the aforementioned formula, it is necessary for professionals and judges working in the field of education first to score and evaluate these qualitative indicators using the percentage system that ranges from 0 to 100. Following the normalization of the index data, the pertinent statistics are then transformed into evaluation values ranging between 0 and 1. The number of nodes in the input layer of the BP neural network is determined by the number of evaluative indicators of the teaching quality of the flipped classroom. The BP neural network is comprised of 20 input neurons, each of which corresponds to one of the twenty evaluative indicators of the teaching quality provided by the flipped classroom. The input that goes into the BP neural network is normalized. Instruction delivered using a flipped classroom should place a value on data derived from an evaluation index. The total number of neurons in the intermediate layer can be determined with the help of the following formula:

$$N_m = \left(N_i + N_o\right)^{0.5} + \lambda \tag{8}$$

$$1 \leq \lambda \leq 10 \tag{9}$$

where N_i is the number of nodes in the input layer, N_o is the number of nodes in the output layer and the middle layer.

The 20 data values that represent teaching quality evaluation indicators in a flipped classroom are input into the BP neural network, and the network then generates an A grade for the quality of the teaching based on the result of that evaluation. The evaluation results can be placed into one of five categories: *excellent* [1–0.9], *good* [0.9–0.8], *moderate* [0.8–0.7], *qualified* [0.7–0.6], or *unqualified* [0.5]. As a direct consequence of this, the output layer is composed of five nodes.

The data that was described in Chapter 3 is still put to use, and Chapters 17 and 3 studied in order to obtain the required 20 indicators. The training error is shown in Figure 5, and the assessment score is shown in Figure 6. The BP neural network that was trained on the test data and used to evaluate the efficacy of the instruction provided in flipped classrooms demonstrates an error of no more than 1.5% in comparison to the value that was anticipated as the output of the network. The strong generalization ability of the AHP and BP neural network-based flipped classroom teaching quality evaluation model makes it a good fit for the evaluation mindset of education industry professionals. This enables more scientific, objective, efficient, and accurate assessments of the quality of flipped classroom teaching.

CONCLUSION

The proliferation of new media and the Internet, along with the ongoing development of cutting-edge information technology, have resulted in a shift away from the traditional model of higher education found in colleges and universities. Multiple channels and dimensions of English knowledge have a significant impact on how the language is taught to students. The use of flipped classrooms in mobile learning environments improves the audio-visual instruction of English at the college level, makes learning easier for students, and allows instructors and students to make more efficient use of their time. This article begins by defining the terms of the flipped classroom through the lens of new media communication, then analyzes the current state of audiovisual instruction in higher

Figure 4.
Graph of the change of error curve

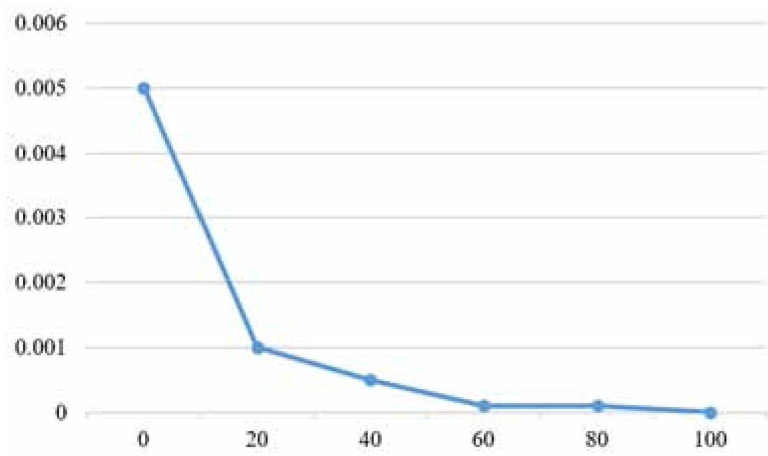
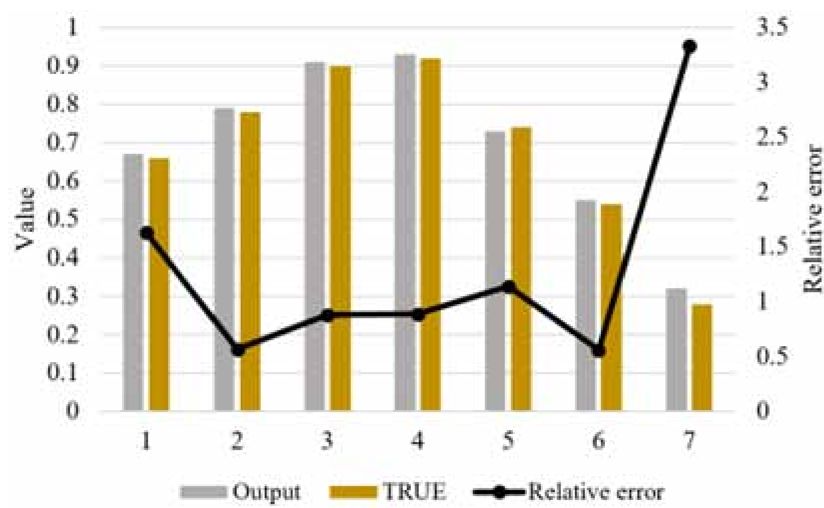


Figure 5.
Evaluation results for seven groups of samples



education, and finally recommends using the flipped classroom approach to teach college students how to speak and listen to English. This paper quantifies the impact range and effective frontier of flipped instruction on the acquisition of a foreign language by college students using multiple linear regression and a conditional quantile model. In conclusion, an AHP and BP neural network-based flipped classroom teaching quality evaluation model is proposed to address issues present in the current process of evaluating flipped classroom instruction. The AHP is used to construct the teaching quality evaluation index system for the flipped classroom; the combined weights of the indexes are determined; the particle swarm algorithm is used to optimize the network's initial parameters; and the BP algorithm is used to train the BP neural network model. Using the evaluation model to evaluate flipped classroom instruction is likely to increase the level of objectivity achieved, as indicated by the results of the simulated experiment.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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