International Journal of Information and Communication Technology Education
Volume 20 • Issue 1

The Application of Flipped Classroom Information Technology in English Teaching in the Context of 6G Network

Xiu Bi, Tongcheng Teachers College, China*
Shuping Ye, China Mobile Group Anhui Co. Ltd., China

ABSTRACT

In the 6G network environment, the flipped classroom teaching mode has broader prospective applications for improving the drawbacks of traditional classroom teaching methods. This study aims to explore the advantages of the flipped classroom teaching mode in the 6G network environment and provide feasible teaching strategies and guidance for English teachers. First, the authors collected information about Chinese English learners. Next, they divided the obtained dataset into two groups: the control group and the experimental group. The students in the control group continued to use traditional teaching methods for English teaching, while the students in the experimental group adopted a flipped classroom teaching mode supported by 6G technology. The results indicate that flipped classroom information technology in the 6G network environment has a good effect on English teaching. This article provides a useful reference for the education field and promotes the application of flipped classroom information technology in English teaching in the 6G network environment.

KEYWORDS

6G Technology, Learning-Based Multifunctional Dragonfly Algorithm, Students' Performance

With the continuous development of information technology, the education field is gradually integrating the trend of digitization and smart technology. The flipped classroom, as a new teaching model, has changed the traditional teaching methods in the classroom by utilizing advanced information technology and internet resources. Especially in the 6G network environment, the flipped classroom teaching mode has broader application prospects. The goal of this study is to explore the advantages of flipped classroom teaching mode in the 6G network environment and provide feasible teaching strategies and guidance for English teachers. By combining advanced information technology and educational theory, we hope to improve the learning effectiveness and interest of students and promote innovation and development in English teaching. First, we collected information about Chinese English learners, including their learning situation, study habits, English proficiency, and other data. These pieces of information will provide basic data for future research and help us understand the current situation and needs of Chinese English learners under traditional teaching models. Next, we divided

DOI: 10.4018/IJICTE.338322
*Corresponding Author

the obtained dataset into two groups: the control group and the experimental group. The students in the control group would continue to use traditional teaching methods for English teaching, while the students in the experimental group would adopt a flipped classroom teaching mode supported by 6G technology. By comparing the learning outcomes and experiences of these two groups of students, we could evaluate the improved application of flipped classroom information technology in English teaching under the 6G network environment. Through the research in this paper, we hope to provide useful references for practitioners and decision makers in the field of education, promote the application of flipped classroom information technology in English teaching in the 6G network environment, and promote innovation and progress in education.

LITERATURE REVIEW

There has been rapid development in China's AI sector in recent years (Bicen & Beheshti, 2022). Several sectors have discovered novel applications for AI as the digital economy has grown. The value of this strategy for inspiring innovative approaches to pressing problems and promoting economic growth is growing (Liu & Ren, 2022). One way to evaluate our level of AI development is via the use of machine learning. For machine learning to succeed, researchers need more data, more efficient algorithms, and more powerful computers (Liu, 2021). The flipped classroom and other novel instructional strategies have found a welcoming home in the Chinese classroom as a result of the country's rapidly changing IT ecosystem (Athanassopoulos et al., 2023). In addition to resolving the problems caused by traditional teaching methods, the flipped classroom also has other advantages (Chen, 2016). First, in a flipped classroom, students learn from their teachers and then apply what they have learned in the real world. State-of-the-art computer tools may help teachers and students make the most of their opportunities for learning and growing together (Ipek et al., 2023). When learning resources are scarce, it might be helpful to provide students with alternative learning environments where they can spend more time preparing for exams and processing what they have learned. With the use of AI fusion algorithms, this nontraditional system will allow for more calculated and streamlined training adjustments (Chan et al., 2020). If teachers use this method, they may get insights on how their instruction is being received by their pupils.

Traditional educational institutions are widely believed to be obsolete in today's information age, with scholars agreeing on this opinion (Chen & Huang, 2021). In order to build a solid system for assessing educators' performance, in-class professional development is crucial (Feng, 2017). The experimental aspects of this model of education are vital even if only the most academically proficient pupils need English. They presented a method to assess the web-based and AI-powered education provided by SPOC+ and WeChat Rain Classroom (Yu & Peng, 2021). They came up with a new approach to teaching people how to speak English using the internet and artificial intelligence. There are still technical hurdles to be cleared before their ground-breaking findings can be applied in reality. Infographics and students' overall academic achievement were all topics of participant questions in a single study by Zhou and Zhang (2017). Students in the experimental group were more likely to be interested in the infographic designed for flipped classroom instruction because of its interactive and comprehensive nature. The paper addressed a number of questions with the experiment, although many remain open. Jensen et al. (2015) concluded that if the roles of teacher and student were reversed, the focus would move from the instructor to the students, leading to a more beneficial learning environment, and increased efforts would be made by students to better themselves intellectually. But there are serious holes in their investigation, and they provide no supporting evidence for their claims. The projected improvement in academic achievement was not seen in the trials. Instead of having strict regulations, they just observed how pupils performed in class and made decisions from there. Fables were used as a teaching tool (Demski, 2013) in massive open online courses (MOOCs), but they are really just a problem-based learning strategy in story form. However, the research and development in science and technology required to implement these concepts are decades away from becoming practical (Zou, 2017). Numerous quantitative studies on the efficiency of English instruction at the university level have been conducted as a result of the widespread adoption of the flipped classroom style implemented in several MOOCs (Prokop et al., 2021). In the present study, we recommend developing an AI-based model to supplement existing approaches to English language instruction. In the study, the author propose a useful strategy for online English instruction (Li, 2020). By grouping students of similar ability and keeping tabs on their progress in real time, teachers may utilize this technology to better meet the needs of their English language learners. In a study by Zou (2017), despite a lack of sophistication and depth in the theoretical techniques used, the experimental findings are quite useful in practice.

Using the internet as a tool in university-level English as a Second Language (ESL) courses is an innovative method. New features on the Internet may provide academics with ideas on how to enhance English instruction in digital environments. While successful domestic use of English online is possible, it has become more challenging because of the present state of online English instruction in higher education (Veselov et al., 2021). Today's college students who are majoring in English know more than ever before about the benefits, drawbacks, costs, and availability of online English courses. Universities and colleges often provide English language instruction, both on campus and online, to ensure that all students can communicate effectively and adhere to all rules and regulations (Sun, 2021). Because the rise of the Internet of Things(IoT), there has been a shift in emphasis in this area of study toward more theoretical and informational instruction (Cheng et al., 2021). Improvements in IoT technology have allowed professors to address the challenges of remote learning and provide their students a more engaging learning environment. We are rapidly moving toward a future where robots and humans can coexist thanks to the widespread use of AI technologies in a wide range of disciplines, including medicine, teaching, industry, and higher education (Baratè et al., 2019). The importance of improving AI education cannot be overstated, since it is essential for students to be able to adjust their learning and development to the contemporary system period. Most overseas students must study abroad (Lin et al., 2019) because of the high cost of attending a university in the United States. The proliferation of online public speaking courses during the epidemic brought to light a number of problems, including the wide variety of potential students, the plethora of already existing platforms, and the difficulty of putting lessons into practice.

Considering that methods of teaching and learning evolve with time, there is always room for improvement. By now, it should be clear that the tried-and-true methods of passing on a language through the generations have failed miserably (Yang, 2014). It is possible that using AI and 6G to teach English would be a great means of piquing students' interest in learning while also fostering their development as communicators. In the field of education, AI and 6G networks could potentially enhance current methods of communication and instruction. In the near future, cutting-edge pedagogical resources may include exciting new technologies like machine learning, convolutional neural networks, and reinforcement learning (Shengxue, 2019). There are pros and cons to the new smart education environment brought about by the rapid development of 6G technology in the higher education sector. The use of 6G technology, with its high data transfer rate, substantial connection, low latency, and great stability, may enhance the learning environment and the quality of education for students. There has to be lightning-fast progress on the design of 6G installation infrastructure and the development of 6G utility networks (Strelan et al., 2020), 6G educational application solutions, 6G test environments, and 6G unified technologies. Many people believe that soft computing techniques should be included in 6G and AI innovations, as well as the revamping of higher education. Research by Karakose et al. (2023) analyzes the pros and cons of using 6G technology in future English language classrooms and makes recommendations for improving the educational system and curricular resources. Students at universities might gain from the suggested method since it requires them to engage in higher-order thinking and deeper understanding of the topic at hand.

RELATED MATERIALS AND METHODS

Conventional Teaching Methods

The students are exposed to the standard methods of classroom instruction. In this setting, instructors have always been authority figures who have played a dominating role in education, while pupils have always been in a position of passive learning. In this kind of teaching method, the instructors are more knowledgeable about the subject matter than the students are, and the pupils merely receive knowledge from instructors and have a relatively low level of autonomy. The teaching method described here is often referred to as "stuffing the duck." When using this approach, the instructor will prepare the lesson ahead of time, at which point the teaching material and knowledge points for the whole class will already be established. This discussion is primarily about the challenges of teaching, as summed up by the instructor's personal experiences in the classroom. The instructional material and techniques that are developed in this manner provide the most assistance to students in their academic pursuits. Furthermore, they are more focused and appropriate for students' problematic areas throughout the stage in which they are responsible for their own self-study.

Educators who employ this strategy often plan their lessons methodically, item by item, and progressively increase the difficulty level of the default setting. Although this method may provide students with some leeway for expression, the ultimate outcome is still up to the teacher's discretion if the design of the interdependent lessons is to be implemented. Thus, students have less opportunity to study on their own terms, are less engaged in the material, and experience a decline in their level of autonomy and critical thinking skills. Teachers often use class time to provide 'big lecture hall'-style presentations, and the role of the learner is limited to observing and absorbing information. Students frequently lose interest in classroom information acquisition, since listening to the lecture and taking notes has become a routine activity.

The Flipped Classroom

The fast expansion of flipped classrooms in China may be attributed to the country's rapid advancement in the development of modern IT, which has not only altered the educational environment but also created an external framework for new teaching methods. Furthermore, the flipped classroom offers advantages that are not available via the traditional educational system. First and foremost, the inverted classroom flips the script on the standard approach to classroom education, which emphasizes the internalization of information through practice and additional work outside of school hours. Knowledge transmission may be accomplished outside of class with the use of 6G technology, and knowledge internalization can be completed in class with the assistance of instructors and pupils. Alternate classrooms are useful when resources are few, because they allow for more study time and discussion for students. This helps instructors more efficiently achieve their instructional objectives and adopt an efficient classroom environment. Therefore, in this research, we investigate the use of the flipped classroom in the context of a 6G network. The suggested technique is shown in a simplified form in Figure 1.

The term *flipped classroom* might mean u*pside-down classroom, upside-down learning*, etc. It is a method of instruction that flips the classroom by using video content. Teachers utilize 6G technology to make short, informative films (called 'micro videos') that students may view ahead of time to prepare for class, and then pupils utilize learning self-service platforms to view the micro videos and apply what they have learned.

Through their questions and concerns raised throughout the activities, students are able to become an integral part of the classroom's learning and communication network. Figure 2 depicts the conventional and flipped models. In the flipped model, pupils have undergone more in-depth learning than in the conventional preparation stage; professors systematically construct instructional programs and encourage pupils to participate.

Figure 1. Flow of proposed methodology

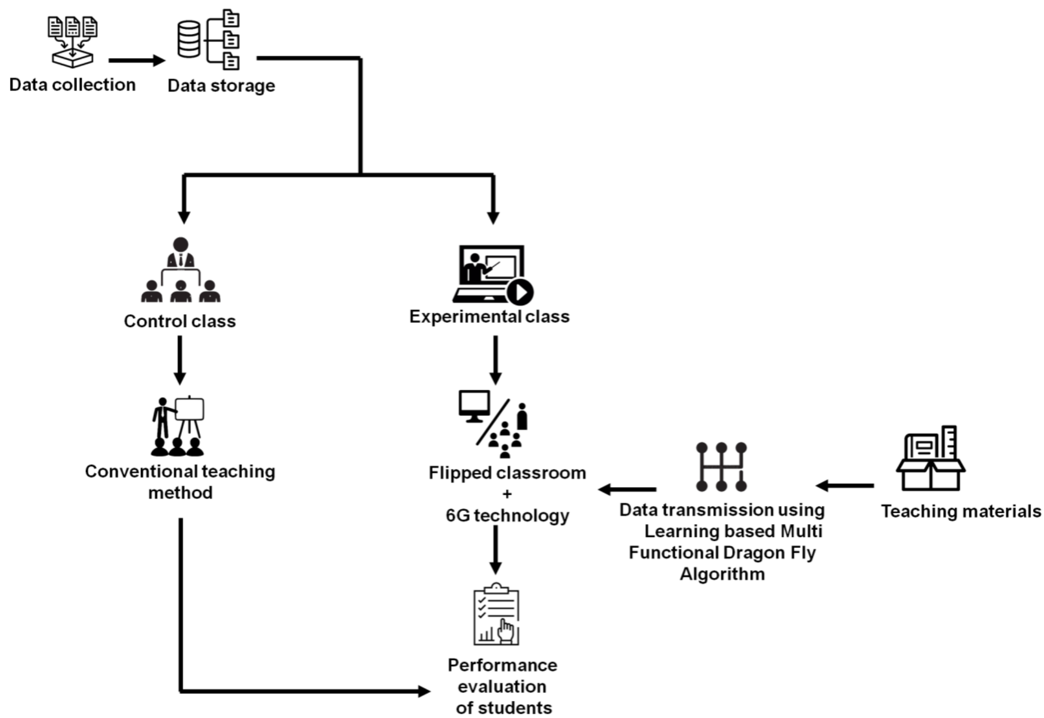
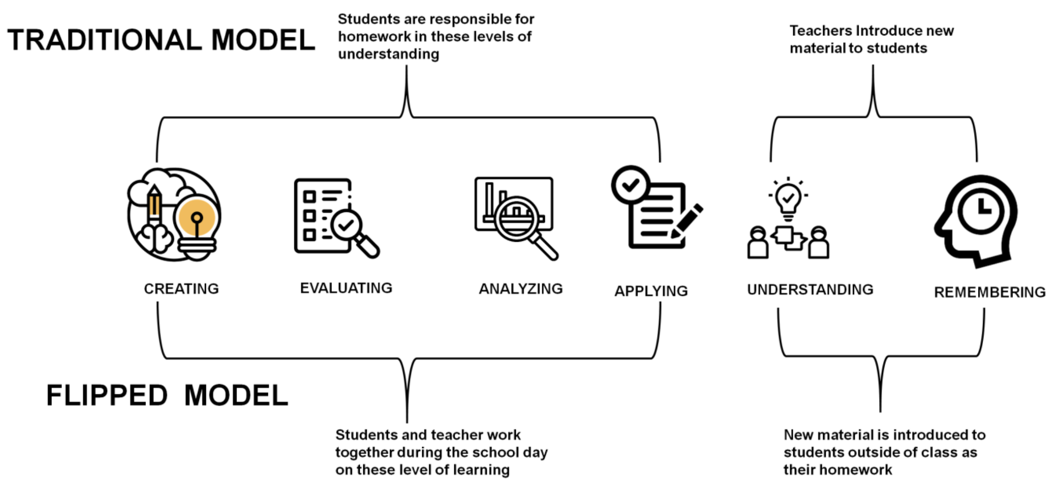


Figure 2. Conventional and flipped models



After class, students can use the educational materials provided by the instructor to improve their conceptual knowledge, learn more about the material they did not fully understand in class, and finally finish developing the meaning of their own knowledge system. Establishing a connection through discussion in the classroom may also enable instructors to pay more attention to pupils who have poor foundations and to give individual tutoring to these students in order to assist with the completion of their knowledge comprehension. Teachers may ask outstanding students questions needing deeper insights in groups. This technique supports differentiated instruction, which requires instructors to pay attention to each student's relative position.

Students assimilate new educational content through workouts, correct mistakes separately, and represent and analyze what they have learned, all in a collaborative educational environment in which the instructor separates the class into teams and allocates collaborative exploration tasks while assisting, allaying pupils' confusion, and expanding on knowledge points appropriately. Teachers may design lesson plans and short videos ahead of time, submit them to a cloud-based instructional tool, and offer students tablets to use in class. Students utilize 6G technology to study at their own speed, download self-test questions and course resources, and provide immediate feedback to the instructor. By signing in, both teachers and students may communicate with one another in advance of and during class. The teacher's awareness of the students' foresight, learning and information reserves, and learning uncertainty is clarified via this participatory approach.

Data Transmission Using Learning-Based Multifunctional Dragonfly Algorithm (LbMFDFA)

The multifunction long fly algorithm (MLFA) for learning is an optimization algorithm based on natural intelligence heuristic algorithms. It simulates the behavior of dragonflies and continuously optimizes the search process through learning mechanisms to solve complex optimization problems. In the field of data transmission, MLFA can be applied to optimize the process of data transmission and has the following advantages:

(1) Improving data transmission efficiency: MLFA can effectively explore the optimal path and strategy in data transmission by simulating dragonfly flight and continuously optimizing the search process through learning mechanisms. This can improve the efficiency of data transmission, reduce transmission time and resource consumption.
(2) Adapting to different network environments: MLFA has adaptability and can be adjusted and optimized according to different network environments and transmission needs. It can intelligently adjust according to factors such as network topology, transmission speed, bandwidth, etc. to adapt to different data transmission scenarios.
(3) Highly parallel: MLFA can search for multiple paths and policies simultaneously, with a high degree of parallelism. This enables it to efficiently search for the best solution in large-scale data transmission scenarios, reducing transmission latency and congestion.
(4) Wide search space: MLFA continuously optimizes the search process through learning mechanisms, which can explore a wide search space and improve the probability of finding the optimal solution. This enables it to handle various complex data transmission scenarios, including large-scale datasets, high-speed transmission, multipath transmission, etc.
(5) Robustness: MLFA has a high degree of robustness and can continue to perform effective search and optimization in the face of network failures, transmission errors, and other abnormal situations. This allows it to maintain high data transmission efficiency in unreliable network environments.

In summary, MLFA for learning has significant significance, benefits, and advantages in data transmission. It can improve data transmission efficiency and adapt to different network environments, and it has high parallelism, wide search space, and high robustness. By applying MLFA, we can optimize the data transmission process, improve system performance, and achieve faster and more reliable data transmission.

The educational materials are transmitted by the teachers to the students by utilizing a LbMFDFA. When calculating multi-objective functions, the suggested data transmission system is utilized to find the optimum and shortest route between the source and destination nodes. Equation 1 represents an equivalence for this multi-objective function.

$$\text{Fit} = \underset{\{\text{os}_{\text{il}}\}}{\arg\min}\left(\text{Pa}_4\right) \tag{1}$$

In Equation 1, the chosen shortest route using the suggested technique is os_{il}, where il=1,2,, IL and IL is the total number of WSN shortest pathways. The range of the shortest route os_{il} is [1, TN], and TN is the total number of WSN. The objective function Pa_4 is formulated here.

$$Pa_1 = \left(\alpha \times D\right) + \left(1 - \alpha\right) \times \frac{1}{Eng} \tag{2}$$

$$Pa_2 = \left(\beta \times Pa_1\right) + \left(1 - \beta\right) \times Dl \tag{3}$$

$$Pa_3 = \left(\gamma \times Pa_2\right) + \left(1 - \gamma\right) \times Th \tag{4}$$

$$Pa_4 = \left(\delta \times Pa_3\right) + \left(1 - \delta\right) \times T \tag{5}$$

The constants α, β, γ, and δ are set to a value of 0.2. For the sake of providing the best possible routing, we measure the 'length among two sensor nodes in same or in different clusters,' with distance denoted by the symbol D. As defined by the equation (6), Euclidean distance, D is calculated between two nodes, and specifies as the 'line segment length among two nodes.'

$$D = \sqrt{\left(n_v - m_u\right)^2 + \left(n_v - m_u\right)^2} \tag{6}$$

According to Equation 6, the coordinates corresponding to these nodes are denoted by v and u, where n and m are the cluster heads used for communication. This residual power, denoted by E, is calculated by using equation 7.

$$E = E_{mm} - \left(e_{mm}^{DT} + e_{mm}^{tg}\right) \tag{7}$$

The delay, denoted by D, is calculated in Equation 8 by adding the delays introduced by propagation and transmission.

$$D = \frac{max \sum od_{il}}{MM} \tag{8}$$

Equation 8 specifies $max \sum od_{il}$ as the maximum rate of data transmission from a sensor node to a base station, and the term MM represents the total nodes in the sensor network. Throughput represented as *Th* in Equation 9.

$$Th = \frac{\sum\left(O_{TD} * B_{O_T}\right)}{snt} \tag{9}$$

Average packet size, denoted by B_{O_T}, and the number of successfully transmitted packets, denoted by O_{TD}, are the two key variables here. The method described here is inspired by the dragonfly's natural behavior (solution). Typically, there are two stages, referred to as 'nymph' and 'adult,' in the solution. The suggested algorithm's ability to avoid real-time optimization issues stands out as its significant factor. It features a fast rate of convergence and superior 'exploitation and exploration' stages. The LbMFDFA is used in many applications because of its ability to rapidly identify optimum solutions and drastically cut down on optimization process errors. LbMFDFA is used in many different contexts, including *computer networks*, *image processing*, *machine learning*, and *wireless networks*. As a result, LbMFDFA was chosen as the data-transmission method in this research. The creatures that provide the solution feed on tiny insects and fish. The swarm's movement patterns and hunting strategies are exploited by LbMFDFA to provide evidence of the swarm's access to food and its ability to fend off predators. For the swarm's movement and hunting behavior, which is shown in five phases (described below), swarm location is crucial.

Separation

As shown in Equation 10, it is used to determine the distance between any pair of neighboring dragonflies.

$$S_m = -\sum_{j=1}^{L}\left(A_m - A_j\right) \tag{10}$$

Here, S_m is the distance between the mth individual, A_m denotes the position of the mth neighbor, L denotes the total number of clusters, and A_j denotes the position of the jth individual.

Alignment

Equation 11 is used to determine where the dragonflies should be positioned

$$B_m = \frac{\sum_{j=1}^{L} U_j}{L} \tag{11}$$

Here, U_j signifies the speed of the jth neighboring individual, and B_m gives the alignment of the mth neighbor.

Cohesion

Calculations are made using the Formula 12.

$$D_m = \frac{\sum_{j=1}^{L} A_j}{L} - A_m \tag{12}$$

The cohesiveness of the mth individual is represented by the variable D_m.

Attraction

Dragonflies are drawn in the directions indicated by Equation 13 for food.

$$E_m = A^{+} - A_m \tag{13}$$

Here, A^{+} indicates the location of the food supply, while E_m describes the m^th^ individual's food source.

Distraction

Using the Equation 14, the dragonflies are diverted in all sorts of ways, allowing them to escape their pursuers

$$FC_m = A^{-} - A_j \tag{14}$$

Here, FC_m stands for 'the location of an opponent of the mth person,' whereas A^{-} indicates 'the position of the natural enemy.' Step vector ΔA and position vector A are used to analyze 'the dragonfly's' location and motions as they go across the search space. As seen in Equation (15), the dragonflies' flight is triggered by the step vector.

$$\Delta A_m^{c+1} = \left(sS_m + bB_m + dD_m + eE_m + fF_m\right) + X\Delta A_m^{c} \tag{15}$$

Here, c stands for iteration counter, X for inertia weight, s, b, d, e, and f for separation, alignment, attraction, cohesion, and distraction, respectively. Equation 16 is then used to calculate an updated set of position vectors.

$$A_m^{c+1} = A_m^{c} + \Delta A_m^{c+1} \tag{16}$$

When there are no nearby solutions, the locations vectors are found in Equation 17.

$$A_m^{c+1} = A_m^{c} + \mathrm{l}X\left(CM\right) \times A_m^{c} \tag{17}$$

Location vector dimension, represented by CM, and levy function, designated by IX(CM), are determined using Equation 18.

$$\mathrm{l}X\left(CM\right) = 0.01 \times \frac{X_1 \times \sigma}{\left|X_2\right|^{\frac{1}{\beta}}} \tag{18}$$

$$\sigma = \left\{\frac{q\left(1+\beta\right) \times sin\left(\frac{\pi\beta}{2}\right)}{q\left(\frac{1+\beta}{2}\right) \times \beta \times 2^{\frac{(\beta-1)}{2}}}\right\}^{\frac{1}{\beta}} \tag{19}$$

We use the notation of X_1 and X_2 for the two arbitrary values in the range [0,1] and β for the constant.

RESULTS AND ANALYSIS

Analysis of Experimental Results

The participants in this study were Chinese fifth graders from two different classrooms (n=32 in one class, n=31 in the other). Both of these classes are considered to be natural classes. Before beginning the experiment, we made a preliminary comparison and study of the pupils enrolled in the two distinct groups. The author decided that the first class would serve as the EC (experimental class), the second would serve as the CC (control class), and the subject that would be covered would be elementary school English. The objective of the research was to determine whether the flipped classroom teaching approach can be successfully implemented using 6G technology. This research evaluated the learning circumstances of the EC with the CC by administering a unified post-test to students in both groups. The experiment lasted for eight weeks, from October 15, 2020 (after the midterm test), to December 15, 2020, and it was conducted as a controlled experiment to ensure that no confounding factors would alter the findings (Farah, 2014). This study compared the conventional learning (Hu, 2021), brain-based learning (Jing, 2019), project-based learning (Pérez & Rubio, 2020) and station rotation learning (Ayob et al, 2020) methods with proposed method. Students' 'reading and learning abilities,' 'writing skills,' 'self-learning capacity,' and 'confidence' are compared in Figure 3 and Table 1. Figure 3 shows that the students in the proposed method had a higher learning ability when compared to other methods of learning. This study aimed to collect students' opinions and feedback by designing questions targeting their learning attitudes. A questionnaire survey can include open-ended and closed-ended questions, aiming to understand students' attitudes toward learning interests, motivations, levels of participation, self-confidence, and other aspects of their education. Schools or teachers use online survey tools or paper questionnaires to collect student responses.

Figure 4 and Table 2 illustrate students' mentalities about learning English. The majority of students using the suggested strategy expressed satisfaction with the proposed approach shown in Figure 5. When compared to other approaches, they also thought learning English using the suggested technique was simple or very simple.

Figure 3. Comparison of students' learning attitudes

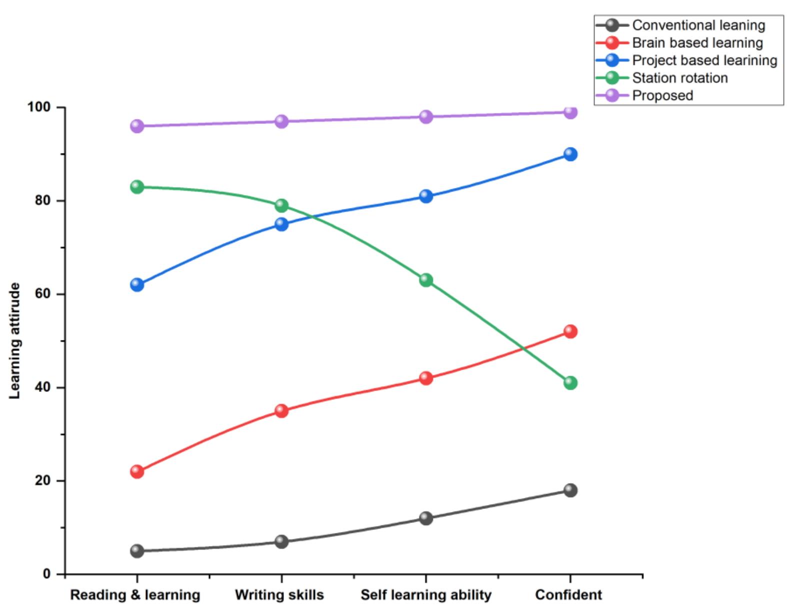


Table 1. Computation analysis of students' learning attitude

Parameters	Methods				
	Conventional Leaning	Brain-Based Learning	Project-Based Learning	Station Rotation-Based Learning	Proposed
Reading & learning in (%)	5	22	62	83	96
Writing skills in (%)	7	35	75	79	97
Self learning ability in (%)	12	42	81	63	98
Confident in (%)	18	52	90	41	99

Figure 4. Students' attitudes toward English learning

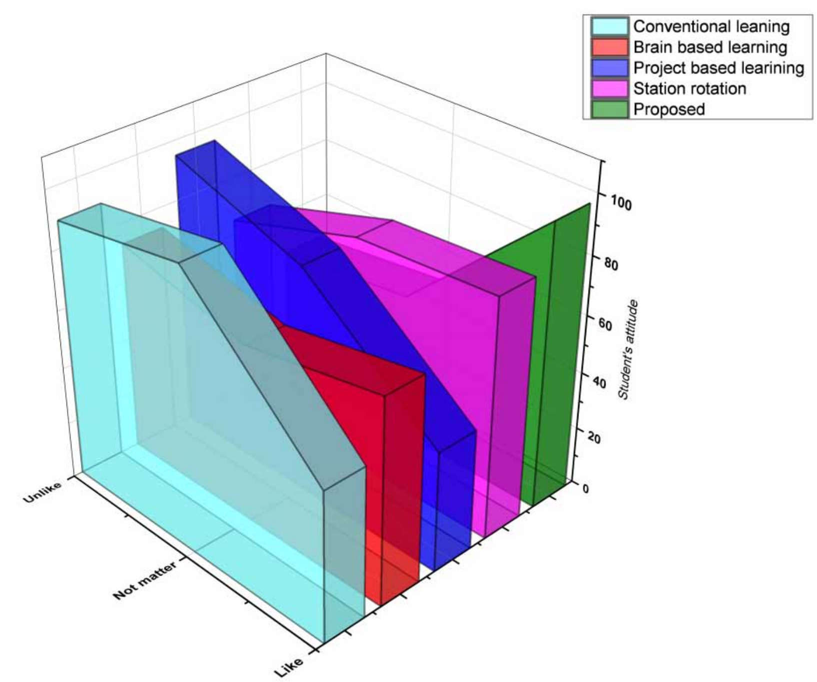


Table 2. Computation analysis of students' attitudes toward English learning

	Methods				
	Conventional Learning	Brain-Based Learning	Project-Based Learning	Station Rotation-Based Learning	Proposed
Like in (%)	52	71	42	83	98
Not matter in (%)	97	62	79	80	51
Unlike in (%)	89	73	95	65	45

From the graph, it is clear that most of the students enrolled in the recommended technique found their course materials to be highly beneficial while studying English. Students using the alternative strategy to learn English were less optimistic about the usefulness of their course materials. This demonstrates that pupils had not acquired effective study techniques, did not have ready solutions to difficulties that arose during at-home study, and would not go online to get answers. Table 3 demonstrates the computation analysis of student perception toward teaching materials.

Figure 6 depicts students' adjustment to the flipped classroom. One-fourth of the participants of this study felt this new learning model was less effective than the conventional approach to education and placed a greater strain on them. Half of the participants were agnostic, believing that either the suggested model or the status quo of education was equally valid. Finally, most of the study's participants found that they had a positive experience with this method of education, agreed that it was an effective means of instruction, felt that they had engaged in the process of inquiry, appreciated how well it was tailored to their individual learning styles, and had fun doing the learning on their own.

Figure 7 displays the results of an English knowledge content exam given to participants in the two courses after the teaching practice. The percentage of exceptional performance (80 points or more) is 40% in the EC and 28% in the CC. Students in the EC had a far larger influence on English learning than CC participants, as can be seen in the figure.

Figure 5. Students' views on teaching materials

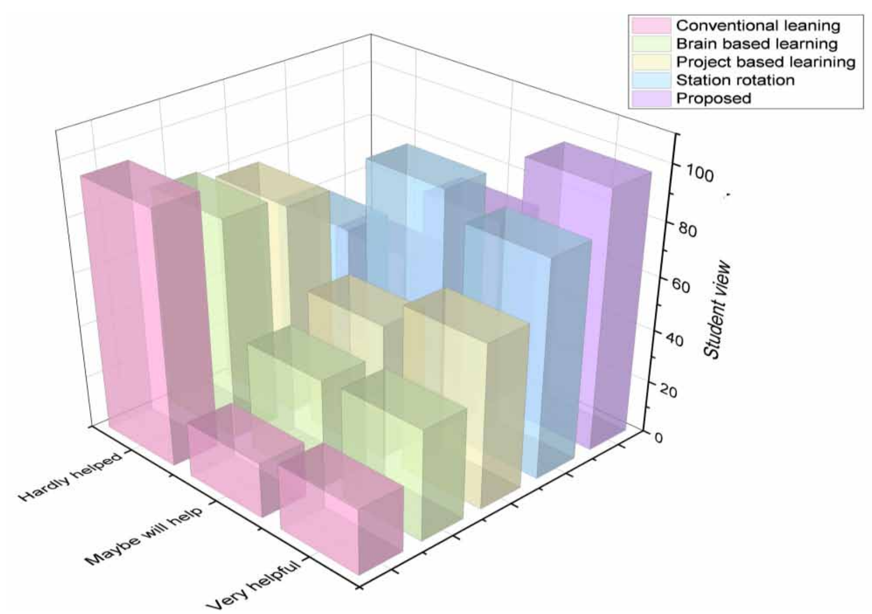


Table 3. Computation analysis of students' views on teaching materials

	Student View on Teaching Materials				
	Conventional Learning	Brain-Based Learning	Project-Based Learning	Station Rotation	Proposed
Very helpful in (%)	25	42	62	82	97
Maybe will help in (%)	21	41	51	91	71
Hardly helped in (%)	95	83	79	62	43

Figure 6. Students' adaptation to the FC

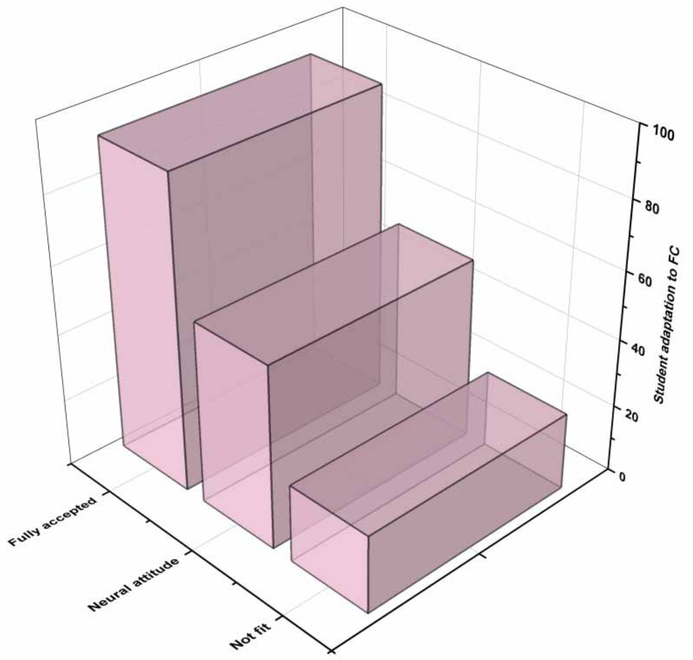
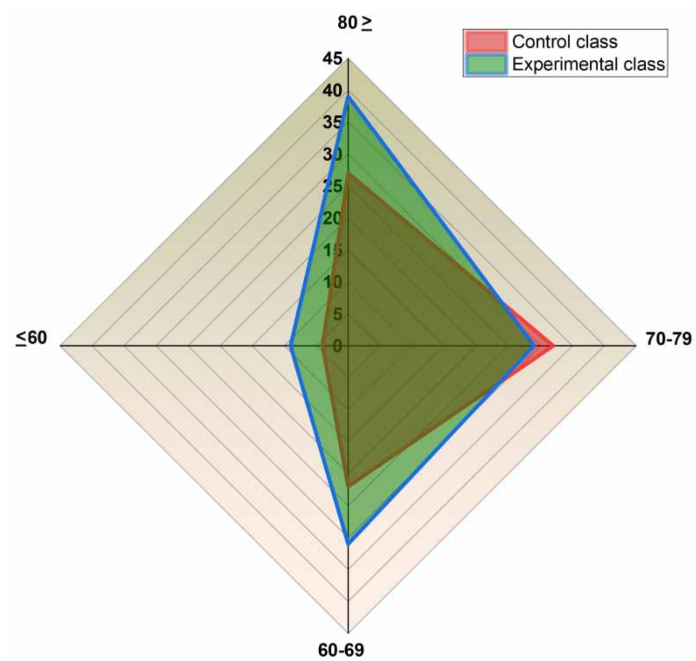


Figure 7. English knowledge content test



Analysis of Practical Applications

In the digital age, the field of education is gradually developing toward networking, intelligence, and personalization. The flipped classroom, as a new teaching model, puts more emphasis on students' active learning and practical exploration on the basis of network and multimedia technology. However, with the increase in data volume and the abundance of educational resources, traditional online environments are no longer able to meet the requirements of flipped classrooms. Therefore, in recent years, people have begun to pay attention to the application of 6G networks in flipped classrooms. Compared to 5G, 6G has higher speed and bandwidth, lower latency, wider connectivity, stronger intelligent support, and more diverse application scenarios. These characteristics will further improve the learning experience of flipped classrooms and promote innovation and development in education. The advantages of 6G have the following importance in flipped classrooms:

(1) Higher speed and bandwidth: 6G has higher speed and bandwidth than 5G. This means that large-capacity educational resources and multimedia content, including high-definition videos, virtual reality (VR), and augmented reality (AR) applications, can be transmitted faster. This will provide a smoother and richer learning experience, allowing students to better participate in flipped classroom learning activities.
(2) Lower latency: 6G has lower latency, which means educational content can be transmitted and engaged with faster in situations with high real-time requirements. For example, real-time video conferencing and information transmission between students and teachers will be smoother and more efficient during remote interaction and collaboration.
(3) Wider connectivity: 6G networks will support larger-scale device connections, which is crucial for flipping multi-device and multi-user environments in classrooms. Students can access educational resources using various smart devices such as smartphones, tablets, laptops, etc., and interact and collaborate with teachers and other students.
(4) Stronger intelligent support: 6G will combine artificial intelligence and machine learning technologies to provide stronger intelligent support. This will make flipped classroom teaching more personalized and adaptive, providing customized learning content and paths based on students' learning needs and interests.
(5) More diverse application scenarios: 6G will drive more innovative application scenarios, such as AR virtual demonstrations, remote laboratories, intelligent assisted teaching, etc. These new technologies and applications will provide more possibilities for flipped classrooms, expanding students' learning methods and experiences.

In summary, the use of 6G in flipped classrooms has many advantages over 5G that are important to education. These characteristics will further improve the learning experience of flipped classrooms and promote innovation and development in education.

Although 6G has many potential advantages in flipped classrooms, it also faces some challenges. Here are some challenges and corresponding countermeasures:

(1) Infrastructure construction: the infrastructure construction required to achieve 6G networks is a huge task. The deployment of new communication equipment, network coverage, and transmission technologies requires a significant amount of time, funding, and resources. To solve this problem, the government and educational institutions can increase investment in infrastructure construction and cooperate with communication operators to promote the construction of 6G networks.
(2) Security and privacy protection: with the development of 6G, network security and privacy protection have become more critical. In flipped classrooms, personal information and learning data of students and teachers may be collected and used. Therefore, it is necessary to ensure sufficient data security and privacy protection mechanisms. Educational institutions should take

necessary security measures, such as encrypted communication, identity authentication, and permission management to protect user data and privacy.

(3) Digital divide: although 6G networks offer higher speeds and bandwidth, there is still a problem of the digital divide. Some regions and students may not be able to enjoy the benefits of 6G networks, a situation that can lead to inequality in educational resources. To address this issue, the government and educational institutions can formulate policies, provide funding and support, and ensure that more regions and students have access to 6G networks.
(4) Teacher training and adaptation: introducing 6G networks requires teachers to have corresponding technical knowledge and abilities to fully utilize new teaching resources and tools. Therefore, teacher training and adaptation have become an important issue. Educational institutions can provide relevant training programs to help teachers master the application methods of 6G networks in flipped classrooms and encourage teachers to actively participate in professional development activities.
(5) Resource development and sharing: with the development of 6G networks, more high-quality educational resources are needed to support flipped classroom teaching activities. To address this issue, educational institutions can encourage teachers and educational experts to participate in resource development and encourage resource sharing and openness. These measures can reduce repetitive labor, improve teaching efficiency, and also promote innovation and cooperation in the field of education.

In summary, the application of 6G networks in flipped classrooms faces some challenges. However, by increasing infrastructure construction, strengthening security and privacy protection, addressing the issue of the digital divide, providing teacher training and adaptation, and developing and sharing resources, these challenges can be overcome to achieve the maximum application of 6G networks in the field of education.

CONCLUSION

This study aimed to explore the advantages of the flipped classroom teaching mode in English teaching under the 6G network environment and provide feasible teaching strategies and guidance for English teachers. In this study, we first collected relevant information about Chinese English learners, including data on their learning situation, study habits, and English proficiency. These data provide a basic foundation for subsequent research and help us understand the current situation and needs of Chinese English learners under traditional teaching modes. Next, we divided the obtained dataset into two groups: a control group and an experimental group. The students in the control group continued to use traditional teaching methods for English teaching, while the students in the experimental group adopted a flipped classroom teaching mode supported by 6G technology. By comparing the learning outcomes and experiences of these two groups of students, we evaluated the application effect of flipped classroom information technology in English teaching in the 6G network environment. On the basis of our research findings, we can draw the following conclusions:

(1) The flipped classroom teaching mode in the 6G network environment can effectively improve the learning effectiveness of students. By utilizing advanced information technology and internet resources, students can engage in self-directed learning outside of the classroom, prepare classroom content in advance, and arrange self-directed learning according to personal learning progress and needs. These applications help to enhance students' learning enthusiasm and initiative and improve their learning outcomes.
(2) The flipped classroom teaching mode in the 6G network environment can stimulate students' interest in learning. With the help of advanced information technology and multimedia resources,

teachers can design rich and diverse teaching content and activities, enabling students to actively participate in the learning process and improving the fun and motivation of learning.

(3) Finally, through the research in this paper, we provide useful references for practitioners and decision makers in the field of education. We promote the application of flipped classroom information technology in English teaching in the 6G network environment, helping to advance innovation and progress in education. We recommend that educational institutions and teachers actively adopt the flipped classroom teaching model in the 6G network environment, combined with advanced information technology and educational theory, to improve students' learning effectiveness and interest and promote innovation and development in English teaching.

Although this study has achieved certain results, there are also some limitations. For example, our research is aimed only at Chinese English learners, and further research and validation may be needed for English learners from other countries or regions. In addition, our research focuses on the flipped classroom teaching mode only in the 6G network environment. In future research, we can consider combining it with other advanced information technologies to further explore more innovative and effective teaching modes.

In summary, the flipped classroom teaching mode in the 6G network environment has important application value in English teaching. By combining advanced information technology and educational theories, we can improve students' learning outcomes and interests and promote innovation and development in English teaching. We encourage practitioners and decision makers in the field of education to actively adopt the flipped classroom teaching model in the 6G network environment and further research and explore more innovative and effective teaching methods to promote the progress and development of education.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the authors upon reasonable request. The figures and tables used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FUNDING STATEMENT

This work was supported by the Office of Education of Anhui Province, research on a survey of the application of smart classroom in comprehensive English teaching in higher vocational colleges (Project No. 2021jyxm1536).

ACKNOWLEDGMENT

This work was supported by the Office of Education of Anhui Province, research on a survey of the application of smart classroom in comprehensive English teaching in higher vocational colleges (Project No. 2021jyxm1536).

REFERENCES

Athanassopoulos, S., Manoli, P., Gouvi, M., Lavidas, K., & Komis, V. (2023). The use of ChatGPT as a learning tool to improve foreign language writing in a multilingual and multicultural classroom. *Advances in Mobile Learning Educational Research*, *3*(2), 818–824. doi:10.25082/AMLER.2023.02.009

Ayob, N. S., Halim, N. D. A., Zulkifli, N. N., Zaid, N. M., & Mokhtar, M. (2020). Overview of blended learning: The effect of station rotation model on students' achievement. *Journal of Critical Reviews*, *7*(6), 320–326.

Baratè, A., Haus, G., Ludovico, L. A., Pagani, E., & Scarabottolo, N. (2019, June). 5G technology for augmented and virtual reality in education. *Proceedings of the International Conference on Education and New Developments*, 512–516. doi:10.36315/2019v1end116

Bicen, H., & Beheshti, M. (2022). Assessing perceptions and evaluating achievements of ESL students with the usage of infographics in a flipped classroom learning environment. *Interactive Learning Environments*, *30*(3), 498–526. doi:10.1080/10494820.2019.1666285

Chan, M., Chun, C., Fung, H., Lee, J. H., & Stuckey, P. J. (2020, April). Teaching constraint programming using fable-based learning. *Proceedings of the AAAI Conference on Artificial Intelligence*, *34*(9), 13366–13373. doi:10.1609/aaai.v34i09.7059

Chen, H., & Huang, J. (2021). Research and application of the interactive English online teaching system based on the internet of things. *Scientific Programming*, *2021*, 1–10. doi:10.1155/2021/5089236

Chen, L. L. (2016). Impacts of flipped classroom in high school health education. *Journal of Educational Technology Systems*, *44*(4), 411–420. doi:10.1177/0047239515626371

Cheng, Q., Li, B., & Zhou, Y. (2021, June). Research on evaluation system of classroom teaching quality in colleges and universities based on 5G environment. *Proceedings of the 2021 1st International Conference on Control and Intelligent Robotics*, 74–85. doi:10.1145/3473714.3473728

Demski, J. (2013). 6 expert tips for flipping the classroom. *Campus Technology*, *26*(5), 32–37.

Farah, M. (2014). *The impact of using flipped classroom instruction on the writing performance of twelfth grade female Emirati students in the applied technology high school* [Master's thesis]. The British University in Dubai]

Feng, T. (2017). Research on teaching model of MOOC-based college English flipped classroom. *Boletin Tecnico/Technical Bulletin, 55*(20), 503–508.

Hu, B. (2021). English listening teaching model in flipped classroom based on artificial intelligence fusion control algorithm. *Mathematical Problems in Engineering*, *2021*, 1–14. doi:10.1155/2021/6005359

Ipek, Z. H., Gözüm, A. C. I., Papadakis, S., & Kalogiannakis, M. (2023). Educational applications of ChatGPT, an AI system: A systematic review research. *Educational Process*, *12*(3), 26–55. doi:10.22521/edupij.2023.123.2

Jensen, J. L., Kummer, T. A., & Godoy, P. D. D. M. (2015). Improvements from a flipped classroom may simply be the fruits of active learning. *CBE Life Sciences Education*, *14*(1), ar5. doi:10.1187/cbe.14-08-0129 PMID:25699543

Jing, Z. (2019). Brain-based learning: A remedy to teaching EFL in China. *Frontiers in Educational Research*, *2*(11).

Karakose, T., Demirkol, M., Aslan, N., Köse, H., & Yirci, R. (2023). A conversation with ChatGPT about the impact of the COVID-19 pandemic on education: Comparative review based on human–AI collaboration. *International Journal (Toronto, Ont.)*, *12*(3), 7–25.

Li, X. (2020). The cultivation of the core literacy of English discipline in senior high school based on' post-method' theory. *Region-Educational Research and Reviews*, *2*(3), 1. doi:10.32629/rerr.v2i3.137

Lin, H., Xie, S., & Cai, K. (2019, August). Construction of classroom teaching model based on the 5G Communication Technology. *2019 IEEE International Conference on Smart Internet of Things (SmartIoT),* 393–396. doi:10.1109/SmartIoT.2019.00069

Liu, L. (2021). Research on IT English flipped classroom teaching model based on SPOC. *Scientific Programming*, *2021*, 1–9. doi:10.1155/2021/9485654

Liu, Y., & Ren, L. (2022). The influence of artificial intelligence technology on teaching under the threshold of "Internet+": Based on the application example of an English education platform. *Wireless Communications and Mobile Computing*, *2022*, 1–9. doi:10.1155/2022/5728569

Pérez, B., & Rubio, Á. L. (2020, February). A project-based learning approach for enhancing learning skills and motivation in software engineering. *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*, 309–315. doi:10.1145/3328778.3366891

Prokop, Y. V., Trofymenko, O. G., & Dykyi, O. (2021). Research of approaches to teaching the course "algorithms and data structures" for computer science students. *Scientific Notes of Taurida National VI Vernadsky University. Series*. *Technical Sciences*, *1*(2), 216–220.

Shengxue, Z. (2019). The transformation and strategies of college English teaching and learning in the era of artificial intelligence. *Journal of Anshun University*, *21*(6), 73–77.

Strelan, P., Osborn, A., & Palmer, E. (2020). The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educational Research Review*, *30*, 100314. doi:10.1016/j.edurev.2020.100314

Sun, X. (2021). 5G joint artificial intelligence technology in the innovation and reform of university English education. *Wireless Communications and Mobile Computing*, *2021*, 1–10. doi:10.1155/2021/2460916

Veselov, G., Tselykh, A., Sharma, A., & Huang, R. (2021). Applications of artificial intelligence in evolution of smart cities and societies. *Informatica (Vilnius)*, *45*(5).

Yang, X. (2014). The connotation and characteristics of smart education in the information age. *China Educational Technology*, *324*, 29–34.

Yu, L., & Peng, N. (2021). Research on English teaching reform based on artificial intelligence matching model. *Journal of Intelligent & Fuzzy Systems*, (Preprint), 1.

Zhou, S., & Zhang, T. (2017). Research on the construction of flipped classroom model for English teaching based on SPOC. *Revista de la Facultad de Ingeniería*, *32*(14), 267–273.

Zou, S. (2017). Designing and practice of a college English teaching platform based on artificial intelligence. *Journal of Computational and Theoretical Nanoscience*, *14*(1), 104–108. doi:10.1166/jctn.2017.6133

Xiu Bi was born in Tongcheng, Anhui, China. She received her master's degree from Hangzhou Normal University, China. She currently works at the Tongcheng Teachers College. Her main research area is English curriculum and teaching.

Shuping Ye was born in Tongcheng, Anhui, China. He received his master's degree from Anhui University, China. He is currently employed by China Mobile Company. His main research area is communication engineering.