

Research on the Innovative Application of Blended Teaching Model in Higher Vocational English under Digital Transformation

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ABSTRACT With the rapid development of digital technology, higher vocational English teaching needs to innovate its teaching model to meet personalized learning requirements and professional application needs. Based on the characteristics of vocational education, this study constructs a blended teaching model integrating multiple digital technologies. The model adopts a three-stage process of pre-class self-study, in-class in-depth interaction, and post-class extension and reinforcement, forming an organic combination of online and offline teaching. The study takes 156 students from three majors in a vocational college as research subjects. Questionnaires, pre- and post-tests, interviews, and learning platform data are used for data collection, followed by statistical analysis. Results show that students in the experimental group significantly improve in comprehensive English application ability, autonomous learning ability, and classroom participation. Differences between pre- and post-test scores are statistically significant, especially in productive skills such as speaking and writing. The study provides a feasible practical path and theoretical reference for the digital transformation of higher vocational English teaching.

INDEX TERMS digital transformation, vocational college english, blended learning, teaching model innovation, learning platform

I. INTRODUCTION

As a crucial course for cultivating students' international perspectives and core professional competencies, vocational college English urgently needs to adapt to digital trends and innovate its teaching models. Traditional vocational college English teaching, primarily lecture-based with a disconnect between online and offline learning, struggles to meet students' personalized learning needs and the English application skills required for professional positions. Blended learning, organically combining online self-study with offline classroom interaction, offers a potential solution to this dilemma. However, current practices in blended learning for vocational college English suffer from fragmented technology application, simple overlay of online and offline learning, and a lack of systematic design, failing to fully leverage the advantages of digital transformation. This study, based on the characteristics of vocational college education and aiming to cultivate core English literacy among technical and skilled personnel, explores innovative paths for blended learning models that integrate diverse digital technologies. The study constructed a three-stage teaching process comprising pre-class, in-class, and post-class phases, and verified its effectiveness through empirical

research within the curriculum. This framework provides necessary theoretical and practical support for promoting profound changes in English teaching in vocational colleges.

II. RELATED WORK

In recent years, the field of English teaching research has shown a multi-dimensional innovation trend. Pham and Cao [1] revealed the various applications of ChatGPT in English teaching in Vietnam and the opportunities and challenges it brings. Yeh [2] believes that simply using AI as a tool is not enough to maximize its teaching value, so he explores how to combine it with inquiry-based learning to fundamentally change the pattern of English teaching. Febriati and Jaya [3] successfully developed English teaching materials suitable for the flipped learning model and verified its effectiveness. These materials can support students to learn independently before class and promote deeper teacher-student interaction and language practice in the classroom, thereby improving the overall teaching effect. Gao and Bu [4] collected multi-dimensional data that affect the effectiveness of college English teaching, then constructed a neural network model and used a genetic algorithm to globally optimize its network structure and parameters to improve the model's

prediction accuracy and generalization ability. Rofi'i et al. [5] successfully designed and developed a mobile game application suitable for primary school English teaching.

Abduh et al. [6] collected teachers' views, experiences and challenges on the English teaching strategies they adopted or should adopt in the new curriculum. Azhary and Fatimah [7] balanced the need for English learning with local cultural identity and revealed the specific practices and effects of integrating local culture into English teaching materials. Natsir et al. [8] depicted the specific picture of English teaching in vocational school industrial mechanical engineering majors and revealed its differences from general English teaching. Mulyati and Kultsum [9] found that integrating Islamic values and culture into English teaching helps students understand English more easily and provides support for students with Islamic backgrounds. Tuan [10] explored the practice of using Canvas, a learning management system, to improve the English teaching process at a science and technology university in Vietnam. The analysis found that Canvas's various functions, such as modules for sharing resources, discussion boards, assignment submission, online meeting facilities and deep links with other platforms, effectively promoted the teaching and learning process of English. Although blended learning has become a research hotspot, most explorations are still at the level of single-point application of technical tools or simple superposition of online and offline teaching, and have failed to build a systematic blended learning model that adapts to the needs of vocational education talent training. This study aims to explore practical pathways that align with the characteristics of higher vocational education, integrate diverse digital technologies, connect in-class and extracurricular activities with online and offline learning, and serve to enhance the core English literacy of technical and skilled personnel. The goal is to provide theoretical reference and practical basis for promoting profound changes in higher vocational English teaching.

III. METHODS

A. DESIGN AND TECHNICAL ARCHITECTURE OF BLENDED LEARNING MODEL

Based on the background of digital transformation and targeting the characteristics of vocational college English teaching, this study constructs a blended teaching model consisting of three stages: pre-class self-study, in-class in-depth interaction, and post-class extension and improvement. This model takes the learning management system as the core platform, integrates various digital tools and resources, and forms a teaching closed loop supported by technology. In the pre-class stage, teachers release micro-lecture videos, reading materials, and pre-class task sheets through the learning management system. Students complete the learning independently and record their questions. The system automatically records learning behavior data [11,12]. In the in-class stage, teachers adjust their teaching strategies based on the feedback from the pre-class learning data.

They adopt teaching methods such as task-driven, situational simulation, and group collaboration to guide students to engage in in-depth interaction and language practice. At the same time, they use tools such as classroom response systems, real-time voting, and word cloud generation to enhance participation. In the post-class stage, teachers assign personalized extension tasks and recommend digital learning resources. Students consolidate and improve their learning through online discussions, peer review of assignments, and self-testing exercises. The learning management system continuously tracks the learning effect.

At the technical architecture level, this study selected Chaoxing Learning Platform as the core platform, integrating diverse digital technologies such as VR virtual scenario simulation software, the Pigai.com intelligent writing review system, the iFlytek Oral English Training App, and the Wenjuanxing survey tool. Chaoxing Learning Platform provides functions such as resource push, assignment submission, discussion interaction, and data statistics, supporting full recording of the teaching process. The VR virtual scenario simulation software creates professional scenarios, such as hotel reception, business negotiations, and technical exchanges, enhancing the realism and practicality of language learning. Pigai.com provides real-time scoring and feedback on students' writing, pointing out language errors and offering suggestions for improvement, supporting students in repeated revisions and improvement. The iFlytek Oral English Training App offers functions such as follow-up reading assessment, situational dialogues, and speech recognition, helping students improve pronunciation and fluency. These technical tools are linked to Learning Platform via interfaces or QR codes, forming a technical matrix to jointly support the implementation of blended learning.

B. RESEARCH SUBJECTS AND IMPLEMENTATION PROCESS

This study chose the research subjects from 156 first-years from three majors (e-commerce, tourism management, and mechatronics) in higher vocational college to participate in the research, including 82 students from experimental class, and 74 students from control class. The experimental class adopted the blended learning model designed in this study, whereas the control class employed a traditional teaching model centered on classroom lectures. Although the instructional arrangements for the control class utilized the same online learning platform as a foundational resource repository, the use of these resources lacked systematic pedagogical design; specifically, there were no explicit pre-class preparation assignments, no interactive activities based on online resources were organized during class sessions, and post-class extension resources served merely as supplementary materials for independent student consultation—thus, the underlying pedagogical logic remained centered on the unidirectional transmission of knowledge from the teacher. The time span of the research was one semester (16 weeks) and the contents taught were the second volume

of “Higher Vocational English” containing eight units such as communication in business life, description of a job, introduction of the product, and technical explanation. The theme of each unit was linked to the professional field. Before the experiment, the students in the two classes were tested about their English proficiency. The result indicated that there relates no significant difference in two groups in the four dimensions of listening, reading, writing, and speaking ($p > 0.05$) and they were equal [13,14].

The process implementation occurs in a three-stage design. Before class, teachers prepare learning task packages and distribute them online on the educational platform three days ahead of each week, consisting of micro-lecture videos (of 10-15 minutes in length), 2-3 extended reading materials, and pre-class self-test questions. Student learning behavior data is automatically recorded by the system such as video viewing time, completion of self-test and number of posts in the discussion forum. During the class, according to the data collected before class, teachers adjust the focus of their teaching, give in-depth explanations about the common difficulties of students, followed by task-based activities based on the situation. After class, teachers give personalized assignments, such as writing English versions of the product manual as well as recording English explanation videos of technical operations. Students submit their assignment written on the learning platform and peer review it, teachers select outstanding works to display them.

C. DATA COLLECTION AND ANALYSIS TOOLS

This research was carried out using a combination of quantitative and qualitative methods to gather data.

Quantitative data included: pre-test and post-test scores (out of 100, including 25 points for listening, 30 points for reading, 25 points for writing and 20 points for speaking); participation data for each stage of blended learning (automatically recorded by the learning management system, including video completion rate, task submission rate, and number of discussion participations); and a questionnaire survey on teaching effectiveness satisfaction (using a five-point Likert-scale, including dimensions of: acceptance of the teaching model; learning interest; and perceived improvement in abilities; 156 questionnaires were distributed, and Qualitative data were obtained from semi-structured interviews in which the 15 students from the experimental class were chosen randomly for one-to-one interviews based on the experiences, gains and suggestions that they have had regarding blended learning. The interview recordings were transcribed and presented in the form of textual data. This study was approved by the Ethics Committee of Zhejiang Institute of Communications, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

Students preferences of digital tools are utilised in Table 1. The table shows that smartphones are the most commonly used learning device with a huge percentage of 89.5%. This implies that the design of a blend learning model should

focus on mobile compatibility and user experience. In terms of the digital tools that are generally used, communication and social networks have the highest rate at 93.4%, followed by video tools with 84.2%, dictionaries with 82.9%. The rate of the usage of learning management systems is still relatively low (57.9%). This suggests that learning management systems have not yet become part of the student's habit to learn and therefore require guidance from their teachers and task driven learning. The most popular English learning functions are, respectively, video explanations (86.8%), instant feedback (79.6%), and interactive communication (72.4%), which can provide a reference for the selection of teaching resource formats.

TABLE 1. Results of a survey on students' preferences for using digital tools

Tool type	Specific projects	Number of users	percentage(%)
Common equipment	smartphones	136	89.5
	laptop	78	51.3
	Tablet PC	42	27.6
	desktop computer	31	20.4
Commonly used digital tools	Communication and social networking apps (WeChat/QQ)	142	93.4
	Video-based (TikTok/Bilibili)	128	84.2
	Dictionary apps (Youdao/Kingsoft)	126	82.9
	Learning Management System (Learning Pass)	88	57.9
	English learning apps (BaiCiZhan/LiuLiShuo)	76	50.0
	Video tutorial	132	86.8
Most popular learning features	Instant feedback and correction	121	79.6
	Interactive communication	110	72.4
	Gamified learning	95	62.5
	Virtual scenario simulation	83	54.6

A data analysis in Table 1 indicates that there are clear mobile, social, and visual characteristic in the students using digital tools. The fact that communication and social networking tools are used by a high rate facilitates the creation of learning groups and the activation of informal learning with WeChat or QQ. Teachers could take advantage of these familiar platforms to send reminders of the learning process as well as sharing high-quality resources. Video lectures are by far the most popular for the reason that the learning preference for the contemporary students includes micro-lessons and short videos. Teachers must concentrate on the creation of succinct and focused video resources. It is interesting that of all those students, only 54.6% opted for the virtual scenario simulation function, which has a special value in terms of learning English in a working context. Acceptance and willingness to use it can be slowly built among students by conducting experiential activities.

IV. RESULTS AND DISCUSSION

A. THE IMPACT OF BLENDED LEARNING ON STUDENTS' ENGLISH SCORES

After a semester of teaching experimentation, significant differences in the English score of the experimental and the

control classes were observed. Table 2 shows the statistical results of the pre-test and post-test scores of the two classes. In the pre-test phase the mean total score of the experimental class and the control class were 72.36 and 72.51 respectively, which shows the difference of only 0.15 points. An independent samples t-test revealed a result $p = 0.892 > 0.05$, which showed that the English proficiency of the two classes was similar before the experiment, and the grouping was reasonable. In the post-test period, the mean total score of the experimental class was increased to 81.24, i.e. improved by 8.88 points from the pre-test total score; 76.38 i.e. the mean total score of the control class was improved in the post-test period 3.87 points from the pre-test total score. The post test score of the experimental class was 4.86 points higher than the control class. An independent samples t-test result shows $t = 4.236$, $p = 0.000 < 0.05$, indicating that there is a statistically significant difference, showing that blended learning model has a significant influence on improving English score of students.

In terms of various skills the speaking and writing which are two output skills, the experimental class showed the greatest improvement in this two skills, increased from 17.82 and 16.93 points to 21.35 and 20.68 points, increase 3.53 and 3.75 respectively. In contrast, the control class has found smaller improvements in terms of speaking and writing, gain 1.46 and 1.27 points respectively. This difference may result from the more opportunities for speaking and writing practice offered by the blended learning approach such as the follow-up assessment on the iFlytek Speaking APP, the intelligent grading on the online correction platform, and classroom scenario simulations which that provide more opportunities for students to produce language and provide feedback to students. Regarding listening, the scores of the experimental class increased from 18.36 points to 20.14 points, that is, 1.78 points; the scores of the control class increased from 18.41 points to 19.23 points, that is, 0.82 points. The improvement of the experimental class was more than doubled compared with the control class, which may be related to the understanding of class micro-lessons before class through video and the expansion of listening resource after class. In terms of reading, the improvement of experimental and control classes were 1.82 and 1.05 points (19.25-21.07 and 19.23-20.28) respectively, which showed that the reading skill improvement of experimental and control classes was also clear.

TABLE 2. Comparison of English pre- and post-test scores between the experimental and control groups

Test Dimensions	Experimental (n=82)	Control group (n=74)	Mean difference	t-value	p-value
Pre-test total score	72.36 ± 6.82	72.51 ± 7.03	-0.15	-0.136	0.892
Pre-test hearing	18.36 ± 2.41	18.41 ± 2.52	-0.05	-0.126	0.900
Pre-test reading	19.25 ± 2.63	19.23 ± 2.58	0.02	0.048	0.962
Pre-test writing	16.93 ± 2.17	16.95 ± 2.21	-0.02	-0.057	0.955
Pre-test oral English	17.82 ± 2.35	17.92 ± 2.43	-0.10	-0.262	0.794
Post-test total score	81.24 ± 6.15	76.38 ± 6.87	4.86	4.236	0.000
Post-test hearing	20.14 ± 2.28	19.23 ± 2.46	0.91	2.412	0.017
Post-test reading	21.07 ± 2.42	20.28 ± 2.51	0.79	2.005	0.047
Post-test writing	20.68 ± 2.35	18.22 ± 2.38	2.46	5.208	0.000
Post-test oral English	21.35 ± 2.41	19.38 ± 2.45	1.97	4.113	0.000

Further analysis of the data in Table 2 shows that the post-test difference in writing and speaking skills was especially significant where p-values were all less than 0.001 and indicate that the blended learning model had a very significant impact on improvement in productive skills. This result can be explained by a specific design of the teaching process: In teaching writing, students had immediate and multiple opportunities to revise their work, as they were given through the intelligent grading system. Students constantly optimized their expression based on feedback from the system, so that the whole writing process became a cycle of repeated revision and improvement, not the traditional one-time submits. At the same time, the peer review function encouraged the learning and reference between students, and the display of excellent works acted as a model and a guide. In speaking teaching, follow-up reading assessment function of Xunfei Speaking APP was used to help students correct many pronunciation, situational dialogue module provided simulated communication, VR virtual scenario software was used to create professional scenarios to improve the reality of language use, and situation performance in the classroom provided a stage for practical application. These designs created a whole chain of pre-class practicing, in-class presenting and post-class strengthening, which effectively had a promoting effect on the improvement of speaking skill.

B. PARTICIPATION ANALYSIS OF EACH STAGE OF BLENDED LEARNING

The effectiveness of blended learning has to do a lot with student participation. Participation data automatically recorded by the learning management system studies that students in the experimental class demonstrated high levels of participation in all stages-before, during and after class. Table 3 shows the average data of participation of the experimental class students in eight teaching units. Overall average submission rate of pre-class tasks was 91.2% and average of total video completion was 88.6% which show the vast majority of the students were able to do their pre-class self-study tasks as required. The average participation rate for in-class interaction was 85.7% indicating that the nature of the classroom activities was such to attract the active participation of most of the students. Based on participation trends across the various units, the classroom interaction

participation rates for Unit 1 and Unit 2 (82.9% and 83.5%, respectively) were both relatively low. This phenomenon suggests that, during the initial stages, students were still in the process of adapting to the blended learning model: on one hand, they required time to familiarize themselves with the operation of the Learning Management System and to adjust to the pace of independent pre-class study; on the other hand, instructors were also exploring how to precisely tailor in-person classroom activities based on online learning data, meaning that the collaborative dynamic between teachers and students was still in the process of being fine-tuned. The average rate of submission for post-class assignments was found to be 93.5%, the average participation rate in peer review was found to be 78.4% and the average click rate on extended resources was found to be 72.3%, indicating a good level of post-class tasks completion but there is still some scope for improvement on peer review and use of extended resources.

Looking at the participation trends across units, the pre-class assignment submission rates for Units 1 and 2 (87.8% and 89.0%, respectively) and video viewing completion rates (85.4% and 86.6%, respectively) were relatively low. The pre-class assignment submission rates for Units 3 through 6 consistently exceeded 91%, reaching a peak of 94.5%. Participation in Units 7 and 8 decreased slightly but remained above 89%. This trend suggests that students need an adjustment period to become familiar with the blended learning model, with peak participation occurring mid-semester (potentially during final exam pressure or increased homework load).

TABLE 3. Participation statistics of students in the experimental class in each stage of blended learning (%; N=82)

Teaching Unit	Pre-class assignment submission rate	Pre-class video completion rate	In-class interaction participation rate	Homework submission rate	sub-Peer assessment participation rate	Click of after-class extended resources
Unit 1	87.8	85.4	82.9	91.5	75.6	68.3
Unit 2	89.0	86.6	83.5	92.1	76.8	69.5
Unit 3	91.5	89.0	85.4	93.9	80.5	72.0
Unit 4	92.7	90.2	86.6	94.5	82.3	74.4
Unit 5	94.5	91.5	89.0	95.1	83.5	75.6
Unit 6	93.9	90.2	87.8	94.5	81.7	73.2
Unit 7	90.2	87.8	86.6	92.7	73.6	71.0
Unit 8	89.6	86.6	84.1	91.5	74.2	69.8
average	91.2	88.6	85.7	93.5	78.4	72.3

Table 3 demonstrates that blended learning model has great advantage in stimulating the participation of the students. The pre-class task submission rate and video completion rate are both close to or above 90%, which indicates the students can accept and adjust to the requirements of pre-class self-study. In-class interaction participation level reached 85.7%. Students said that the situational tasks of class were interesting and related to learning in real life, VR simulated professional situations could make them experience the practical application of language, and group work could enhance communication and cooperation between peers. The post-class homework submission rate was as high as 93.5% but the rate of participation in peer review and

click rate on extended resources was quite low at 78.4% and 72.3%, respectively. Some of the students had interviewed reported that in the peer review process, they didn't know how to evaluate other people's homework, they are worried that they will evaluate it inaccurately, or they will hurt other people's feelings; extended resources of available but there were no clear guidance and requirements, it is easy to be overlooked. This implies in further teaching that teachers should reinforce guidance for peer assessment, providing evaluation standard and examples, using extended resources appropriately integrated with the course tasks to help guide students to make full use of good resources.

C. TEACHING EFFECTIVENESS SATISFACTION AND STUDENT FEEDBACK

The results obtained from the survey on satisfaction on teaching effectiveness demonstrate that students have high overall satisfaction of the blended learning model. Table 4 shows the evaluations of students regarding different indicators of teaching effectiveness. In terms of the overall satisfaction, 85.5% of students were very satisfied or relatively satisfied only 4.6% of the students ranked in the unsatisfied to highly dissatisfied, it is evident that a majority of students approve of the blended learning model. In terms of certain indicators, the acceptance of the model of teaching found the highest score at 87.5% very satisfied or somewhat satisfied which means the students are willing to accept and adapt their learning through this new teaching model. Regarding the improvement in learning interest, the statistics revealed that 84.2% of them were very satisfied or somewhat satisfied and 5.3% were dissatisfied or very dissatisfied, which means the majority of the students agree that blended learning enables them to make learning English more interesting. In terms of perceived improvement in skills, the most satisfied group of the students were for oral skills with the rate of satisfaction being 82.9% (very satisfied or somewhat satisfied) and this was followed by writing skills (80.3%) which supports the results of the performance analysis which showed the most improvement in oral and writing skills. Regarding self-directed learning ability, 69.7 percent was very satisfied or somewhat satisfied and 10.6 percent was dissatisfied or very dissatisfied respectively. This suggests that it is still some of the students are struggling with adapting to self-guided learning and require more help from the teachers. From the mean scores (1 for very dissatisfied, 2 for dissatisfied, 3 for neutral, 4 for somewhat satisfied and 5 for very satisfied), all indicators had a mean score that was higher than 3.8. Acceptance of teaching model got the highest mean score (4.21) followed by perceived improvement in oral communication skills (4.13), while the perceived improvement in self-directed learning ability was relatively low (3.85). This result suggests that the blended learning model is significantly effective in terms of improving productive skills such as oral and writing, but there are still room for improvement in the case of cultivating the self-directed learning ability of the students.

It involves reinforcing information about strategies to learn, and self-directed learning process.

TABLE 4. Student satisfaction evaluation of blended learning effectiveness

Evaluation indicators	Very satisfied (%)	Satisfied (%)	generally (%)	Dissatisfaction (%)	Very dissatisfied (%)	Mean (score)
Acceptance of teaching models	38.2	49.3	8.6	2.6	1.3	4.21
Enhance learning interest	35.5	48.7	10.5	3.3	2.0	4.12
Perception of improving oral communication skills	36.8	46.1	11.8	3.3	2.0	4.13
Improving writing skills and perception	34.2	46.1	13.8	4.0	1.9	4.07
Hearing ability enhances perception	30.3	45.4	16.4	5.3	2.6	3.96
Improve reading ability and perception	28.9	44.7	18.4	5.9	2.1	3.92
Improve self-learning ability	27.6	42.1	19.7	6.6	4.0	3.85
Overall satisfaction	36.2	49.3	9.9	2.6	2.0	4.15

Further analysis of the data in Table 4 shows that the perceived improvement scores for listening and reading skills were relatively low, at 3.96 and 3.92 respectively. This may be related to the fact that these two skills mainly rely on receptive learning. The advantage of blended learning lies in increasing opportunities for productive training, while the improvement of receptive skills is mainly achieved through resource expansion, with a relatively indirect effect. Some students in the interviews also mentioned that the improvement of listening and reading skills is a gradual process, and the effect is not as obvious in the short term as in speaking and writing. The perceived improvement score for self-directed learning ability was the lowest (3.85). Interviews revealed that some students are accustomed to teacher-led classroom teaching and feel uncomfortable with arranging their own study time and choosing learning content, exhibiting problems such as procrastination and confusion. This suggests that when designing blended learning, teachers should not only provide resources and technical support but also strengthen guidance on learning strategies to help students gradually develop metacognitive abilities and learn to plan, monitor, and regulate their own learning process.

V. CONCLUSION

This study, grounded in the context of digital transformation and tailored to the characteristics of engineering vocational education, constructs and implements a blended teaching model integrating multiple digital technologies to facilitate the acquisition of high-performance fiber science technical English. By embedding the linguistic nuances of automated manufacturing into the digital curriculum, the framework ensures that language instruction directly supports the specialized communication needs of the modern industrial environment. Through a three-stage design—pre-class self-study, in-class deep interaction, and post-class extension and enhancement—it effectively integrates online and offline teaching. The model developed in this study provides an actionable practical path for the digital transformation of vocational college

English teaching: integrating diverse digital tools based on a learning management system, driving language application through vocational contextual tasks, adjusting teaching

strategies through data feedback, and promoting deep learning through peer assessment. This study also has certain limitations, such as a research period of only one semester and a sample from the same institution. Future research could extend the observation period and expand the sample scope to verify the long-term effects of this model within engineering and high-performance fiber science curricula, while also exploring deeper applications such as AI-powered personalized learning recommendations tailored to the technical requirements of automated manufacturing. By integrating learning analytics-supported teaching interventions, the framework will further enhance the precision of technical English acquisition for students navigating the complex linguistic and operational standards of the global industrial environment.

AUTHOR CONTRIBUTIONS

Min Zhu designed, collected and analyzed the data, and drafted the manuscript. Min Zhu conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Min Zhu participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Zhejiang Institute of Communications, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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