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Research Article

Construction of Teaching and Education Quality Improvement Model Based on Distributed Information Fusion

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Following the growth of educational informatization, the integrated adoption of the Internet in classroom teaching has facilitated the change of instructional pattern from the conventional instructional pattern to a novel information-based instructional pattern. Based on the background of "Internet+," a variety of new information-based classroom teaching models have emerged. However, in practice, there are still many deficiencies due to the immature application of the model. This paper proposes to use the design-based research paradigm to construct and optimize the teaching mode, and to clarify the design principles of the teaching mode. This paper analyses and designs the English lesson instruction pattern in the distributed information convergence condition from five dimensions: theoretical foundation, online instructional setting, instructional targets, instructional events, and instructional assessment, which construct an instructional pattern. It adopts the method of combining quantitative research with qualitative research and combines the experimental method, questionnaire survey method, classroom observation method, and interview method to assist the research. Through the investigation of 122 valid data, it is shown that the overall amount of classroom codes before the experiment is 57, and the overall amount of classroom codes after the experiment is 150. There is a big difference between the two. It validates the effectiveness of the English lesson instruction pattern in distributed information integration terms in improving students' English achievement, cooperative learning ability, information literacy, and problem-solving ability.

1. Introduction

The proposal of the theory of teachers' professional development makes demands on teachers' knowledge structure and ability level. Teachers, as professionals, are required to grow from "novice" to "expert" and become learners, researchers, and collaborators in the process of development. Irrespective of the era, teachers are professionals in education and teaching, and they should all take the road of professional development. On the road of development, they need to conform to the characteristics and requirements of the development of the times in order to adapt to social development and meet the needs of education and teaching. With the development of social progress and productivity, distributed information fusion methods are becoming more and more mature. Applying it in education and teaching is conducive to the innovation and optimization of the teaching mode. In terms of practical significance, this research adopts a combination of quantitative research and qualitative research to carry out teaching mode practice. Through two rounds of teaching practice, the teaching mode is continuously adjusted and the implementation path of the teaching mode is optimized. The effectiveness of the teaching model is also verified. The application strategies of the teaching mode under the condition of distributed information fusion are summarized through practical verification, and the research will be helpful for the exploration and reconstruction of the teaching mode under the condition of distributed information fusion, which provides practical experience for schools and teachers to carry out English classroom teaching in a distributed information fusion environment.

In recent years, many scholars have carried out research on the improvement of teaching and education quality. Wu found that promoting the development of students' thinking quality is important in teaching reading in English [1]. Yin and Na used SPSS software to analyze the reliability indicators of microlearning resources and MOOC, and the results showed that this teaching model has high stability and reliability, which can promote the effectiveness of teaching English in university [2]. Theory plays an important role in educational planning and research. A scoping review was conducted by Goldman J to examine the application of theory to quality improvement and patient safety education [2, 3]. However, its application to quality improvement and patient safety education has not been fully described. Wang and Wang analyzed and compared the characteristics of MOOC and SPOC, and proposed and constructed a new model of post-MOOC online education based on "autonomy" [4]. Liu and Yang explored the design of a creative teaching model for computer-aided design [5]. However, the research methods for teaching reading are not efficient enough.

Distributed information fusion is becoming increasingly important and Mokhtar et al. proposed a distributed architecture for sensing information processing and fusion to improve sensing performance and reduce reporting errors [6]. However, it did not improve the efficiency and reliability of sensing in Rayleigh fading environments. Benzerouk et al. proposed a new consensus-based approach to the Cuature Kalman filtering problem for inertial sensor networks with gyroscope and accelerometer saturation [7]. However, the experimental results do not demonstrate the superiority of the CKF-based consensus over the previously proposed consensus-based unscented Kalman filter. Olatunbosun and Lawal developed algorithms on distributed and decentralized multi-sensor data estimation and fusion [8]. However, this algorithm cannot asynchronously complete the transmission of new information when the amount of information measured in terms of randomness is less than a fixed threshold level. Chetty and Yamin proposed a novel intelligent processing method based on soft and hard sensor fusion for obtaining better actionable intelligence from automated computer-based decision support systems [9]. Hakimi and Abed Hodtani solved the problem of digital amplitude phase modulated signals in multi-sensor systems for distributed classification problem for these sensors observing unknown signals corrupted by additive Gaussian white noise [10]. The proposed scheme improved the classification accuracy but did little to improve performance. The aim of Korneev et al.'s research was to identify the use of ontological methods that could go towards building innovative automated education management systems [11]. These studies have made a good exploration of the application value of distributed information fusion but have not innovatively integrated it with the field of education. Only the use of innovative methods and tools for distributed information fusion can allow a flexible implementation of methodological support for education and educational activities.

In terms of teaching behavior, the total number of codes taught by classroom teachers before the experiment was 184, and the total number of classroom codes after the experiment was 198. It shows that teachers reduce the proportion of knowledge teaching in the classroom, and increase the proportion of problem explanation and knowledge summary. In the command behavior, the total number of codes taught by classroom teachers before the experiment was 112, and the total number of classroom codes after the experiment was 48. It highlights the dominant position of students in the classroom. The innovation of this paper is based on the relevant theories of the teaching mode under the condition of distributed information fusion, and is based on the English subject. An English classroom teaching model under the condition of distributed information fusion is constructed, and the teaching model is practiced to verify its effectiveness. A combination of quantitative research and qualitative research is used in teaching practice. Comprehensive experimental method, questionnaire method, classroom observation method, and interview method are used to track the implementation of the teaching mode and measure the effect of the teaching mode.

2. Construction Method of Teaching Mode of Distributed Information Fusion

2.1. Information Classroom Resource Construction. Information classroom resources are the basis for innovating classroom models and developing learner-centered research-based learning. Applying information technology to the classroom can not only strengthen the communication and interaction between teachers and students but also stimulate students' enthusiasm for learning. In the information-based teaching environment, classroom teaching has become more intelligent, and students' learning has become more autonomous. Therefore, the resource construction of information-based classrooms should be based on Internet technology. An intelligent teaching system including modern information technology equipment and supporting control software should be built so as to be able to carry out various intelligent activities in the following figure. The technical characteristics of the information-based classroom construction are shown in Figure 1.

As shown in Figure 1, the hardware facilities of the informatization classroom are the foundation of the informatization of the high school physics classroom, and they provide a strong technical support for the implementation of the informatization classroom. Its features mainly include collection of teaching situations, dynamic and precise feedback, real-time push of content, collaboration, communication and interaction, data intelligent analysis, and teaching resource sharing. The gradual improvement of the information-based classroom teaching model will inevitably put forward new requirements for information technology, and the two are the driving force and they complement each other.

The two essential elements for building an information-based teaching model are modern information technology and an intelligent teaching resource library. Only by deeply integrating the two can a new classroom teaching model that

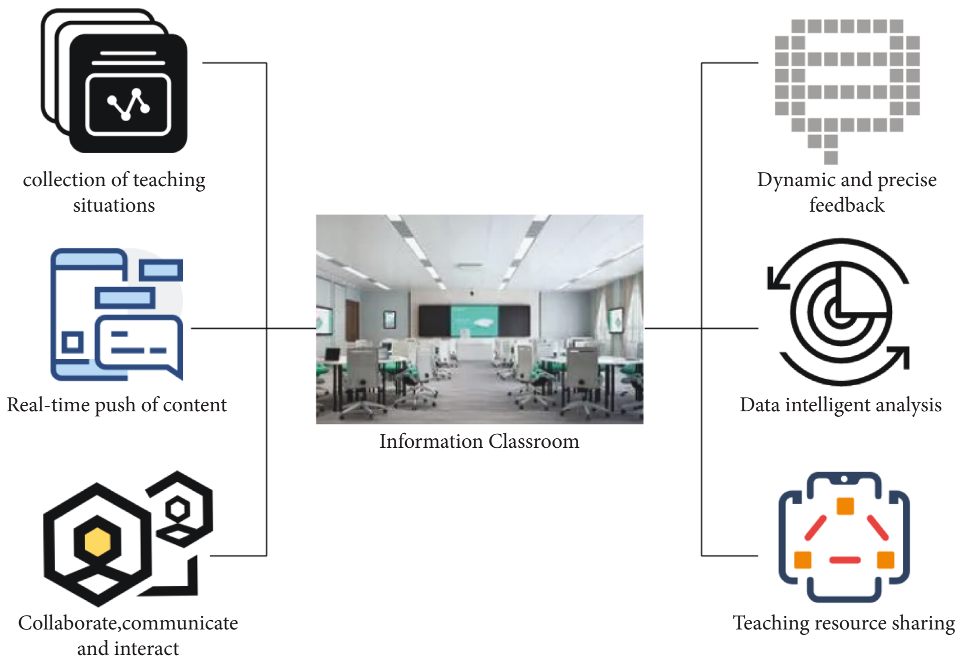

Figure 1: Technical characteristics of information classroom construction.

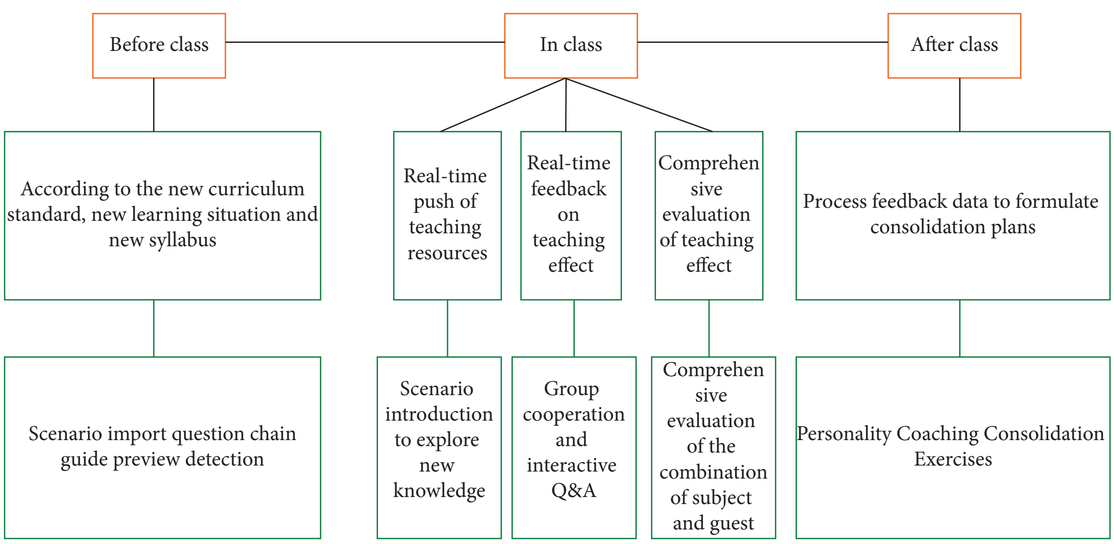

Figure 2: Information classroom teaching mode.

includes the whole process of pre-class, in class, and after-class be built [12]. The information-based classroom teaching mode is shown in Figure 2.

As shown in Figure 2, in the design of the information-based teaching model, the teaching concept of "teacher-led, student-centered" has always been followed. According to the concept of information technology in education, the deep integration of information technology and classroom teaching provides an effective way to achieve an efficient classroom [13].

2.2. Distributed Information Fusion Algorithm. The information interpolation algorithm is the process of estimating the sensor information of the unsampled area based on the sensor information that has been sampled. It is based on the model construction and application of the existing sensor information. Affected by the monitoring methods and the monitoring environment, it is impossible to obtain high-precision sensor information data, while sensor information interpolation can play an important role here, indicating that sensor information interpolation is very necessary [14].

2.2.1. Sensory Information Spline Interpolation. The sensing information spline function interpolation method obtains the sensing information interpolation estimation result by minimizing the curvature of the interpolation estimation plane. Finally, a smooth surface covering the sampling points of known sensing information can be obtained [15]. Points are defined as internal nodes, and the spline function minimizes the curvature of the surface estimated by interpolation according to the known sampling points of sensing information. It is expressed as

$$S(x, y) = T(x, y) + \sum_{i=1}^{N} \lambda_i R(r_i). \tag{1}$$

There are two main types of spline functions: regular and tension function methods. The regular spline function method will introduce values outside the sampling interval of known sensor information for interpolation estimation. For the regular spline function, the mathematical expressions of its variables T and R are given as formulas (2) and (3):

$$T(x, y) = a_1 + a_2 x + a_3 y, \tag{2}$$

$$R(r_i) = \frac{r_i^2 [\ln (r_i/2\tau) + c - 1] + \tau^2 [k_0 (r_i/\tau) + c + \ln (r_i/2\pi)]/4}{2\pi}. \tag{3}$$

In formula (2), a_i is the constant coefficient of the result of the linear system of equations. In formula (3), τ is the weighting coefficient; r is the distance between the sensor information interpolation estimation point and the known sensor information point; k_0 is the corrected Bessel function; and the size of c is equal to 0.577215.

For the tension spline function, the mathematical expressions of its variables T and R are given as formulas (4) and (5):

$$T(x, y) = a_1, \tag{4}$$

$$R(r_i) = \frac{1}{2\pi\varphi^2} \left[\ln \left[\frac{r_i \varphi}{2} \right] + c + k_0 (r_i \varphi) \right]. \tag{5}$$

Among them, a_i in formula (4) has the same definition as in formula (2). In formula (5), φ is the weighting coefficient; r is the distance between the sensor information interpolation estimation point and the known sensor information point. The definitions of k_0 and c are the same as those of formula (3).

2.2.2. Sensing Information Kriging Interpolation. The sensory information Kriging interpolation method is a probability and statistical model based on the autocorrelation statistical relationship between the sensory information sampling points [16]. While performing the interpolation estimation of the sensing information, it can also evaluate the interpolation estimation result of the sensing information.

The Kriging interpolation method formula for distributed sensing information is given as formula (6):

$$\widehat{Z}_0 = \sum_{j=1}^{N} \lambda_j Z_j. \tag{6}$$

In formula (6), $\widehat{Z}_0$ is the interpolated estimate of the sensory information at point (x, y), that is, $z_0 = z(x_0, y_0)$.

First, the premise of the interpolation estimation of the Kriging sensor information is that the regional characteristic z is continuous, uniform, and unique. For any sensing information sampling point (x, y) in the area, the expectation c and the variance σ^2 are consistent [17, 18]. For any sensing information sampling point, formulas (7) and (8) can be obtained:

$$E[z(x, y)] = E[z] = c, \tag{7}$$

$$\mathrm{Var}[z(x, y)] = \sigma^2. \tag{8}$$

The value $z\ (x, y)$ at any sensing information sampling point is composed of the regional sensing information mean c and the random deviation $R\ (x, y)$ of the sampling point, as shown in formula (9):

$$z(x, y) = E[z(x, y)] + R(x, y) = c + R(x, y). \tag{9}$$

In formula (9), $R\ (x, y)$ represents the deviation at the sensing information sampling point (x, y), and its variance is constant.

$$Var[R(x, y)] = \sigma^2. \tag{10}$$

The theoretical premise of unbiased estimation of the Kriging sensor information interpolation is $E(\widehat{Z}_0 - z_0) = 0$, substituting formula (6) into formula (11):

$$E\left(\sum_{j=1}^{N} \lambda_j z_j - z_0 \right) = 0. \tag{11}$$

Since $E\ [z] = c$ for any z, then formula (12) can be obtained:

$$c \sum_{j=1}^{N} \lambda_j - c = 0. \tag{12}$$

It can be solved and formula (13) can be obtained:

$$\sum_{j=1}^{N} \lambda_j = 1. \tag{13}$$

This is one of the constraints of the weight coefficient λ_j.

Next, the estimation error $J = \mathrm{Var}(z_j - z_0)$ is analyzed. The cost function is given as formula (14):

$$J = \sum_{j=1}^{N} \sum_{i=0}^{N} \lambda_j \lambda_i \mathrm{Cov}(z_j, z_i) - 2 \sum_{j=1}^{N} \lambda_j \mathrm{Cov}(z_0, z_i) + \mathrm{Cov}(z_0, z_0). \tag{14}$$

The symbol $C_{ij} = \mathrm{Cov}(z_j, z_i) = \mathrm{Cov}(R_i, R_j)$ is defined. Here, $R_i = z_i - c$ is the deviation of the sensory information value at the point (x_i, x_j) which is relative to the area average sensory information value. Then, formula (15) can be obtained:

$$J = \sum_{j=1}^{N} \sum_{i=0}^{N} \lambda_j \lambda_i C_{ij} - 2 \sum_{j=1}^{N} \lambda_j C_{i0} + C_{00}. \tag{15}$$

Finally, the semi-variance function is substituted into formula (15), and the constraint formula (13) of the weight coefficient is introduced. Formula (16) can be obtained:

$$J = \sigma^2 - \sum_{j=1}^{N}\sum_{i=0}^{N}\lambda_j\lambda_i r_{ij} - 2\sigma^2 + 2\sum\nolimits_{j=1}^{N}\lambda_j r_{i0} + \sigma^2 - r_{00} = 2\sum_{j=1}^{N}\lambda_j r_{j0} - \sum_{j=1}^{N}\sum_{i=0}^{N}\lambda_j\lambda_i r_{ij} - r_{00}, \tag{16}$$

When J is the smallest, a set of λ_i needs to be written down, and J is a function of λ_i, so the partial derivative of J with respect to λ_i is set to 0, as shown in formula (17):

$$\frac{\partial J}{\partial \lambda_i} = 0; i = 1, 2, \cdots, n. \tag{17}$$

For Lagrangian solving for conditional extrema, the first step is to come up with a polynomial function based on constraints, as shown in formula (18):

$$J + 2\phi\left(\sum_{j=1}^{N}\lambda_j - 1\right). \tag{18}$$

In formula (18), φ is the Lagrange multiplier. Then, the parameter set φ that minimizes the value of this objective function needs to be solved. λ_j, the minimum value of J under the constraints, can be obtained. Then, the linear equation system about the weight coefficient λ_j can be obtained as shown in formula (19):

$$\begin{cases} r_{11}\lambda_1 + r_{12}\lambda_2 + \cdots + r_{1n}\lambda_n - \phi = r_{10}, \\ r_{21}\lambda_1 + r_{22}\lambda_2 + \cdots + r_{2n}\lambda_n - \phi = r_{20}, \\ \cdots, \\ r_{n1}\lambda_1 + r_{n2}\lambda_2 + \cdots + r_{nn}\lambda_n - \phi = r_{n0}, \\ \lambda_1 + \lambda_2 + \cdots + \lambda_n = 1. \end{cases} \tag{19}$$

For the matrix form of the above equations, the optimal coefficients can be obtained by inverting the matrix, which can be substituted into formula (6) to solve the distributed sensing information interpolation estimation value [19]. The interpolation algorithm in distributed information fusion has high precision, can effectively calculate and analyze teaching data, and obtain accurate and reliable analysis results.

3. Experiment on the Construction of Teaching Mode Integrating Distributed Information

3.1. Methods. Experimental method: The experimental method requires that according to the purpose of the experiment, the experimental results are assumed. The experimental plan is designed, and the experimental objects are selected. The experimental conditions are also controlled. Then, its experimental results are compared and analyzed, and the validity of the hypothesis can be determined. This study uses the experimental method to verify the effectiveness of the English classroom teaching model. A certain class was selected as the experimental object, and another parallel class was selected as a control class (CC) to conduct controlled trials. In order to ensure the validity of the experiment, the students of the experimental class and the control class were randomly selected, and other experimental conditions of the two classes were kept the same. Before and after the two practice cycles, the students' performance and ability were measured before and after, and the measurement results were compared horizontally and vertically, in order to analyze whether the English classroom teaching mode under the condition of distributed information fusion can improve students' English achievement, cooperative communication ability, problem-solving ability, and information literacy [20].

Design-based research methods: Design-based research methods, also known as design-based research paradigms, involve researchers in real-world situations to conduct formative research. The research process used a variety of research methods comprehensively, and feedback information was obtained through practice. Based on feedback, it iteratively improved until problems and defects were eliminated, forming a stable and reliable design, so as to achieve dual development of theory and practice. This research adopted a design-based research paradigm in the construction and practice of the teaching model, and comprehensively used the experimental method, classroom observation method, interview method, questionnaire method, and physical analysis method. The focus of practice was to pay attention to the effect and procedural laws of teaching implementation from the teacher's level, and to refine and optimize the classroom teaching mode.

Classroom observation: Classroom observation is a qualitative research method, through which researchers use senses and related auxiliary tools to collect data from classroom situations and analyze classroom observation data. The focus of classroom observation is to pay attention to the various behaviors of teachers and students. This study adopted the form of nonparticipatory observation, and the observers did not participate in the teaching activities of the observed. Instead, they needed to be outside the classroom teaching activities, and recorded the teaching activities of teachers and students by means of transcripts, audio recordings, and video recordings. On the one hand, the classroom observation scale was used to record the students' classroom performance. On the other hand, the classroom was recorded to observe the real and objective classroom situation.

Physical analysis: Physical analysis is one of the methods of qualitative research, and physical data can provide an effective material basis for educational research. It can provide more accurate judgments for teachers' teaching effect, so as to promote teachers to improve their educational behavior and improve their teaching level. Through the physical analysis of teachers' teaching reflection sheets, this research tracked the changes in teachers' teaching concepts and teaching methods in the process of teaching mode practice. Through the physical analysis of students' homework works, the changes in students' cooperation and communication ability, problem-solving ability, and information literacy were explored.

3.2. Teaching Mode Construction. In this study, the teaching mode is defined as a structural form, and a complete teaching mode has five elements: theoretical basis, teaching objectives, realization conditions, operating procedures (teaching activities), and teaching evaluation. The teaching situation of this research is that the distributed information fusion has changed the external environment of classroom teaching, so the realization conditions of this research put more emphasis on the Internet teaching environment. The research revolves around five elements of the teaching model: theoretical basis, teaching objectives, Internet teaching environment, teaching activities, and teaching evaluation. The English classroom teaching mode under the condition of distributed information fusion is constructed, as shown in Figure 3.

As shown in Figure 3, the teaching mode is supported by the Internet learning environment, and its teaching goal is to cultivate students' comprehensive ability to use English language and acquire cross-cultural communication skills. The teaching links are carried out in sequence according to online and offline guidance, offline classroom guidance, as well as online and offline after-school assistance. Teaching evaluation adopts diversified and comprehensive evaluation methods to comprehensively and systematically evaluate students' learning activities.

Teaching objectives: The teaching goal of the English teaching model under the condition of distributed information fusion is based on the teaching purpose of cultivating students' cross-cultural communication ability, which is refined into overall objectives, subject objectives, and three-dimensional objectives. The overall goal is to improve students' English performance and information literacy, cooperation and communication skills, and problem-solving skills, which are the core literacy attributes of Chinese students. The overall goal includes course goals, unit goals, and class hour goals in specific English subject content. The implementation of subject goals is refined into three-dimensional goals of knowledge and skills, process and methods, emotional attitudes and values in classroom teaching. The teaching objectives of each level are adjusted according to the specific learning content and teaching situation. However, to a certain extent, they can reflect the overall direction of the discipline and the overall direction of the activities.

Teaching activities: Teaching activities refer to the organization and guidance of teaching content, the mixed application of teaching methods, and the transmission and guidance of teaching emotional value. The specific operating procedures and practices of teaching activities at different stages are different. Any teaching model has a relatively fixed operating procedure, but it is not absolutely fixed and can be appropriately combined. The teaching activities of the English classroom teaching mode under the condition of distributed information fusion are divided into three parts: pre-class learning (online + offline), classroom learning (offline), and after-school assistance (online + offline).

Teaching evaluation: Teaching evaluation is an indispensable basic requirement and link in the process of teaching activities. The evaluation of English classroom teaching mode under the condition of distributed information fusion emphasizes the diversification of teaching evaluation, and the specific evaluation indicators are shown in Figure 4.

As shown in Figure 4, the realization condition of the English classroom teaching mode under the condition of distributed information fusion is mainly the Internet teaching environment. The Internet teaching environment mainly includes mobile terminal equipment, online teaching resources, digital teaching tool platform, and other environmental factors. The operation procedure of the English classroom teaching mode under the condition of distributed information fusion is mainly the organization and arrangement of teaching activities. Teaching activities are divided into three stages, namely, pre-class learning, in-class learning, and after-class learning assistance. The three-stage teaching links are interlinked so that a seamless connection between inside and outside the classroom can be achieved. Each stage has basic steps, but each step is not rigid. Teachers can make reasonable adjustments according to the actual situation to meet the needs of actual teaching. The teaching evaluation of the English classroom teaching mode under the condition of distributed information fusion reflects the characteristics of diversification, and the multivariate evaluation is the core of the teaching evaluation. The evaluation method adopts a combination of formative evaluation and summative evaluation. The evaluation content includes online evaluation and offline evaluation. The evaluation subjects include teaching, students, and parents, and the evaluation dimensions include students' knowledge of English and various abilities.

3.3. Practice of English Classroom Teaching Mode under the Condition of Distributed Information Fusion. The practice of the new classroom teaching model under the condition of distributed information fusion is the core content of this research, and the model practice is carried out in two rounds according to the design-based research paradigm. Teaching practice aims to realize the normalized application of teaching mode and forms a stable teaching structure. Therefore, it focuses on classroom teaching situation and changes in students' performance and ability from the perspective of teachers. To further explore the practical laws of the teaching mode and optimize the practical effect of the teaching mode, the focus is on students' process performance and changes in performance and ability from the perspective of students. The overall framework of teaching model practice research is shown in Figure 5.

As shown in Figure 5, the teaching mode practice aims to form a stable classroom teaching structure through teaching experiments in accordance with the basic links of the teaching mode—pre-class learning, classroom learning, and after-school assistance—to carry out teaching practice.

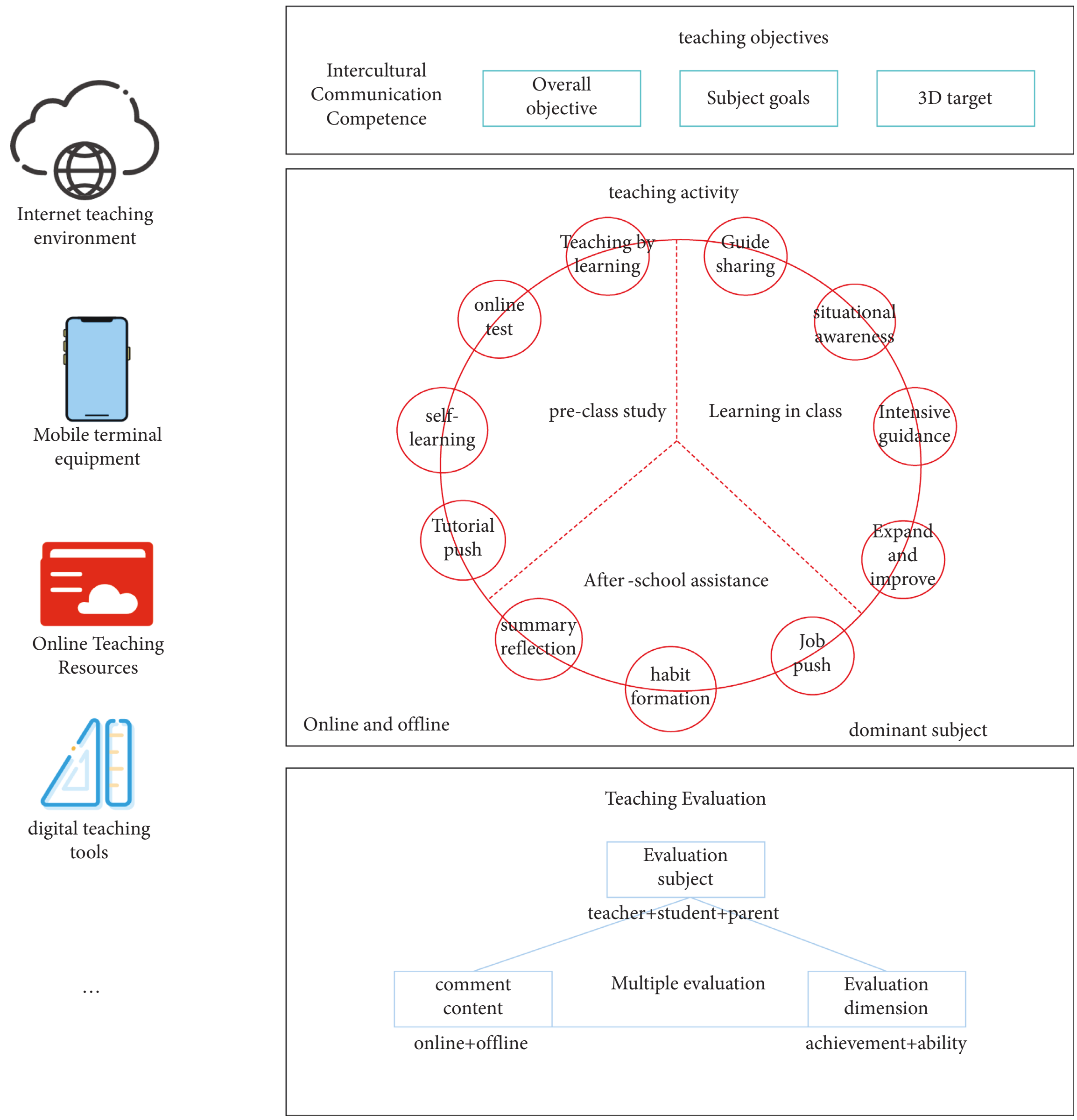

Figure 3: English classroom teaching mode under the condition of distributed information fusion.

Through qualitative observation and tracking, classroom observation and analysis of teaching videos are carried out, and physical analysis of teachers' teaching reflection forms is carried out. The focus should be on whether the teacher, as the subject, conducts classroom teaching according to the teaching mode, whether the teaching method has changed, and whether there are problems in the process of teaching implementation. The conclusions of the experimental research and qualitative research can be mutually confirmed, and the data support and theoretical basis for the revised implementation plan of teaching practice can be provided.

3.3.1. Experimental Design

(1) Test Object. A certain class in this study was the experimental object, and the teacher of the experimental class (EC) taught 2 parallel classes. One of the classes was the EC, with a total of 62 students, 26 boys and 36 girls, and the other class was the CC, with a total of 62 students, 28 boys and 34 girls. The EC and the CC had the same level of basic English ability.

(2) Experimental Content. This experiment focused on the influence of English classroom teaching mode on students' English achievement, cooperative communication ability, problem-solving ability, and information literacy under the condition of distributed information fusion. The independent variable was the teaching mode, and the dependent variables were English achievement and three ability indicators. The validity of the teaching mode was verified through the changes of the dependent variables.

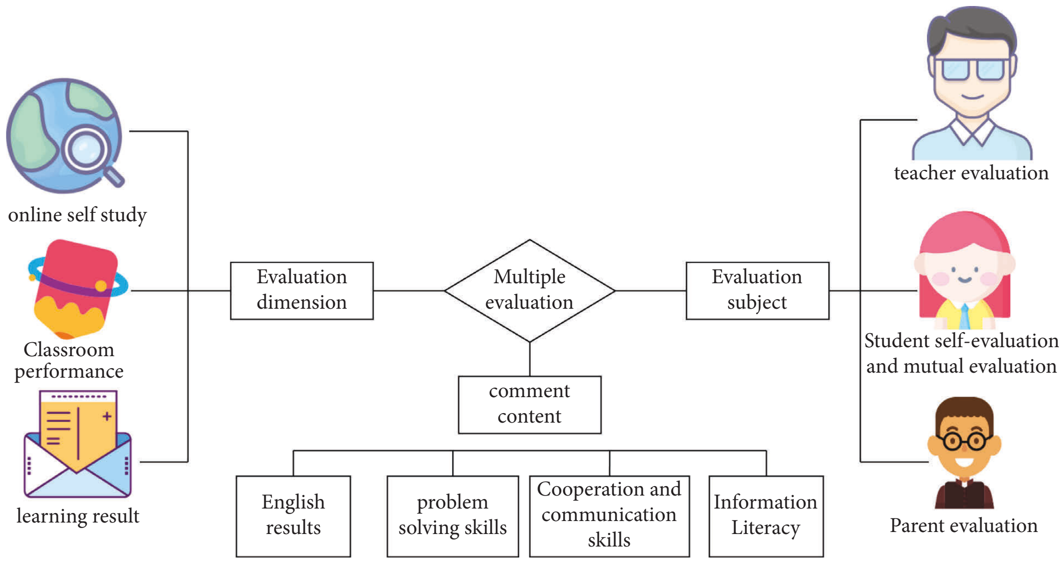

Figure 4: Multi-evaluation in English classroom under the condition of distributed information fusion.

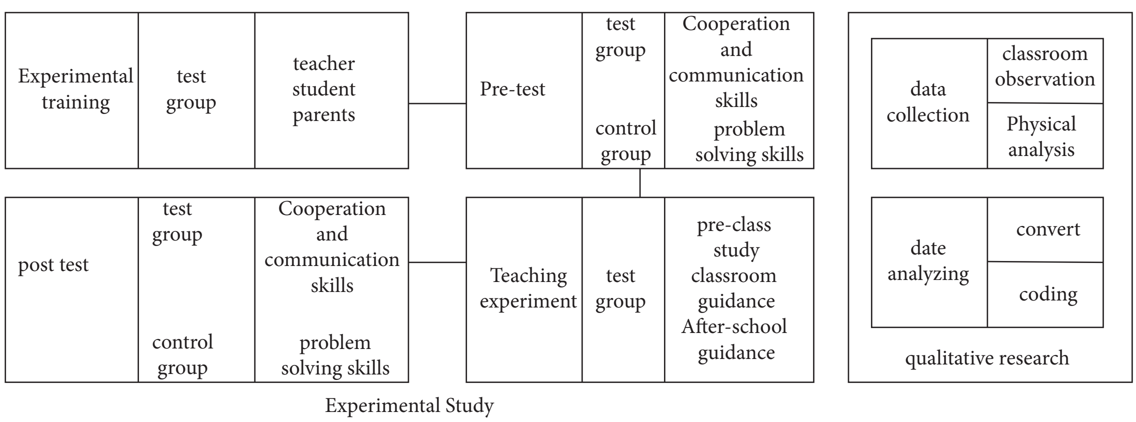

Figure 5: Practical research framework.

(3) Measuring Tools. Combined with the teaching objectives of English subjects, it focused on the impact of the new classroom teaching mode on learners' academic performance, cooperation and communication ability, problem-solving ability, and information literacy. For English study results, the subject scores of the previous semester were used as pretest scores, and the final exam scores were used as posttest scores. Combined with the subject teaching content, the problem-solving ability test was prepared, and the overall reliability of the scale reached 0.933.

(4) Experiment Preparations. In order to carry out the experiment more smoothly and efficiently, sufficient preparatory work was carried out before the experiment. Preliminary preparations included formulating an experimental system, training experimental teachers, mobilizing students' parents, and equipping experimental equipment. First, a scientific and efficient management system has been formulated, with a clear division of responsibilities, to ensure that problems found are solved in a timely manner, so that the experimental plan can be successfully completed. Second, pretraining was carried out for teachers participating in the experiment, so that teachers could clarify the experimental content, experimental process, and precautions. At the same time, training on the use of teaching platform tools was carried out for the teachers of the experimental class, so that teachers can be proficient in operating the Internet teaching tool platforms, such as the cloud school home platform, teaching assistants, and interactive classrooms in advance. Third, a teaching practice mobilization meeting was held for the parents of the students, and the purpose and significance of this experiment were introduced to them through the parent meeting. Questionnaires were distributed to collect parents' questions and suggestions on how students use mobile phones to learn, how parents supervise and manage, and a mobile phone supervision and management manual was formulated for parents to allow parents to play a role in supervision and management, cooperating with school teaching experiments through home-school co-education. In terms of facilities, the experimental equipment included class intelligent all-in-one equipment, students' smart phones, tablet computers and

other mobile portable electronic devices, and experimental data recording and analysis equipment.

3.3.2. Experiment Implementation. This research implemented the English classroom teaching mode under the condition of distributed information fusion to the EC. The classrooms of the EC were equipped with intelligent all-in-one computer equipment, tablet computers and other mobile portable electronic devices, and Internet teaching tool software (cloud school home platform, teaching assistants and interactive classrooms, etc.). Teachers used these hardware devices and software platforms to carry out teaching. The traditional classroom teaching was implemented for the CC, and the teaching environment of the CC was a conventional multimedia classroom. The practice period was 3 months, with a total of 64 class hours. During the experiment, the author participated in the setting of the curriculum, prepared lessons and research with teachers, and selected knowledge points to make learning videos. Besides, the author also continued to listen to and observe lessons, observed the status of the classroom, and recorded the classroom proceedings. The EC and the CC were measured for achievement and ability, and the experimental data were summarized, processed, and analyzed.

We have adopted the method of combining theory with practice and designed a "three-stage" whole process teaching mode of "before class, during class, and after class." Then, teaching experiments were carried out in the EC. There were four links in the classroom learning stage, including learning guidance sharing, overall perception, difficulties exploration as well as expansion and improvement. In the after-school assistance stage, the focus was on the design of students' reflection activities.

In the experiment, before and after the cycle, the EC and the CC were measured in English achievement, cooperative communication ability, problem-solving ability, and information literacy ability. A total of 124 pieces of data were recovered, the recovery rate of which was 100%, including 2 invalid results and 122 valid data. Through the analysis of students' performance, communication ability, problem-solving ability, and information literacy assessment data, the following conclusions were obtained.

3.4. Practice Results of English Classroom Teaching Mode

3.4.1. Differences in English Learning Achievements. In order to explore whether there is a difference in the English scores of the EC before and after the semester, this study conducted a horizontal independent sample T-test on the pretest scores and posttest scores of the EC and the CC, respectively. The analysis results are shown in Table 1.

As shown in Table 1, the results show that there is no significant difference (NSD) in the pretest English scores of the EC and the CC before the experiment. It also can be seen that the pretest scores of the EC and the CC are homogeneous [21]. The students' initial English knowledge level is relatively consistent, which can be studied in groups. There is NSD in the posttest English scores between the EC and the CC.

This shows that after the teaching practice, the English performance of the experimental class did not improve significantly. The reasons for the significant improvement in the English scores of the experimental class may include these aspects: First, the experimental period of the teaching mode is insufficient. The experimental period was 3 months, and the performance improvement effect of the new English classroom teaching mode was not obvious in a short period of time. Second, teachers are in the stage of adapting to the new teaching mode. Teachers need time to adapt to the transition of the teaching mode. In the early stage of the teaching mode experiment, teachers were still in the application and exploration stage. In the limited time, teachers cannot use the new teaching mode to implement activities. It is difficult to give full play to the advantages of the teaching mode. Therefore, there is no significant improvement in student performance. Third, students' learning autonomy is weak. The new English classroom teaching mode under the condition of distributed information fusion has high requirements for students' autonomy. Students need to complete the guidance tasks before class, conduct exploratory learning in class, and complete homework on time after class, which are the prerequisites for improving performance. However, students are accustomed to passively accept knowledge under the traditional classroom teaching mode, their learning autonomy is inhibited, and their autonomous learning ability is relatively weak. Students also need time to change their learning attitudes and adjust their learning methods to adapt to the new classroom model, so the performance improvement in a short period of time is not significant.

3.4.2. Ability Change Comparative Analysis. In order to explore whether the cooperative communication ability, problem-solving ability, and information literacy of the EC are different before and after the semester, this study conducted a horizontal pretest and posttest independent sample t-test between the EC and the CC. The analysis results are shown in Table 2.

As shown in Table 2, the cooperative communication, problem-solving ability, and information literacy of the EC may not be significantly improved. In order to further analyze the differences before and after the students' cooperative communication ability, it is necessary to conduct longitudinal pre- and posttest comparative analysis on the cooperative communication ability, problem-solving ability, and information literacy of the EC and the CC. The paired-samples t-test was performed on the pre- and posttest abilities of the EC and the CC, respectively. Its analysis results are shown in Table 3.

As shown in Table 3, there is NSD in the cooperative communication ability of the EC before and after the experiment ($Sig = 0.547$, $Sig > 0.05$), and there is NSD in the cooperative communication ability of the students in the CC before and after the experiment ($Sig = 0.457$, $Sig > 0.05$). There is NSD in the problem-solving ability of the students in the EC before and after the experiment ($Sig = 0.221$, $Sig > 0.05$), and there is NSD in the problem-solving ability

Table 1: Independent sample *t*-test for pretest and posttest scores in EC and CC.

Pre- and post-test	Class	Number of cases	Average value	Levin's variance *F*	Equality test	Mean *t*	*t*-test
Pretest comparison	EC	61	94.11	0.004	0.952	0.599	0.550
	CC	61	91.59				
Posttest comparison	EC	61	94.885	3.113	0.080	1.328	0.187
	CC	61	88.738				

Table 2: Independent sample test of pretest and posttest ability of EC and CC.

Ability	Pre- and posttest	Class	Average value	Levin's variance *F*	Equality test	Mean *t*	*t*-test
Cooperation and communication skills	Pretest	EC	116.950	1.001	0.319	0.995	0.322
		CC	113.623				
	Posttest	EC	115.525	4.130	0.044	1.150	0.252
		CC	111.098				
Problem-solving skills information	Pretest	EC	74.295	1.441	0.232	1.421	0.158
		CC	71.131				
	Posttest	EC	72.328	5.144	0.025	0.553	0.582
		CC	70.934				
Literacy ability	Pretest	EC	14.115	0.001	0.975	0.803	0.424
		CC	13.590				
	Posttest	EC	12.820	0.635	0.427	−0.114	0.910
		CC	12.902				

Table 3: Paired sample test of pretest and posttest ability in EC and CC.

Ability	Class	Pretest mean (*E*)	Posttest mean (*E*)	Correlation coefficient	Before and after test *t*	Salience
Cooperation and communication skills	EC	116.47	114.79	0.296	0.605	0.547
	CC	113.623	111.098	0.247	0.748	0.457
Problem-solving skills information	EC	74.226	71.984	0.226	1.237	0.221
	CC	71.131	70.934	0.458	0.100	0.921
Literacy ability	EC	14.115	12.820	0.999	1.934	0.058
	CC	12.902	13.590	0.405	1.286	0.203

of the students in the CC before and after the experiment (Sig = 0.921, Sig > 0.05). There is NSD in the information literacy of the students in the EC before and after the experiment (Sig = 0.058, Sig > 0.05), and there is NSD in the information literacy of the students in the CC before and after the experiment (Sig = 0.203, Sig > 0.05).

To sum up, through experimental research, it is found that the new English classroom teaching mode under the condition of distributed information fusion may have a promoting effect on students' English achievement. It has no effect on improving students' cooperation and communication skills, problem-solving skills, and information literacy. Considering the short experimental period of the model, the lack of teachers' informatization teaching ability, and the time it takes for students to adapt to the teaching model, this research will combine qualitative analysis to further analyze students' cooperative communication ability, problem-solving ability, and information literacy from students' classroom performance and works.

3.4.3. Coding System Construction. The classroom observation of the study is based on the analysis of Flemish classroom interaction, focusing on the observation of language behavior in the classroom. The ITIAS (Information Technology-Based Interactive Analysis and Coding System) coding analysis method can provide a reference idea for the classroom observation analysis of this study. ITIAS is highly similar to studying distributed information fusion teaching situations, so this study codes classroom behaviors according to ITIAS. ITIAS divides classroom teaching behavior into four categories: teaching behavior of teachers, learning behavior of students, technical behavior, and silent behavior. Teacher behavior refers to the behavior of teachers in teaching, instructing, asking questions, etc. Student behavior refers to the behavior of students answering questions and communicating and discussing. Technical behavior refers to the behavior of teachers and students operating multimedia and information technology. Silence behavior refers to chaotic behaviors other than the above behaviors that do not contribute to classroom teaching. Based on this, this study draws on ITIAS to code classroom behaviors, forming a total of 17 codes, and also elaborates on various teaching behaviors in combination with teaching situations. Meanwhile, on the basis of the teaching mode link, the two classroom links are coded, respectively, according to the

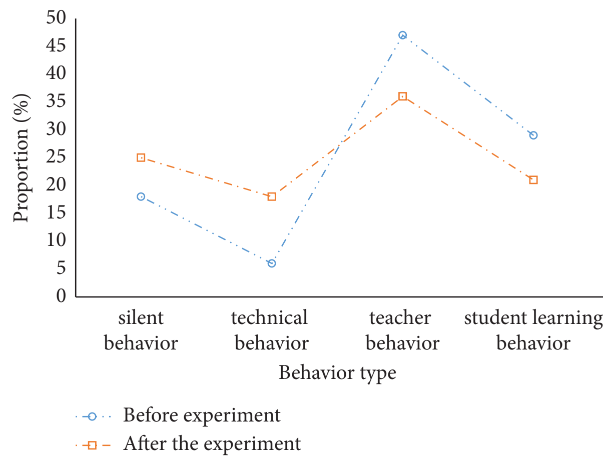

Figure 6: Classroom behavior type ratio chart.

actual teaching process, and a total of 12 codes are formed in the teaching link. The comparative analysis of classroom behavior coding ratio is shown in Figure 6.

As shown in Figure 6, the proportion of classroom behavior before the experiment is from high to low: teacher behavior, student behavior, silent behavior, and technical behavior, which are 47%, 29%, 18%, and 6%, respectively. The proportion of classroom behavior after the experiment is from high to low: teacher behavior, silent behavior, student behavior, and technical behavior, which are 36%, 25%, 21%, and 18%, respectively. Classroom technical behavior and silent behavior after the experiment are higher than those before the experiment, and the overall ratios of teacher behavior and student behavior decreases. The decrease in teacher behavior is due to reduced teacher questioning behavior and increased rate of technology impacting students. Students are stimulated by media technology, and the effect of technology on students replaces part of teachers' behavior, resulting in a decline in the overall rate of teacher behavior. The reason for the decrease in student behavior includes reduced student response behavior and increased rate of technology impacting students. Therefore, the student behavior ratio is relatively reduced. The change in silent behavior is due to a large increase in the rate of unhelpful teaching confusion in silent behavior. The comparative analysis of teacher teaching behavior matrix coding is shown in Figure 7.

As shown in Figure 7, the frequency distribution of teacher behaviors in the two classrooms is initially compared, and the behaviors of teacher teaching, instructing, and asking closed questions rank the top three. In terms of teaching behavior, the total number of codes taught by classroom teachers before the experiment is 184, and the total number of classroom codes after the experiment is 198, which are close to each other. The lecture behavior in the classroom before the experiment appears more frequently in the knowledge intensive lecture and the practice lecture, while in the classroom after the experiment the teaching behaviors are distributed evenly in the summarization, feedback and explanation, and classroom practice. This has a lot to do with the student-centered classroom design of "learning before teaching". Teachers reduce the proportion of knowledge teaching in the classroom and increase the proportion of problem explanation and knowledge summary. In terms of instruction behavior, the total number of codes taught by classroom teachers before the experiment is 112, and the total number of classroom codes after the experiment is 48. There is a big difference between the two. It can be seen that in the classroom before the experiment, the teacher has a strong control over the students, while the teacher in the classroom after the experiment gives the initiative to the students, and the dominant position of the students in the classroom is more prominent. In raising closed questions, the total number of classroom codes before the experiment is 116, and the total number of classroom codes after the experiment is 56, which is quite different. In the classroom before the experiment, the teacher has already preset the questions when preparing the lesson, so the teacher needs to ask more closed questions before the experiment, which may be related to the relatively boring traditional classroom. Teachers need to get the learner's attention by asking this behavior. In terms of critical behavior, the total number of classroom codes before the experiment is 1, and the total number of classroom codes after the experiment is 18. The difference between the two is obvious. Criticism occurs in the chaotic state of the classroom. There are many activities in the classroom after the experiment, and the use of classroom interactive technology causes confusion among students. Therefore, teachers need to exercise more classroom control. There are significantly more critical behaviors than in the classroom before the experiment. It can be seen that the classroom after the experiment is more likely to cause confusion than the traditional classroom, so the requirements for teachers' teaching management ability are higher. In other behaviors, such as encouragement and praise, the frequency of occurrence before and after the experiment tends to be consistent, which is related to the teacher's personal teaching style, and the teacher has less emotional communication with the students during the teaching process. The comparative analysis of student learning behavior matrix coding is shown in Figure 8.

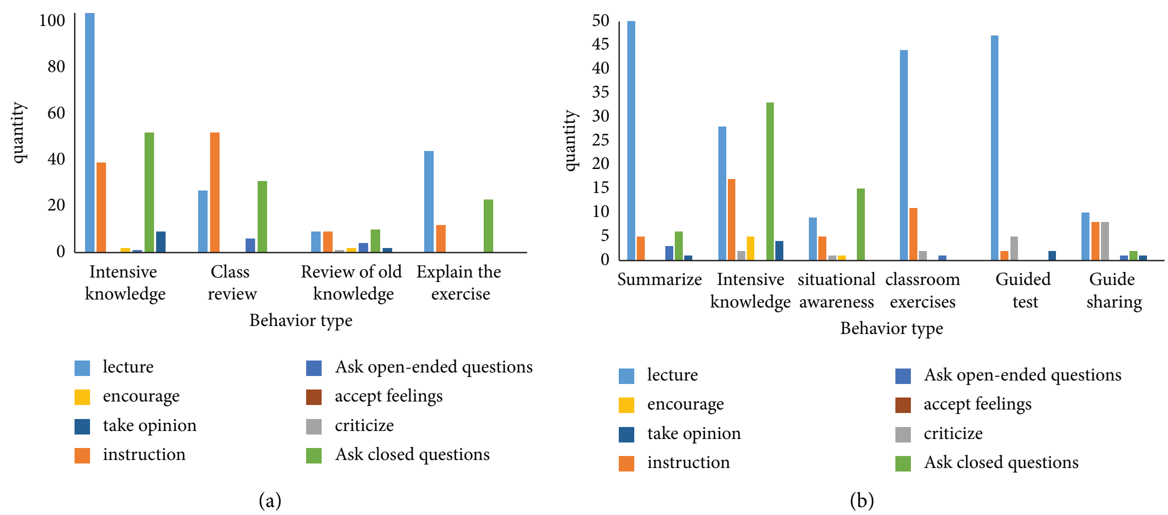

Figure 7: Comparison of teacher behavior before and after the experiment. (a) Before experiment. (b) After experiment.

As shown in Figure 8, the frequency distribution of student behaviors in the two classrooms is initially compared. In terms of active response behavior, the total frequency of classroom occurrences before the experiment is 93, and the total number of active response codes in the classroom after the experiment is 102, which are basically the same. Both of them occur most frequently in the knowledge-intensive session. Because the knowledge-intensive session is mainly about the explanation and learning of new knowledge, and students have many new questions, the knowledge-intensive session has the highest frequency. In terms of the number of passive responses, the total frequency of occurrences in the classroom before the experiment is 152, and the total number of codes taught by the teachers in the classroom after the experiment is 43, which is consistent with the fact that teachers raised more closed questions in the preexperiment classroom. Teachers use more instructions and closed questions to attract students' attention and answer questions, so students will respond more passively. In terms of discussing behavior with peers, the total frequency of classroom occurrences before the experiment is 27, and the total number of codes taught by teachers in the classroom after the experiment is 47. The classroom discussion behavior after the experiment is much higher than that in the classroom before the experiment. The behavior of peer discussion is not only role-playing but also point of view and thinking, which is consistent with the new English teaching mode to cultivate students' cooperative learning ability through cooperative inquiry. Teachers consciously designed cooperative learning activities in multiple teaching links. The technical behavior matrix coding comparison analysis is shown in Figure 9.

As shown in Figure 9, a preliminary comparison of the frequency distributions of the two classroom technology behaviors shows that in the two classroom environments, technology has the most effect on the coding of student behaviors. In terms of teachers' operating technology behavior, the total number of classroom codes before the experiment is 1, and the total number of classroom codes after the experiment is 19. There is a big difference between the two. In the classroom environment before the experiment, teachers use relatively few Internet technology means, but in the classroom after the experiment, the classroom teaching environment and the online learning environment are seamlessly connected. Before class, teachers use the cloud school home platform to publish tutorial assignments, and students upload them to the platform after completion. Teachers teach directly using the teaching assistant during class. Because teachers use the teaching assistant software to call homework, courseware, online teaching resources, and classroom interactive tools embedded in the platform, etc., the behavior of teachers operating technology has increased significantly. In terms of the effect of technology on student behavior, the total number of classroom codes before the experiment is 57, and the total number of classroom codes after the experiment is 150. There is a big difference between the two. This echoes the behavior of teachers in operating technology. In the classroom before the experiment, the frequency of technology acting on students occurs in classroom practice and knowledge-intensive lectures, among which classroom practice accounts for the most. This is because the listening training is carried out in the classroom practice session, and the technical role is mainly to present the teaching content. In the classroom after the experiment, the effect of technology on student behavior exists in every aspect of the classroom, and the most important part is the sharing of learning. This is because in the tutorial sharing session, teachers use teaching assistants to retrieve homework and audio works from the cloud school home platform, play and display them in the whole class, and review knowledge at the same time. The comparative analysis of silent behavior matrix coding is shown in Figure 10.

As shown in Figure 10, a preliminary comparison of the frequency distribution of silent behavior in the classroom before and after the experiment shows that students in the silent behavior accounted for the largest proportion of practice behaviors. In terms of students'

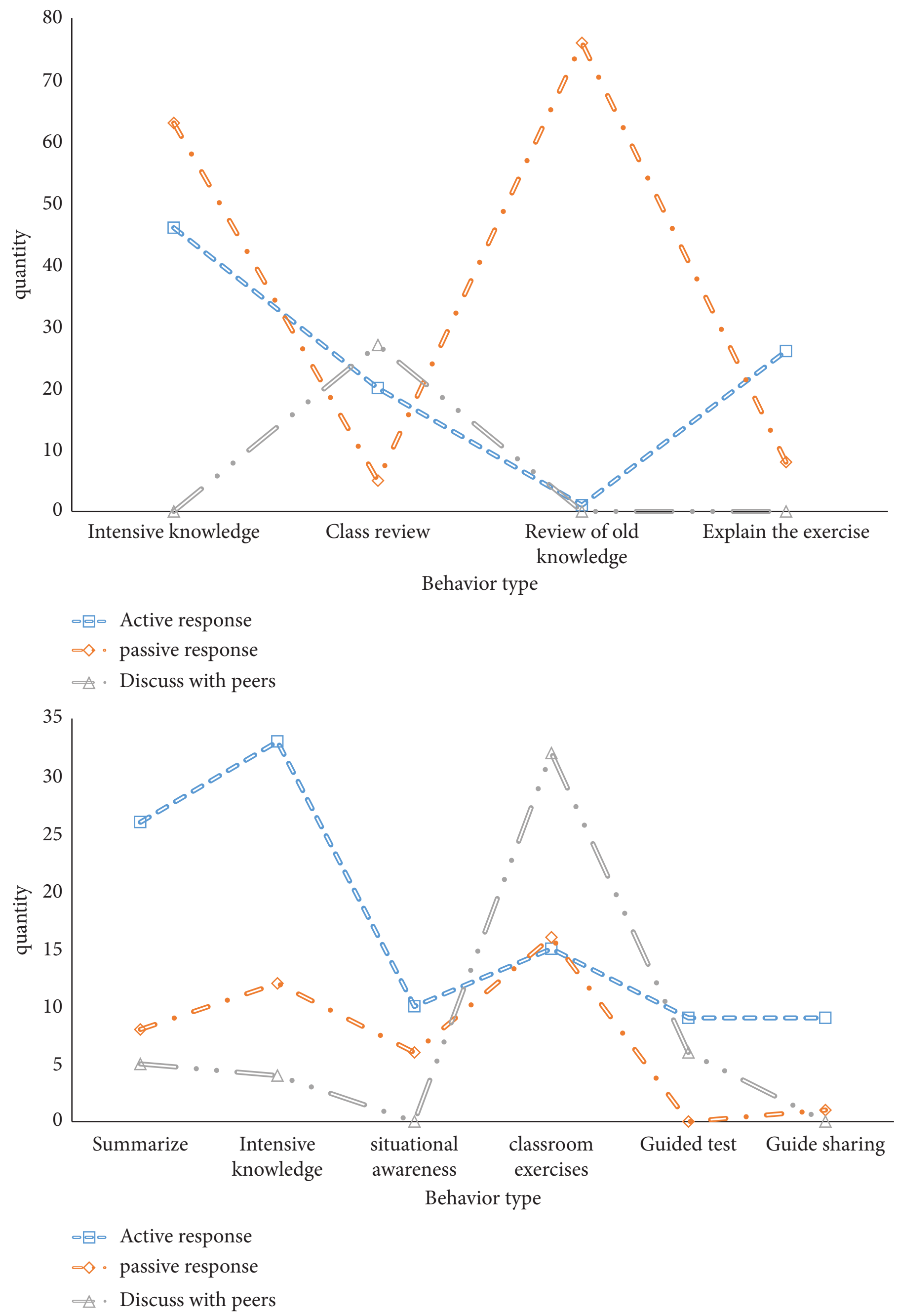

Figure 8: Student row coding matrix before and after the experiment.

practice behavior, the total frequency of classroom occurrences before the experiment is 109, and the total number of classroom codes after the experiment is 130. There is a big difference between the two. It can be seen that the homework practice in the classroom after the experiment is relatively scattered, and it runs through the entire teaching process, which is more flexible and reasonable than the homework practice before the experiment. In terms of students' thinking behavior, the total frequency of classroom occurrences before the experiment is 22, and the total number of classroom codes after the experiment is 4, which may be related to the behavior of students discussing with their peers. In the classroom after the experiment, the behavior of discussing with peers is more, and more thinking behavior occurs in the process of students discussing with their peers, so the students in the silent behavior think less than the classroom before the experiment. In terms of confusion that does not help teaching, the total frequency of occurrences in the classroom before the experiment is 31, and the total number of codes in the classroom after the experiment is 101. The latter is significantly higher than the former. This is consistent with the results of the teacher's critical behavior in the previous article, where criticism corresponds to

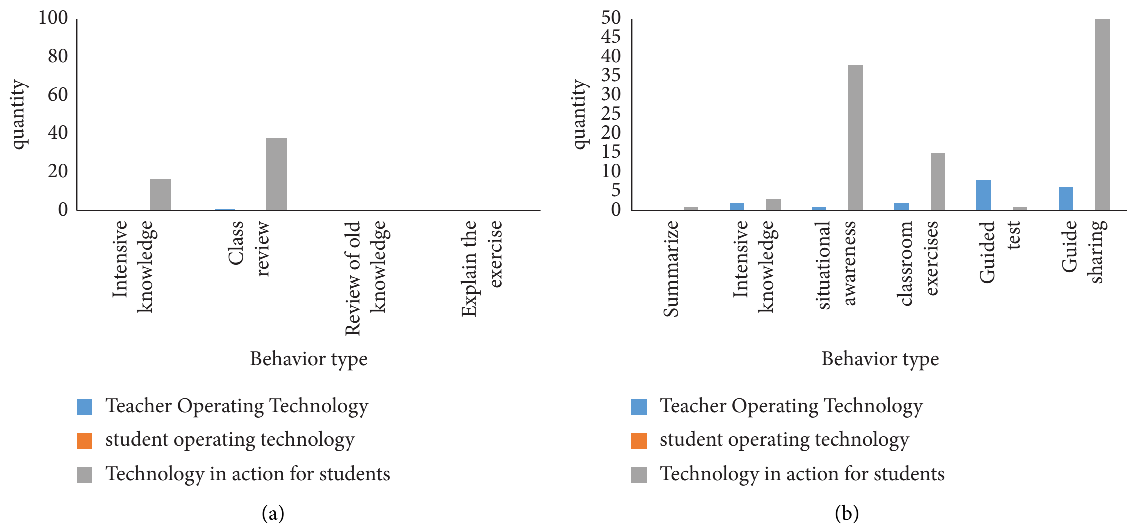

Figure 9: Technical behavior coding matrix before and after the experiment. (a) Before experiment. (b) After experiment.

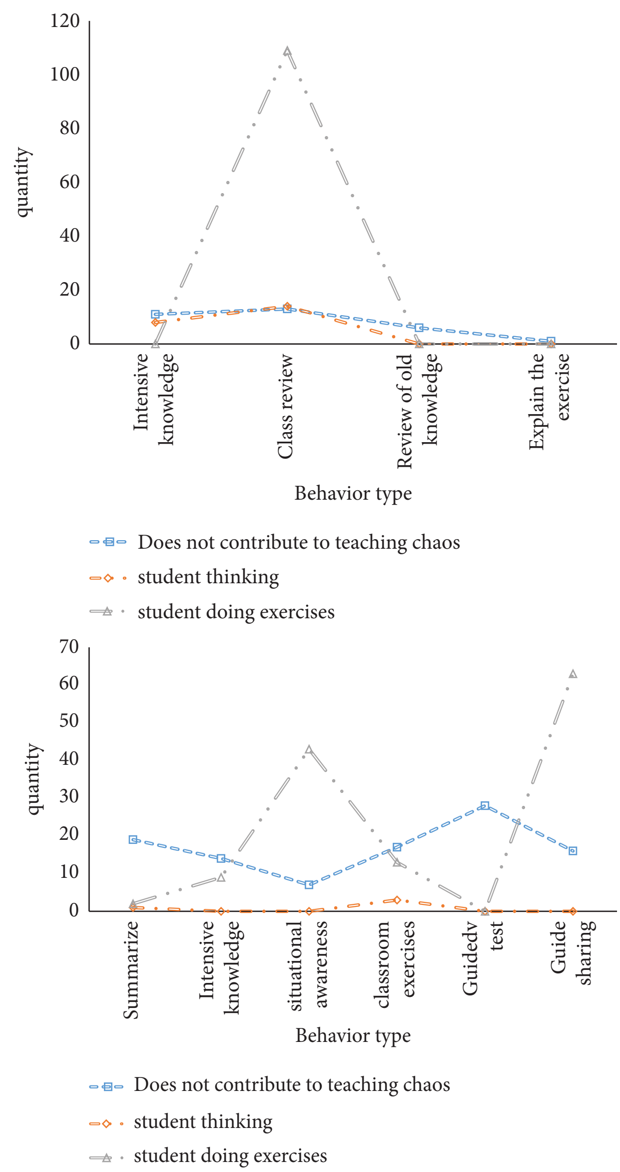

Figure 10: Silence behavior coding matrix before and after the experiment.

classroom chaotic behavior. Because the overall teaching links in the classroom after the experiment are more abundant and flexible and there are more independent activities of students, the use of classroom interactive technology (random selection, etc.) is more likely to cause classroom confusion.

4. Conclusions

This study sorts out the research status of English lesson instruction and instructional patterns through relevant studies, and it starts from the problems existing in English lesson instructional patterns under the terms of distributed information fusion. Combined with theory and practice, this paper presents an analysis of the theoretical foundations, instructional targets, instructional events, the online instructional setting, and the features of the instructional assessment of this instructional pattern. Then, this article clarifies the design principles of the mode construction, and constructs a pattern of English lesson instruction in distributed information integration terms. The application strategy of teaching mode is proposed, which provides theoretical support and practical path for teachers to clarify the integration path of distributed information fusion and English classroom, innovate classroom teaching form, and enhance classroom vitality. The design-based research paradigms are used. Under the combined use of study approaches, NVivo and SPSS were then applied for qualitative interpretation and quantitative manipulation. The changes of students' English achievement, cooperative learning ability, information literacy, and problem-solving ability are accurately measured through experimental research, and then the conclusions of quantitative research are explained in combination with the process data of qualitative research. The research revealed that the application of the English lesson instructional pattern under the condition of distributed information fusion can effectively improve the students' ability and quality, but the improvement of students' English performance is not significant. As the learning environment and conditions of each student in the class vary, and some students may not be able to use other tools to supplement their online learning outside of class time, it is challenging to fully consider all students in the classroom and to keep each student on track. In the future research, we will improve the shortcomings of the article study, promote the composition of the instructional and educational quality improvement model, and facilitate the scientific progress of education.

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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