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An innovative model program for teaching educational psychology based on the maximum information entropy model

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ABSTRACT

This paper carries out a research on the quantitative evaluation of classroom behavior based on the maximum information entropy model, explains the theory related to information entropy and analyzes the concept of information entropy. The improved iFIAS interactive analysis system was used as the main analysis tool, and S-T analysis and time series analysis were used as auxiliary analysis methods to analyze the classroom teaching behaviors. Classroom teaching behaviors were coded and sampled, from which classroom teaching behavior related data were obtained, through which teaching behavior information entropy, redundancy, interaction mode, teaching mode and behavior category frequency were analyzed. After analysis, the overall classroom teaching characteristics of the psychoeducational quality lesson examples are teacher behavior and student behavior as the main, psychoeducational and teaching materials as the secondary, and the teacher's behavior in the early part of the classroom accounts for a high proportion in order to drive the students into the classroom. The proportion of student behavior rises in the middle and late stages. The proportion of hybrid and dialogic teaching mode is 95.83%, which is dozens of times more than the proportion of lecture. It reveals the teaching mode of quality psychology classroom teachers, i.e., focusing on the interaction with students and replacing the pure teacher lecture student acceptance mode with interactive counseling student active learning. The teaching analysis of quality classroom teaching behaviors with the maximum information entropy model realizes the establishment of an innovative model of psychological teaching and clarifies the direction for the future development of psychoeducational classrooms.

Keywords: information entropy, classroom teaching analysis, S-T analysis, time series analysis, educational psychology

1. Introduction

Educational psychology is a science that studies the basic psychological laws in the interaction

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between teaching and learning, and is an important part of the teacher education curriculum system. With the rapid development of society and the arrival of the knowledge economy era, educational psychology in colleges and universities plays an important role in cultivating the ability of college students to develop comprehensively [1-3]. Although some researchers have carried out reform and exploration, there is still a big gap between the actual teaching effect of educational psychology and the expectations of teachers and students, the value of the course itself, the development of education in the information age, and the requirements of the future teaching profession [4-6]. The traditional education model mainly focuses on knowledge transfer and test scores, while neglecting the cultivation of individual differences, creative thinking, and emotional and interpersonal relationships. However, in the new era, the challenges faced by college students are becoming more and more diversified and put forward higher-level demands on them [7-9]. Information entropy reflects the average uncertainty of information sources and is often used to assess the level of equilibrium and complexity of a system. Nowadays, information entropy has been widely used in the fields of ecology, geography, and social sciences [10-12]. Based on the maximum information entropy model, the proposed educational psychology teaching innovation model program can promote the reform of educational psychology courses in colleges and universities to achieve positive and effective results, and cultivate talents who adapt to the needs of social development and have the ability of creative thinking, provide better educational services for college students and promote their comprehensive development to meet the challenges of the future society [13-15].

After summarizing and elaborating the definition related to information entropy, the time series analysis method, S-T analysis method, and iFIAS interactive analysis system were determined as the research methods to categorize the psychological classroom teaching behaviors. First, the dynamic behaviors in the process of classroom teaching were coded with information, and the serial number of each behavior category was used as the code number. Observations were made to determine the category to which the classroom teaching behaviors belonged and the corresponding code numbers of the behaviors were recorded into the database. Form the migration data of the original psychological classroom teaching behaviors, based on which the psychological classroom teaching behaviors were judged by calculating the amount of information of the teaching process, the amount of redundant information of the classroom teaching, the analysis of the classroom teaching interactions, the determination of the classroom teaching mode, and the calculation of the frequency distribution of the behavioral categories. Explore the effectiveness of information entropy in amplifying the fine details of insignificant data, and in evaluating the overall state of psychological teaching activities.

2. Overview

Knowledge of educational and psychological sciences is an essential condition for teachers, and it is important to strengthen the reform of the program “Educational Psychology”. Literature [16] analyzes the characteristics of the educational intervention method based on positive psychology and confirms its scientific validity, which plays an important role in stimulating the development of students' strength of character. Literature [17] proposed an educational psychology instructional design method based on deep learning and artificial intelligence, and confirmed the feasibility of the proposed method through practical application of teaching experiments, which can improve students' academic performance in various subjects, and indirectly reflects the disadvantages of biased education, which indicates that the school should pay equal attention to all subjects. Literature [18] describes the progress made so far in the methodological reform movement and how educational psychology is particularly suited to contribute, aiming to constructively validate the integration of open scientific reforms and strengthen the foundations of educational psychology. Literature [19] highlights the importance of educational psychology in higher vocational education, and in terms of its theoretical perspective, analyzes the increasingly prominent problems of higher vocational education, such as the lack of certain historical deposits and insufficient faculty, which lead to poor quality of teaching and students' learning outcomes, as well as the role of educational psychology in solving these problems, in order to examine the educational psychology's reform and development of higher education in terms of its Value. Literature [20] points out the theoretical and applied characteristics of educational psychology courses in higher education and describes the path of curriculum reform in the period of its high-quality development, such as innovations in the curriculum content system, teaching methodology, and teaching evaluation, with a view to facilitating the implementation of talent cultivation goals. Literature [21] used deep learning algorithms to construct a social media online learning behavior evaluation model based on learning psychology, aiming to improve the online learning effect of students, and verified the validity of the model through experimental tests, which can be applied to online teaching and helps to cultivate college students' ability of comprehensive development.

3. Basic Theory and Research Methods

3.1. Definitions related to information entropy

Consider a discrete random variable X with n possible values x_i, with a probability of occurrence corresponding to p_i, and satisfying: $0 \le p_i \le 1$, $i = 1, 2, \ldots, N$, $\Sigma p_i = 1$. Shannon introduces the function:

$$H(X) = H\left(p_1, p_2, p_3, \ldots, p_N\right) = -\sum_{i=1}^{N} p_i \log p_i \tag{1}$$

Where H is called the information entropy, also known as the edge entropy. When the base of the logarithm is 2, e, and 10 respectively, the unit of information is bit, nits, and dits respectively. In the formula for information entropy, if some $p_i = 0$, then $0 \log 0 = 0$ is specified.

For a continuous random variable X, the probability density function is $p(x)$ and the distribution function $P(x)$ is the probability that the value of the variable is less than x, i.e., $P(x) = \int_{-\infty}^{x} p(t)dt$. The probability that the variable is between a and b when the distance $\Delta x = |a - b|$ between the values a and b of the random variable X is very small is $\int_b^a p(x)dx \approx \Delta x p(x) = |a - b| p(a)$, and the logarithmic value of the inverse of the probability of each division of the interval in which the values are taken is averaged, i.e., $H_{\Delta x}(X) = -\sum_i \Delta x p\left(x_i\right) \log \Delta x p\left(x_i\right)$, and tends to infinity when the length of the division of the interval Δx tends to zero, $\lim_{\Delta x \to 0} H_{\Delta x}(X) = -\int_{-\infty}^{+\infty} p(x) \log p(x) - \lim_{\Delta x \to 0} \log \Delta x$. Shannon eliminates the infinity term $-\lim_{\Delta x \to 0} \log \Delta x$ and the differential entropy is defined in the form:

$$H_S(X) = -\int_{-\infty}^{+\infty} p(x) \log p(x) \tag{2}$$

The differential entropy of a continuous random variable has the main characteristics of discrete entropy, but is not nonnegative since it omits a positive value at infinity. The introductory section on the basic properties of information entropy is as follows:

1) Symmetry

$$H\left(p_1, p_2, p_3, \ldots, p_n\right) = H\left(p_{k_1}, p_{k_2}, p_{k_3}, \ldots, p_{k_n}\right) \tag{3}$$

Where: $\left(p_{k_1}, p_{k_2}, p_{k_3}, \ldots, p_{k_n}\right)$ is any permutation of $(1, 2, \ldots, n)$. This property indicates that the amount of information remains unchanged by changing the order of events.

2) Non-negativity

$$H(X) = H\left(p_1, p_2, p_3, \ldots, p_n\right) \ge 0 \tag{4}$$

where the equal sign holds when and only when is a degenerate distribution. This property indicates that the entropy of a deterministic field (non-random field) is minimized.

3) Extremality

$$H(X)=H\left(p_1,p_2,p_3,\ldots,p_n\right)\leq\log n \tag{5}$$

where the equal sign holds if and only if $p_k=1/n$, $k=1,2,\ldots,n$. This property shows that the equal probability field has maximum entropy.

4) Additivity

$$\begin{aligned}&H\left(q_{11},\ldots,q_{1k_1},q_{21},\ldots,q_{2k_2},q_{n1},\ldots,q_{nk_n}\right)\\&=H\left(p_1,p_2,\ldots,p_n\right)+\sum_{i=1}^{n}p_iH\left(\frac{q_{i1}}{p_1},\ldots,\frac{q_{ik_i}}{p_i}\right)\end{aligned} \tag{6}$$

Where: $q_{ij}\geq 0$, $p_i=\sum_{j=1}^{k_i}q_{ij}$, $\sum_{i=1}^{n}p_i=1$.

5) Shannon's inequality

$$H\left(p_1,p_2,\ldots,p_n\right)=-\sum_{i=1}^{n}p_i\log p_i\leq-\sum_{i=1}^{n}p_i\log q_i \tag{7}$$

where $\left(q_1,q_2,\ldots,q_n\right)$ may be incompletely distributed.

Two quantities can be derived from Shannon's inequality.

i. $-\sum_{i=1}^{n}p_i\log q_i$ is called inaccuracy.

ii. $E\left(p\|q\right)=\sum_{i=1}^{n}p_i\log\left(p_i/q_i\right)$ is called relative entropy, $K-L$ dispersion or information gain. Clearly, inaccuracy is the sum of entropy H and information gain $E\left(p\|q\right)$.

6) Upper convexity

The entropy function $H\left(p_1,p_2,\ldots,p_n\right)$ is a strictly upper convex function of the probability distribution $\left(p_1,p_2,\ldots,p_n\right)$.

For a two-dimensional random variable (X,Y) with marginal probability distributions p_i and $p_{.j}$, respectively, and joint probability distributions $p\left(x_i,y_j\right)=p_{ij}$, $i=1,2,\ldots,N$; $j=1,2,\ldots,M$, the two-dimensional joint entropy $H(X,Y)$ of (X,Y) is defined as:

$$H(X,Y)=-\sum_{i=1}^{N}\sum_{j=1}^{M}p_{ij}\log p_{ij} \tag{8}$$

Generalizing the case to higher dimension $\left(X_1,\ldots,X_n\right)$, corresponding to a joint probability distribution of $p_{i_1,\ldots,i_n}\left(i_1=1,2,\ldots,N_1,i_2=1,2,\ldots,N_2,\ldots,i_n=1,2,\ldots,N_n\right)$, the multidimensional joint entropy is defined as:

$$H\left(X_1,\ldots,X_n\right)=-\sum_{i_1=1}^{N_1}\sum_{i_2=1}^{N_2}\cdots\sum_{i_n=1}^{N_n}p_{i_1\ldots i_n}\log p_{i_1\ldots i_n} \tag{9}$$

The conditional entropy $H(X\mid Y)$ for condition X with known Y and the conditional entropy $H(Y\mid X)$ for condition Y with known X are respectively:

$$H(X\mid Y)=-\sum_{i=1}^{N}\sum_{j=1}^{M}p_{ij}\log\frac{p_{ij}}{p_j} \tag{10}$$

$$H(Y\mid X)=-\sum_{i=1}^{N}\sum_{j=1}^{M}p_{ij}\log\frac{p_{ij}}{p_i} \tag{11}$$

Mutual information denotes the measure of the amount of information that one random variable contains about another random variable, and also refers to the amount by which the uncertainty of the original random variable is reduced, given the information about the other random variable.

Mutual information describes the redundancy and transfer of information between two variables, and is therefore also known as the amount of information transferred. Mutual information is the relative entropy between the joint distribution p_{ij} and the product distribution $p_i p_j$ of two random variables, defined as follows:

$$T(X,Y)=\sum_{i=1}^{N}\sum_{j=1}^{M}p_{ij}\log\left(\frac{p_{ij}}{p_i p_j}\right) \tag{12}$$

The relationship between simultaneous mutual information and edge entropy, joint entropy, and conditional entropy is as follows:

$$T(X,Y)=H(X)+H(Y)-H(X,Y) \tag{13}$$

$$T(X,Y)=H(X)-H(X\,|\,Y) \tag{14}$$

$$T(X,Y)=H(Y)-H(Y\,|\,X) \tag{15}$$

Noted:

$$T(X,X)=H(X)-H(X\,|\,X)=H(X) \tag{16}$$

It can be seen that the mutual information between a random variable and itself is the entropy of the random variable, so the entropy is also called self-information. From the relationship between mutual information and edge entropy and the non-negativity of entropy, it can be seen that the range of values of mutual information satisfies $0\le T(X,Y)\le \min(H(X),H(Y))$, so the upper boundary of mutual information is determined by the edge entropy of the random variable, and the directed information transfer index is introduced to standardize the mutual information, which is defined as follows:

$$DIT(X,Y)=\frac{T(X,Y)}{H(X)} \tag{17}$$

$$DIT(Y,X)=\frac{T(X,Y)}{H(Y)} \tag{18}$$

Where $DIT(X,Y)$ denotes the amount of information transmitted from variable Y to unit variable X and $DIT(Y,X)$ denotes the amount of information transmitted from variable X to unit variable Y. The range of values of DIT satisfies the relation $0\le DIT\le 1$. When $DIT=0$, it means that the two random variables are independent of each other, and when $DIT=1$, it means that the two random variables are perfectly correlated. Unlike mutual information, the directed information transfer index does not have symmetry.

The information correlation coefficient R_0, which describes the mutual relation of random variables X and Y, is defined by mutual information:

$$R_0=\sqrt{1-\exp(-2T)} \tag{19}$$

From Eq. (19), we know that the mutual information represents the upper limit of the amount of information transmitted by random variables X and Y. For two variables (X,Y) which are normally distributed and linearly correlated, the information correlation coefficient is then equal to the classical Pearson correlation coefficient. Therefore, the information correlation coefficient based on mutual information can be regarded as a generalization of the correlation between variables.

By the chain rule of information entropy, let the random variable $X_1,X_2,\ldots,X_n$ obey $p(x_1,x_2,\ldots,x_n)$, then it satisfies:

$$H(X_1,X_2,\ldots,X_n)=\sum_{i=1}^{n}H(X_i\,|\,X_{i-1},\ldots,X_1) \tag{20}$$

The conditional mutual information of random variables X and Y given random variable Z is defined as:

$$T(X;Y\mid Z)=H(X\mid Z)-H(X\mid Y,Z) \tag{21}$$

Mutual information also satisfies the chain rule, so by generalizing the conditional entropy and mutual information to higher dimensions, the amount of information transfer from random variable $X_1, X_2, \ldots, X_n$ to Y is defined as:

$$\begin{aligned} T\left(X_1, X_2, \ldots, X_n; Y\right) &= H\left(X_1, X_2, \ldots, X_n\right) \\ &\quad - H\left(X_1, X_2, \ldots, X_n \mid Y\right) \\ &= \sum_{i=1}^{n} H\left(X_i \mid X_{i-1}, \ldots, X_1\right) \\ &\quad - \sum_{i=1}^{n} H\left(X_i \mid X_{i-1}, \ldots, X_1, Y\right) \\ &= \sum_{i=1}^{n} T\left(X_i; Y \mid X_1, X_2, \ldots, X_{i-1}\right) \end{aligned} \tag{22}$$

The total correlation is used to describe the redundancy of information between multiple random variables and provides a test for linear and nonlinear correlation between multiple variables, defined as:

$$C\left(X_1, \ldots, X_n\right)=\sum_{i=1}^{n} H\left(X_i\right)-H\left(X_1, \ldots, X_n\right) \tag{23}$$

The total correlation is symmetric and non-negative, and is 0 when the random variables are independent of each other; when the number of variables is 2, the total correlation degenerates into mutual information.

3.2. Research methodology

3.2.1. Time series analysis methods. Time-series analysis [22] is applied in educational research as a method of noting and analyzing the teaching and learning process based on the process-outcome model of teaching and learning, which represents the interaction between teachers and students in the teaching and learning process mainly through time, actors, and categories of behaviors.

3.2.2. S-T analysis methods. In this paper, the sampling of the teaching process is based on the Classroom Teaching Behavior Classification System (CTBCS), and the sampling data are recorded. The CTBCS is first converted into $S-T$, i.e., the behavior categories in the behavior category system are converted into S and T categories of behaviors.

After transforming the behavioral categories in the Classroom Teaching Behavior Classification System into $S-T$ attributes, there is no need to sample $S-T$ behaviors when conducting the teaching pattern analysis based on $S-T$ analysis, and only the S or T attributes of the behavioral categories need to be recorded during the sampling process.

$S-T$ The graph can show the general direction of teaching, such as the overall close to the horizontal axis indicates that the teaching of the teacher's behavior is predominant, the overall closer to the vertical axis indicates that the teaching of the student's behavior is predominant, $S-T$ The graph can also show that the teaching of a certain period of time, such as a period of time connecting the line did not take place in the turn indicates that this period of time the teaching of the behavior of a single.

T Behavioral occupancy Rt indicates the proportion of the teaching process that is occupied by T behavior. Let the sampling number of behaviors in the teaching process be N, where the number of T behaviors is N_T and the number of S behaviors is N_S, then there are:

$$N = N_T + N_S \tag{24}$$

T Behavioral possession Rt for:

$$R_t = N_T / N = (N - N_S)/N = 1 - (N_S/N) \tag{25}$$

Similarly S behavioral occupancy can be defined as Rs it is the proportion of the teaching process that is S behaviorally occupied then:

$$R_s = N_S / N \tag{26}$$

It can be seen that the sum of Rt and Rs is 1, because the various behaviors in the teaching process are simplified to teacher behavior T and student behavior S. The values of Rt and Rs in the teaching process are in the range of 0 to 1. The larger the value of Rt, the greater the percentage of T behaviors and the smaller the percentage of S behaviors.

Behavior conversion rate Ch indicates the ratio of the number of times T behaviors and S behaviors are converted to each other and the total number of behaviors sampled during the teaching process. In the collected behavioral samples, two consecutive behaviors are not the same then it can be considered as a behavioral conversion, and the succession of the same behaviors is called company, and the behavioral conversion rate can be calculated by behavioral company.

Let the S-T data be: TTSSTSSTTT, there are 10 behavioral samples in this data, and there are 5 concatenations: $\underline{TT}$ $\underline{SS}$ $\underline{T}$ $\underline{SS}$ $\underline{TTT}$.

Denoting the number of consecutive in the data by g, there are $g = 5$. The behavioral conversion rate Ch during teaching is:

$$Ch = (g-1)/N = (5-1)/10 = 0.4 \tag{27}$$

Depicting the calculated Rt and Ch data on a plane with a horizontal axis of Rt and a vertical axis of Ch yields the $Rt - Ch$ graph. Obviously, a lesson is taught that corresponds to a point in the $Rt - Ch$ graph. Figure 1 shows the $Rt - Ch$ graph. The shaded portion of the graph is the logical range in which the (Rt, Ch) point exists, i.e., the (Rt, Ch) of the general teaching process should fall within the shaded range.

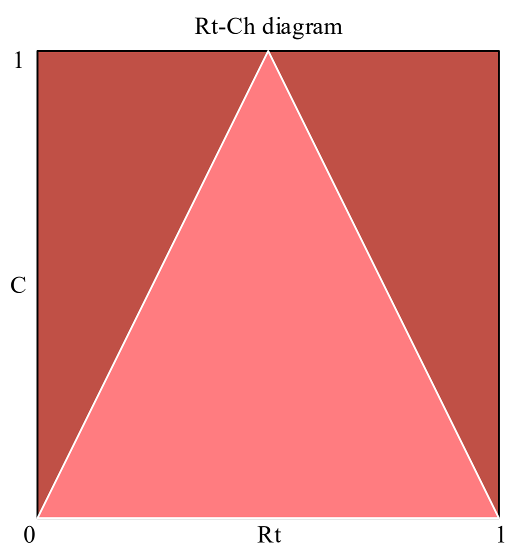

Fig. 1. Rt-Ch figure

In order to compare multiple instruction, the Rt-Ch for each instruction can be calculated and traced on an Rt-Ch plot, from which the instructional patterns of these multiple instruction can be compared.

3.2.3. iFIAS interactive analysis system：

1) Introduction to the iFIAS system. The Flanders Interaction Analysis System (FIAS), which contains 10 codes for interactive behaviors, is a method used to observe the teaching and learning process for post-coding analysis. FIAS and ITIAS were further optimized to form an improved Flanders Interaction Analysis System, or iFIAS, to support the digital classroom. iFIAS changes the number of codes to 14, which helps researchers to analyze teacher-student interactions in the classroom more objectively and concretely. Therefore, the author chose iFIAS as a research tool and improved it [23].

2) Coding of analyzing process in iFIAS. According to the coding rules, the teaching process is coded once every 3 seconds, and the reliability should be tested after the coding is completed, and the test method is the same as the reliability test method of S-T method. Although the definition of coding in iFIAS has been very clear, the teaching behaviors in the actual classroom are very complex and it is difficult to determine the type of coding for certain behaviors, so scholars such as Flanders developed some special coding rules.

First, adjacent codes are connected into ordinal pairs, then the number of identical ordinal pairs is counted and filled into the analysis matrix, and finally the sum of each row and column is counted.

The results are generally analyzed using two methods: matrix analysis and ratio analysis.

Some cells in the matrix analysis table represent a particular kind of verbal interaction behavior.

Ratio analysis is to calculate the proportion of behaviors such as "teacher language", "student language", "silence conducive to teaching" and "technical operation" in the classroom according to the data of the matrix table, so as to understand the teacher's control over the classroom.

Realizing diversified and efficient interactions is one of the important functions of the smart classroom, and teachers can use the support of the smart classroom to realize the cultivation of higher-order thinking of students. In order to correctly determine which level of teachers' use of information technology belongs to, the coding system of the technology level of iFIAS needs to be refined.

Students' use of technology mainly refers to students' use of mobile learning terminals for activities such as accessing resources, experiencing functions, practicing independently, discussing and interacting, and displaying and evaluating results.

3.3. Study design

The 24 class cases were taught by the same teacher based on the same teaching philosophy, using the same teaching design and teaching mode to teach the same content to 24 classes with no obvious differences, the only difference is the teaching environment, i.e., the smart classroom and the multimedia classroom. There was little difference in the ratio of males to females in the 24 classes, and there was no difference in the results of the psychoeducational classes. In view of the above, the author chose these 24 cases as the subjects of this study.

1) Analysis of teaching philosophy. Teaching philosophy is a concentrated expression of the understanding of teaching, but also the teachers' views on classroom teaching activities and the basic attitude and concept, is their belief in teaching activities, teaching activities have an extremely important guiding significance.

2) Analysis of teaching structure. There are three main forms of instructional structures that exist, namely teacher-centered, student-centered, and combined dominant-subject instructional structure forms. This study combines $S-T$ with iFIAS analysis results and classroom reality to analyze them.

3) Analysis of teaching activities. According to the “Behavioral Stability Grid” area of the iFIAS system matrix, the main activities in the teaching process are analyzed in conjunction with the classroom situation, such as the teacher's lectures, the students' use of technology, and the students' discussions and interactions. Clarifying the types of teaching activities and the proportion of time they take up will help to understand the structure of the classroom, whether the teacher's time arrangement is

reasonable, and whether the students have enough time to carry out meaningful constructive learning.
4) Analysis of teaching media. Detailed description of the teaching media utilized in the teaching process and their teaching roles and effects, and then combined with the "technology" code in the iFIAS system to make a detailed analysis of the role played by information technology in the classroom and the level of application.
5) Analysis of teaching behavior interaction. According to the theory of symbolic interaction, the classroom is essentially a microcosm of society, and the process of classroom teaching is the process of interaction between teachers and students and between students and students using various symbols as tools. In this study, we use the iFIAS system to analyze the interactive features of the teaching behaviors of the classroom in terms of the interactions between human beings and people, between human beings and technology, and the types of teacher's language.
6) Comparative analysis. Comparative analysis of the two cases in the five aspects of teaching philosophy, teaching structure form, teaching activities, teaching media and teaching behavior interaction, from the perspective of the four elements of the teaching system, i.e., teachers, students, teaching content and teaching media, to summarize the impact of the smart classroom on the teaching structure and the factors affecting it.

The research process can be divided into the following five steps.

(1) Determine the purpose of the study.

(2) Selection of research tools. Taking domestic and foreign professional databases as the source, the author reviewed domestic and foreign literature on teaching behavior interaction and teaching structure, gained a comprehensive understanding of the current state of research, and correctly and comprehensively grasped the classical tools and methods of teaching behavior interaction analysis, so as to select the iFIAS system, the $S-T$ -analysis method, and the time series analysis method as the research tools of this study.

(3) Recording of teaching examples. In order to ensure the representativeness of the lesson examples and the credibility of the study as much as possible, the recording of the lesson examples was carried out with as little disruption to the classroom as possible.

(4) Statistical analysis of data. Using research tools to analyze and quantify the lesson examples, at the same time to verify the reliability of the data obtained, unreliable, then re-quantitative processing, reliable can be used, and then the results of the analysis of the 24 lesson examples for comparative analysis, to derive the impact of the smart classroom on the structure of the teaching and learning and the factors affecting it.

(5) Conclusion and Prospect. Summarize the results of the study, reflect on the shortcomings of the study, and then give suggestions for future research.

4. Classroom teaching analysis system

The classroom teaching analysis of this study is based on the paradigm of analysis and evaluation, and the teaching analysts, based on the classification of classroom teaching behaviors, observe and judge the behavioral category to which the current classroom teaching behavior belongs every fixed time and make corresponding records to form the original behavioral migration data, and based on the original behavioral migration data formed, highly integrated and systematic judgment of classroom teaching, such as calculation of the amount of information of the teaching process, Based on the raw behavioral migration data, a highly integrated and systematic judgment of classroom teaching is made, such as the calculation of teaching process information, the calculation of redundant information of classroom teaching, the analysis of classroom teaching interaction, the judgment of classroom teaching mode, and the calculation of the frequency distribution of behavioral categories, etc., which constitutes a comprehensive classroom teaching analysis system, and the architecture of the system is shown in Figure 2.

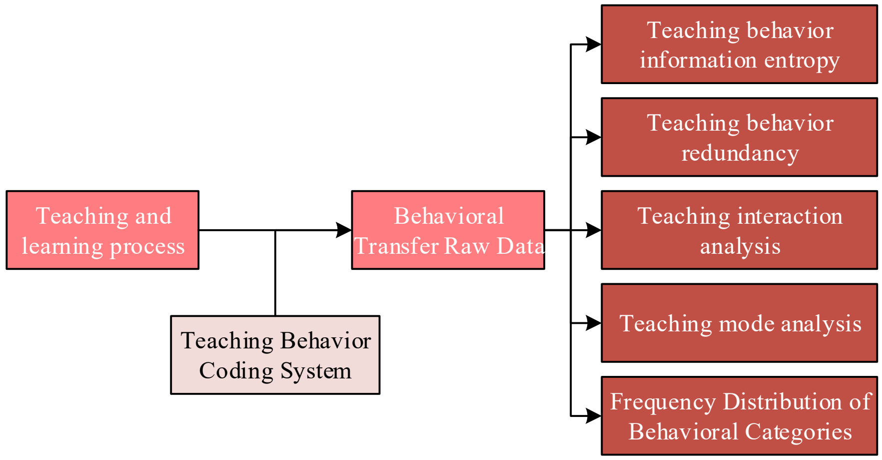

Fig. 2. Classroom teaching analysis system diagram

4.1. Teaching behavior coding and sample collection

Classroom analysis begins with coding information about dynamic behaviors in the classroom, and the coding system uses the serial number of each behavioral category as its coding number.

The classroom observer samples the content of the observation at regular intervals and records it in the database with the appropriate code number according to the behavioral category of the sample.

4.2. Information Entropy Analysis of Teaching Behavior

The classroom teaching system can be regarded as a probabilistic system based on behavioral categories, so the analysis of the teaching system can be quantified using the behavioral information entropy, the teaching behavioral information entropy [24] is calculated as follows:

Let $i\left(i=1,2,3,\cdots,n\right)$ be a particular type of behavior in the instructional system (there are a total of n types of behaviors in this instructional system), M be the total number of samples from which instructional behaviors were sampled, m_i be the total number of instructional behaviors sampled in Type i, and P_i be the probability of occurrence of Type i, then:

$$P_i = m_i / M \tag{28}$$

Let H be the information entropy of teaching behavior, according to the principle of information entropy calculation, then:

$$H = -\sum_{i=1}^{n} P_i \log 2^{P_i} \tag{29}$$

According to entropy theory, when the probabilistic system has equal probability of occurrence of each event, the entropy value of the system will reach the maximum value, so that $H_{\max}$ is the maximum information entropy of the teaching behavior, then:

$$H_{\max} = \log 2^{n} \tag{30}$$

Teaching behavior information entropy is the quantification of the classroom teaching process system, the calculated entropy value reflects the overall state of the classroom teaching process, for this information theory as a guide, the quantitative analysis of the borrowing of mathematical tools need to make a pedagogical interpretation of the significance of the teaching theory, in order to restore teaching behavior information entropy of the teaching process in the true nature of the teaching process, we need to be from the following point of view to understand:

4.3. Analysis of Redundancy in Teaching Behavior

Appropriate redundant information can improve the anti-interference ability of transmitted information. In the teaching analysis based on the classification of teaching behaviors, the redundancy of information of teaching behaviors refers to the redundancy of teaching behaviors, and the redundancy of teaching behaviors can be calculated by relative entropy.

Let H be the information entropy of the teaching behavior of a class, $H_{\max}$ be the maximum value of the information entropy of the teaching behavior of the class, and h be the relative information entropy of the teaching behavior system of the class, then:

$$h = \frac{H}{H_{\max}} \tag{31}$$

Let r be the redundancy of the teaching process for the lesson, then:

$$r = 1 - h = 1 - \frac{H}{H_{\max}} \tag{32}$$

4.4. Analysis of teaching interactions

Teaching interactions can be divided into teacher-student interactions and interactions between students, and in the teaching analysis based on the Classroom Teaching Behavior Classification System (CTBCS), the analysis of teaching interactions mainly involves counting the number of interactions so as to know the situation of teaching interactions. Let I be the total number of teaching interactions, I_1 be the number of teacher-student interactions, I_2 be the number of interactions between students, and $I = I_1 + I_2$.

4.5. Analysis of teaching models

The analyses of teaching models in this paper are all based on $S-T$ analysis. The so-called $S-T$ analysis refers to the simplified division of behaviors in teaching into two categories: student (S) behaviors and teacher (T) behaviors. It greatly improves the objectivity and reliability of teaching analysis. Based on $S-T$ analysis, the teaching pattern of specified teaching can be represented in two different ways, one is represented by $S-T$ diagrams of S behaviors and T behaviors over time, and the other is represented by Rt-Ch diagrams that show the type of teaching.

4.6. Frequency analysis of behavioral categories

Behavior category frequency is the ratio of the number of samples of a particular category of behavior to the total number of samples of all behaviors in the instructional process. Let $i\left(i = 1, 2, 3, \cdots, n\right)$ be a category of behavior in the instructional system (the instructional system has a total of n categories of behavior), M be the total number of samples of instructional behaviors sampled, m_i be the total number of samples of instructional behaviors in category i, and P_i be the relative frequency of behavior in category i, then:

$$P_i = \frac{m_i}{M} \times 100\% \tag{33}$$

In the analysis of teaching and learning, the relative frequency distribution of categories can be made to visualize the use of various types of behaviors in the teaching and learning process.

5. Analysis of classroom teaching behavior

5.1. Results of Comparative Analysis of Student Behavior

The overall analysis of the data related to student behavior is shown in Table 1, and the numbered prefixes SA, SB, and SC represent student behavior in the organization of teaching and learning activities, student verbal behavior, and student activity behavior, respectively.

Table 1. Student behavior data table

Coding	Probability	Information content
SA1	0.83	0.18
SA2	0.02	0.05
SA3	0.15	0.41
SB1	0.44	0.44
SB2	0.15	0.52
SB3	0.29	0.42
SB4	0.09	0.31
SB5	0.00	0.31
SB6	0.02	0.22
SC1	0.04	0.15
SC2	0.03	0.12
SC3	0.04	0.16
SC4	0.31	0.53
SC5	0.06	0.35
SC6	0.01	0.04
SC7	0.51	0.48

According to the analysis of student behavior data resulted in the comparison of information entropy and probability of the overall situation of student behavior, the results of the comparison of the probability of student behavior and information entropy of the overall situation are shown in Fig. 3 and Fig. 4, respectively.

According to the comparison of information entropy and probability of student behavior, it can be clearly seen that, on the one hand, the observation points of the items shown in the probability graph are not obvious, especially the values of the observation points such as sb6, sc1, sc2, sc3, etc. are very small, and the change of each of these items in the various observation points cannot be seen very clearly, so there will be some difficulties in analyzing and comparing the data. The method of information quantity is to make a fine zoom of each data on the basis of probability, that is, it is in the zoom of the data in the probability analysis chart where the observation points are not obvious, so that the observer-analyst can see the changes of each observation point very clearly.

Here the students' classroom behavior is divided into three independent parts to calculate the information entropy value of each part, and the size of the entropy value can reflect some states of teaching activities. The information entropy value of the organization of students' teaching activities is HSA=0.64, and the maximum information entropy value is Hmax=0.52. The information entropy value of students' verbal behaviors is HSB=1.84, and the maximum information entropy value is Hmax=2.55, which is a larger value of information entropy, which means that students' verbal behaviors are richer and more activities, and according to the data in the graph, it can be analyzed that students mainly face the whole class to operate and answer the questions. The information entropy value of students' activity behavior is HSC=1.67, the maximum information entropy Hmax=2.82, the information entropy value is small, which indicates that the students' activities are more single, and it can be seen that the students' activities are based on watching the teacher's or other classmates' activities, and practicing activities, and the behavior of other activities is very little, almost zero. Therefore, through the size of the information entropy value is able to reflect the behavior of classroom teaching activities, which plays a certain role in evaluating and promoting the evaluation of classroom teaching.

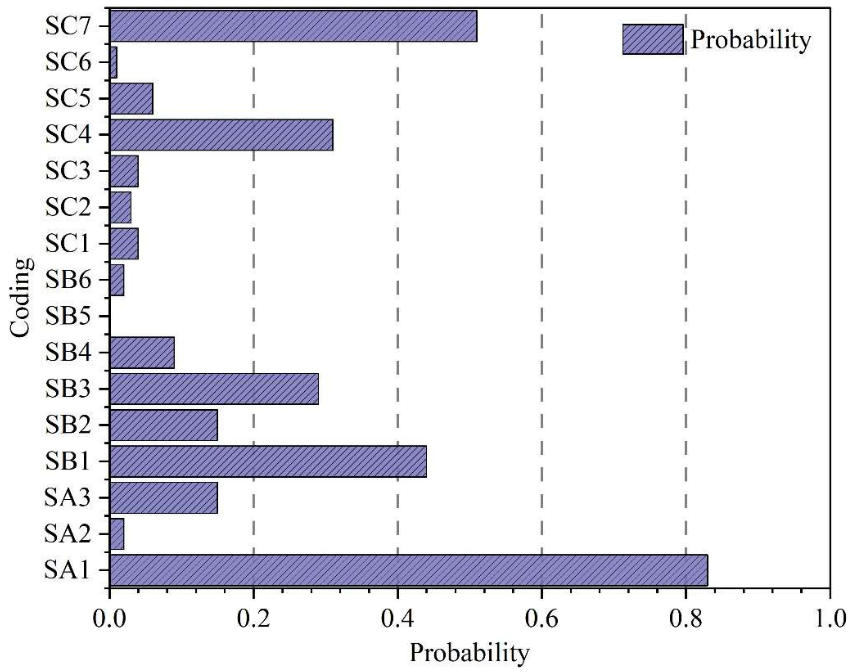

Fig. 3. The overall probability of student behavior

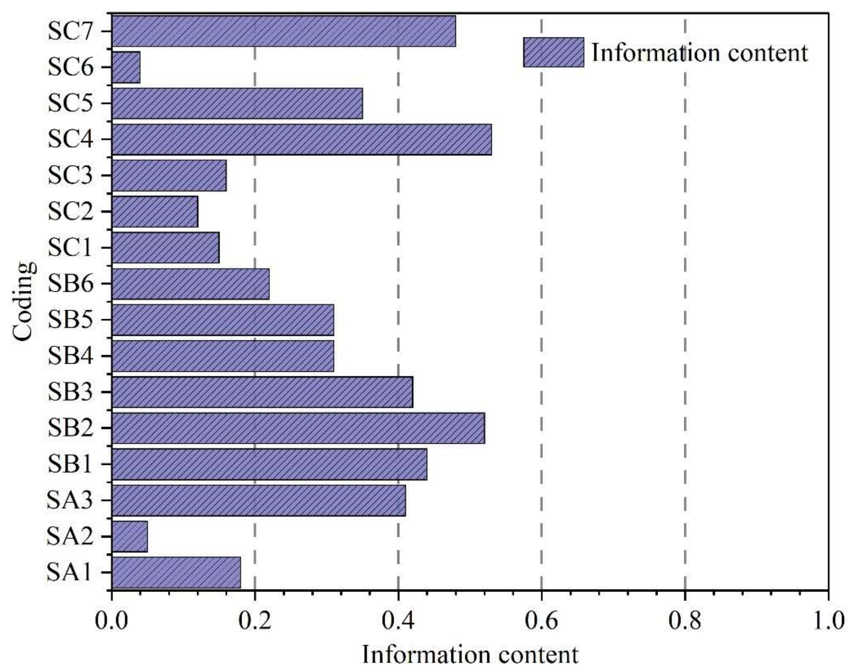

Fig. 4. Student behavior overall information entropy

The overall analysis of the data related to teacher behaviors is shown in Table 2, and the numbered prefixes TA, TB, and TC represent teacher behaviors of classroom activity organization, teacher speech behaviors, and teacher activity behaviors, respectively.

Table 2. Teacher behavior data table

Coding	Probability	Information content
TA1	0.93	0.08
TA2	0.05	0.25
TA3	0.01	0.05
TB1	0.21	0.45
TB2	0.40	0.54
TB3	0.18	0.42
TB4	0.13	0.38
TB5	0.09	0.31
TB6	0.02	0.12
TC1	0.03	0.21
TC2	0.00	0.00
TC3	0.43	0.52
TC4	0.32	0.52
TC5	0.21	0.48
TC6	0.02	0.08
TC7	0.02	0.08

According to the teacher behavior data analysis after the teacher behavior overall situation information entropy and probability comparison, teacher behavior probability and overall situation information entropy comparison results are shown in Figure 5 and Figure 6 respectively.

From the comparison of the two figures, it can be seen that the information entropy can be local amplification of the data, easy to observe and analyze the data which is one of the most prominent features of the information entropy.

Teacher's classroom organization activity HTA = 0.34, the maximum information entropy value is Hmax = 0.54. Teacher's verbal behavior information entropy value HTB = -2.23, the maximum information entropy value is Hmax = 2.56, the difference of information entropy H = 0.33, and the difference of the maximum information entropy is relatively small, which shows that the teacher's verbal behavior activities are more abundant, and it can be seen from the data that the teacher's activities such as speaking, questioning, evaluating, and so on are more frequent. Questions and other activities are more frequent Teacher activity behavior information entropy value HTC = 1.81, the maximum information entropy value is Hmax = 2.82, the information entropy difference H = 1.01, the information entropy difference is larger, indicating that the teacher's activities are more monotonous on the activities of the activities of the content of the activities of the lesser, and from the point of view of our actual data, teacher's activities is indeed relatively small, the majority of the activities are concentrated in the demonstration, display, observation rounds. The results of data analysis are consistent with the actual teaching situation.

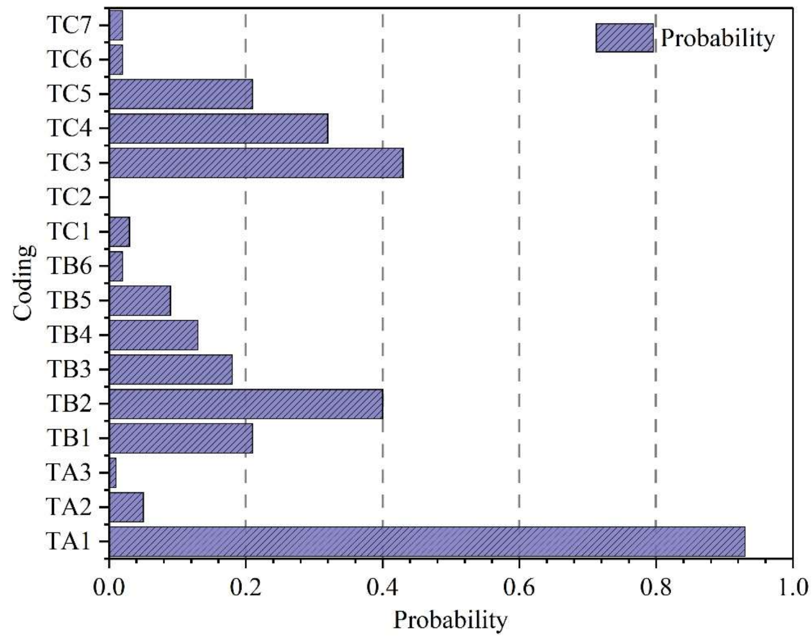

Fig. 5. The overall probability of teacher behavior

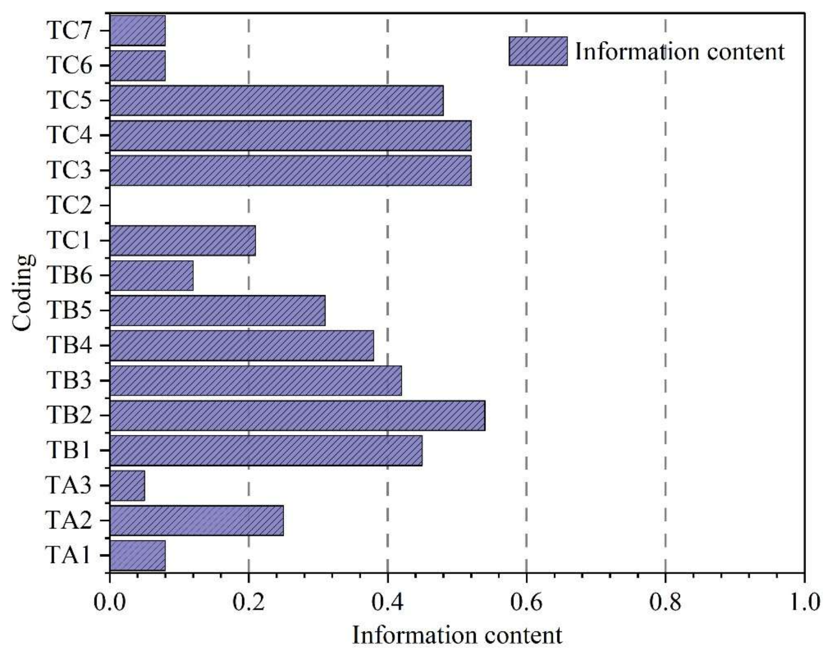

Fig. 6. Teacher behavior overall information entropy

5.2. Curve analysis

Taking time as the horizontal coordinate and the interactive behavior code of psychological classroom teaching as the vertical coordinate, the recorded data can be expressed in a line graph, which is more visual and intuitive to show the conversion of interactive behaviors in the process of psychological classroom teaching, and get the teaching behavior time-sequence diagram, which is more intuitive than the behavior conversion matrix and has a time-sequence. Take the recorded data of the first five minutes of a class case as an example, construct a line graph of the change of behavioral categories with the behavioral moments, and the time sequence diagram of teaching behavior is shown in Figure 7.

Teaching behavior chronogram, part of the curve parallel to the horizontal axis, indicating that the behavior corresponding to the vertical coordinate continues to occur during this period of time: part of the curve has a certain degree of inclination, indicating that the teaching behavior is transformed, and the more inclined the fold line, the more the behavior is transformed. In this example, between 120 seconds and 200 seconds, the teaching behavior is switched back and forth in categories 1, 3, and 7, that is, "the teacher asks questions after giving feedback on the students' response results, the students respond immediately, the teacher asks questions again, the students respond to them, and then the teacher responds according to the content of the students' responses".

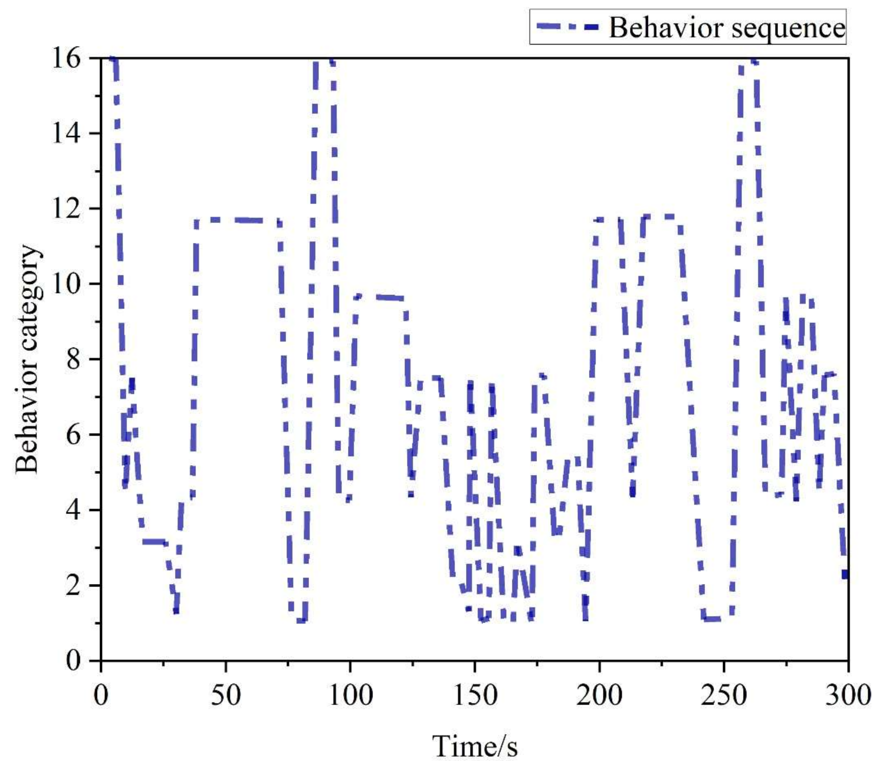

Fig. 7. Sequence of teaching behavior

In the Flanders Speech Interaction Analysis System, the Classroom Speech Curve Analysis graph visualizes the changes in the teacher-student speech ratio as it develops over time, which plays an important role when analyzing the data and summarizing the conclusions. The first-level dimensions of this study are teacher, student, psychoeducational, textbook, and other, and the interaction of teacher, student, psychoeducational, and textbook is also emphasized in the interaction analysis.

Therefore, this study constructs a classroom element curve analysis diagram modeled after the classroom speech curve analysis diagram, and the classroom element curve analysis is shown in Figure 8. The curves corresponding to the teacher's behavior and the curves corresponding to the student's behavior both appeared in the teaching process and were maintained at a relatively stable level in the first half, indicating that the teacher-student interaction in this classroom example was stable, with the teacher organizing the teaching activities and the students actively participating. The curve corresponding to psychoeducation appeared intermittently at the beginning, middle, and end of the class, and the highest rate at the beginning was in the 8th minute of the class, which accounted for 74%. This indicates that the teacher in this case utilized psychoeducation as an aid in teaching activities such as the introduction of the topic. The curves corresponding to the textbook appeared at higher rates around the 16th, 20th, 26th, 31st, and 39th minutes at the beginning of the classroom, indicating that the teacher utilized the textbook to assist in teaching during these time periods and that it was intermittent, as was the case with psychoeducational use.

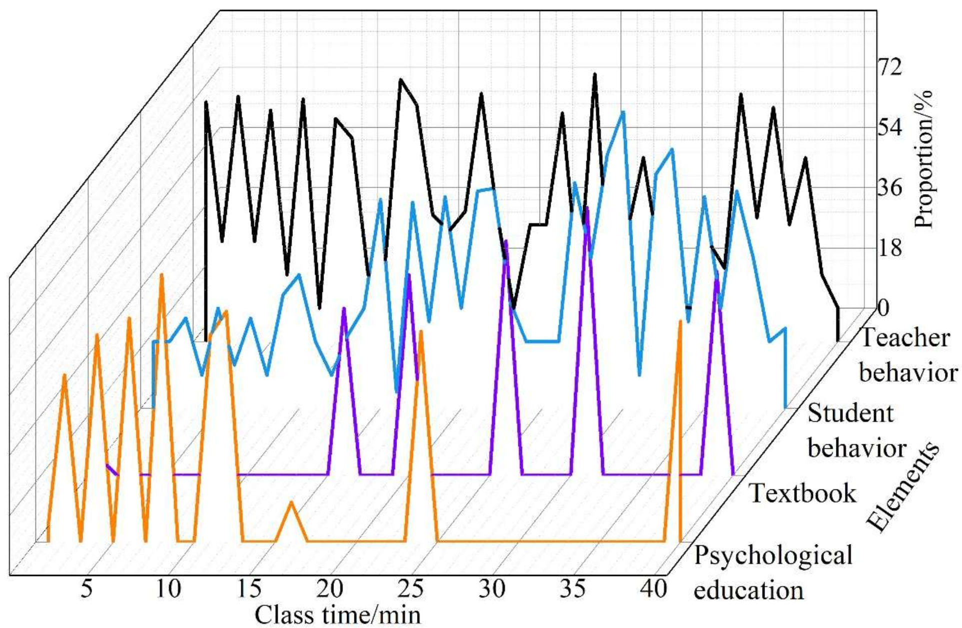

Fig. 8. The classroom elements are analyzed

A total of 24 lesson examples were selected, and all of them can get the corresponding classroom element curve analysis chart to analyze the interaction of teaching behaviors in each lesson. Similarly, the behaviors of the 24 lesson examples can be accumulated to get the overall classroom element curve analysis graph, and the overall classroom element curve analysis graph is shown in Figure 9. As can be seen in Figure 9, the 24 psychoeducational quality teaching video lessons as a whole present behavioral interaction characteristics as classroom teaching is dominated by teacher behavior and student behavior, psychoeducation and textbooks as teaching and learning mediums, appearing at a steadily low rate, with a relatively high proportion of teacher behavior in the early stages of the classroom, and with the highest proportion of teacher behavior in the fifth minute, 69%, which indicates that the teacher is the organizer and the guide of the classroom teaching and learning activities This shows that teachers are the organizers and guides of classroom teaching activities. As the classroom teaching activities advance in an orderly manner, the proportion of teacher behavior oscillates downward and the proportion of student behavior oscillates upward, and the curve crosses in the middle and late stages and maintains a relatively stable state, indicating that the students are the main body of teaching and the teachers are the leading ones.

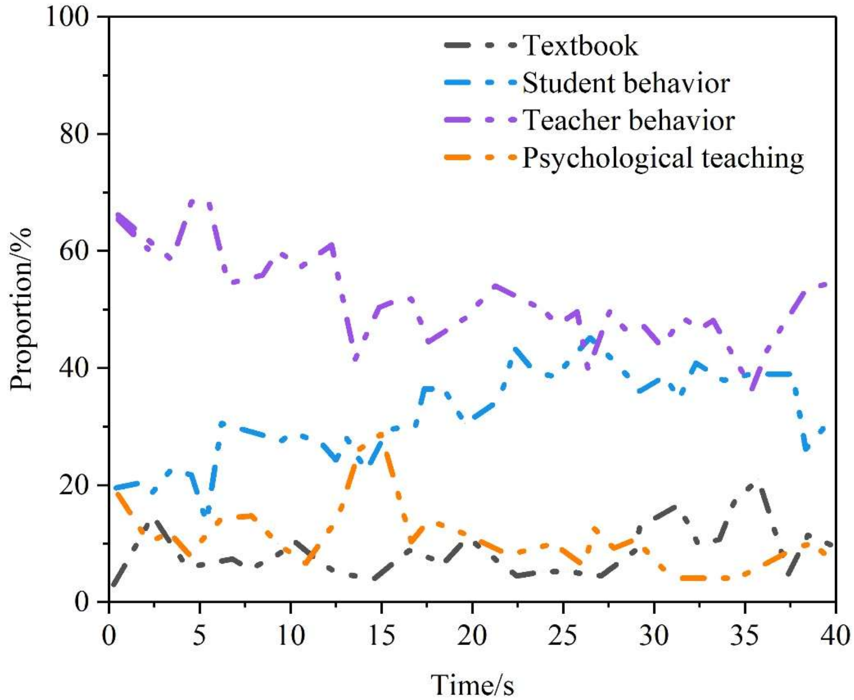

Fig. 9. The total factor of the whole class is the ratio

5.3. Research on Teacher and Student Behavior Based on S-T Analysis

In this part, the author used random samples instead of overall samples for analysis. The author divided the 24 lesson examples into four groups according to the order of the information table, the first group is K1-K6, the second group is K7-K12, the third group is K13-K18, the fourth group is K19-K24, six lesson examples in each group, and then, the fourth lesson example in each group was selected for the statistical analysis of the teacher's behavior and the student's behavior, with the student's behavior S as the vertical coordinate and the teacher's behavior T as the horizontal coordinate, and each unit representing 30 seconds, the S-T graphs of the four lessons were plotted, and the S-T graphs are shown in Figure 10.

From the S-T curves of the four random lesson examples, the fitting angle of all four curves is about 45°, which indicates that the percentage of teacher-student behaviors in the quality lessons is roughly equal. All four curves have a high portion of broken lines, and these broken lines indicate more teacher-student interaction behavior. All four curves also have distinct break sections, with horizontal breaks indicating that teacher behavior occurs on a continuum and that the teacher forms fewer interactions with students during that time period. Vertical breaks indicate that student behaviors are occurring in a continuum and that the teacher is not providing appropriate instructional interventions during student-directed learning activities. The average time occupied by the teacher in the classroom for the four quality lessons was 18.556 minutes and the average time occupied by student behavior was 21.444 minutes. From the point of view of the time spent by teachers and students in the classroom, the cumulative time spent by students is higher than that spent by teachers, which shows that teachers have changed from the traditional “indoctrination” classroom, and that the status of students in the classroom has gradually come to the fore.

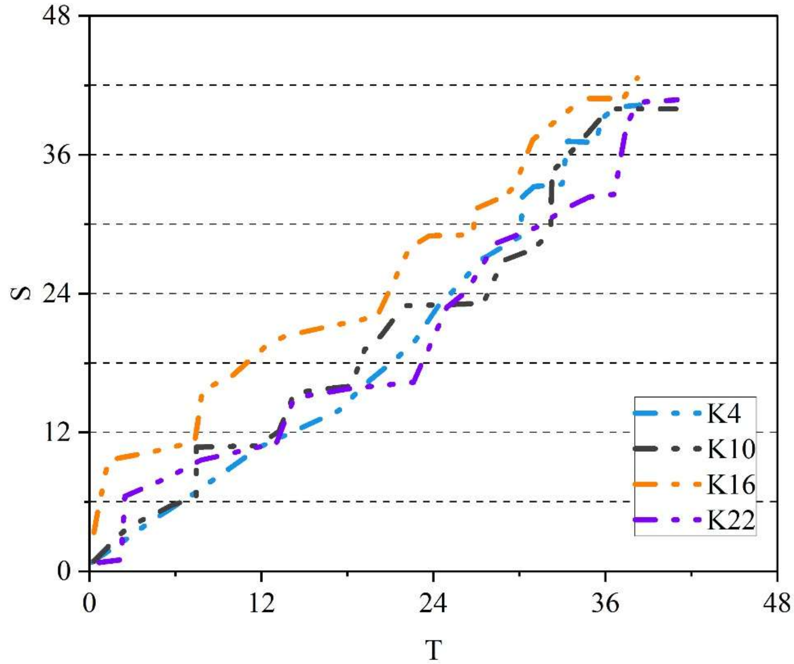

Fig. 10. S-T Graphs

5.4. Rt-Ch chart analysis for psychology classes based on S-T analysis

Rt and Ch values are two important parameters in the S-T analysis method, which represent the teacher behavior occupancy rate and behavior switching rate, respectively. The author recorded S and T data for 24 lessons by watching and obtained teacher behavior Nt, student behavior Ns, total number of behaviors 80, and the number of consecutive behavior occurrences g. The Rt value and Ch value were calculated.The Rt-Ch diagram represents different teaching patterns and the Rt-Ch diagram is shown in Fig. 11.

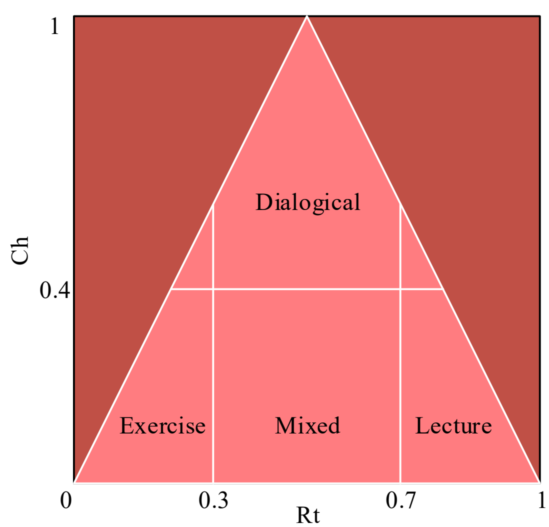

Fig. 11. Rt-Ch Graph

An Rt-Ch plot is a depiction of the calculated Rt and Ch data on a plane with Rt on the horizontal axis and Ch on the vertical axis, respectively. Each lesson taught corresponds to a point in the Rt-Ch chart, and the calculated Rt and Ch values for the 24 lessons are corresponded to the chart. Using this Rt-Ch diagram as a standard, the teaching patterns of the 24 quality lesson examples can be determined based on the Rt and Ch values, and the statistical results are shown in Table 3. Among the 24 psychological quality lessons, there are 12 mixed-type lessons, accounting for 50% of the total lesson examples, 11 dialogic-type lessons, accounting for 45.83% of the total lesson examples, and 1 lecture-type lesson, accounting for 4.17% of the total lesson examples. It can be seen that among these high-quality lessons, the hybrid and dialogic teaching modes accounted for as high as 95.83%. The hybrid and dialogic teaching modes are characterized by a comparable proportion of teacher-student behavior, and the interaction between teachers and students in the dialogic teaching mode is higher than that in the hybrid mode. From the data, it seems that most of the teachers of quality classes are able to focus on interaction with students in the classroom, and it is no longer the traditional situation of a class where only the teacher lectures and the students accept it, and there has been a great change in the way teachers teach, and the teachers of quality classes focus on playing the main role of students in the classroom, and applying the concepts advocated by the new curriculum to the real world.

In terms of the occupancy rate of teacher behavior Rt, the average value of the occupancy rate of teacher behavior in 24 quality lessons is 0.505, which is higher than this average value indicating that the teachers have more behaviors in the classroom. There are 13 quality lessons with teacher behavioral occupancy rate lower than this mean, the teachers of these 13 quality lessons realized the students' subject position and guided the students more in the classroom to participate in the classroom activities. There are 11 quality lessons where the percentage of teacher behaviors is higher than the average, which means that these 11 lessons have more teacher behaviors than the other quality lessons. These teachers can let go a little more in the classroom, give students more space for their own learning and discussion, and appropriately reduce the percentage of their own behaviors in the classroom.

Table 3. Quality class psychology teaching mode

Number	Nt	Ns	N	g	Rt	Ch	Teaching model
K1	41	39	80	33	0.5	0.3873	Hybrid type
K2	47	33	80	30	0.6	0.3501	Hybrid type
K3	47	33	80	36	0.5999	0.4248	Dialogical
K4	46	34	80	36	0.5876	0.4251	Dialogical
K5	34	46	80	31	0.4377	0.3625	Hybrid type
K6	35	45	80	38	0.4625	0.4495	Dialogical
K7	34	46	80	30	0.413	0.3502	Hybrid type
K8	48	32	80	30	0.6126	0.3499	Hybrid type
K9	31	49	80	31	0.3749	0.3621	Hybrid type
K10	57	23	80	36	0.7248	0.4249	Teaching type
K11	38	42	80	36	0.487	0.4247	Dialogical
K12	42	38	80	34	0.5123	0.4001	Dialogical
K13	50	30	80	22	0.637	0.2499	Hybrid type
K14	37	43	80	38	0.4752	0.45	Dialogical
K15	25	55	80	23	0.3504	0.2629	Hybrid type
K16	42	38	80	36	0.5	0.4253	Dialogical
K17	31	49	80	37	0.4123	0.4378	Dialogical
K18	41	39	80	36	0.5251	0.4253	Dialogical
K19	48	32	80	28	0.6128	0.3248	Hybrid type
K20	31	49	80	28	0.4	0.3249	Hybrid type
K21	31	49	80	34	0.4	0.4	Dialogical
K22	32	48	80	36	0.4378	0.425	Dialogical
K23	51	29	80	30	0.6251	0.35	Hybrid type
K24	32	48	80	16	0.4373	0.1748	Hybrid type

6. Calculation of information entropy and the direction of development of classroom teaching and learning

6.1. Calculating Information Entropy

There are 16 major categories of teacher and student behaviours, and if each teaching behaviour occurs with equal probability, the maximum information entropy of this example $S-T$ analysis process is calculated from the perspective of the principle of maximum information entropy as:

$$H=-\sum_{1}^{16} p_{log} p_i = 3.29 p = \frac{1}{16} \tag{34}$$

The pedagogical information entropy of this process is:

$$H=-\sum_{1}^{16} p_i \log_2 p_i = 3.29 \tag{35}$$

The information entropy of the teacher's behaviour in this process is if it is calculated using student behaviour and teacher behaviour as the two main categories:

$$H = -\sum_{1}^{16} p_i \log_2 p_i = 1.645 \tag{36}$$

The information entropy of a student's behaviour is: $H = 2.29 - 1.645 = 0.645$. Considering each behaviour as a separate event, the information entropy calculated for $T1$ (the teacher's statement), for example, is 0.48.

The information entropy of the teacher's behaviour in a lesson example is 50.4% of the maximum information entropy, which is small, indicating that the teaching behaviour of the lesson example is not rich enough, simply repeating a certain teaching behaviour, and there is less transformation between teaching behaviours, which makes the teaching seem dull and lack of classroom vitality.

Information entropy reflects the uncertainty of the teaching behaviour system.The greater the information entropy.Teaching behaviour in the teaching process is more abundant.When the information entropy is maximum, each teaching behaviour occurs with an equal chance, indicating that the teacher focuses on the interspersed transformation of different teaching behaviours.The transformation of multiple types of teacher behaviours can reflect the teacher's efforts in classroom instructional control, instructional guidance and student guidance, and the emergence and transformation of multiple types of student behaviours can also reflect the degree of students' classroom participation, mutual support and research, and self-construction of meaning.Information entropy theory considers that the increase of entropy is the result of the increase of system state.According to the principle of maximum entropy, an increase in entropy is the result of an increase in teaching behaviours or a uniform distribution of the probability of teaching behaviours.An increase in systematic teaching behaviours means an increase in the way teaching information is transmitted, teaching is lively, and it can better promote students' active thinking activities.At the same time, the increase in teaching behaviour also indicates that teaching information can be transmitted in different teaching behaviours collision, and thus maximize the understanding and acceptance by students.

6.2. Directions for Psychological Classroom Teaching and Learning

The future direction of psychology classroom teaching develops in the following 3 aspects.

1) Transform the learning mode of students, so that students become the subject of the object. In the future psychological classroom teaching mode, we need to completely change the way students learn, students are not only the object of education, but more importantly, the subject of development. Only by allowing students to actively participate in the whole process of classroom teaching can they comprehend the relevant disciplinary discoveries, disciplinary knowledge and the harvest of the creative process. Through the students' own experience in the process of teaching and learning interaction, access to sensible emotional experience, interpersonal skills, accumulation of knowledge and methods, and cultivate their creative spirit and creative ability.

2) Teachers are in the leading position, combining the teaching of psycho-pedagogical knowledge and the cultivation of students' active inquiry ability. We advocate a “student-centered” psychological classroom teaching model, psychological classroom to the students as the main body, but absolutely inseparable from the leading role of the teacher, that is, teacher-led student body. Realize the two-way communication between teachers and students, fully mobilize the enthusiasm and initiative of both sides, to achieve the best benefits of teaching and learning.

3) Teacher-student interaction, constructing a harmonious teaching environment. We advocate that students should increase their participation in the process of classroom teaching, emphasize two-way communication between teachers and students, equal communication, fully mobilize the enthusiasm and initiative of both sides, easy learning in communication, and organically unify teaching and learning will become the dominant direction for the development of future psychological classroom teaching.

7. Conclusion

Based on the information entropy theory, this paper combines the time series analysis method, the S-T method and the iFLAS system to analyze the psychological classroom teaching behaviors with a view to improving the psychoeducational teaching process.

The overall classroom teaching characteristics presented in the 24 psychoeducational teaching classes were that teacher behavior and student behavior accounted for the main proportion, and intermittent low ratios of psychoeducational and teaching materials appeared, and teacher behavior accounted for a high proportion in the early part of the classroom, with the highest proportion at the fifth minute, reaching 69%. As the classroom activities continued, the percentage of teacher behavior decreased and the percentage of student behavior gradually increased.

The time occupied by teacher behavior in the quality psychology class was 18.556 minutes, and the time occupied by student behavior was 2.888 minutes higher than that of teacher behavior. The time of student behavior is higher than the time of teacher behavior, indicating that the teaching mode of the selected quality classes has gradually changed from traditional classroom to a new teaching mode in which the students' subject position is enhanced.

Among the 24 quality psychology lessons, the hybrid and dialogic teaching modes accounted for 95.83% of the total, and the lecture mode accounted for only 4.17% of the total lessons. It shows that the teachers of quality psychology classes are able to focus on the interaction with students, and it is no longer the traditional mode of teachers lecturing and students receiving.

The teaching mode of quality psychology class provides an effective reference for many psychological education teachers to standardize their teaching mode in classroom teaching, and clarifies the new direction of the development of psychological education classroom teaching. Let students actively participate in the process of classroom teaching, advocate “student-centered” psychological classroom teaching mode, while the leading role of the teacher, to the students as the main body of classroom teaching, emphasizing two-way interaction between the teacher and the students, to achieve equal communication.

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