Tutoring Exploration of Diversified Japanese Teaching Mode Based on Intelligent CAD and Data Mining Technology

Yimei Wang

School of Foreign Language, Shangqiu University, Shangqiu 476000, Henan, China

Corresponding author: Yimei Wang, 15737900602@163.com

Abstract. In order to improve the efficiency of Japanese teaching, this paper combines the Internet of Things technology and data mining technology to analyze the multi-level Japanese teaching mode. The processing efficiency of teaching information is improved by improving the algorithm, and the expansion moments on the patches far away from the observation point are merged by a series expansion of Green's function, thereby speeding up the calculation process. Its essence is equivalent to changing the multiplication of N-dimensional dense matrix and N-dimensional vector into the multiplication of sparse matrix and vector, thus speeding up the multiplication calculation. Furthermore, it is easily combined with iterative solvers such as GMRES to speed up the solution of boundary integral equations. The clustering results show that the diversified Japanese teaching model based on the Internet of Things and data mining technology proposed in this paper can effectively improve the efficiency of Japanese teaching.

Keywords: Internet of things; data mining; diversification; analysis of Japanese teaching
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1 INTRODUCTION

Teaching quality evaluation in colleges and universities should combine teacher self-evaluation, student evaluation, leader evaluation, peer evaluation, internal evaluation and external evaluation, and student evaluation and graduate evaluation. At the same time, it is necessary to combine the individual teaching quality evaluation of teachers with the collective teaching quality evaluation of schools so that the teaching quality evaluation system becomes a network system with full participation and benign interaction [16].

Intelligence is not centered on the ability of language, mathematical, or logical reasoning as mentioned in the traditional definition, nor is it the only standard to measure the level of intelligence.

It is centered on the ability to solve problems in real life and create effective products needed by society, and it is also the standard to measure the level of intelligence [12]. The new intelligence theory covers the new concepts emerging in the research of intelligence in recent years in China's theoretical circle: emotional intelligence, psychological intelligence, and nonintelligent factors. This new intelligence theory is also of great significance to school education. It proves the absurdity of the unified value standard of teacher evaluation that widely exists in China today. It shatters the theoretical cornerstone of instrumental rationality that exists in today's school education and becomes the theoretical basis of diversified teacher evaluation research [9].

In today's increasingly mature market economy, the school's social reputation is the lifeblood of the school's survival and development. Therefore, the evaluation of teaching quality must attach great importance to the adaptability of professional talents trained by the school to social needs and the satisfaction of employers. The school should establish a credible graduate tracking and investigation system and dynamically adjust the school's professional setting and talent training program according to social feedback so as to establish a benign school running mechanism with high-quality teaching effects and distinctive talent training characteristics and promote the development of the school's comprehensive school running practice [10].

Teaching is a system composed of teachers, students, courses, teaching resources, teaching environment, and other factors. The quality of teaching depends on the quality of various factors in the system and the quality of their interaction. Therefore, the evaluation of teaching quality should be based on the evaluation of each link of the teaching process, not only from simple classroom teaching to other links of teaching but also from the main elements of teaching to the relevant factors of teaching. It is necessary to carry out longitudinal teaching quality evaluations for each grade and to grasp each link to carry out horizontal quality evaluations [5]. In terms of evaluation methods, it is shown that the formative evaluation carried out in the teaching process is combined with the final evaluation at the end of the teaching process so that the teaching quality evaluation runs through the whole teaching process and the teaching quality is monitored and guaranteed in every stage and link of the teaching process in a timely manner. Of course, when constructing the teaching quality evaluation system, we should not only focus on the system but also consider its feasibility and strive to grasp the main indicators to avoid the complexity of the system and time-consuming and laborious operation [13].

Evaluation is a kind of value judgment activity. It is a degree of satisfaction of the object itself and its attributes to the subject and its needs. The control and application of evaluation results are determined by the subject. Student evaluation is an important part of educational evaluation; different experts and scholars have given different interpretations of the concept of "student evaluation" [1]. Literature [4] points out that "student evaluation refers to the activity of describing and judging the development process and status of students' ideological and moral character, academic performance, physical and mental quality, emotional attitude, etc., under the guidance of certain educational values and according to certain standards, using scientific methods and technologies. Literature [8] points out that student evaluation is an activity in which the controller measures and summarizes students' accomplishments in moral, intellectual, physical, aesthetic, labor, and other aspects to a certain extent in the teaching field. The author believes that the concept of student evaluation should include the following elements: the scale of evaluation basis, the subject of evaluation, the evaluated, the evaluation content, the evaluation method, and the evaluation results. The concept of student evaluation, which includes these six elements, can be put forward as follows: in the field of education and teaching, student evaluation refers to the measurement and judgment of students' academic performance, ideological and moral character, physical and mental quality, etc. by the subject of evaluation according to certain development goals, using scientific evaluation methods and technologies, to obtain the results of students' achievement of goals or completion of tasks, and feedback the results to education and teaching activities. Cai Yonghong defined diversified student evaluation in his paper as follows: "It refers to a series of evaluation methods that not only use standardized tests but also use a variety of ways to evaluate students' learning results in unstructured situations." Literature [11] believes that diversified student evaluation is an activity in the field of education and teaching that involves multiple evaluation subjects and uses multiple methods to evaluate and judge students' various development results according to multiple standards. To be specific, diversified student evaluation is the enrichment and innovation of traditional student evaluation. It points out the main problems existing in the traditional student evaluation and solves them. It reforms and innovates the traditional evaluation model. It is an evaluation model that can better adapt to quality education and promote the overall development of students. It is also a new evaluation model derived from the negation of the traditional evaluation model. In the field of education, diversified student evaluation is not only a theoretical concept but also a very practical concept. Educators should understand this concept and be able to practice it in teaching practice. The purpose of diversified student evaluation is to comprehensively understand the development of students at a certain stage, guide teaching, enrich teaching, and promote the healthy development of teachers and students towards certain goals [14]

The theory of multiple intelligences holds that human intelligence is multidimensional and multi-domain rather than single-dimensional and linear. It breaks the traditional intelligence theory that only takes language ability and mathematical logic ability as the core. Its vastness and openness enable us to have a more comprehensive, correct, and thorough understanding of individual intelligence. It brings a new atmosphere to the education and teaching community and has a high reference value for education evaluation [15]. It has made great changes in the concept that educators adhere to when evaluating students. It tells educators to have diversity when evaluating thousands of different individuals rather than absolute "one size fits all." Every individual has no difference between good and bad, and only their intelligence is strong or weak. The student evaluation that promotes students' development as the purpose should adhere to the "whole person view" [3].

Although postmodernism does not propose operable evaluation models and methods for student evaluation, it provides a new concept and perspective for student evaluation and has a profound impact on student evaluation. First of all, it believes that the purpose of student evaluation is to promote the comprehensive and harmonious development of students rather than blindly choosing and judging. Student evaluation is indeed a value judgment activity, but this judgment is a judgment of learners' gains and losses in development, and a judgment of learners' achievement of development goals and completion of development tasks. This judgment is to promote learners' further development, rather than a judgment of learners' ability and personality [2]. For learners who fail to achieve their development goals, The evaluator must not classify them as "inferior students" or "incompetent." We should help them find out the reasons for their unfinished goals, give them sufficient care and help, and actively promote their development in a benign direction. Secondly, it emphasizes the negotiation of student evaluation. In the evaluation community, there should be different evaluators first, and the relationship between evaluators should be communication, communication, and consultation. In addition, the evaluator should respect the differences between the evaluated and see the shortcomings and advantages of different individuals. Thirdly, it advocates that student evaluation should weaken the function of discrimination, enhance the function of stimulation and encouragement, and really play a role in promoting the overall development of individuals [6]

The basic purpose and function of education is to promote the healthy development of students, and students' physical and mental development has a certain regularity. Education can better promote students' physical and mental development only if it is adapted to this law. The universal differences in students' physical and mental development are an important rule. This difference exists at different levels. From the perspective of groups, it is first shown in the differences between men and women and, secondly, in the physical and mental development of individuals at different stages [7].

This paper combines the Internet of Things technology and data mining technology to analyze multiple Japanese teaching modes and constructs an intelligent Japanese teaching system to improve the effectiveness of Japanese teaching.

2 OPTIMIZATION USING FAST MULTIPOLE METHOD

The Fast Multipole Method (FMM) is applied to solve the N-body problem. This method can accelerate the N-body problem of $O(N^2)$ to $O(N)$ complexity. Since then, FMM has been widely used in many fields of physics and engineering, such as potential field calculation, elastic system solution, fluid calculation, and so on.

2.1 Fundamentals of FMM

The solution to the harmonic field $\phi(\boldsymbol{x})$ we want to ask for can be expressed as:

$$\phi(\boldsymbol{x}) = \oint_{\partial\mathcal{D}} q(\boldsymbol{x}')G(\boldsymbol{x},\boldsymbol{x}')d\boldsymbol{x}' \tag{1}$$

After discretizing the boundary $\partial\mathcal{D}$ into a triangular mesh T, the above formula is discretized as:

$$\phi(\boldsymbol{x}) = \sum_{\forall t_i \in T} \oint_{t_i} G(\boldsymbol{x},\boldsymbol{x}')q(\boldsymbol{x}')d\boldsymbol{x}' \tag{2}$$

The computational complexity of the above formula is $O(N)$. Considering that the value of Green's function $G(\boldsymbol{x},\boldsymbol{x}')$ is relatively small when the point x and the point $\boldsymbol{x}'$ are far away, so when the point x is far away from the triangle t_i, we can approximate the integral $\oint_{t_i} G(\boldsymbol{x},\boldsymbol{x}')d\boldsymbol{x}'$ in some way.

In the above formula, $G(\boldsymbol{x},\boldsymbol{x}')$ is also called kernel function, which has different forms for different problems. Since we are only concerned with the case of the three-dimensional Laplace equation, we will discuss this special case only in this chapter.

To realize the above idea, we first need to find the series expansion of the kernel function $G(\boldsymbol{x},\boldsymbol{x}')$. More precisely, $G(\boldsymbol{x},\boldsymbol{x}')$ needs to be expanded into the form:

$$G(\boldsymbol{x},\boldsymbol{x}') = \sum_{k=0}^{\infty} O_k(\boldsymbol{x}-\boldsymbol{x}_c)I_k(\boldsymbol{x}'-\boldsymbol{x}_c) \tag{3}$$

The above formula is called the multipole expansion of the kernel function. It separates point $\boldsymbol{x}$ and point $\boldsymbol{x}'$ by introducing a middle point $\boldsymbol{x}_c$. With the above multilevel sub-expansion, the integral in formula (2) can be calculated as follows:

$$\oint_S G(\boldsymbol{x},\boldsymbol{x}')\, q(\boldsymbol{x}')\, d\boldsymbol{x}' = \sum_{k=0}^{\infty} O_k(\boldsymbol{x}-\boldsymbol{x}_c)\, M_k(\boldsymbol{x}_c) \tag{4}$$

In the formula,

$$M_k(\boldsymbol{x}_c) = \oint_S I_k(\boldsymbol{x}'-\boldsymbol{x}_c)\, q(\boldsymbol{x}')\, d\boldsymbol{x}' \tag{5}$$

It is called the moment of the multilevel sub-expansion, which is only related to the middle point $\boldsymbol{x}_c$, but not related to the point x, so it can be pre-computed. Usually, in the actual solution, the middle point $\boldsymbol{x}_c$ is taken close to the center of the Japanese teaching grid S.

More precisely, the following conditions need to be met:

$$|\boldsymbol{x}-\boldsymbol{x}_c| > |\boldsymbol{x}'-\boldsymbol{x}_c| \tag{6}$$

For the three-dimensional Laplace operator, the kernel function is the Green's function, and its multipole expansion is as follows:

$$G(\boldsymbol{x},\boldsymbol{x}') = -\frac{1}{4\pi}\sum_{n=0}^{\infty}\sum_{m=-n}^{n} \overline{S_{n,m}}(\boldsymbol{x}-\boldsymbol{x}_c)\, R_{n,m}(\boldsymbol{x}'-\boldsymbol{x}_c) \quad (|\boldsymbol{x}-\boldsymbol{x}_c| > |\boldsymbol{x}'-\boldsymbol{x}_c|) \tag{7}$$

In the formula, $S_{n,m}$ and $R_{n,m}$ are solid harmonic functions.

$$\left.\begin{aligned} R_{n,m}(\boldsymbol{x}) &= \frac{1}{(n+m)!} P_n^m(\cos\theta)\, e^{im\phi} r^n \\ S_{n,m}(\boldsymbol{x}) &= (n-m)!\, P_n^m(\cos\theta)\, e^{im\phi} \frac{1}{r^{n+1}} \end{aligned}\right\} \tag{8}$$

The overline represents the complex conjugate, (r,θ,ϕ) is the spherical coordinate of the point x, and P_n^m is the associated Legendre function.

$$P_n^m(x) = (-1)^m (1-x^2)^{m/2} \frac{d^m}{dx^m} P_n(x) \tag{9}$$

In the formula, $P_n(x)$ is the Legendre function.

$$P_n(x) = \frac{1}{2^n n!} \frac{d^n}{dx^n} (x^2-1)^n \tag{10}$$

In the context of the three-dimensional Laplace equation, the integral in formula (2) can be calculated as follows:

$$\oint_S G(\boldsymbol{x},\boldsymbol{x}')\, q(\boldsymbol{x}')\, d\boldsymbol{x}' = -\frac{1}{4\pi}\sum_{n=0}^{\infty}\sum_{m=-n}^{n} \overline{S_{n,m}}(\boldsymbol{x}-\boldsymbol{x}_c)\, M_{n,m}(\boldsymbol{x}_c) \tag{11}$$

In the formula, the moment $M_{n,m}(\boldsymbol{x}_c)$ is:

$$M_{n,m}(\boldsymbol{x}_c) = \oint_S R_{n,m}(\boldsymbol{x}' - \boldsymbol{x}_c)\, q(\boldsymbol{x}')\, d\boldsymbol{x}' \tag{12}$$

Using the above multipole expansion, we can optimize the above integral sum of O(N) complexity into the following $O(\log N)$ -complexity algorithm.

It is easy to think that since the multipole expansion gives the magnitude of the integral value generated at point x for any Japanese teaching grid S, then for the Japanese teaching grid S_i which is far away from x, we can combine them into a larger sub-Japanese teaching grid and precompute its multipole expansion, thus reducing the complexity of summation.

Based on this idea, we build the space partition tree as follows. Each element in the bottom layer contains one or more patches, and each element can obtain its multipole expansion by summing the multipole expansion moments of the patches in the element. The multipole expansion of the parent cell can be obtained by summing the multipole expansions of the child cells. Obviously, the depth of the tree is $O(\log N)$ .When a point x is given, to find the integral value there, it is only necessary to traverse the tree from top to bottom. If a unit is far enough away from x, that is, it satisfies formula (6); the integral can be calculated directly by the multipole expansion of the unit without continuing to traverse downwards. Obviously, the complexity of this algorithm is $O(\log N)$.

To be more specific about how to judge "far enough", we introduce the following concept:

1. Two cells at the same level and sharing at least one boundary point are called neighbors.

2. Two non-neighboring units at the same level are called well-separated.

3. An interaction list is defined on each cell i, which consists of cells that are well separated from i in the child cells of all the neighbors of i's parent cell, as shown in Figure 1.

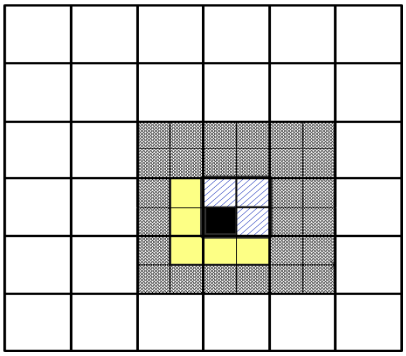

Figure 1: The interaction list and the interaction list of black cells are marked in gray.

We set the midpoint x of the multipole expansion of each cell at the position of the cell center. Obviously, the constraints given by equation (6) are satisfied between all non-neighboring units. Therefore, we judge non-neighbor cells as "far enough."

In the above method, we can calculate each cell's "far enough" set of cells. However, in order to implement the $O(\log N)$ -algorithm, there is one more problem to be solved: the middle point $\boldsymbol{x}_c$ is different due to the multipole expansion of each unit. Therefore, the multipole expansion moments of the parent element cannot be directly obtained by summing the multipole expansion moments of the child elements. In the above method, we can calculate each cell's "far enough" set of cells. However, in order to implement the algorithm, one more problem needs to be solved. Since the midpoint of the multipole expansion of each element is different, the multipole expansion moment of the parent element cannot be directly obtained by summing the multipole expansion moments of the child elements. To solve this problem, we need the following transformation.

$$M_{n,m}(\boldsymbol{x}_c') = \sum_{n'=0}^{n}\sum_{m'=-n'}^{n'} R_{n',m'}(\boldsymbol{x}_c - \boldsymbol{x}_c')\, M_{n-n',m-m'}(\boldsymbol{x}_c) \tag{13}$$

The above equation is called the M2M transform, which provides the means to transform the middle point $\boldsymbol{x}_c$ in the multipole expansion to another point $\boldsymbol{x}_c'$.

Finally, for the neighbor element, we point out that since it does not satisfy the constraint (6) of the multipole expansion, its integral calculation can only use the direct calculation method.

Now, we outline the steps of the $O(\log N)$ algorithm as follows:

1. The algorithm performs initialization. The algorithm builds a space partition tree and calculates its multipole expansion for each underlying unit.

2. The algorithm uses the M2M transform to calculate the multipole expansion of the parent unit by the sum of the child units.

3. The algorithm computes the interaction list for all units. At this point, the initialization is over.

4. Algorithm Given a point, in order to calculate (2), accumulate the sum of the multipole expansions of the interaction list of the unit where it is located and all its ancestors. The algorithm directly calculates the patches in the remaining neighbor units.

After using the $O(\log N)$ algorithm, we write the calculation formula of the integral in formula (2) as the following form:

$$\oint_S G(\boldsymbol{x},\boldsymbol{x}')\,q(\boldsymbol{x}')\,d\boldsymbol{x}' = \sum_{\forall C_i \in FAR(C_{\boldsymbol{x}})} \left(-\frac{1}{4\pi}\sum_{n=0}^{\infty}\sum_{m=-n}^{n} \overline{S_{n,m}}(\boldsymbol{x}-\boldsymbol{x}_{C_i})\, M_{n,m}(\boldsymbol{x}_{C_i}) \right) + \sum_{\forall S_j \notin FAR(C_{\boldsymbol{x}})} \oint_{S_j} G(\boldsymbol{x},\boldsymbol{x}')\,q(\boldsymbol{x}')\,d\boldsymbol{x}' \tag{14}$$

Although the $O(\log N)$-algorithm described above is a huge improvement over the direct-sum method $O(N)$, upon closer inspection, it can be found that the reason why the $O(\log N)$-algorithm has this complexity is that $FAR(C_{\boldsymbol{x}})$ contains $O(\log N)$ units. When summing up these units, these terms cannot be combined, and the moments cannot be accumulated due to the different unfolding intermediate points $\boldsymbol{x}_{C_i}$ of each unit. If these terms can be combined, the complexity can be further reduced. This is the $O(1)$ algorithm described in the next section.

To be able to merge the summation terms over the cells in $FAR(C_{\boldsymbol{x}})$, we introduce the following two transformations. The first transform is the following M2L transform.

$$\sum_{n=0}^{\infty}\sum_{m=-n}^{n}\overline{S_{n,m}}(\boldsymbol{x}-\boldsymbol{x}_c)M_{n,m}(\boldsymbol{x}_c)=\sum_{n=0}^{\infty}\sum_{m=-n}^{n}R_{n,m}(\boldsymbol{x}-\boldsymbol{x}_0)L_{n,m}(\boldsymbol{x}_0) \tag{15}$$

This transformation transforms the multipole expansion into a local expansion at point x_0. In the formula,

$$L_{n,m}(\boldsymbol{x}_0)=\sum_{n'=0}^{\infty}\sum_{m'=-n'}^{n'}(-1)^{n}\overline{S_{n+n',m+m'}(\boldsymbol{x}_0-\boldsymbol{x}_c)}M_{n',m'}(\boldsymbol{x}_c) \tag{16}$$

is called the coefficient of the local expansion.

It should be noted that the above transformation must meet the following conditions:

$$|\boldsymbol{x}_0-\boldsymbol{x}_c|>|\boldsymbol{x}_0-\boldsymbol{x}| \tag{17}$$

Using the M2L transform, we can transform the multipole expansion of each unit in $FAR(C_{\boldsymbol{x}})$ to the local expansion at the center point of the unit $C_{\boldsymbol{x}}$ where x is located. This way, we can combine these summation terms. After merging, we will get a local expansion. Using this local expansion, the magnitude of the integral contributed by these distant elements can be calculated in O(1) complexity.

Considering that $FAR(C_{\boldsymbol{x}})$ is the sum of the exchange lists of $C_{\boldsymbol{x}}$ and its ancestors, for different $C_{\boldsymbol{x}}$, its $FAR(C_{\boldsymbol{x}})$ has a large repeated part. Therefore, it is inefficient to directly traverse the cells in $FAR(C_{\boldsymbol{x}})$ for each underlying cell and sum it up.

In order to realize the above idea, we introduce a second transformation, namely the following L2L transformation.

$$L_{n,m}(\boldsymbol{x}_1)=\sum_{n'=n}^{\infty}\sum_{m'=-n'}^{n'}R_{n'-n,m'-m}(\boldsymbol{x}_1-\boldsymbol{x}_0)L_{n',m'}(\boldsymbol{x}_0) \tag{18}$$

This transformation gives the means to transform a local expansion point $\boldsymbol{x}_0$ to another point $\boldsymbol{x}_1$.

2.2 Solving Boundary and Partial Equations Using FMM

So far, the FMM algorithm we have discussed only focuses on the fast solution of equation (2), that is, the fast integral calculation, and does not involve the fast solution of the linear equation system (25). In this section, we will discuss this topic. More generally, the FMM is used to solve the following boundary integral equations quickly.

$$\oint_S G(\boldsymbol{x},\boldsymbol{x}')q(\boldsymbol{x}')=\phi_0(\boldsymbol{x}),\boldsymbol{x}\in S \tag{19}$$

FMM is equivalent to giving a fast calculation of the matrix-vector multiplication on the right side of the equal sign of the linear equation (25), which speeds up the operation that originally required

$O(N^2)$ complexity to O(N). Thus, we can use an iterative solver such as GMRES to solve this linear system of equations and then combine it with FMM.

GMRES (Generalized Minimal Residual Method) solves a system of linear equations of the form:

$$A\boldsymbol{x} = \boldsymbol{b} \tag{20}$$

Like popular numerical solution methods such as the Lanczos algorithm and the conjugate gradient method, GMRES attempts to find approximate solutions of the above equations in the Krylov subspace.

$$K_r(A,\boldsymbol{b}) = span\{\boldsymbol{b}, A\boldsymbol{b}, A^2\boldsymbol{b}, \ldots A^{r-1}\boldsymbol{b}\} \tag{21}$$

Since the vectors $\boldsymbol{b}, A\boldsymbol{b}, A^2\boldsymbol{b}, \ldots A^{r-1}\boldsymbol{b}$ are not linearly independent, they need to be orthogonalized first. GMRES uses the Arnoldi algorithm to do this orthogonalization. This method iteratively calculates the standard orthonormal basis $V_r = \{\boldsymbol{v}_1, \boldsymbol{v}_2, \ldots \boldsymbol{v}_r\}$ of K_r. The process is as follows:

1. The algorithm initializes $\boldsymbol{v}_1$ to a certain unit vector $\|\boldsymbol{v}_1\| = 1$.

2. When $j = 1,2,\ldots$, the algorithm performs the following calculation.

$$h_{i,j} = (A\boldsymbol{v}_j \cdot \boldsymbol{v}_i), i = 1,2,\ldots j \quad \overline{\boldsymbol{v}_{j+1}} = A\boldsymbol{v}_j - \sum_{i=1}^{j} h_{i,j}\boldsymbol{v}_i \quad h_{j+1,j} = \|\overline{\boldsymbol{v}_{j+1}}\| \quad \boldsymbol{v}_{j+1} = \overline{\boldsymbol{v}_{j+1}} / h_{j+1,j}$$

After r-1 iterations, V_r can be obtained. If V_r is written in matrix form, where the i-th column is $\boldsymbol{v}_i$, then any $\boldsymbol{x} \in K_r$ can be written as $\boldsymbol{x} = V_r\boldsymbol{y}, \boldsymbol{y} \in \mathbb{R}^r$ .If each $h_{i,j}$ is written as a matrix, then after r steps of iteration, a matrix $\overline{H_r}$ with r+1 row and r column is obtained, and the element in the i-th row and the j-th column is $h_{i,j}$. The matrix satisfies the following relation:

$$AV_r = V_{r+1}\overline{H_r} \tag{22}$$

Therefore, we have:

$$\|A\boldsymbol{x} - \boldsymbol{b}\| = \|AV_r\boldsymbol{y} - \boldsymbol{b}\| = \|V_{r+1}\overline{H_r}\boldsymbol{y} - \boldsymbol{b}\| = J(\boldsymbol{y}) \tag{23}$$

Considering that V_{k+1} is a standard orthogonal matrix, the above formula can be further written as:

$$J(\boldsymbol{y}) = \|V_{r+1}(\overline{H_r}\boldsymbol{y} - V_{r+1}^T\boldsymbol{b})\| = \|\overline{H_r}\boldsymbol{y} - \beta\boldsymbol{e}_1\| \tag{24}$$

Thus, an approximation to x can be obtained by minimizing $J(\boldsymbol{y})$ to find y. This is a least squares problem. Subsequently, there is:

$$\boldsymbol{x} = V_r\boldsymbol{y} \tag{25}$$

The complete GMRES algorithm steps can be described as follows:

1. The algorithm sets r=1, and uses the Arnoldi algorithm to find V_r and $\overline{H_r}$ .1.

2. The algorithm minimizes $J\ \boldsymbol{y}$ and finds $J\ \boldsymbol{y}$.

3. The algorithm finds x from $\boldsymbol{x} = V_r \boldsymbol{y}$.

4. The algorithm calculates the residual $\| A\boldsymbol{x} - \boldsymbol{b} \|$. If the residual is small enough, the algorithm ends; otherwise, r=r+1, and the algorithm goes to step 1 for the next iteration.

It is not difficult to see that three matrix-vector multiplications need to be calculated in each iteration of GMRES, which are the calculation of $A\boldsymbol{v}_j$ once, the calculation of $\boldsymbol{x} = V_r \boldsymbol{y}$ and the calculation of residuals in the Arnoldi algorithm.

3 EXPLORATION AND ANALYSIS OF DIVERSIFIED JAPANESE TEACHING MODE BASED ON THE INTERNET OF THINGS AND DATA MINING TECHNOLOGY

The computer adaptive test design in the study guidance system studied in this paper is mainly based on the following ideas. Considering that there is a strong correlation between the learned knowledge points, for example, some knowledge points are basic knowledge points, which need to be firmly mastered to learn subsequent knowledge points. Therefore, the process of adaptive testing needs to be carried out in an orderly manner according to the relationship between knowledge points, as shown in Figure 2.

The whole system structure of the learning guidance system is designed and is mainly divided into the following layers: data storage layer, control layer, presentation layer/test management layer, as shown in Figure 3.

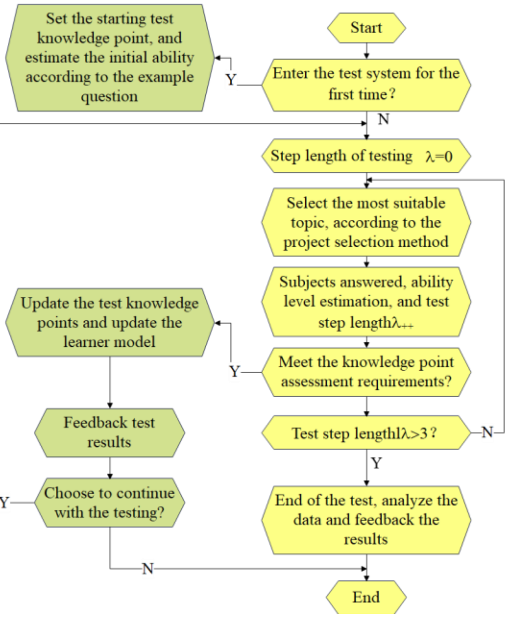

Figure 2: Flowchart of the guidance system.

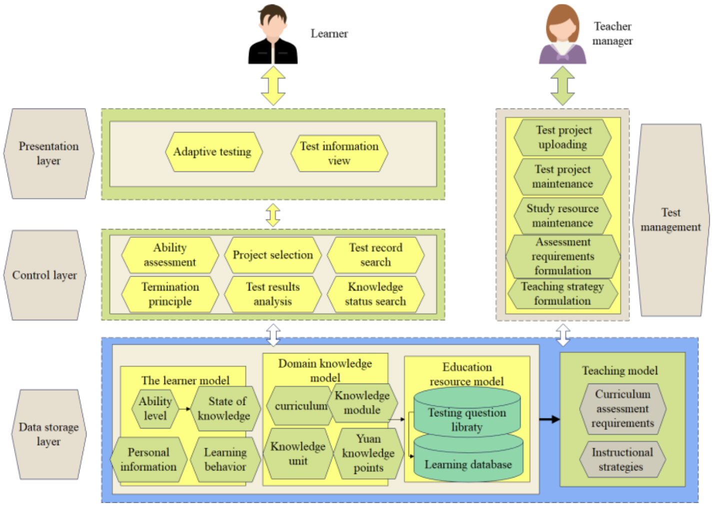

Figure 3: Design of the overall structure of the system.

The structure of an intelligent learning guidance system based on a clickstream data warehouse includes the following five aspects: information collection, personalized analysis, personalized scheduling, clickstream data warehouse, and rule adaptation. Furthermore, it includes a learner information base, a weblog, and a rule base (Figure 4). According to the system model diagram shown in Figure 1, the following system operating mechanism is obtained.

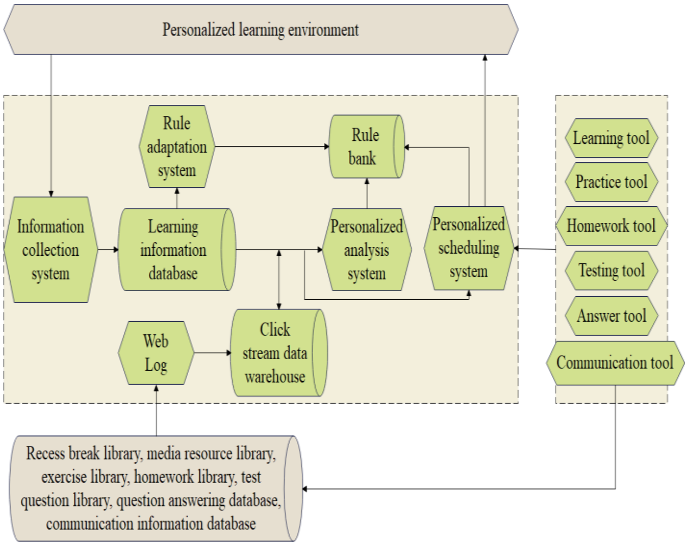

Figure 4: Structure diagram of intelligent learning guidance system based on click stream data warehouse.

The click stream data warehouse is divided into five layers: data source layer, data ETL layer, data storage layer, OLAP analysis layer, and data presentation layer. As shown in Figure 5.

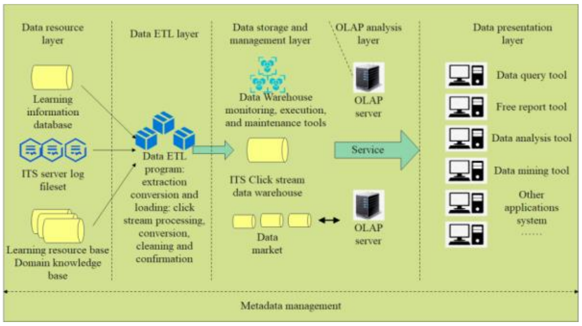

Figure 5: Architecture of a clickstream data warehouse.

In this system, multimedia courseware is synthesized by one or more of the components, such as video, audio, subtitles, outlines, and diagrams, or is synthesized by multiple small courseware components, as shown in Figure 6.

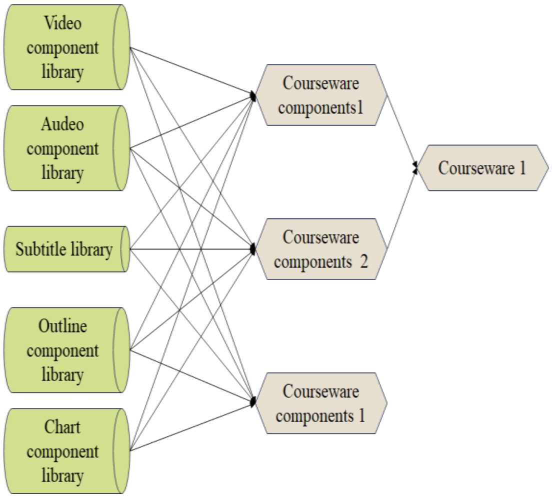

Figure 6: Componentized courseware organization model.

After all the components of the courseware already exist on the Internet, a new courseware can be created. The data flow of the courseware production system is shown in Figure 7.

This paper proposes an innovative online education model, SPOC (Small Private Online Course), that integrates the concept of blended learning into the Japanese teaching model. Based on the learning support service theory and the general model of instructional design, combined with the SPOC teaching process and the design and implementation of the network-guided strategy, the SPOC network-guided strategy implementation model is constructed, as shown in Figure 8.

Through the above research, a diversified Japanese teaching model based on the Internet of Things and data mining technology is constructed. In order to verify the validity of the model in this paper, this paper clusters the Japanese teaching effect from three perspectives of Japanese learning: vocabulary learning, pronunciation learning, and grammar learning, and gets the verification results shown in Figure 9.

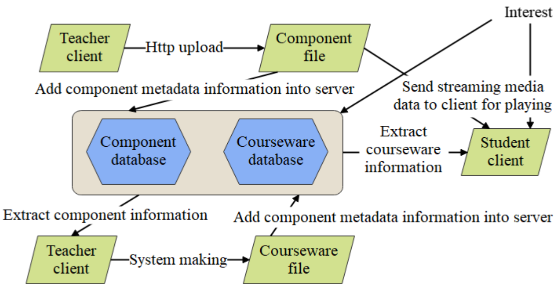

Figure 7: Data flow of multimedia courseware production system.

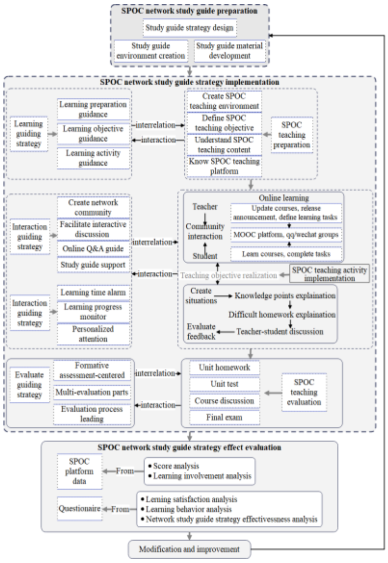

Figure 8: Implementation model of SPOC online Japanese learning strategy.

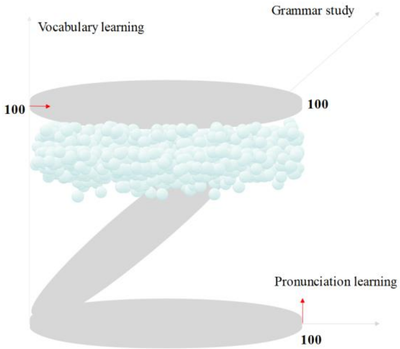

Figure 9: Clustering verification of diversified Japanese teaching model based on the Internet of Things and data mining technology.

From the clustering results shown in Figure 9, it can be seen that the diversified Japanese teaching model based on the Internet of Things and data mining technology proposed in this paper can effectively improve the efficiency of Japanese teaching

4 CONCLUSIONS

A good teaching quality evaluation system should be based on extensive support and participation, and a variety of evaluation subjects should be used to conduct all-around and multi-angle inspections and evaluations of teaching. The evaluation of teaching quality should not only emphasize the various links in the teaching process and its effects but also the requirements and needs of society and students for higher education. Therefore, teachers, students, department leaders, school functional departments, etc., from within the school, as well as graduates, employers, parents, and administrative departments from outside the school, should participate in the evaluation and feedback activities of teaching quality as the subject of evaluation. Furthermore, a multi-angle review of teaching quality is formed to ensure the objective and rationality of teaching quality evaluation. This paper analyzes multiple Japanese teaching modes based on Internet of Things technology and data mining technology, constructs an intelligent Japanese teaching system, and improves the effectiveness of Japanese teaching. From the clustering results, it can be seen that the diversified Japanese teaching model based on the Internet of Things and data mining technology proposed in this paper can effectively improve the efficiency of Japanese teaching.

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Yimei Wang, https://orcid.org/0009-0002-5127-7061

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