Developing a Digital Based Cross-Cultural Knowledge Teaching System for Japanese Majors in Colleges and Universities using Big Data Technology

Nian Tong[1*]

[1]College of International Education, Shanghai Jianqiao University, Shanghai, China 201306

Corresponding author: Nian Tong, svxd12356@163.com

Abstract. In order to improve the teaching effect of cross-cultural knowledge for Japanese majors in colleges and universities, this paper combines big data technology to construct a cross-cultural knowledge teaching system for Japanese majors in colleges and universities. Moreover, this paper analyzes the basic equations of traditional SPH method, smooth kernel function and some related numerical processing techniques in the method, and discusses the accuracy of the kernel approximation of SPH method. In addition, this paper proposes a modified SPH method based on the traditional SPH method to make up for the shortcomings of the SPH method.Finally, this paper constructs a system based on the cross-cultural knowledge teaching needs of Japanese majors. From the cluster analysis, it can be seen that the cross-cultural knowledge teaching system for Japanese majors in colleges and universities based on data technology proposed in this paper can effectively improve the teaching effect of cross-cultural knowledge for Japanese majors in colleges and universities.

Keywords: big data; Japanese; cross-cultural knowledge; teaching system; Digital Heritage
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1 INTRODUCTION

The literature [2] believed that knowledge transfer is a process in which knowledge is continuously transferred between knowledge subjects, and the knowledge receiver finally realizes the knowledge accumulation process. Since the concept of knowledge transfer was put forward, scholars' research on knowledge transfer has not stopped. The literature [18] proposed a knowledge management model, which is a comprehensive knowledge transformation process model formed by the interaction of explicit and tacit knowledge at four different levels: individual, team, organization, and organization. The model argues that effective knowledge management requires the combination of knowledge rather than the division of knowledge.The literature [5] recognized the importance of knowledge transfer management in learning and proposes a conceptual model to understand the process of knowledge transfer. This model considers knowledge transfer as a dynamic process from knowledge sender to receiver, which includes knowledge acquisition, application, reception and absorption. The literature [7] used action research methods to study a large number of cases, and proposed that knowledge transfer is a process of learning and communication. This process generally produces a behavior of self-reconstruction of knowledge, which promotes the absorption and reuse of knowledge.The literature [14] summarizes the process of knowledge transfer, deeply expounds the importance and value of knowledge transfer in the process of enterprise informatization, and proposes that when the knowledge sender and the knowledge receiver transfer their acquired knowledge to each other. This interactive process realizes the collaborative innovation of knowledge. Gather digital heritage resources, including texts, images, videos, and audio recordings that relate to Japanese culture and history

Literature [8] studies the content and mechanism of enterprise knowledge management, deeply discusses the meaning and representative model of enterprise knowledge transfer, and introduces the concept of knowledge potential energy to explain knowledge transfer. The process of subject transfer with low potential energy shows that the condition of knowledge transfer activities is the knowledge difference existing on both sides of knowledge transfer. Reference [9] starts from the relationship between overlapping knowledge and knowledge transfer between organizations, and comprehensively considers the relationship between overlapping knowledge, knowledge distance, relative absorptive capacity, relationship embedding and knowledge transfer between organizations, and forms the relationship between overlapping knowledge and knowledge transfer between organizations. Model. The research believes that overlapping knowledge between organizations will affect the knowledge transfer between organizations through factors such as knowledge distance, relative absorptive capacity and relationship embedding. Therefore, in the knowledge transfer between organizations, the difference between overlapping knowledge between organizations on knowledge transfer between organizations should be considered Influence paths and their influence effects. Literature [15] believes that a separate study from a certain aspect of the knowledge transmitter or receiver will isolate "teaching and learning", which is not conducive to forming a deeper understanding and understanding of knowledge transfer between organizations. It is pointed out that both parties of knowledge transfer must understand and apply knowledge in the process of transfer, so as to achieve the effect of knowledge transfer.

Course content is the core content of the online teaching process and a substantial part of the knowledge transfer process. General course content is divided into two parts: teaching content and content organization. The former refers to the quality of the course itself, such as content coverage, the use of theoretical cases and the use of professional terms, etc. The latter mainly refers to the organization of teaching resources in the online teaching platform. , such as the introduction to the course before the class, the time interval of the course and the update of the course resources, etc. [11]. Literature [4] divides the first-level indicators of course content into six second-level evaluation indicators: frontier, normative, authoritative, comprehensive, general, and update speed. Among them, cutting-edge means that the latest theories are added to the teaching process, and the course can gather hotspots and cutting-edge issues; normative means that the use of relevant professional terms in the course meets the requirements of the discipline; authoritative means that the course is usually a high-quality course or the instructor is well-known ; Comprehensiveness and generality respectively refer to the extensive knowledge coverage of the course and the general teaching content before the class; the update speed refers to the appropriate interval between courses and the timely update of course resources [10].

Knowledge disseminators are the main body in the online teaching process and the source of knowledge in the process of knowledge transfer. The influence of knowledge disseminator's selfcultivation, personal ability and teaching attitude in the teaching process is extremely important. In the process of online teaching, teachers should be able to use the characteristics of online teaching to design course tasks and organize student discussions. This process not only reflects the knowledge level of knowledge disseminators, but also reflects their teaching attitude [1]. Academic accomplishment refers to the abundant knowledge reserves of teachers; teaching language and personal charisma refer to teachers' appropriate teaching language, clear and loud voice, and strong personality; Tutoring and answering questions for students, organizing students to discuss and guide thinking; course tasks refer to teachers assigning corresponding learning tasks after the course [12]; expansion materials refer to teachers providing relevant expansion materials to help them better understand the latest developments in the subject.

The teaching platform is the carrier in the online teaching process and the basis for the development of online teaching. An online teaching platform should meet the basic requirements of reasonable platform design, stable teaching system, and perfect platform functions [16]. Reasonable platform design is related to the presentation of the online teaching platform, and it is related to the user experience such as easy operation, comfortable color matching, reasonable structure design, and easy search of corresponding sections. The stability of the teaching system means that the platform can meet the requirements of a large number of students studying online at the same time, and the response speed is fast when using it [6]. In order to meet the needs of different groups when using the teaching platform, the corresponding functions should also be improved. According to the above analysis, the literature [3] refined the first-level indicators of the teaching platform into ten categories: convenience, operability, system stability, response speed, resource transmission, personalized push, online feedback, retrieval function, update frequency, and video playback function. A secondary indicator to explore the influence of various factors in the teaching platform on the quality of online teaching.

Discipline classification is the most basic basis for the division of resource content. Therefore, the biggest advantage of this model is that it is easy to organize and manage, and further refines each discipline into knowledge units and knowledge points. Features take a variety of forms and modes of operation. Since the resources of each discipline are relatively independent, they can work in parallel during construction, which is beneficial to improve the overall operational efficiency [13]. At present, the construction of the resource library tends to provide a practical, real-time and personalized platform to build a mechanism for co-construction and sharing, not just to provide rich educational resources, not to mention the amount of resources is endless, massive, rich It is difficult to satisfy users [17].

This paper combines big data technology to build a cross-cultural knowledge teaching system for Japanese majors in colleges and universities to improve the quality of cross-cultural knowledge teaching for Japanese majors.

2 INTELLIGENT BIG DATA ANALYSIS ALGORITHM

2.1 Introduction to SPH Method

In the SPH method, the integral expression of the function u(x) is:

$$u(x)=\int_{\Omega} u(x')\delta(x-x')dx' \tag{1}$$

Q is the integral field of x, and $\delta(x-x')$ is the Dirac δ function, which has the following properties:

$$\delta(x-x')=\begin{cases}1, x=x' \\ 0, x\neq x'\end{cases} \tag{2}$$

If the smooth function $w(x-x',h)$ is used to replace the Dirac δ function, then (1) can be changed to:

$$u(x)=\int_{\Omega} u(x')W(x-x',\mathrm{h})dx'=\langle u(x)\rangle \tag{3}$$

From formula (3), the approximate formula of the first-order derivative $\nabla\cdot u(x)$ of space can be obtained:

$$\langle\nabla\cdot u(x)\rangle=\int_{\Omega}[\nabla\cdot u(x)]W(x-x',\mathrm{h})dx' \tag{4}$$

Because

$$[\nabla\cdot u(x')]W(x-x',h)=\nabla\cdot[u(x')W(x-x',h)]-u(x')\cdot W(x-x',h) \tag{5}$$

By substituting formula (5) into formula (4), we can get:

$$\langle\nabla\cdot u(x')\rangle=\int_{\Omega}\nabla\cdot[u(x')W(x-x',h)]dx'-\int_{\Omega}u(x')\cdot W(x-x',h)dx' \tag{6}$$

By applying the divergence theorem to formula (6), the integral of the first term on the right-hand side of the equation is transformed into an area integral.

$$\langle\nabla\cdot u(x)\rangle=\int_{S}u(x')W(x-x',h)\cdot\bar{n}dS-\int_{S}u(x')\nabla W(x-x',h)dx' \tag{7}$$

Formula (7) can be simplified as:

$$\langle\nabla\cdot u(x)\rangle=-\int_{\Omega}u(x')\cdot\nabla_{s}W(x-x',\mathrm{h})dx' \tag{8}$$

Because of $\nabla W(x-x',\mathrm{h})=\nabla_{x'}W(x-x',\mathrm{h})=-\nabla_{s}W(x-x',\mathrm{h})$, the final expression for the first derivative of the function space is:

$$\langle\nabla\cdot u(x)\rangle=\int_{\Omega}u(x')\cdot\nabla_{x}W(x-x',\mathrm{h})dx' \tag{9}$$

Similarly, the approximate formula of the second derivative of the function space is:

$$\left\langle \nabla^2 u(x) \right\rangle = \int_{\Omega} \left[\nabla^2 u(x') \right] W(x-x',\mathrm{h})\, dx' \tag{10}$$

By applying the integral by parts formula and the divergence theorem, the above formula becomes:

$$\left\langle \nabla^2 u(x) \right\rangle = \int_{S} \left[\nabla u(x') \right] W(x-x',\mathrm{h}) \cdot \bar{n} dx' - \int_{S} u(x') \cdot \nabla W(x-x',\mathrm{h}) \cdot \bar{n} dx' + \int_{\Omega} u(x') \cdot \nabla^2 W(x-x',\mathrm{h})\, dx' \tag{11}$$

Similarly, when the support domain is inside the problem domain, formula (11) can be transformed into:

$$\left\langle \nabla^2 u(x) \right\rangle = \int_{\Omega} u(x') \cdot \nabla^2 W(x-x',\mathrm{h})\, dx' \tag{12}$$

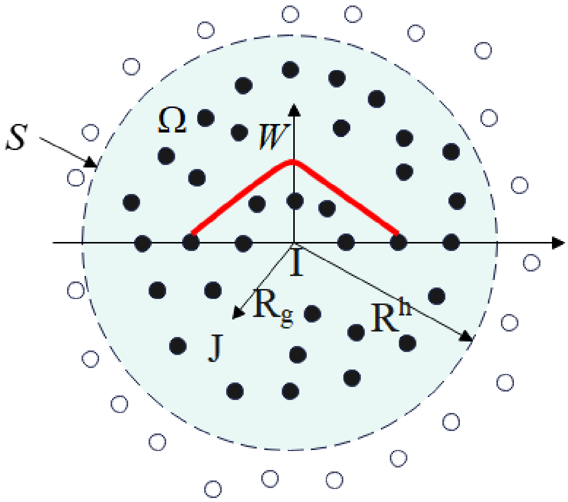

Figure 1: Schematic Diagram of Particle Approximation Method.

The particle approximation method is the most important step in the SPH method, so that the method is no longer based on the background grid.

Its schematic diagram is shown in Figure 1. The solution to particle i can be determined by using a circular smooth kernel function with excitation as the radius to support all particles j in the domain.

If the infinitesimal voxel dx' is replaced by the particle volume ∇V_j, and the particle density ρ_j is introduced, the particle mass m_j can be expressed as:

$$m_j = \Delta V_j \rho_j \tag{13}$$

Therefore, formula (3) can be transformed into the following discretized form:

$$\left\langle u(x)\right\rangle = \int_{\Omega} u(x')W(x-x',\mathrm{h})dx \approx \sum_{j=1}^{N} u(x_j)W(x-x_j,h)\Delta V_j$$
$$= \sum_{j=1}^{N} u(x_j)W(x-x_j,h)\frac{1}{\rho_j}(\rho_j\Delta V_j)$$
$$= \sum_{j=1}^{N} \frac{m_j}{\rho_j}u(x_j)\cdot W(x-x_j,h) \tag{14}$$

Finally, the functional particle approximation at particle i is:

$$\left\langle u(x)\right\rangle = \sum_{j=1}^{N} \frac{m_j}{\rho_j}u(x_j)\cdot W_{ij} \tag{15}$$

Among them, $W_{ij} = W(x_i - x_j, h)$.

In the same way, the particle approximation of the first-order and second-order derivative integral expressions (9) and (12) of the function u(x) at i is finally:

$$\left\langle \nabla u(x_i)\right\rangle = \sum_{j=1}^{N} \frac{m_j}{\rho_j}u(x_j)\cdot \nabla_i W_{ij} \tag{16}$$

$$\left\langle \nabla^2 u(x_i)\right\rangle = \sum_{j=1}^{N} \frac{m_j}{\rho_j}u(x_j)\cdot \nabla_i^2 W_{ij} \tag{17}$$

Among them,

$$\nabla_i W_{ij} = \nabla_i W(x_i - x_j, h) = \frac{x_i - x_j}{r_{ij}}\cdot\frac{\partial W_{ij}}{\partial r_{ij}} = \frac{x_{ij}}{r_{ij}}\cdot\frac{\partial W_{ij}}{\partial r_{ij}} \tag{18}$$

$$\nabla_i^2 W_{ij} = \nabla_i\left(\nabla_i W(x_i - x_j, h)\right) \tag{19}$$

r is the distance between particle.

The smooth kernel function is one of the important concepts in the SPH method.Therefore, in practical applications, it is particularly important to select an appropriate smooth kernel function. The selection of the smooth kernel function needs to have the following three characteristics:

1. The regularization condition is:

$$\int_{\Omega} W\left(x-x',h\right)dx'=1 \tag{20}$$

2. The tightness condition is:

$$W\left(x-x',h\right)=0,\ \left|x-x'\right|>kh \tag{21}$$

3. The properties of the $\delta\left(x-x'\right)$ function are:

$$\lim_{h\to 0} W\left(x-x',h\right)=\delta\left(x-x'\right) \tag{22}$$

In the following, several commonly used smooth kernel functions are introduced.

1. Piecewise cubic spline smoothing kernel function

Monaghan and Lattanzio6 proposed the following piecewise cubic spline function:

$$W\left(R,H\right)=\alpha_d\times\begin{cases}\frac{2}{3}-R^2+\frac{1}{2}R^2,0\le R<1\\ \frac{1}{6}\left(2-R\right)^3,1\le R<2\\ 0,R\ge 2\end{cases} \tag{23}$$

In one-dimensional, two-dimensional and three-dimensional spaces, the normalization coefficient α_d is $\frac{1}{h}$, $\frac{15}{7\pi h^2}$, $\frac{3}{2\pi h^3}$ respectively, the relative distance between particles is $R=\frac{r}{h}$, and r is the distance between two points.

2. Piecewise quintic spline smoothing kernel function

Proposed the piecewise quintic spline kernel function, and its expression is as follows:

$$W\left(R,H\right)=\alpha_d\times\begin{cases}\frac{2}{3}-R^2+\frac{1}{2}R^2,0\le R<1\\ \frac{1}{6}\left(2-R\right)^3,1\le R<2\\ 0,R\ge 2\end{cases} \tag{24}$$

α_d is $\frac{120}{h}$, $\frac{7}{478\pi h^2}$, $\frac{3}{359\pi h^3}$ in one-dimensional, two-dimensional, and three-dimensional spaces, respectively.

3. Double cosine smooth kernel function

In 2014, Liu Moubin et al. proposed a smooth kernel function whose support field size is variable and adapts the support field by changing the parameter k.

$$W(R,h) = \alpha_d \times \begin{cases} 4\cos\left(\frac{\pi}{k}R\right) + \cos\left(\frac{2\pi}{k}R\right) + 3, 0 \le R \le k \\ 0, R > k \end{cases} \tag{25}$$

Among them, the coefficients of α_d in one-dimensional, two-dimensional and three-dimensional are $\frac{1}{6kh}$, $\frac{\pi}{(3\pi^2-16)k^2h^2}$, $\frac{\pi}{(4\pi^2-30)k^3h^3}, 2 \le k \le 3$ respectively, and the double cosine kernel function is selected for numerical simulation in this paper.

In the simulation process of the SPH method, NNPS will take up a lot of computing time, so it is necessary to choose an appropriate NNPS method. The following introduces two commonly used NNPS methods in SPH.

1. Full pair search method

For a given particle i (i= 1,2,…,N), N is the total number of particles, and the steps of the full pair search method are as follows (as shown in Figure 2):

i. The algorithm calculates the distance rij from particle i to all particles j in the problem domain, j = 1, 2,...,N.

ii. The algorithm determines whether it is the nearest neighbor particle by judging the relationship between the distance and distance rij between the particles and the size of the support field kh.

2. Linked list search method

Different from the full pair search method, the linked list search method only needs to search the surrounding part of any particle, so as to improve the calculation speed. The details are as follows (as shown in Figure 3):

i. The algorithm first re-divides the area grid, and the grid size of each unit is the excitation, which is the same as the size of the support domain.

ii. The algorithm calculates the distance rij from particle i to the grid cell where the particle is located and all particles j in the adjacent grid cells, j=1,2,...,N.

iii. The algorithm determines whether it is the nearest neighbor particle by judging the relationship between the distance rij between the particles and the size of the support field.

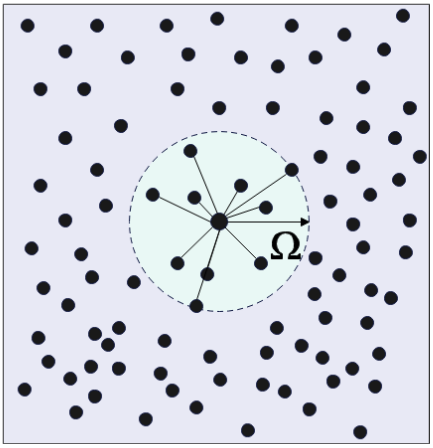

Figure 2: Full Pair Search Method.

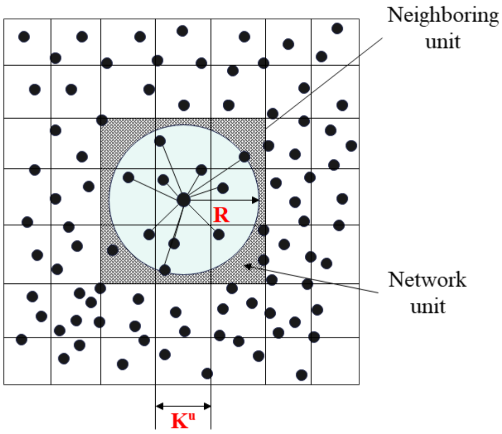

Figure 3: Linked List Search Method.

Under the regular distribution of particles, the kernel approximation of the function u(x) and its first-order and second-order derivatives in the SPH method has $O\left(\Delta x^2\right)$-order accuracy.

Proof: Taking a one-dimensional equation as an example, the function u(x) is Taylor expanded to the second derivative term at point xi, and the same kernel is used to approximate both sides of the equation

$$\int_{\Omega} u(x) W dx = \int_{\Omega} u(x_i) W dx + \int_{\Omega} u'(x_i)(x - x_i) W dx + \int_{\Omega} \frac{u''(x)}{2!}(x - x_i)^2 W dx + O\left(\Delta x^3\right) \tag{26}$$

$W=W\left(x-x_i,h\right)$ and there is O(1/Δx) order. At this point, according to the properties of the kernel function, we get:

$$\int_{\Omega} Wdx, \int_{\Omega}\left(x-x_i\right)Wdx=0$$

At this time, the formula (26) is:

$$u\left(x_i\right)=\int_{\Omega} u\left(x\right)Wdx-\int_{\Omega}\frac{u''\left(x\right)}{2!}\left(x-x_i\right)^2 Wdx+O\left(\Delta x^4\right) \tag{27}$$

$\int_{\Omega}\frac{u''\left(x\right)}{2!}Wdx \sim C_1\Delta x^2$, and C1 is a constant independent of the position of xi. By substituting it into equation (27), we get:

$$\begin{aligned} u\left(x_i\right)&=\int_{\Omega} u\left(x\right)Wdx-C_1\Delta x^2 u''\left(x_i\right)+O\left(\Delta x^4\right) \\ &=\int_{\Omega} u\left(x\right)Wdx+O\left(\Delta x^3\right) \end{aligned} \tag{28}$$

Therefore, the kernel approximation of u(x1) has second order accuracy.

Using the derivative of the kernel function instead of the kernel function, we get:

$$\begin{aligned} u\left(x_i\right)&=\int_{\Omega} u\left(x\right)Wdx-C_1\Delta x^2 u''\left(x_i\right)+O\left(\Delta x^4\right) \\ &=\int_{\Omega} u\left(x\right)Wdx+O\left(\Delta x^3\right) \end{aligned} \tag{29}$$

In the same way, from the properties of the kernel function, we get:

$$\int_{\Omega} W_x dx=0, \int_{\Omega}\left(x-x_i\right)W_x dx=1, \int_{\Omega}\left(x-x_i\right)^2 W_x dx=0$$

$$u'=\int_{\Omega} W_x dx=0, \int_{\Omega}\left(x-x_i\right)W_x dx=1, \int_{\Omega}\left(x-x_i\right)^2 W_x dx=0 \tag{30}$$

Therefore, the kernel approximation of u(xi) has second order accuracy. By substituting formula (27) into the above formula, we can get:

$$u(x_i)=\int_{\Omega 2}\left(\int_{\Omega 1}u(x')Wdx'\right)W_x dx-\int_{\Omega 2}\left(\frac{u''(x)}{2!}\int_{\Omega 1}(x'-x)^2 Wdx'\right)W_x dx$$
$$+\int_{\Omega 2}O(\Delta x^4)W_x dx+O(\Delta x^2)$$
$$=\int_{\Omega 2}\left(\int_{\Omega 1}u(x')Wdx'\right)W_x dx-\int_{\Omega 2}\left(\frac{u''(x)}{2!}\int_{\Omega 1}(x'-x)^2 Wdx'\right)W_x dx$$
$$+O(\Delta x^3)+O(\Delta x^2) \tag{31}$$

In the formula, Ω_1 and Ω_2 represent two different support domains. From $\int_{\Omega 1}(x'-x)^2 Wdx' \sim C_1\Delta x^2$, it can be seen that:

$$\int_{\Omega 2}\frac{u''(x)}{2!}W_x dx=\frac{u''(x_i)}{2!}+O(\Delta x^2) \tag{32}$$

Then, the calculation result of the first derivative is:

$$u(x_i)=\int_{\Omega 2}\left(\int_{\Omega 1}u(x')Wdx'\right)W_x dx-C_1\Delta x^2\frac{u''(x)}{2!}$$
$$+O(\Delta x^4)+O(\Delta x^3)+O(\Delta x^2)$$
$$=\int_{\Omega 2}\left(\int_{\Omega 1}u(x')Wdx'\right)W_x dx+O(\Delta x^2) \tag{33}$$

Next, the calculation accuracy of the kernel approximation of $u''(x_i)$ is analyzed, and u(x) in formula (29) is replaced by $u'(x)$ to get:

$$\int_{\Omega}u'(x)W_x dx=\int_{\Omega}u'(x)W_x dx+\int_{\Omega}u''(x_i)(x-x_i)W_x dx$$
$$=\int_{\Omega}\frac{u''(x_i)}{2!}(x-x_i)^2 W_x dx+O(\Delta x^2) \tag{34}$$

When the particle distribution is uniform, $\int_{\Omega} W_x dx = 0$, $\int_{\Omega} (x - x_i) W_x dx = 1$,and $\int_{\Omega} (x - x_i)^2 W_x dx = 0$. By substituting it into formula (34), we get:

$$u''(x_i) = \int_{\Omega} u'(x) W_x dx + O(\Delta x^2) \tag{35}$$

By keeping formula (32) to the third-order term, we get:

$$\begin{aligned} u'(x_i) &= \int_{\Omega 2} \left(\int_{\Omega 1} f(x') W dx' \right) W_x dx - C_1 \Delta x^2 \frac{u''(x_i)}{2!} \\ &- \int_{\Omega 2} \frac{u''(x_i)}{3!} (x - x_i)^3 W_3 dx + O(\Delta x^3) \end{aligned} \tag{36}$$

Among them, $\int_{\Omega 1} (x' - x)^3 W_x dx \sim C_2 \Delta x^2$, C_2 is constants of the same type as C_1, then

$$\begin{aligned} u'(x_i) &= \int_{\Omega 2} \left(\int_{\Omega 1} u(x') W dx' \right) W_x dx - C_1 \Delta x^2 \frac{u''(x)}{2!} - C_2 h^2 \frac{u'''(x)}{3!} + O(\Delta x^3) \\ &= \int_{\Omega 2} \left(\int_{\Omega 1} u(x') W dx' \right) W_x dx + C_3 \Delta x^2 u'''(x_i) + O(\Delta x^3) \end{aligned} \tag{37}$$

Among them, $C_3 = -\frac{C_1}{2!} - \frac{C_2}{3!}$. From the derivation of formula (30), it can be known that $\int_{\Omega} \frac{u'''(x)}{3!} W_x dx = \frac{u^{(4)}(x_i)}{3!} + O(\Delta x^2)$. By substituting formula (37) into formula (35) and by simplification, we get:

$$\begin{aligned} u''(x_i) &= \int_{\Omega 3} \left(\int_{\Omega 2} \left(\int_{\Omega 1} u(x') W dx' \right) W_x dx + C_3 \Delta x^2 u''(x_i) + O(\Delta x^3) \right) W_x dx + O(\Delta x^2) \\ &= \int_{\Omega 3} \left(\int_{\Omega 2} \left(\int_{\Omega 1} u(x') W dx' \right) W_x dx \right) + C_3 \Delta x^2 u^{(4)}(x_i) + O(\Delta x^2) \\ &= \int_{\Omega 3} \left(\int_{\Omega 2} \left(\int_{\Omega 1} u(x') W dx' \right) W_x dx \right) W_x dx + O(\Delta x^3) \end{aligned} \tag{38}$$

Among them, $\Omega 1$, $\Omega 2$ and $\Omega 3$ represent the three support domains.

To sum up, when the particles are distributed regularly, the accuracy of u(x), u'(x) and u"(x) in the integral expression of SPH is up to $O\left(\Delta x^2\right)$.However, when the particles are irregularly distributed, $\int_\Omega \left(x-x_i\right)Wdx \neq 0$, $\int_\Omega \left(x-x_i\right)W_x dx \neq 1$, $\int_\Omega \left(x-x_i\right)^2 W_x dx \neq 0$ exist. These factors can make accuracy worse. Therefore, it is very necessary to improve the accuracy of the traditional SPH algorithm. On this basis, this paper proposes a modified SPH algorithm to improve the accuracy.

2.2 Modified Discrete Format of SPH Method

The traditional SPH method has low accuracy, and the numerical stability is lower than the first-order accuracy when the particle distribution is non-uniform or close to the boundary of the calculation area. Therefore, many scholars began to revise the method for these problems. In this section, based on the Taylor expansion of the first derivative, a modified SPH (CSPH) method is given by using the idea of local matrix symmetry, as follows:

From the discrete form of the first derivative in the traditional SPH method, it can be known that the approximate SPH expression of ∇u at point x is:

$$\left\langle \nabla \cdot u\left(x\right)\right\rangle = \int_\Omega u\left(x'\right)\nabla W dx' - u\left(x\right)\int_\Omega \nabla W dx' \tag{39}$$

We perform Taylor expansion on the first term on the right side of the above equation:

$$\begin{aligned}\left\langle \nabla \cdot u\left(x\right)\right\rangle &= \frac{\partial u\left(x\right)}{\partial x}\int_\Omega \left(x'-x\right)\nabla W dx' + \frac{\partial u\left(x\right)}{\partial x}\int_\Omega \left(y'-y\right)\nabla W dx' + O\left(h^2\right)\\ &+ \frac{\partial u\left(x\right)}{\partial y}\int_\Omega \left(y'-y\right)\nabla W dx' + O\left(h^2\right)\end{aligned} \tag{40}$$

By substituting formula (40) into formula (39), we get:

$$\left\langle \nabla \cdot u\left(x\right)\right\rangle = \frac{\partial u\left(x\right)}{\partial x}\int_\Omega \left(x'-x\right)\nabla W dx' + \frac{\partial u\left(x\right)}{\partial y}\int_\Omega \left(y'-y\right)\nabla W dx' + O\left(h^2\right) \tag{41}$$

After ignoring the error O(h2), the above formula is subjected to particle discretization, and we get:

$$\begin{cases} \left(\dfrac{\partial u}{\partial x}\right)_i M_{xx} + \left(\dfrac{\partial u}{\partial y}\right)_i M_{yx} = \sum_j V_j\left(u_j - u_i\right)\dfrac{\partial W_{ij}}{\partial x_i} \\ \left(\dfrac{\partial u}{\partial x}\right)_i M_{xy} + \left(\dfrac{\partial u}{\partial y}\right)_i M_{yy} = \sum_j V_j\left(u_j - u_i\right)\dfrac{\partial W_{ij}}{\partial y_i} \end{cases} \tag{42}$$

Among them, $M_{\alpha\beta}=\sum_j\left(x_j^\alpha-x_i^\alpha\right)V_j\frac{\partial W_{ij}}{\partial x_i^\beta}$. Obviously, the coefficient matrix $M=\left(M_{\alpha\beta}\right)$ in formula (42) is not a symmetric matrix, which will affect the stability of numerical simulation.This is a freeform surface problem due to changes in particle position. To solve this problem, we replace the " $\frac{\partial W_{ij}}{\partial x_i^\beta}$ " term in formula (42) with the $\left(x_j^\alpha-x_i^\alpha\right)W_{ij}$ term. At this time:

$$\left(\nabla u\right)_i=\sum_j V_j\left(u_j-u_i\right)\nabla_i^C W_{ij} \tag{43}$$

Among them, the discretized form of the kernel gradient is:

$$\nabla_i^C W_{ij}=\left(M^C\right)^{-1}\begin{pmatrix}\left(x_j-x_i\right)W_{ij}\\ \left(y_j-y_i\right)W_{ij}\end{pmatrix} \tag{44}$$

The local coefficient matrix M can be expressed as a symmetric matrix in formula (45):

$$M^C=\left[M_{\alpha\beta}^C\right]=\frac{m1-m2}{\gamma_j^2} \tag{45}$$

3 CONSTRUCTION OF CROSS-CULTURAL KNOWLEDGE TEACHING SYSTEM FOR JAPANESE MAJORS IN COLLEGES AND UNIVERSITIES BASED ON BIG DATA TECHNOLOGY

For the classroom system, the system has multiple industrial computer servers, one for each classroom. In the classroom, the teacher can use the WEB client, and the students use the mobile APP to access the industrial computer in the current classroom. The uploaded classroom data is stored in the front-end server of classroom, and then connected to the back-end server of Lijiang Classroom through the campus network. Using the RESTful data interface, the resource sharing between the industrial computer and the backend server of classroom is realized through two methods: regular push and active acquisition.Then, each user role uses different operation permissions to access the uploaded classroom data through the WEB client on the browser. The structure of the Supervision System is also similar, but the Supervision has only one IPC server, which supports the use of all teachers in the school.

Teachers can access the theoretical classroom data uploaded to the Lijiang Classroom in Guangxi through the web client in the browser, including the main content of course management, class assignments, class attendance, class questions and usual grades. Among them, the teacher can view the detailed information of each course through the course management module, and can manage the courses taught in a unified manner. Through the classwork module, the situation of homework can be recorded, including the number of homework, homework questions and homework answers. The class attendance module allows teachers to understand the attendance status of each class and adjust the teaching management method in time.

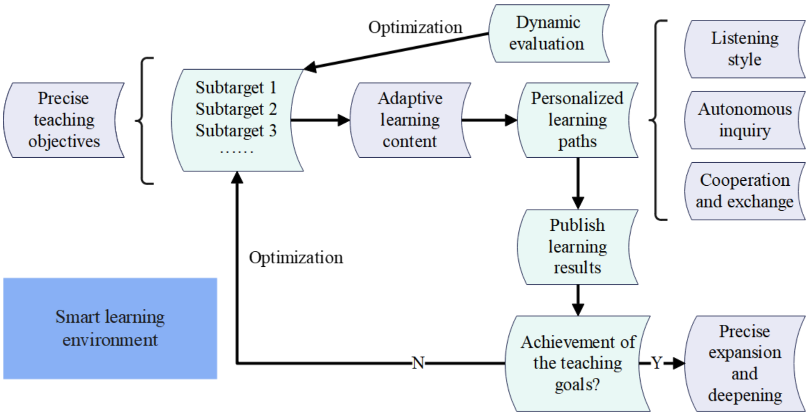

Figure 4: Japanese Cross-Cultural Teaching System.

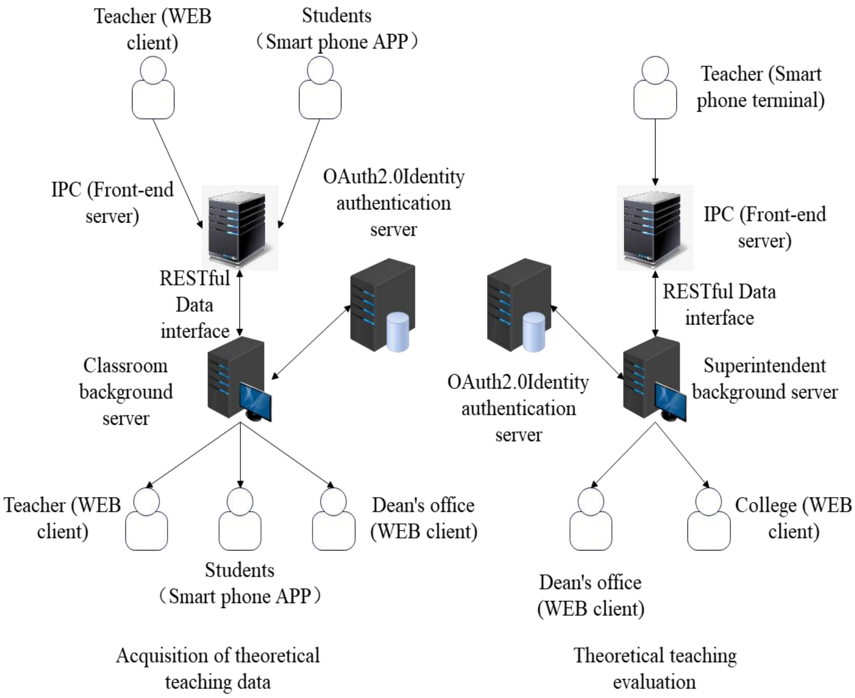

Figure 5: Platform Architecture Diagram.

The classroom questioning module can record the questions asked by students in theoretical classrooms, including the number of questions and the content of the questions, and supervise the interaction between classroom teachers and students. The usual grades module is mainly used to count the comprehensive grades of each student for each course in the semester, so that teachers can teach students according to their different levels of knowledge. The structure diagram of the teacher's version of the cross-cultural knowledge teaching system for Japanese majors is shown in Figure 6.

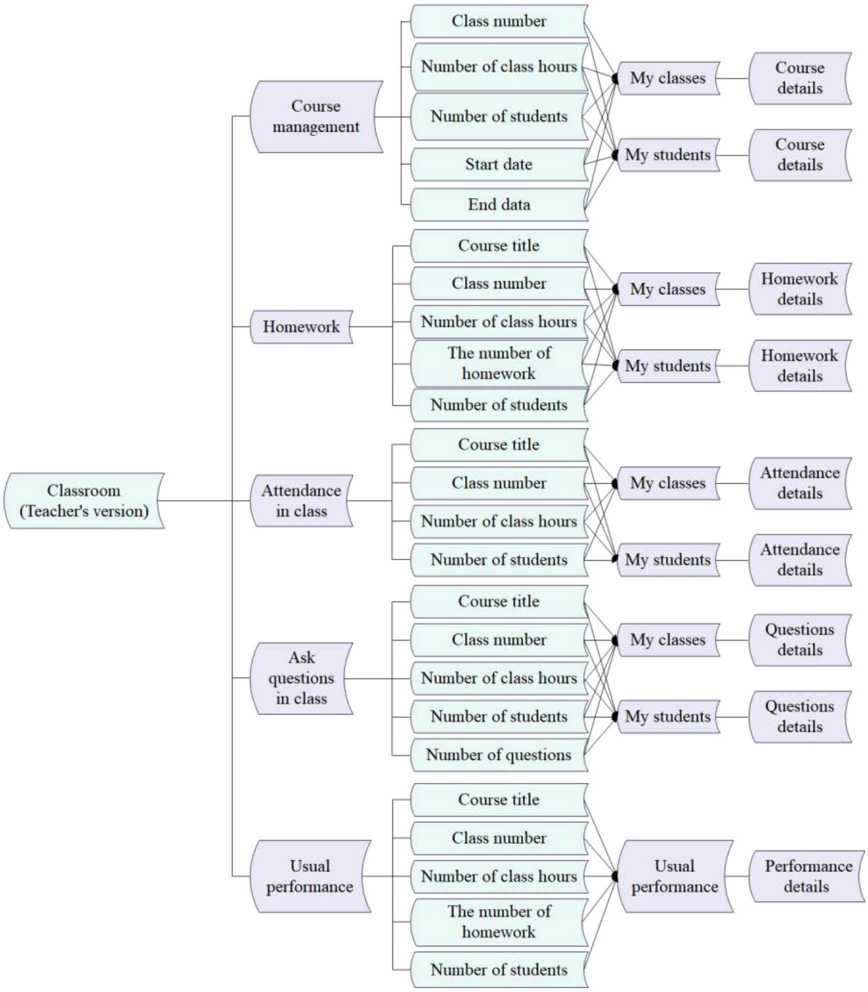

Figure 6: Structure Diagram of the Teacher's Version of the Cross-Cultural Knowledge Teaching System for Japanese Majors.

Students can also access the theoretical classroom data uploaded to Guangxi Lijiang Classroom through the web client in the browser, including the main content such as classroom assignments and classroom results. Among them, students can view the detailed homework information of each course through the classwork module, and manage the coursework in a unified manner, including the number of homework, homework topics, etc. Through the effective management of homework, students can strengthen their knowledge gaps in theoretical knowledge in a targeted manner. Through the classroom grade module, the usual grades of each course can be viewed, which is helpful for students to fully understand their mastery of theoretical knowledge. The structure diagram of the student version is shown in Figure 7.

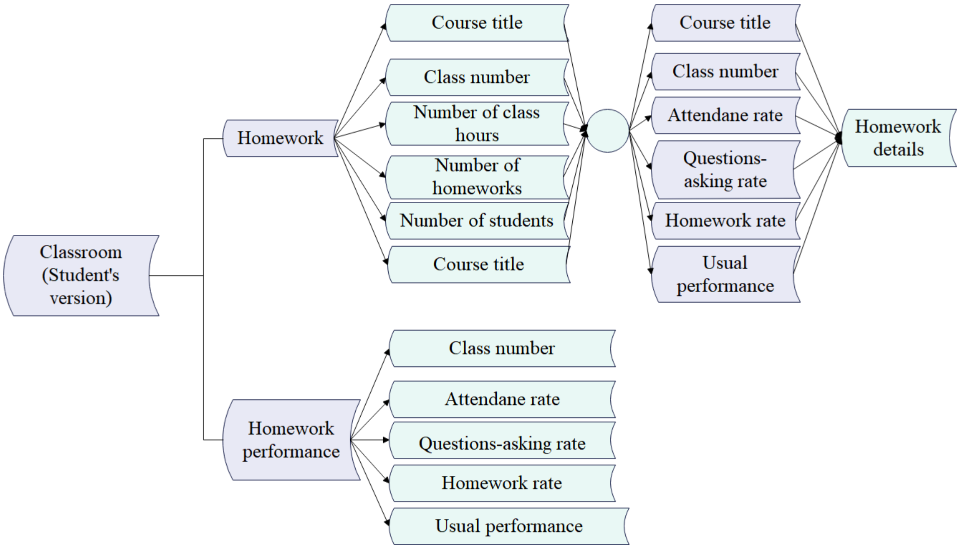

Figure 7: Structure Diagram of the Student Version.

For a system, database design is very important. The quality of database design directly determines the difficulty of data maintenance in the future, and also affects the performance of an application system. All databases provide services to the application system. Any good database design will give priority to meeting the business requirements of the application system and accurately represent the corresponding relationship between the data. Secondly, it is necessary to ensure the accuracy, uniformity and robustness of the data. Moreover, a good database design should also have good scalability, so that the data structure can be extended at any time when the application system needs it.

In the process of completing the database structure design, the following six stages are mainly covered. The first stage is to complete the demand analysis.That is to analyze the needs of users in detail, which includes data, functions and performance requirements. In the second stage, the design of the conceptual structure is completed. This stage usually adopts the entity-relationship model, that is, the E-R model to design the database, which includes the completion of the E-R diagram.In the third stage, the design of the logical structure is completed. By converting the E-R diagram into a data table, the E-R model is converted into a relational model. In the fourth stage, the physical design of the database is completed. The most important thing at this stage is to choose an optimal storage structure and access path for the designed database.The fifth stage, the implementation of the database, this stage mainly covers programming, testing and testing and completing the trial operation. In the sixth stage, the database operation and maintenance are completed. That is, the operation of the system and the daily maintenance of the database are completed. The E-R diagram of the database is shown in Figure 8.

The above constructs a cross-cultural knowledge teaching system for Japanese majors in colleges and universities based on big data technology, and then the effect of the system is verified, and clustering analysis is carried out in combination with the actual situation. The statistical clustering results are shown in Figure 9.

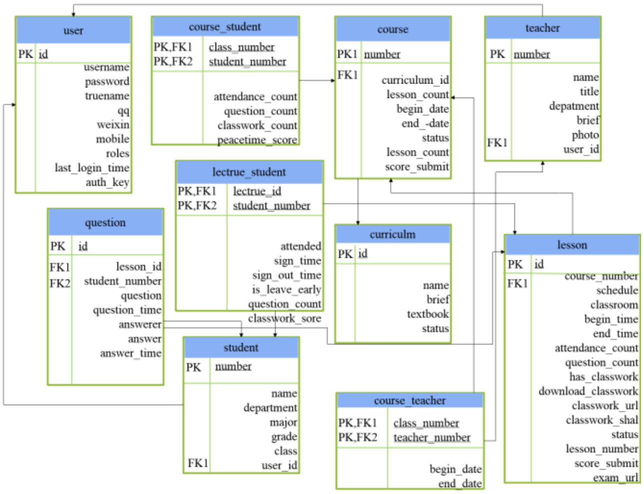

Figure 8: Database E-R Diagram.

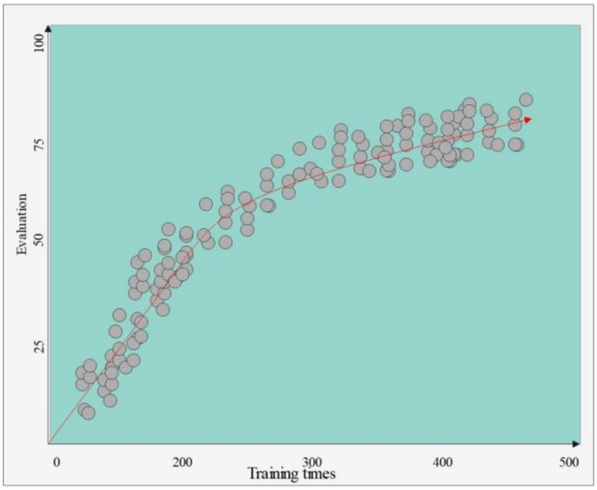

Figure 9: System Clustering Effect.

From the above clustering results, it can be seen that the cross-cultural knowledge teaching system for Japanese majors in colleges and universities based on data technology proposed in this paper can effectively improve the teaching effect of cross-cultural knowledge for Japanese majors in colleges and universities.

4 CONCLUSION

Online cross-cultural knowledge teaching for Japanese majors is a new educational method that uses the network, multimedia and various interactive means to conduct systematic teaching and interaction. It consists of basic elements such as computers and basic network facilities, teachers, teaching platforms, learning content and learners. By combining the characteristics of the online

Japanese major cross-cultural knowledge teaching platform with knowledge transfer theory, the four elements of knowledge source, knowledge subject, knowledge receiver and transfer environment in knowledge transfer are corresponding to the four first-level indicators of course content, knowledge disseminator, knowledge receiver and teaching platform.On the basis of following the construction principles of the evaluation index system, the characteristics of the first-level indicators are analyzed, and they are refined into corresponding second-level indicators. This paper combines big data technology to build a cross-cultural knowledge teaching system for Japanese majors in colleges and universities. From the cluster analysis, it can be seen that the cross-cultural knowledge teaching system for Japanese majors in colleges and universities based on data technology proposed in this paper can effectively improve the teaching effect of cross-cultural knowledge for Japanese majors in colleges and universities.

Nian Tong, https://orcid.org/0009-0006-4901-9986

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