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Construction and Empirical Research on the Model of Cultivating Intercultural Sensitivity of English in Digital-Enabled Higher Vocational Schools

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SUMMARY: *In the time of digital change, the importance of English cross-culture consciousness has become more and more important in the course of enhancing international cooperation and communication, and it is necessary to formulate a model for cultivating English intercultural sensitivity in higher vocational education that fits the digitalization background.By means of utilizing the Intercultural Sensitivity Scale, this research article carries out a deep exploration and examines the current situation of English intercultural sensitivity of students from higher vocational colleges, and designs a digitally empowered English intercultural sensitivity cultivation model to address the problem of unsatisfactory quality of English intercultural sensitivity cultivation.For carrying out the verification on the model's actual application worth, the first group of English major students in one advanced vocational college, which is located inside city C that belongs to province B under province A, was chosen to be the appointed research object. After that, the research data were obtained through the way of scale experiment,according to this,non-paired t-examination, Pearson's correlation coefficient , and regression model from mathematical statistics were utilized by us to carry out empirical research and analysis for the model.There does not exist any obvious difference between the control class before and after the intervention carries out. By comparison, an obvious discrepancy can be observed in the experiment class, which satisfies the standard of notable difference with $P < 0.05$, that is, the practical effect of the model that the model for English cross-cultural sensitivity cultivation by digital means is far more obvious. Furthermore, therefore there exists an obvious connection between communication participation, unique self-identity, communication self-confidence, communication pleasure, communication concentration, and intercultural susceptibility, and the regression equation of students' English intercultural sensitivity is further obtained as 0.438+0.426*Communicative Engagement+0.772*Differential Identity+0.306* Communicative Confidence+0.314* Communicative Pleasure+0.417*Communicative Concentration. It comprehensively exposes the role relationship between the dimensions in the digital empowerment model of English intercultural sensitivity cultivation in higher vocational education, which is instructive for the cultivation of English intercultural sensitivity in higher vocational students.*

KEYWORDS: *independent samples t-test; Pearson correlation coefficient; regression model; English intercultural sensitivity; cultivation model*

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1 Introduction

Language is the vessel that holds culture. Therefore, when a person begins the road of studying a language, it is unavoidable to obtain the culture connected with it [1]. Cross-culture communication refers to the interaction between persons coming from different cultural backgrounds. This this not only includes the communication itself but also includes the cognition and emotion mutual effect [2].Because of the differences on values, thinking modes, and traditional customs, certain differences can be found in the process when cross-cultural communication carries on, and they often cause misunderstanding and conflict in communication, so the communicating parties should try to seek commonalities in different cultural contexts [3-5]. In the traditional Chinese higher vocational English classroom, due to the emphasis on exam-oriented education,educators always put emphasis on explaining language knowledge and ignore the teaching of culture-related knowledge, and students often make judgments according to the cultural characteristics of their own countries,this therefore brings about the restricted language communication ability of students with regard to the overall utilization of language,this therefore brings about the restricted language communication ability of students with regard to the overall utilization of language, and frequent pragmatic errors, which affects the communicative effect [6-8]. In addition to cultivating students' ability to use language correctly, the purpose of teaching English at higher vocational level should also be to improve students' sensitivity and tolerance to cultural differences, so that they can deal with culturally relevant issues flexibly in future cross-cultural communication [9].

In the system of building up cross-cultural communication ability, intercultural sensitivity occupies an important position. Therefore, the cultivation of intercultural sensitivity is generally regarded as the beginning stage for promoting intercultural communication ability [10]. Higher vocational English teaching should not only cultivate students' language skills, but also place them in the practice of cultural teaching and learning, which will eventually enable them to acquire communicative competence and thus improve their intercultural communication [11, 12]. Research on intercultural sensitivity began in the mid-20th century. Early studies concluded that social cognition consists of two main abilities: sensitivity to others and sensitivity to inter-individual differences [13]. The term “sensitivity to inter-individual differences” is similar to cross-cultural sensitivity, and this study is considered one of the first to address cross-cultural sensitivity [14]. With the gradual expansion of research on cross-cultural sensitivity in the academic circle, a relatively clear theoretical statement on the definition of cross-cultural sensitivity has emerged. For instance, Via the statement of reference[15], cross-cultural sensitivity is one of the main manifestations of cross-cultural communication ability. It possesses the possibility to lessen the cultural barriers which come forth when communications happen between persons coming from different cultural backgrounds.In the first place, it includes five items: "Interactive participation", "Recognition of culture differences", "Interactive self-confidence", "Interactive joy", and "Interactive concentration".Literature [16] defines intercultural sensitivity as the attitudes people hold toward others' behaviors, opinions, attitudes, and emotions during intercultural communication, and its importance cannot be ignored in today's intercultural and multicultural society where it is in increasing demand. Literature [17], through a systematic review of intercultural sensitivity in the field of education, found that individual differences related to students' intercultural sensitivity were categorized into four main categories, i.e., experiences, cultural values, demographic characteristics, and linguistic competence.Furthermore, the study which is in existing documents has established a Developmental Model of Intercultural Sensitivity which is called DMIS, and it is built upon the constructivist theory as well as the communication

theory, which suggests that realistic experiences are constructed through perception and that more complex categories of perception lead to more complex (higher level) experiences.

In terms of empirical research on intercultural sensitivity, literature [19] tested freshmen students at Bangkok International College in Thailand through the Intercultural Sensitivity Scale (ISS), and the results of the study showed that these freshmen students presented high differences in levels of intercultural sensitivity as measured by the ISS, and that this difference was mainly due to two factors: nationality and international friendships. Literature [20] analyzed the relationship between the three dimensions of intercultural sensitivity (communicative engagement, communicative confidence, and difference identity) and ethnic diversity among 447 Malaysian university students,our research has found that differences in the ethnic diversity among students have a remarkable and positive connection with these three dimensions of intercultural awareness. Literature [21], by using the ICSI (Intercultural Sensitivity Inventory) scale on management students in a liberal arts college in the United States, found that students with some intercultural sensitivity and high intercultural sensitivity were more likely to change their behavior in accordance with cultural norms. In one [22] research which is recorded in Literature, a practice evaluation was done upon the intercultural ability and intercultural sensing capability of 167 teachers who teach English as a second foreign language. The result showed that these English teachers have higher levels of both intercultural ability and sensitivity. Furthermore, an obvious correlative connection has been found by us between these two respect aspects. At present, the importance of intercultural sensitivity in English language teaching has been widely noticed and recognized, but the related research still remains in the theoretical research.In the empirical research on the strategy of cultivating intercultural sensitivity, there is a difference concerning the degree to which students' intercultural sensitivity gets promoted, which is precisely a necessary condition for improving students' intercultural communicative competence.

This paper draws on relevant literature, and after many corrections and refinements, finally completes the design of the intercultural sensitivity scale, which contains five factors: communicative participation, differential identity, communicative confidence, communicative pleasure, and communicative concentration, and through the scale test of 1054 higher vocational students in 10 provinces and cities, it reveals the dilemma that the quality of the cultivation of intercultural sensitivity of English in the higher vocational level is unsatisfactory at present. To address the dilemma, a digital-enabled English intercultural sensitivity cultivation model was constructed from the three dimensions of classroom cultural teaching, second classroom activities, and short-term exchanges abroad.The research this paper does puts its focus on the first group of students who study English as their major and entered the senior vocational English study program in City C, which is in Province B of Region A. This group of people was divided into one experiment class and one control group. The research data were collected through a before-test and an after-test that uses one scale, after that, we carried out a real data analysis on this model. This work required the utilization of an independent samples t-test, Pearson's correlation coefficient, and one regression model. The whole final goal was to promote the cultivation quality of English cross-cultural consciousness feeling among advanced vocational school students.

2 Empirical Research Design for Digitally-Enabled Higher Education English

2.1 Exploring the Current Situation of Higher Education Students' English Intercultural Sensitivity

2.1.1 Cross-cultural sensitivity scale

Through several years of modification and experimentations, a more reliable cross-cultural sensitivity measuring tool has been successfully produced. This measuring tool is formed by 30 entries and includes 5 factors: communication participation, unique identity, communication self-confidence, communication pleasure, and communication concentration. At the present stage, this measurement of cross-cultural sensitivity is situated among the most updated and credible ones.

2.1.2 Analysis of the current situation

Questionnaire Star was used to collect and organize questionnaires from 1054 students from applied higher vocational education in 10 provinces and cities, including Hebei, Liaoning, Zhejiang, Shandong and Jiangsu, and the data were analyzed by SPSS.The results that we got from the checking of the scale data are put in Table 1. The average score which is gotten from students in the aspect of intercultural sensitivity is 3.654. The minimal score which got recorded was 2.133, hence the maximal score achieved was 4.816. In addition, the standard deviation has been calculated by us as 0.321. Because the questionnaire used a five-point scale, the students needed to choose one of the numbers from 1 to 5 to measure their level of intercultural sensitivity, in this scale: 1 expresses total opposing, 2 shows opposing, 3 means having no clear opinion, 4 expresses agreeing, and 5 expresses total agreeing.The average score got by participants lies between 3 and 4, which indicates that participants hold a good opinion on cross-cultural communication. However, the extent of cross-cultural sensitivity has the necessity to be promoted. Among the five elements of its composition, the highest level of differential identity of all participating students is 3.948, followed by communicative engagement (3.715), communicative concentration (3.617), communicative pleasure (3.506), and communicative confidence (3.228). The last-ranked factor, sociable confidence, was much lower than the other five factors. The factors with large internal differences were communicative pleasure and communicative concentration. This shows that the general level of students' difference identity is high, but lacks communicative confidence.

Table 1: Analysis results of scale data

Project	Number of people	Min	Max	Mean	Standard deviation
Cross-cultural sensitivity	1054	2.133	4.816	3.654	0.321
Communicative engagement	1054	1.532	5.000	3.717	0.416
Differential identity	1054	2.316	5.000	3.948	0.477
Communication confidence	1054	1.000	5.000	3.228	0.457
Communicative pleasure	1054	1.000	5.000	3.506	0.619
Communicative concentration	1054	1.000	5.000	3.617	0.506

The frequency distributing of cross-cultural sensitivity is shown by Figure 1. Altogether 24 students have chosen a result that is under 3 points, this therefore accounts for 1.582% of the whole number. 274 students chose the result of 3~3.5 points, accounting for 26.05%. 608

students chose the result of 3.5~4 points, accounting for 57.47%. 158 students chose the result of 4~5 points, accounting for 14.72%. There were no students with less than 2 points, and the percentage of students with more than 4 points was also small. According to the five-point scale in the questionnaire, 2 corresponds to disagree and 4 corresponds to agree,this therefore indicates that the foreign-language teaching reform which was carried out in the past several years has obtained positive effects, and the whole inter-cultural sensitivity degree of the students lies in the medium scope. However, from the distribution of the scores, the percentage of students with high scores (above 4) is relatively small, and more than half of the students' scores are between 3.5 and 4, which has a lot of room for improvement. It can be seen that teaching should focus on cultivating students' intercultural sensitivity.

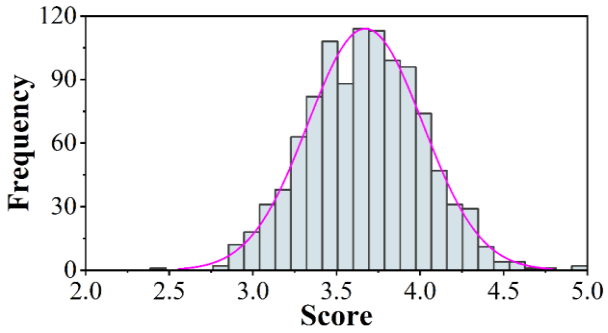


Figure 1: Frequency distribution of cross-cultural sensitivity of spoons

2.2 Construction of English intercultural sensitivity cultivation model

Having taken thought of the characteristics of students in applied higher vocational education and the talent cultivation model, and having considered the current situation of intercultural sensitivity in higher vocational education,under the big background of economic globalization, cultural diversity and social informationization, a "multi-sided" cultivation model of intercultural sensitivity which has high practicality and relevance and conforms to the teaching characteristics of the digital era has been put forward. The digitization-assisted English language nurture mode is shown in Figure 2. The intercultural sensitivity cultivation model is shown in Figure 2. The model embodies the following three dimensions: classroom cultural teaching, second classroom activities, and short-term exchanges abroad, where classroom cultural teaching refers to cultural teaching based on students' activities and supplementary teaching based on the Internet's microclasses, rain classrooms, and WeChat pushes. The second classroom activities refer to the cultural exchange activities mainly for international students and foreign teachers. Short-term exchanges abroad refer to short-term exchanges and paid internships during winter and summer vacations, and intercollegiate cultural exchange activities.

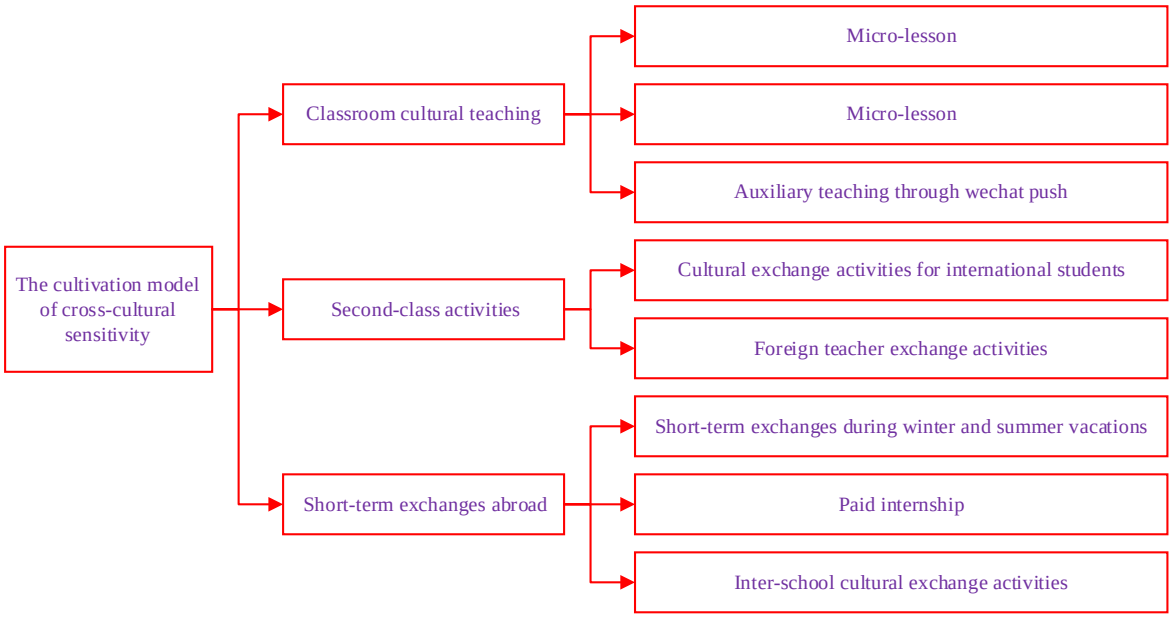


Figure 2: The cultivation model of cross-cultural sensitivity in English

2.3 Study design

2.3.1 Objects of study

From February 2022 to September 2022, the author was engaged in teaching internship and experimental work at Higher Vocational C in City B, Province A. Higher Vocational C is a full-time junior higher vocational institution affiliated with the Education Bureau of City B.This writer holds an instructor position at Higher Vocational College C, which that college situates in City B, Province A. This writer holds the position of an education worker at the Higher Vocational College C which is located in City B of Province A. The author's internship class was English major 1 class major 2 class, the number of class 1 was 50, 29 boys and 21 girls, while the number of class 2 was 48, 28 boys and 20 girls. In the two final exam scores of this class in the first and second semesters, both of them are in the middle level of the grade, which has a good sample representation, and the English major class 1 is set as an experimental class, which adopts the Digital Empowerment of English Intercultural Sensitivity Cultivation Mode. English major class 2 was set as the control class, adopting the traditional English cross-cultural sensitivity cultivation model.

2.3.2 Research tools and methods

(1) Scale

The Intercultural Sensitivity Scale adopts the form of Likert five-point scale to measure English intercultural sensitivity, and the validity and reliability of this scale has been repeatedly refined and test-tested with a certain degree of reliability and validity. There are 24 items in this scale, it contains five components: communicative participation, unique self-position, communicative self-confidence, communicative pleasure, and communicative concentration.

(2) Pre-test

This author at the beginning measured the five dimensions of students in both the experiment class and the comparison class. These respects were communication participation, unique identification, communication self-confidence, communication pleasure, and communication concentration. This measurement has been conducted in accordance with what is known as the Intercultural Sensitivity Scale which is made for Higher Vocational English

students, and then input the collected score data directly into the SPSS data software for descriptive analysis.

(3) Post-test

Through one semester of experimental teaching, using the English Intercultural Sensitivity Scale for Higher Vocational Students research tool, we have carried out a post-test measurement upon the intercultural sensitivity in the English subject of the students who are in the experimental class and also the control class. After that, the score data which had been collected were put into the SPSS data analysis software for carrying out inspection.Judge whether there is an obvious difference in cross-cultural communication ability, and finally verify the application effect and value of the digital-supported English cross-cultural sensitivity cultivation model.

2.3.3 Mathematical statistics

(1) t-test for independent samples

The independent two-sample T checking method is utilized by us to judge whether two independent samples are taken out from populations which possess a same average value, specifically speaking, the objective is to inspect whether the average values of two independent normal populations are identical.

The examination of two independent samples T includes conducting inspection on whether there exists a notable difference between the average values of two populations. Its null hypothesis is $H_0 : \mu_1 - \mu_2 = 0$, where μ_1 and μ_2 are the means of the two aggregates respectively.

The examination of the means of two independent samples has an assumption that the distributions of the two independent populations all follow the normal distributions $N = \left(\mu_1, \sigma_1^2\right)$ and $N = \left(\mu_2, \sigma_2^2\right)$, where, σ_1^2 and σ_2^2 are the variances of the two aggregates, respectively.

When the null hypothesis holds true, the test that checks the means of two independent samples uses the t statistic. We have chosen the t statistic that is used for constructing two independent samples, and we have examined it in two different kinds of situations:

When the two overall variances are unknown but equal, i.e., $\sigma_1^2 = \sigma_2^2$, the constructed t test statistic is:

$$t = \frac{X_1 - X_2 - \left(\mu_1 - \mu_2\right)}{S_v \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \tag{1}$$

where n_1 and n_2 are the two-sample capacities; S_1 and S_2 are the standard deviations of these two samples, separately

and $S_v^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$, and the statistic obeys the t distribution with $n_1 + n_2 - 2$ degrees of freedom.

Under the situations that the two entire variances are both not known, and they have different sizes, i.e., $\sigma_1^2 \neq \sigma_2^2$, the constructed t test statistic is:

$$t = \frac{X_1 - X_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \tag{2}$$

This statistics method complies with a t distribution which has adjusted freedom degrees.

$$df = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{\left(\frac{S_1^2}{n_1}\right)^2}{n_1} + \frac{\left(\frac{S_2^2}{n_2}\right)^2}{n_2}} \tag{3}$$

In statistics evaluation, when the variances of two groups are equal, this situation is regarded as satisfying the variance chi-square requirement. To make certain whether the variances of two independent samples obey the chi-square distribution is of great importance for the formulation and selection of the T test statistic for two independent samples.The Levene F variance chi-square test can be utilized to carry out an evaluation of whether there exists a conspicuous difference between the variances of the two populations:

To perform the Levene F variance chi-square test, the null hypothesis $H_0 : \sigma_1^2 = \sigma_2^2$ is first formulated;in the carrying out of the test procedure, if the probability p value is less than the given significance level, the null hypothesis H_0 when it is rejected, the variances of the two sums are considered to be not equal. On the opposite side, people hold the view that no substantial difference exists in variance between the two sums.

The formula which is used to calculate the value of the F statistic in this F test is just like below:

$$F = \frac{\max\left(S_1^2, S_2^2\right)}{\min\left(S_1^2, S_2^2\right)} \sim F\left(n_1 - 1, n_2 - 1\right) \tag{4}$$

where $n_1 - 1$ is the degrees of freedom of $\max\left(S_1^2, S_2^2\right)$ and $n_2 - 1$ is the degrees of freedom of $\min\left(S_1^2, S_2^2\right)$.

Given the null hypothesis, the test value 0 is brought into the $\mu_1 - \mu_2$ part of the t statistic to obtain the observed value of the test statistic as well as the value of the probability p calculated from the distribution function of the t distribution. When the probability p value of the test statistic is less than the significance level, the null hypothesis is rejected and the overall mean is considered to be significantly different from μ_0; by contrast, the null hypothesis obtains acceptance, and people hold the view that no conspicuous difference exists between the two overall average values.

(2) Pearson correlation coefficient (pearson)

Pearson correlation coefficient is a parameter that describes the degree of closeness of the link between 2 fixed-distance variables, and measures the linear correlation between the variables X and Y, with a value between -1 and 1, generally expressed as r. The formula is shown in equation (5):

$$r_{xy} = \frac{\left(n\sum XY - \sum X \sum Y\right)}{\sqrt{\left[N\sum X^2 - \left(\sum X\right)^2\right]\left[N\sum Y^2 - \left(\sum Y\right)^2\right]}} \tag{5}$$

where n is the sample size, X and Y are the values of the 2 variables respectively, if $r > 0$, it reflects that the 2 variables are positively correlated. If $r = 0$, it means that the 2 variables are not correlated. If $r < 0$, it reflects that the 2 variables are negatively correlated. The larger the absolute value of r, the stronger the correlation. In general situation, the magnitude of correlation force is assessed on the basis of the below value scopes. The absolute value that the correlation coefficient has, when it lies r between 0.8 and 1.0, therefore indicates an extremely strong correlation. When the absolute numerical value sits between 0.6 and 0.8, it therefore represents a strong correlative connection. A middling relevant connection is indicated by an absolute numerical value that lies in the scope from 0.4 to 0.6. When the absolute value lies between 0.2 and 0.4, a weak correlation is shown by this. At last, an absolute numerical value which lies between 0.0 and 0.2 can imply that there is an extremely weak correlation or even no correlation exists at all. The method is highly efficient, according to the principle can quickly establish a mathematical calculation model, objective quantitative analysis, quantitative calculation of the parameters, to avoid the uncertainty of qualitative analysis, and practicality.

(3) Regression model

When the number of independent change quantities is equal to or more than two, the model which is built is named as a multiple linear regression model. The expression form of the multivariate linear regression model may be regarded as an expansion of the single-dimensional linear regression model. Generally speaking, it is displayed in the following way:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_m x_m + \varepsilon \tag{6}$$

where y is the dependent variable, $x_1, x_2, \cdots, x_m$ are the independent variables, $\beta_0, \beta_1, \beta_2, \cdots, \beta_m$ are the regression coefficients, and ε is the random error of the model. Obviously, from equation (6), when $\beta_2 = \beta_3 = \cdots = \beta_m = 0$, the model is a one-way linear regression model.

In the practical use, we may suppose that there are n some groups of observed data in which the number of independent variables is m, then the multiple linear regression model (6) can be expressed as:

$$\begin{cases} y_1 = \beta_0 + \beta_1 x_{11} + \beta_2 x_{12} + \cdots + \beta_m x_{1m} + \varepsilon_1 \\ y_2 = \beta_0 + \beta_1 x_{21} + \beta_2 x_{22} + \cdots + \beta_m x_{2m} + \varepsilon_2 \\ \cdots\cdots \\ y_n = \beta_0 + \beta_1 x_{n1} + \beta_2 x_{n2} + \cdots + \beta_m x_{nm} + \varepsilon_n \end{cases} \tag{7}$$

Eq. (7) can be further written in the form of a matrix as follows:

$$y = X\beta + \varepsilon \tag{8}$$

Eq.

$$y=\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, X=\begin{bmatrix} 1 & x_{11} & \cdots & x_{1m} \\ 1 & x_{21} & \cdots & x_{2m} \\ \vdots & \vdots & & \vdots \\ 1 & x_{n1} & \cdots & x_{nm} \end{bmatrix}, \beta=\begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_m \end{bmatrix}, \varepsilon=\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \tag{9}$$

Before we carry out the construction of the model, some certain assumptions must be put forward for the simplification of the calculation of the parameters of this model. This model is required that it must follow the below assumptions:

Assumption 1 Zero mean assumption: $E(\varepsilon_i)=0, i=1,2,\cdots n$, i.e.:

$$E(\varepsilon)=E\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}=\begin{bmatrix} E(\varepsilon_1) \\ E(\varepsilon_2) \\ \vdots \\ E(\varepsilon_n) \end{bmatrix}=0 \tag{10}$$

Hypothesis 2 Homoskedasticity hypothesis:

$$Var\left(\varepsilon_i\right)=E\left(\varepsilon_i^2\right)=\sigma_\mu^2, \left(i=1,2,\cdots,n\right) \tag{11}$$

Assumption 3 No autocorrelation:

$$Cov(\varepsilon_i,\varepsilon_j)=E(\varepsilon_i\varepsilon_j)=0, (i\neq j, i, j=1,2,\cdots,n) \tag{12}$$

$$\begin{aligned} E\left(\varepsilon\varepsilon'\right)&=E\left[\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}(\varepsilon_1,\varepsilon_2,\cdots,\varepsilon_n)\right]=E\begin{bmatrix} \varepsilon_1^2 & \varepsilon_1\varepsilon_2 & \cdots & \varepsilon_1\varepsilon_n \\ \varepsilon_2\varepsilon_1 & \varepsilon_2^2 & \cdots & \varepsilon_2\varepsilon_n \\ \vdots & \vdots & \vdots & \vdots \\ \varepsilon_n\varepsilon_1 & \varepsilon_n\varepsilon_2 & \cdots & \varepsilon_n^2 \end{bmatrix} \\ &=\begin{bmatrix} E(\varepsilon_1^2) & E(\varepsilon_1\varepsilon_2) & \cdots & E(\varepsilon_1\varepsilon_n) \\ E(\varepsilon_2\varepsilon_1) & E(\varepsilon_2^2) & \cdots & E(\varepsilon_2\varepsilon_n) \\ \vdots & \vdots & \vdots & \vdots \\ E(\varepsilon_n\varepsilon_1) & E(\varepsilon_n\varepsilon_2) & \cdots & E(\varepsilon_n^2) \end{bmatrix}=\begin{bmatrix} \sigma_\mu^2 & 0 & \cdots & 0 \\ 0 & \sigma_\mu^2 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & \sigma_\mu^2 \end{bmatrix} \\ &=\sigma_\mu^2 I_n \end{aligned} \tag{13}$$

Hypothesis 4 put forward that the random error item ε displays no connection with the explaining variable X :

$$Cov(X_{ji},\mu_i)=0, (j=1,2,\cdots,k, i=1,2,\cdots,n) \tag{14}$$

We suppose five random error terms ε are following a normal distribution which has mean zero and one variance σ^2 :

$$\varepsilon_i \sim N\left(0,\sigma_\mu^2 I_n\right) \tag{15}$$

Hypothesis 6 There is no complete multicollinearity between the explanatory variables:

$$rank(X) = m+1 \le n \tag{16}$$

The estimates of the parameters $\beta_0, \beta_1, \beta_2, \cdots, \beta_m$ the coefficient values in a multiple linear regression model are different when the rank of the matrix which is made of sample observations X of the dependent variable equals the number of parameters $m+1$.

In the multiple linear regression model building, one of the key important aspects is to carry out the calculation for the estimations of the obtained regression coefficients. Just as the parameter estimation method for the one linear regression model, the parameter estimated values for the often used multiple linear regression model are also gotten by means of the least squares method.Under the frame of the multiple linear regression model, one must make the assumption that no perfect covariance exists among the independent variables. In the actual application scenarios, although there usually occurs an approximate covariance problem among the independent variables, this circumstance does not violate the basic hypothesis of the multiple linear regression model.Therefore, the method of least squares is still the most optimum linear unbiased estimation method. This subsection puts focus on the basic tenets of the least squares method.

With respect to the system of multiple linear regression equations that is shown in equation (7), the ascertainment of the parameters $\beta_0, \beta_1, \beta_2, \cdots, \beta_m$ is estimated by the method of least squares, and the estimation of parameters $\beta_0, \beta_1, \beta_2, \cdots, \beta_m$ is found as the estimates of parameters $\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_m$, it is that we obtain the sum of the squared differences which are between the model and the observations. In another words:

$$Q(\beta_1, \beta_2, \cdots, \beta_m) = \sum_{i=1}^{n} \left[y_i - (\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_m x_{im}) \right]^2 \tag{17}$$

Obtain the minimum value, when the deviation sum of squares is minimum:

$$\begin{aligned} Q\left(\hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_m\right) &= \sum_{i=1}^{n} \left[y_i - (\hat{\beta}_0 + \hat{\beta}_1 x_{i1} + \hat{\beta}_2 x_{i2} + \cdots + \hat{\beta}_m x_{im}) \right]^2 \\ &= \min_{\hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_m} \sum_{i=1}^{n} \left[y_i - (\beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_m x_{im}) \right]^2 \end{aligned} \tag{18}$$

The $\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_m$ obtained in Eq. (18) is then referred to as the least squares estimate of the regression coefficients $\beta_0, \beta_1, \beta_2, \cdots, \beta_m$. The estimates of the regression coefficients $\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2, \cdots, \hat{\beta}_m$ need to fulfill the following conditions:

The condition for the least squares estimation of the regression coefficient:

$$\begin{cases} \left.\dfrac{\partial Q}{\partial \beta_0}\right|_{\beta_0=\hat{\beta}_0} = -2\sum_{i=1}^{n}\left[y_i - (\hat{\beta}_0 + \hat{\beta}_1 x_{i1} + \hat{\beta}_2 x_{i2} + \cdots + \hat{\beta}_m x_{im}) \right] = 0 \\ \left.\dfrac{\partial Q}{\partial \beta_1}\right|_{\beta_1=\hat{\beta}_1} = -2\sum_{i=1}^{n}\left[y_i - (\hat{\beta}_0 + \hat{\beta}_1 x_{i1} + \hat{\beta}_2 x_{i2} + \cdots + \hat{\beta}_m x_{im}) \right] x_{i1} = 0 \\ \cdots\cdots \\ \left.\dfrac{\partial Q}{\partial \beta_m}\right|_{\beta_m=\hat{\beta}_m} = -2\sum_{i=1}^{n}\left[y_i - (\hat{\beta}_0 + \hat{\beta}_1 x_{i1} + \hat{\beta}_2 x_{i2} + \cdots + \hat{\beta}_m x_{im}) \right] x_{im} = 0 \end{cases} \tag{19}$$

For X in Eq. (17), if there exists $(X'X)^{-1}$, after that, it is possible for people to obtain a least-squares estimation which belongs to the regression coefficients. This method of least squares estimation is as below:

$$\hat{\beta} = (X'X)^{-1} X'y \tag{20}$$

At this time point, the calculation works for the estimations of the regression coefficients are conducted, and the obtained multiple linear regression model is as below:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \cdots + \hat{\beta}_m x_m \tag{21}$$

In the foregoing time, the overall shape of the multiple linear regression model and the computation of its parameters have been given out. After the multiple linear regression model has been built up, one must carry out a significance examination for this model.The dependability of the multiple linear regression model is gotten through the using of this significance test. The evaluation of the regression model mainly includes a goodness-of-fit examination for the model and a significance examination for the model.

a) Goodness-of-fit test of multiple linear regression models

The explanation ability of the multi-linear return model, which is like the ability of the single-variable linear return model, shows the degree to which the model can explain the sample data. A higher grade of explanation ability means that the model can provide a better explanation for the data. This explanatory ability is measured through the magnitude of the numerical value of the determination coefficient, R^2 ,this can act as an index for how good the estimated model matches with the sample data, it indicates the degree of the goodness-of-fit.

The computing method of the determination R^2 coefficient and the evaluation criteria of the multiple linear regression model are the same as what the simple linear regression model has.In the practice usage, although, the determination R^2 coefficient increases when one independent variable is added into the model. According to this, we put forward the hypothesis that increasing the number of independent variables can make the model obtain a better fitting result. Nevertheless, in actual reality situations, the coefficient of determination has a rising R^2 because the number of independent variables has increased, hence there does not exist a strong correlation with the goodness-of-fit. Therefore, it is necessary to adjust the coefficient of determination R^2 to obtain the adjusted goodness-of-fit formula:

$$R^2 = 1 - \frac{SSE}{n-k-1} \Big/ \frac{SST}{n-1} \tag{22}$$

where $n-k-1$ is the degrees of freedom of the residual sum of squares SSE; $n-1$ is the degrees of freedom of the overall sum of squares SST.

Similar to the single-variable linear regression model, in the inside of the multi-variable linear regression model, the more close the calculated value of the coefficient of determination R^2 gets to 1, the more good the fitting effect is, hence the larger the interpretation ability of the model.

b) Significance test of multiple linear regression model

The significance evaluation of the multiple linear regression model usually utilizes the F test, which expands the equation for the total sum of squared deviations SST as:

$$SST=\sum_{i=1}^{n}(y_i-\bar{y})^2=\sum_{i=1}^{n}(y_i-\hat{y}_i)^2+\sum_{i=1}^{n}(\hat{y}_i-\bar{y})^2 \tag{23}$$

Constructing statistics:

$$F=\frac{\sum_{i=1}^{n}\left(\hat{y}_i-\bar{y}\right)^2}{\sum_{i=1}^{n}\left(y_i-\hat{y}_i\right)^2\Big/\left(n-2\right)}\sim F\left(1,n-2\right) \tag{24}$$

Perform hypothesis testing:

Original hypothesis H_0: $\beta_0=\beta_1=\beta_2=\cdots=\beta_m=0$.

Alternative hypothesis H_1: $\beta_0,\beta_1,\beta_2,\cdots,\beta_m$ are not simultaneously zero.

If the rejection domain $\chi_0=\left\{F>F_{1-\alpha}\left(1,n-2\right)\right\}$, i.e., the rejection of the original hypothesis H_0, the regression model passes the test of significance, which indicates that the regression model is good. Conversely, if $\chi_0=\left\{F<F_{1-\alpha}\left(1,n-2\right)\right\}$, then the original hypothesis H_0 is accepted, and the regression model is considered to have failed the test of significance, i.e. the model is not significant.

3 Analysis of empirical studies

3.1 Analysis of the results of the pre-test and post-test of the intercultural sensitivity scale

3.1.1 Analysis of the results of the pre-test of the intercultural sensitivity scale

After the students all completed the intercultural sensitivity scale assessment work, the data were input into the SPSS23 software. The result of pre-test about intercultural sensitivity is given in Table 2.Under the situation of the five dimensions of cross-cultural sensitivity, the students of the control group and the experimental group have a ranking that is completely the same, and the mean values were very close to each other, so the two classes had comparable levels of intercultural sensitivity, which also provided referability for the next step of the experiment.In the student groups of both experiment and control, the level of difference recognition has reached its peak, with an average score of 4 or higher than that. It is followed by communicative engagement, communicative concentration and communicative pleasure,

while communicative confidence has the lowest score.From the five elements, the confirmation of cultural differences is the most important part of cross-cultural sensitivity. This sensibility acts as the base for promoting one's capability to carry out communication successfully among different cultures, and the mean values of difference identity of the students in the two classes are 4.05 and 4.04 respectively, which shows that the students' level of difference identity is generally high, but there is still room for improvement. Communicative confidence comes last, with mean values of 3.18 and 3.08 respectively, which are low, and it can be seen that students are not confident enough in intercultural communication with foreigners.

Table 2: The results of the cross-cultural sensitivity pretest

Cross-cultural sensitivity	Valid volume		Min		Max		Mean		SD	
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG
Communicative engagement	48	50	2.18	2.05	4.59	4.78	3.69	3.67	0.29	0.37
Differential identity	48	50	3.11	3.11	5.04	4.77	4.05	4.04	0.44	0.37
Communication confidence	48	50	2.54	1.87	4.57	4.32	3.18	3.08	0.36	0.38
Communicative pleasure	48	50	2.07	2.06	5.03	5.02	3.42	3.44	0.59	0.54
Communicative concentration	48	50	3.11	2.16	5.04	4.89	3.58	3.57	0.44	0.49

3.1.2 Analysis of the Post-test Results of the Intercultural Sensitivity Scale

After we carried out the traditional English cross-cultural sensitivity cultivation model and the digital-enabled English cross-cultural sensitivity cultivation model for a whole semester, a cross-cultural sensitivity post-test was given by us to the students of the two classes at the end of the semester. The outcomes of the scale after-test are showed in Table 3. After one semester study of the intercultural communication course, the average score points of students' intercultural sensitivity have increased to different degrees in both the control class and the experimental class. The ordering of the five indicators did not change, and the level of Difference Identity remained the highest, followed by Communicative Participation, Communicative Concentration and Communicative Pleasure, while the level of Communicative Confidence remained the lowest.In the beginning of the semester,after we distributed one individual questionnaire, the average number points of the control group were a little bit bigger than those of the experimental group.Nevertheless, the existing data show that the average number values of the experiment group have already exceeded those of the comparison group. Therefore, this change can hence be attributed to the carrying out of the digital-supported model for cultivating English cross-cultural awareness in the experimental group. Teachers need to prepare a lot of materials for students to learn independently, and students also need to spend more time thinking to complete the tasks. In the learning of materials and the participation in many classroom activities, students' intercultural sensitivity increased substantially as a whole. In the control class, although students' participation in the classroom was not as high as in the traditional mode of teaching, their intercultural sensitivity increased to different degrees under the teacher's explanation and guidance.

Table 3: Post-test results of the scale

Cross-cultural sensitivity	Valid volume		Min		Max		Mean		SD	
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG
Communicative engagement	48	50	3.03	3.03	4.66	4.92	3.76	4.79	0.36	0.42
Differential identity	48	50	3.03	3.03	4.92	4.92	4.13	4.96	0.36	0.51
Communication confidence	48	50	2.18	2.18	4.36	4.36	3.19	4.42	0.37	0.38
Communicative pleasure	48	50	2.04	2.04	4.96	4.96	3.46	4.57	0.39	0.56
Communicative concentration	48	50	3.02	2.74	4.96	4.96	3.64	4.61	0.44	0.39

3.2 Analysis of Mathematical and Statistical Results

3.2.1 Independent samples t-test

For judging whether obvious change exists in students' English cross-cultural sensitivity after one-semester intervention, when being compared with the beginning of the semester, an independent samples t-test has the need to be conducted. We have carried out an independent sample t-test by utilizing the data that come from Tables 2 and 3, and the results of this test are shown in Table 4.According to what the data in the table shows, thus it can be clearly seen that the control group did not have obvious differences in communication participation, independent identity, communication self-confidence, communication pleasure and communication concentration, both before and after the implementation of the intervention. The p-values in relation to these aspects are 0.099, 0.146, 0.245, 0.068, and 0.105,this points out that the actual carrying out of the traditional model for cultivating English cross-cultural awareness does not reach what people hope for.On the opposite side, the experiment group showed obvious differences in communication participation, clear self-identity, communication self-confidence, and communication pleasure both before and after the interference measure,furthermore, on the aspect of communication focus, the numerical values are 0.012, 0.029, 0.028, 0.047, and 0.048. These digital numbers satisfy the $P < 0.05$ standard, hence hence indicating that the actual effect of the digital English cross-cultural sensitivity training model is relatively more obvious.

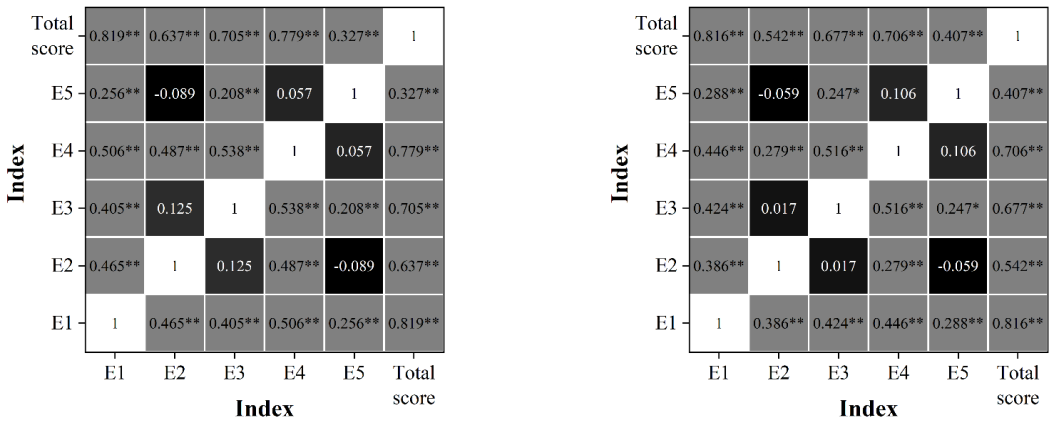
Table 4: Independent sample t-test results

Cross-cultural sensitivity		Before		After		Mean difference	Standard error value	T	P
		Mean	SD	Mean	SD				
Communicative engagement	CG	3.69	0.29	3.76	0.36	0.07	0.07	2.084	0.099
	EG	3.67	0.37	4.79	0.42	1.12	0.05	1.538	0.012
Differential identity	CG	4.05	0.44	4.13	0.36	0.08	0.08	2.532	0.146
	EG	4.04	0.37	4.96	0.51	0.92	0.14	0.351	0.029
Communication confidence	CG	3.18	0.36	3.19	0.37	0.01	0.01	2.881	0.245
	EG	3.08	0.38	4.42	0.38	1.34	0	0.385	0.028
Communicative pleasure	CG	3.42	0.59	3.46	0.39	0.04	0.2	2.299	0.068
	EG	3.44	0.54	4.57	0.56	1.13	0.02	1.198	0.047
Communicative concentration	CG	3.58	0.44	3.64	0.44	0.06	0	2.507	0.105
	EG	3.57	0.49	4.61	0.39	1.04	0.1	1.185	0.048

3.2.2 Correlation analysis

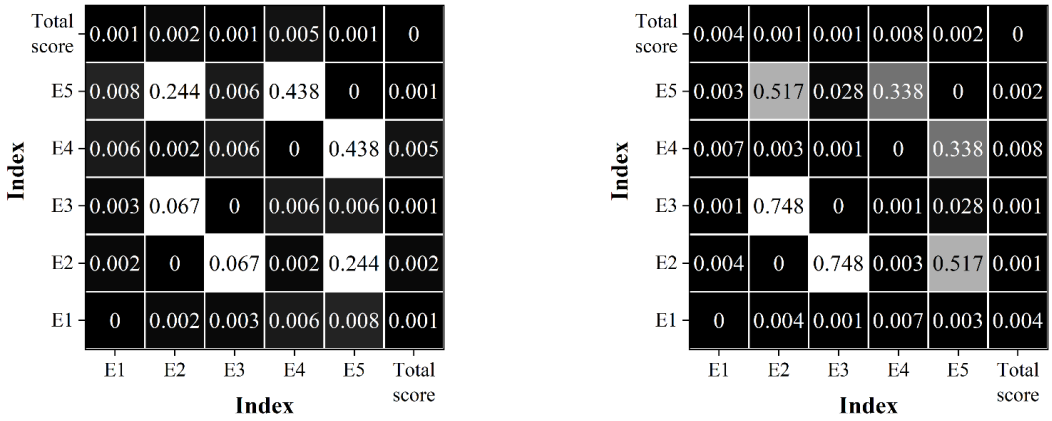
According to what the above-mentioned independent samples t-test has shown, the actual-world putting into practice of the traditional English intercultural sensitivity cultivation model brings about outcomes that are below what people hope for, while the practical efficacy of the digitally empowered English intercultural sensitivity cultivation model designed in this paper is more outstanding. This subsection only explores the correlation between the five dimensions in the digital empowerment model of English intercultural sensitivity development,figure 3 gives the

results of the Pearson correlation coefficient, therefore Figure 4 displays the Sig outcomes. In these pictures, (a) corresponds to the condition before we carry out intervention, and (b) shows the situation after the intervention was done,inside the table, the names E1 to E5 stand for the grades of communicative interaction, different self-identities, self-assurance in communication, pleasure from communication, and concentration during communication.At the same time, Pearson represents the Pearson correlation coefficient.In the pre-test, all the connection relations between every single item and the total score all reached a remarkable degree and were firm and strong. However, the correlation number for communicative attention, which was at 0.327, became an exception, which showed a weak correlation. When the 5 factors were compared two by two, most of them showed high correlations, indicating that they influence each other. It is worth noting that communicative pleasure has the highest correlation value with communicative confidence when comparing it with the other 4 factors, i.e., the confidence index is most likely to influence pleasure. Involvement had the strongest relationship with pleasure when compared with the other 4 items. Differential Identity did not correlate well with Communicative Confidence and Communicative Focus and did not reach the level of significance. This means that although students are willing to accept cultural differences, they are not confident enough to experience the differences in real-life communication and are concerned about receiving information in communication. The correlation value of communicative concentration with communicative pleasure was also low, neither of which reached the level of significance. In the correlation analysis of the posttest data, the results obtained were consistent with the pre-test, except for a slight change in the data. The correlation values of Differential Identity with Communicative Confidence and Communicative Concentration were 0.027 and -0.059 respectively, and the correlation value of Communicative Concentration with Communicative Pleasure was 0.106.To make a conclusion, it is thus clear that, as a whole, the students' cross-cultural consciousness has obtained a certain degree of promotion.



(a)Before intervention (b)After the intervention

Figure 3: Pearson correlation coefficient result



(a)Before intervention (b)After the intervention

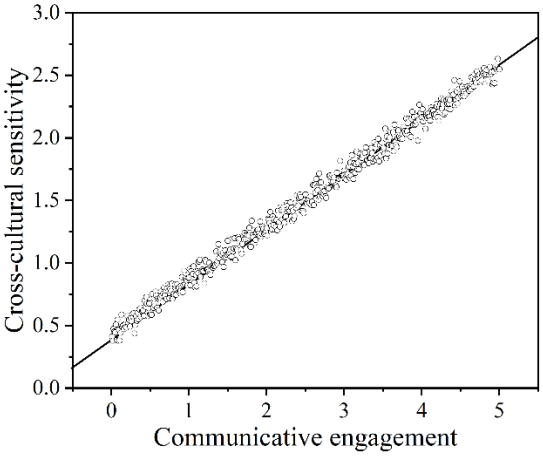
Figure 4 Sig result

3.2.3 Regression analysis

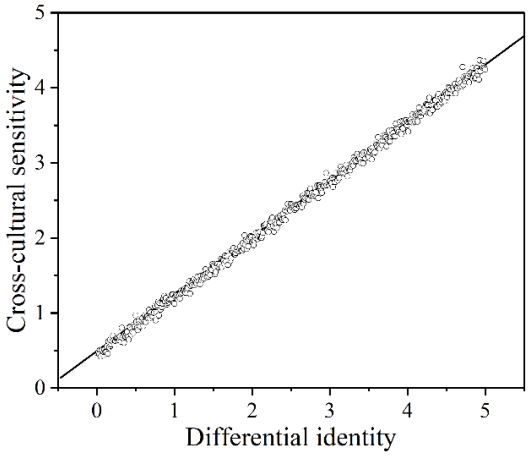
For further probing the connections between every part inside the digital enabling frame which is used to nurture English cross-cultural awareness in higher vocational colleges, one must carry out a regression analysis, the results of the regression analysis are given in Table 5. In this analyzing work, the variable of English cross-cultural sensitivity acts as the dependent variable,figure 5 gives out the outcomes of a regression analysis in which communicative involvement, clear self-identity, self-confidence in the communication process, pleasure got from communication, and concentration in communication are taken as the independent variables. In this picture, sub-pictures from (a) to (e) represent communication participation, different selfhood, communication self-confidence, communication pleasure, and communication attention one by one. Based on the data that is shown in the diagram, it can be seen that the regression equation of students' English intercultural sensitivity is 0.438+0.426* Communicative Engagement+0.772*Differential Identity+0.306* Communicative Confidence+0.314*Communicative Pleasure+0.417*Communicative Concentration, furthermore, the independent variable is able to give explanation for 82.4% of the change that exists in the dependent variable. By revealing the role relationship between the dimensions in the digital empowerment higher vocational English intercultural sensitivity cultivation model,it plays a guiding function for the growth of students' English cross-culture consciousness. For example, for every 1-unit increase in difference identity, students' English intercultural sensitivity increases by 0.772 units, and the same applies to the others.

Table 5: Regression analysis results

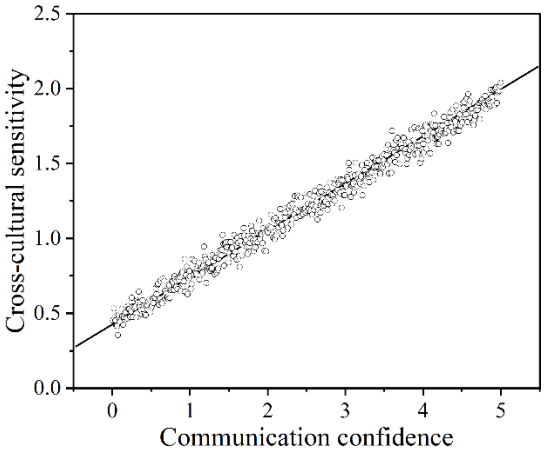
Model	Unstandardized regression coefficients		Standardized regression coefficients	T-Value	P-Value
	$\beta - Value$	Standard error	Beta		
Constant	0.438	0.057		1.703	0.038
Communicative engagement	0.426	0.053	0.472	0.721	0.028
Differential identity	0.772	0.054	0.795	0.668	0.034
Communication confidence	0.306	0.058	0.347	0.063	0.046
Communicative pleasure	0.314	0.031	0.332	0.507	0.024
Communicative concentration	0.417	0.057	0.455	1.703	0.038
F	1.428				
R-square	0.824				



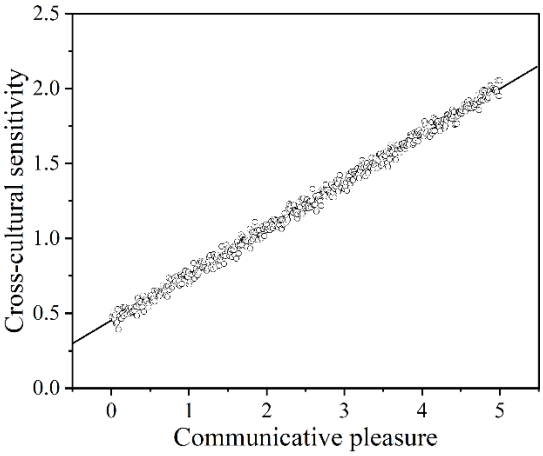
(a)Mutual Interaction Communication IMPORTANT



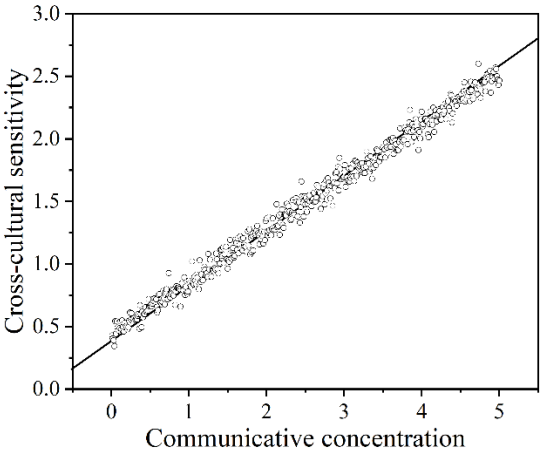
(b)Differentiated Characteristics Identity



(c)Communication confidence



(d)The Joy of Mutual Information Exchange



(e)Communicative concentration

Figure 5: Regression analysis visualization results

4 Conclusion

With the increasing frequency of international communication, the cross-cultural consciousness in English language of higher vocational college students has the particular importance. For promoting the effect of fostering cross-cultural consciousness in higher vocational English teaching, a digital empowerment higher vocational English cross-cultural sensitivity cultivation model was constructed, and empirical analysis was carried out with the help of scales and mathematical statistics.

(1) After one semester of intervention, regarding communicative participation, tolerance of different opinions, communicative self-confidence, pleasure from communication and concentration in communication, there is no obvious difference between students of the control class. However, one obvious difference is found among students in the experiment class, with corresponding values being 0.012, 0.029, 0.028, 0.047, and 0.048. This thus shows that the actual effect of the digital-based model on the cultivation of English cross-cultural awareness is more obvious.

(2) In the correlation analysis, we have found that a remarkable correlation exists between English cross-cultural sensitivity and many kinds of factors, which include communication participation, unique identity, communication self-confidence, communication pleasure, communication attention. After that, we have carried out a regression analysis in order to get the regression equation of English intercultural sensitivity. When the sense of distinct identity has one unit's increase, therefore it causes a 0.772-unit growth on students' English cross-cultural sensitivity. This identical pattern was also maintained for the other four independent variables.

About the Author

Yingying Ni was born in Wenzhou, Zhejiang, P.R. China, in 1982. She obtained a master's degree from Shanghai University in China. She is currently teaching English in Shanghai Donghai Vocational & Technical College. Her main research interest is cross-cultural communication and English pedagogy.

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