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Artificial Intelligence Driven English Translation: Utilizing Machine Learning and IoT Data to Improve Context Accuracy

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Abstract The traditional English teaching mode ignores the differences between individual students, resulting in some students' low motivation to learn, while personalized English learning based on the support of Internet of Things can effectively improve students' learning efficiency. In this paper, we construct the evaluation index system of student engagement from four dimensions: learning attitude, learning process, learning effectiveness and emotional experience, and quantify the degree of student engagement in IoT-supported personalized English learning through a fuzzy mathematical model. In order to further improve student engagement, a student engagement improvement mechanism is designed based on four evaluation results: excellent, good, moderate and poor. The study takes the freshman (1) class of English majors in School A, which uses IoT technology for personalized English learning, as the research object and uses a fuzzy mathematical model to quantify student engagement. The evaluation grade of student engagement in this class is "medium", and the evaluation score is 71.37. Accordingly, a student engagement improvement mechanism was introduced. After 8 weeks of rectification, the final grade of student engagement in English learning is "excellent", with an evaluation score of 88.49, which is a total improvement of 17.12 points, and the student engagement enhancement mechanism designed in this paper has a significant effect.

Index Terms Internet of Things, Fuzzy Mathematical Model, Student Engagement, Personalized English Learning

I. Introduction

In today's globalized society, English has become a widely learned language. However, traditional English education programs cannot meet the learning needs of each student. Therefore, the proposal of personalized learning program has become a hot topic in English education at present [1]-[4]. Personalized learning, that is, according to the different needs and characteristics of students, provides individualized and diversified learning programs and resources to meet the learning goals of each student [5]-[7]. IoT technology can realize the data collection and analysis of students' learning behaviors and provide personalized learning services for students [8]-[10]. By analyzing students' learning data, the system can recommend suitable learning resources and learning paths according to students' learning characteristics and needs, improve students' learning effects, and have a positive impact on improving students' engagement [11]-[14].

Student engagement in English learning is one of the important indicators to evaluate the degree of active participation of students in the English learning process. Active participation refers to students' performance in the classroom in terms of learning motivation, thinking ability, interactive communication and cooperation [15]-[18]. A higher level of student participation means that he is more interested and committed to learning, which is more conducive to his academic achievement. In contrast, students with low engagement may have problems such as low motivation and poor learning outcomes [19]-[22]. Therefore, it is of great significance to design a fuzzy mathematical model-based mechanism to enhance student engagement based on the application of IoT in education.

Literature [23] examined the integration of IoT and generative AI in English education to develop a personalized speaking assessment method. The method creates a dynamic and adaptive learning environment. The study bridges the gap between traditional teaching methods and emphasizes the need for AI methods. Literature [24] studied the application of loT in English language teaching. It reveals that the intelligent English teaching platform based on loT can effectively improve the stability of the teaching system and enhance students' personal experience. It provides a reference for intelligent teaching in colleges and universities. Literature [25] proposed Al-L-TM centered on analyzing learning performance and acquiring new information and used to recommend learning paths, and explored the advantages and disadvantages of these technologies, such as AI and lot, as well as their importance for building smarter and more adaptive online learning environments. Literature [26] developed a cloud classroom for English education based on IoT and data mining methods and revealed the effectiveness of the developed cloud classroom by utilizing a three-tier B/S model that will use SQLserver as the database. Literature [27] describes the construction of CPLRS-EL-RA personalized learning content recommendation system, and points out that the CPLRS-EL-RA method exhibits high accuracy. It also analyzes the high memorization rate of the personalized recommendation system for English teaching resources and the recommendation system based on learners' comments. The above study reflects the wide application of IoT in education, especially in English education to effectively improve the English teaching effect.

The study firstly constructed a student engagement evaluation index system consisting of learning attitude, learning process, learning effectiveness and emotional experience. It also used a fuzzy mathematical model to quantify student engagement in personalized English learning supported by the Internet of Things, and the model can classify student engagement into four grades: excellent, good, moderate and poor. Then a student engagement improvement mechanism was designed based on the quantitative results. Finally, the freshman (1) class of English majors in School A is taken as the research object for empirical analysis. According to the initial evaluation results, the teaching rectification is carried out using the student engagement enhancement mechanism constructed in this paper, and the effectiveness of teaching practice is analyzed according to the evaluation scores of the fuzzy mathematical model.

II. Personalized English learning based on IoT support

II. A. Enrich teaching resources and expand English learning channels

Internet of Things technology breaks through the original limitations of paper textbooks and increases the density of teaching information delivered to students in the classroom. Teaching resources are no longer limited to books and fixed learning reference materials, and the shared teaching resources of some famous schools can be utilized at any time [3]. With the help of the network to present students with a large amount of information outside the book for students to choose, conducive to students' independent learning and to meet the needs of individualized learning. This is also in line with the requirements and characteristics of English teaching.

II. B. Improve the teaching mode and enhance the effectiveness of classroom teaching management

The application of Internet of Things (IoT) technology can greatly expand the space of traditional classroom teaching and improve the mode of classroom teaching. The quantization and publicization of teaching information provides opportunities for students with different learning levels, and individual teaching can be truly implemented. The sharing of resources and the intelligence of learning standards provide the basis for cooperative learning, and the popularization of the mobile Internet guarantees that mobile learning will become a reality. English teaching is no longer confined to the traditional oral teaching of teachers and students, and a variety of teaching modes may be carried out at the same time.

Spoken language is a difficult problem in English listening and speaking teaching, and IOT technology can be utilized to carry out oral correction and voice correction, which can enable students to obtain standard English learning. The standard English accent patterns and standard speech are digitized by digital camera and digital recording of speech. The features of mouth shape and speech are described digitally and then programmed into software with standard English pronunciation and mouth shape demonstration functions and automatic assessment of students' learning.

With the establishment and improvement of the smart campus, schools can integrate the data obtained from IoT into the existing teaching platform for teaching and management by developing new modules: on the one hand, teachers can conduct developmental evaluation based on the acquired student learning data, and the examination management implemented using IoT is more transparent, fair and efficient. The teaching department can integrate all kinds of student information for management, and parents can log on the platform to get their children's test scores, teachers' comments, students' abnormalities and related notices, etc., so as to timely understand the situation of their children in school, thus effectively cooperating with the school to personalize their children's tutoring and education, and improving the overall level of teaching and management.

III. Quantitative study of student engagement based on fuzzy mathematical modeling

Although personalized English learning based on the Internet of Things can greatly improve students' learning efficiency, it differs greatly from the traditional teaching mode, and it is difficult to evaluate the students' participation in this teaching mode in the process of specific practical teaching. Based on this, this chapter constructs a fuzzy mathematical model to quantify student participation.

III. A. Construction of the evaluation index system for student engagement

Referring to related literature [4], this paper explores student engagement in IoT-supported personalized English learning from four aspects: learning attitude, learning process, learning effectiveness and students' emotional experience, respectively. The evaluation index system constructed is shown in Table 1. The evaluation index system contains 12 secondary indicators.

Table 1: Student engagement evaluation index system

Target layer	Primary indicator	Secondary indicator
Student participation	Learning attitude(A)	Learning time(A1)
		Topic participation(A2)
		Class interaction(A3)
	Learning process(B)	Student attendance(B1)
		Task point completion(B2)
		Chapter learning(B3)
		Learning resource utilization (B4)
	Learning results(C)	Master the situation(C1)
		Ability to improve(C2)
	Student emotional experience(D)	Student participation(D1)
		Course resource recognition(D2)
		Ability culture recognition(D3)

III. B. Application of fuzzy mathematical modeling

III. B. 1) Determination of indicator weights

According to the 1-9 scale method, a judgment matrix is established for each evaluation indicator at the same level of the evaluation system using a two-by-two comparison method. The judgment matrix expresses the status of evaluating the relative importance of each relevant element in the previous level with respect to the element in that level, and is of the following form:

$$B=\begin{bmatrix} b_{11} & b_{12} & \dots & b_{1j} & \dots & b_{1n} \\ b_{21} & b_{22} & \dots & b_{2j} & \dots & b_{2n} \\ \dots & & & & & \\ b_{n} & b_{i2} & \dots & b_{ij} & \dots & b_{in} \\ \dots & & & & & \\ b_{n1} & b_{n2} & \dots & b_{nj} & \dots & b_{nn} \end{bmatrix} \tag{1}$$

where, n represents the number of indicator systems and b_{ij} in the matrix represents the importance of b_i compared to b_j.

III. B. 2) Constructing a rubric collection

The set of evaluation rating grades $V=\{v_1,v_2,v_3,v_n\}$ (n represents the number of rubric sets), where $v_j(j=1,2,\dots,n)$ represents all levels of evaluation from high to low, and $n=4,v_1,v_2,v_3,v_4$ in the set of student engagement grades represents the rubric sets: excellent, good, fair, and poor, respectively.

III. B. 3) Single-factor fuzzy evaluation mathematical model

Let all possible comments have n, recorded as $V=\{v_1,v_2,\dots,v_n\}$, representing a variety of evaluations composed of a collection, called the evaluation factor set.

Generally, the factors in the factor set are inconsistent in their impact on the thing being evaluated, so the weights of the factor set are assigned to a fuzzy vector on U, $A_i=\{a_1,\dots,a_i,\dots a_n\}$, and the weights are a quantitative representation of the importance of each indicator, and their reasonableness or lack of reasonableness has a direct impact on the accuracy of the evaluation results. The weights of each factor are given directly, and the weights of specific indicators are:

$$A_i=(a_1,\dots,a_i,\dots a_n)\text{, And satisfy}=1,\sum_{i=1}^{n}aa_i\geq 0 \tag{2}$$

Thus, the synthesized evaluation can be regarded as a fuzzy set on V, denoted as: $B=(b_1,b_2,\dots,b_{12})$. Where: b_j denotes the position of the j th rubric in the overall V of the evaluation.

If there is a fuzzy relation $R=(r_{ij})_{m\times m}$ from U to V, then a fuzzy transformation T_r can be obtained by using R.

Thus, there is then a fuzzy evaluation model with the following structure, which is divided into four steps:

(1) Single-factor evaluation and construction of the judgment matrix

A single factor evaluation is made for single factor $u_i(i=1,2,\ldots,n)$ in factor set U, and the affiliation r_{ij} of the indicator to rubric $v_j(j=1,2,\ldots,m)$ is determined from factor u_i, resulting in a single factor evaluation set for factor i: $r_i=\left(r_{i1},r_{i2},\ldots,r_{im}\right)$, which is a fuzzy subset on the set of rubrics, viz:

$$T_R:F(U)\to F(V),A\mapsto A\cdot R,\ Which,\ R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \tag{3}$$

T is the fuzzy relationship matrix from U to V, $R=\left(r_{ij}\right)_{n\times m}$, and call R the judgment matrix. The value of r_{ij} is determined as follows:

For the expert scoring (or test scores) results are counted and organized to get for indicator U_{ki} there are v_i level V_1 rubrics, v_{i2} level V_2 rubrics, ..., v_{im} level V_m rubrics, then for $i=1,2,\ldots,n$, there are:

$$r_{ij}=\frac{V_{ij}}{\sum_{j=1}^{n}V_{ij}}(j=1,2,\ldots,m) \tag{4}$$

In this way the evaluation matrix is established for all the first-level factors containing second-level factors, and the most basic evaluation data can be derived, laying the foundation for further second-level evaluation.

(2) Determining the fuzzy set of factor importance

Since the degree of influence of each factor on the indicator is not the same, some factors may have a greater degree of influence in the overall evaluation, while others may be smaller. Therefore, in the evaluation, it is necessary to give the degree of importance of each factor in the overall evaluation, that is, a fuzzy subset $A=\left(a_1,a_2,\ldots a_n\right)$ is given on factor U, where a_i is a measure of the degree of influence of factor $u_i(i=1,2,\ldots,n)$ in the overall evaluation, and to a certain extent, it also represents the ability to assess the grade according to a single factor u_i, and we call A as the fuzzy subset of the degree of importance of the factors on factor U, and we call a_i as the coefficient of the degree of importance of factor u_i.

(3) Determine the evaluation model and find the fuzzy evaluation set

When the fuzzy set of factor importance A and the judgment matrix (fuzzy relationship) R are known, A is transformed into a fuzzy subset on the evaluation set V by making a fuzzy linear transformation on R:

$$B=A*R=\left(b_1,b_2,\ldots,b_m\right) \tag{5}$$

where "*" denotes the generalized fuzzy combinatorial multiplication operation, i.e:

$$b_j=\left(a_1\hat{*}r_{1j}\right)\breve{*}\left(a_2\hat{*}r_{2j}\right)\breve{*}\ldots\breve{*}\left(a_n\hat{*}a_{rj}\right)(j=1,2,\ldots,m) \tag{6}$$

Here "*" denotes generalized fuzzy "and" operation, "*" denotes generalized fuzzy "or" operation, B is called the fuzzy evaluation set on comment set V, and $b_j(j=1,2,\ldots,m)$ is the membership degree of rank (comment) v_j to the fuzzy evaluation set B obtained by the evaluation.

(4) Comprehensive judgment

According to the principle of maximum affiliation, the grade (rubric) v_j corresponding to the largest b_j in the fuzzy evaluation set $B=\left(b_1,b_2,\ldots,b_m\right)$ is selected as the result of the judgment.

The significance of the judgment is that when factor u_i is considered alone, the evaluation of u_i is subordinate to comment v_j to the degree of $r_{ij}(j=1,2,\ldots,m)$, and the result $\hat{a}_i*r_{ij}$ (denoted as r_{ij}^*) calculated by the generalized ambiguity of "and" is the adjustment of r_{ij} when the evaluation of u_i is subordinate to the degree of membership of v_i when considering all factors comprehensively, that is, when considering the degree of influence of factor u_i in the overall evaluation a_i. Finally, the generalized fuzzy "or" operation is used to process each adjusted degree of affiliation by r_{ij}^* to arrive at a reasonable evaluation result.

Let the set of evaluation indicators be $U=\{u_i\}$, in the formula $i=1,2,3\ldots12$, is the set of evaluation indicators, the evaluation of each indicator is divided into 4 grades, then these four grades constitute the set of comments. Set a total of a number of participants, and the indicator $U=\{u_i\}$, in the formula $i=1,2,3\ldots12$, the number of people rated as the $v_j(j=1,2,3,4)$ grade accounted for the total number of people t_{jk}, the ratio that is the indicator of the (u_i) and a certain grade (u_j) degree of affiliation (t_{jk}), so that we get a fuzzy judgment matrix on the evaluation set: $T=[T_1,T_2,T_3T_4]$, of which $T_i=[t_{i1},t_{i2},t_{i3},t_{i4}]$ is the fuzzy judgment vector of the first i factors, the fuzzy judgment vector of all the single-factor fuzzy judgment constitutes a multi-factor fuzzy judgment matrix.

Evaluation of factor $u_i(i=1,2,\ldots,n)$ yields a fuzzy subset on V - a single-factor evaluation vector $T_i=(t_{i1},t_{i2},t_{i3},\ldots,t_{im})$, which determines a fuzzy evaluation matrix U from U to V (t_{ij} indicates the degree of affiliation of indicator u_i rated as v_j):

$$U=(t_{ij})_{n\times m}=\begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1m} \\ t_{21} & t_{22} & \cdots & t_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ t_{n1} & t_{n2} & \cdots & t_{nm} \end{bmatrix} \tag{7}$$

III. B. 4) Conducting fuzzy integrated evaluations

Considering the assignment of weights in the case of multiple factors, the fuzzy comprehensive evaluation model of student engagement is:

$$U=A\cdot R=(b_1,b_2,b_3,\ldots,b_m) \tag{8}$$

To wit:

$$\begin{aligned} B&=(a_1,a_2,a_3,\ldots,a_n)\begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1m} \\ t_{21} & t_{22} & \cdots & t_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ t_{n1} & t_{n2} & \cdots & t_{nm} \end{bmatrix} \\ &=(b_1,b_2,b_3,\ldots,b_m) \end{aligned} \tag{9}$$

The fuzzy transformation $A\cdot R$ from U to V, i.e., the synthesis operation, is carried out to obtain the fuzzy subset B on V, i.e., the result of the fuzzy composite evaluation of student engagement.

IV. Design of mechanisms to enhance student engagement

Based on the fuzzy mathematical model designed above can quantify the situation of student participation, which can provide teachers with auxiliary reference for teaching. This chapter designs a mechanism for improving student engagement based on the model, i.e., different methods are used to make teaching adjustments for the four evaluation results of excellent, good, moderate and poor student engagement.

IV. A. Provide interesting and challenging course content

Classes with a quantitative result of "excellent" in student engagement indicate that the overall teaching methodology has been applied well, and that opportunities can be created for students to conduct their own investigations.

For example, teachers can encourage students to choose an English topic of interest and conduct relevant research and investigation. Teachers can also provide some independent learning resources and tools so that students can apply them for independent learning. Teachers can provide online learning platforms according to the needs so that students can choose and use them freely to develop their independent learning ability and interest in learning. By creating opportunities for self-directed inquiry, students can participate more actively in the learning process and bring their initiative and creativity into play. They are able to learn according to their own interests and needs, increasing their autonomy and participation in learning.

IV. B. Encourage students to actively participate in classroom discussions

Classes with a quantitative result of "good" for student engagement indicate that student learning is not effective and that students can be encouraged to interact and debate with each other.

Students can ask questions, express their views, and debate and discuss different points of view with each other. Teachers can establish rules and guidelines, such as respecting the views of others, focusing on argumentation and logic, and encouraging diversity and inclusion. In addition, teachers can act as moderators and guides of the debate process to ensure order and quality of discussion. Teachers can ask questions, give feedback, summarize the results of the discussion, and guide students to think and look ahead. By encouraging students to actively participate in classroom discussions, students are able to express their own views, listen to the opinions of others, and improve their thinking skills and learning outcomes through communication and debate.

IV. C. Introduction of group activities and multimedia resources

Classes with "moderate" and "poor" quantitative results for student engagement indicate that there are too few opportunities for students to participate in the learning process and that the IoT technologies currently in use are not very appealing to students. Therefore, students can be actively encouraged to assist and cooperate with each other, and multimedia resources can be utilized to enrich the classroom content.

On the one hand, teachers can provide students with guidance for discussion and cooperation, encourage them to share ideas and solve problems, and provide guidance and support for group members. First, teachers can set up group activities and cooperative tasks. By dividing students into groups and encouraging them to work together to solve problems, hold discussions and complete projects, they can stimulate a sense of cooperation and mutual support among students. Teachers can set up reasonable group rules to ensure that each group member has the opportunity to participate, and also provide appropriate evaluation and incentives for group performance and results to encourage students to better cooperate and support each other. Secondly, teachers can also utilize technological means to promote communication and cooperation among students. For example, online discussion forums or social media platforms can be utilized to create a virtual learning community where students can communicate with each other, share learning resources and answer questions at any time. In addition, teachers can introduce activities such as role-playing or group competitions to increase students' interest and motivation to participate. By setting up role-playing tasks where students assist each other and cooperate to solve problems in simulated situations, they can improve their language practice and teamwork skills. And group competitions can increase the atmosphere of cooperation and competition among students and stimulate positive learning motivation and cooperative enthusiasm.

On the other hand, teachers can use multimedia materials such as images, videos and audios to visualize abstract concepts so that students can understand and remember them more easily. For example, introducing real video materials to show the application scenes of English in real life helps students better understand the context and language usage. At the same time, teachers can also provide rich and varied interactive teaching materials, such as online games, story comics, etc., through online resources or learning software to stimulate students' interest and increase the fun and participation in learning.

V. Empirical analysis

The empirical analysis of this paper is based on all 60 students in the freshman (1) class of English majors in school A who use IoT technology for personalized English learning. Using the fuzzy mathematical model constructed in this paper, student engagement in class (1) was assessed, and the corresponding rectification methods were selected for practical teaching based on the assessment level.

V. A. Quantitative analysis of student engagement

V. A. 1) Determination of indicator weights

According to the hierarchical indicator system established in Table 1, the affiliation between different levels can be determined. Experienced experts in hierarchical analysis were hired to adopt the 1~9 scale method for determining the relative importance of each element between the same levels as the basis for determining the quantitative value of judgment, and the comparative importance scores of the first-level indicators and the second-level indicators are shown below.

The weights and consistency tests of the factors of student engagement are shown in Table 2. CR=0.096<0.1, which passed the consistency test.

Table 2: Student participation factors and consistency tests

	A	B	C	D	W_i
A	1	5	2	1/5	0.236
B	1/5	1	1/3	1/2	0.352
C	1/2	3	1	1/3	0.134
D	5	2	3	1	0.278
λmax=5.332,CI=0.108,CR=0.096<0.1					

The weights and consistency test of the factors of learning attitude are shown in Table 3. CR=0.042<0.1, which passed the consistency test.

Table 3: Study attitude factors and consistency tests

	A1	A2	A3	W_i
A1	1	2	3	0.363
A2	1/2	1	1/5	0.31
A3	1/3	5	1	0.327
λmax=3.105,CI=0.047,CR=0.042<0.1				

The weights of the factors of the learning process and the consistency test are shown in Table 4. CR=0.016<0.1, which passed the consistency test.

Table 4: The factors of the learning process and the consistency test

	B1	B2	B3	B4	W_i
B1	1	3	1/2	1/5	0.231
B2	1/3	1	1/3	3	0.277
B3	2	3	1	1/2	0.139
B4	5	1/3	2	1	0.353
λmax=3.239,CI=0.018,CR=0.016<0.1					

The weights and consistency tests of the factors of learning effectiveness are shown in Table 5. CR=0.031<0.1, which passed the consistency test.

Table 5: Learning effectiveness factors and consistency testing

	C1	C2	W_i
C1	1	5	0.436
C2	1/5	1	0.564
λmax=3.019,CI=0.035,CR=0.031<0.1			

The weights and consistency test of the factors of students' affective experience are shown in Table 6. CR=0.063<0.1, which passed the consistency test.

Table 6: Students' emotional experience of various factors and consistency tests

	D1	D2	D3	W_i
D1	1	5	1/3	0.316
D2	1/5	1	2	0.332
D3	3	1/2	1	0.352
λmax=2.369,CI=0.071,CR=0.063<0.1				

In summary, the set of weights for the evaluation indicators of student engagement was calculated as shown in Table 7. Among them, the utilization of learning resources (B4) has the highest percentage among all evaluation indicators, which is 0.124.

Table 7: Student engagement evaluation index weight set

Primary indicator	W_i	Secondary indicator	W_i	Composite weight
A	0.236	A1	0.363	0.086
		A2	0.31	0.073
		A3	0.327	0.077
B	0.352	B1	0.231	0.081
		B2	0.277	0.098
		B3	0.139	0.049
		B4	0.353	0.124
C	0.134	C1	0.436	0.058
		C2	0.564	0.076
D	0.278	D1	0.316	0.088
		D2	0.332	0.092
		D3	0.352	0.098

V. A. 2) Specific applications of fuzzy mathematical models

Ten experts were invited to evaluate the participation of students in class (1), and the judgment set of secondary indicators was $V = \{Excellence, Good, Medium, Bad\}$. SPSS 26.0 was used to analyze the reliability of the data, and the Cronbach's alpha value of the questionnaire was obtained to be 0.833, and the split-half reliability was 0.795, which indicated that the data collected for this evaluation of the validity of students' participation was of high reliability. At the same time, KMO and Bartlett spherical calibration were carried out to analyze the correlation of the variables of the indicator system, and the KMO value was calculated to be 0.824, and the Bartlett spherical calibration results showed that the approximate chi-square value was 8639.337, and the Sig values were 0.000<0.01, which indicated that the data of this evaluation of the validity of the students' participation has a good reliability and validity. The normalization operation on the collected data obtained the affiliation value of each evaluation factor as shown in Table 8. Initially, it was judged that the evaluation of each index by 10 experts was concentrated in the "medium" level.

Table 8: Expert evaluation statistics

Primary indicator	Secondary indicator	Evaluation set			
		Excellence	Good	Medium	Bad
A	A1	0.1	0.1	0.4	0.4
	A2	0.1	0.2	0.5	0.2
	A3	0	0.1	0.6	0.3
B	B1	0	0.4	0.6	0
	B2	0	0.1	0.7	0.2
	B3	0.2	0.1	0.6	0.1
	B4	0	0.1	0.8	0.1
C	C1	0	0.3	0.6	0.1
	C2	0.1	0.1	0.5	0.3
D	D1	0.1	0.1	0.6	0.2
	D2	0.2	0.2	0.6	0
	D3	0.2	0.1	0.5	0.2

According to Eq. (8) and Eq. (9), the membership degree of the fuzzy evaluation set is calculated as $[0.08, 0.152, 0.593, 0.175]$, and according to the principle of maximum membership, the student participation of class (1) can be rated as "medium", in order to facilitate the judgment of the effect of the student participation promotion mechanism, the corresponding score of $V = \{Excellence, Good, Medium, Bad\}$ is set to 90 points, 80 points, 70 points, and 60 points, and the comprehensive score of student participation evaluation of class (1) is 71.37 points.

V. B. Analysis of the effect of increased student engagement

The student engagement of class (1) was measured as "Medium" above, and after 4 weeks of teaching and learning with the introduction of group activities and multimedia resources against the student engagement enhancement mechanism designed in the previous section, the expert scores are shown in Table 9. At this time, the number of people who gave a "poor" grade was zero.

Table 9: Expert evaluation statistics

Primary indicator	Secondary indicator	Evaluation set			
		Excellence	Good	Medium	Bad
A	A1	0.6	0.3	0.1	0
	A2	0.6	0.2	0.2	0
	A3	0.7	0.2	0.1	0
B	B1	0.6	0	0.4	0
	B2	0.7	0.2	0.1	0
	B3	0.7	0.2	0.1	0
	B4	0.8	0.1	0.1	0
C	C1	0.6	0.1	0.3	0
	C2	0.6	0.3	0.1	0
D	D1	0.7	0.2	0.1	0
	D2	0.7	0.2	0.1	0
	D3	0.8	0.2	0	0

Using the fuzzy mathematical model to calculate the affiliation degree of the fuzzy evaluation set as $\left[0.685, 0.182, 0.133, 0\right]$, the overall score of the student engagement evaluation was raised to 85.52, and the evaluation grade was raised to "excellent".

Then the students were provided with interesting and challenging course content, and the expert scoring was conducted again after 4 weeks, and the scoring results are shown in Table 10. At this time, the number of people with "poor" and "moderate" grades is zero, and the effect of the mechanism for improving student participation is significant.

Table 10: Expert evaluation statistics

Primary indicator	Secondary indicator	Evaluation set			
		Excellence	Good	Medium	Bad
A	A1	0.9	0.1	0	0
	A2	0.8	0.2	0	0
	A3	0.8	0.2	0	0
B	B1	1	0	0	0
	B2	0.8	0.2	0	0
	B3	0.8	0.2	0	0
	B4	0.9	0.1	0	0
C	C1	0.9	0.1	0	0
	C2	0.9	0.1	0	0
D	D1	0.8	0.2	0	0
	D2	0.8	0.2	0	0
	D3	0.8	0.2	0	0

After this teaching practice, the affiliation of the fuzzy evaluation set was $\left[0.849, 0.151, 0, 0\right]$. The composite score of the student engagement evaluation was 88.49, which was a total of 17.12 points higher compared to before the introduction of the student engagement improvement mechanism. After an 8-week rectification period, student engagement increased significantly.

VI. Conclusion

Under the IoT environment, English learning resources, learning channels, teaching modes and teaching management can meet students' personalized learning needs. In this paper, we design a student engagement enhancement mechanism incorporating a fuzzy mathematical model, and empirically analyze it with the freshman (1) class of English majors in School A. The students in this class were found to be "medium" in IoT-enabled personalized English learning. At the initial stage, the students' engagement in IoT-supported personalized English learning was "medium", with a comprehensive score of 71.37. After the introduction of the student engagement enhancement mechanism, the student engagement of the class in the middle period increased to "excellent", with a score increase of 14.15 points. At a later stage, the Student Engagement Enhancement Mechanism was re-introduced, resulting in a final score of 88.49, an increase of 2.97 points compared to the interim period.

The smaller increase in score is due to the short cycle of teaching practice on the one hand, and on the other hand, it is more difficult to improve within the same grade than across grades.

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