Research on Core Literacy Evaluation of Information Technology Subject Based on Fuzzy Comprehensive Evaluation

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Abstract: With the development of education and teaching reform, the core literacy of students' development has become the goal of China's basic education goals. However, it is difficult for us to evaluate students' comprehensive literacy with a single, linear evaluation criterion. Therefore, this paper takes the core literacy of information technology for example, and a core literacy evaluation method based on fuzzy comprehensive evaluation is proposed. The method is to imitate the evaluation experience and intelligent behavior of educational experts to obtain an optimal evaluation system. Firstly, the core literacy evaluation indicators of junior high school students' information technology are compiled, and then the students' information technology core literacy evaluation model is obtained according to the fuzzy comprehensive evaluation method. Through the evaluation model, the core literacy of students can be evaluated more accurately, which avoids the one-sidedness and unity of the traditional evaluation methods, making the evaluation of students more comprehensive and objective.

1. Introduction

The report of the 18th National Congress of the Communist Party of China put forward "to regard the Lide Shuren as the fundamental task of education and to cultivate the socialist builders and successors of all-round development of morality, intelligence, art and work" for the first time [1].In order to implement the important initiatives of Lide Shuren, the "Opinions on Comprehensively Deepening the Reform of Curriculum Implementation and Implementing the Fundamental Tasks of Lide Shuren" is developed and issued by the Ministry of Education in 2014[2].After three years of research work, the six core literacy has composed by a joint research group of Beijing Normal University and other universities which has established, including humanistic heritage, scientific spirit, learning to learn, healthy living, responsibility, and practice innovation[2]. As shown in Figure 1, each core literacy is refined into three basic points, a total of 18 basic points, each of which is related, mutual complement, mutual improvement. "Core Literacy" is the fundamental goal of teaching and educating . It runs through the whole process of curriculum objectives, structure, content, teaching implementation and quality standards and evaluation[3]. To implement core literacy, which it is necessary to complete the subject curriculum or even the interdisciplinary curriculum from the perspective of curriculum planning, How to evaluate the core literacy of students according to the connotation and extension of core literacy is an important link in the education and teaching process, and it is also a very complicated link. Traditional evaluation methods often use examinations, investigations, etc. to evaluate students' learning effects from a certain aspect or some aspects. Such evaluation methods can not meet the evaluation requirements of the existing education and teaching objectives, so it is necessary to study more comprehensive evaluation indicators and evaluation models that meet the contemporary core literacy evaluation.

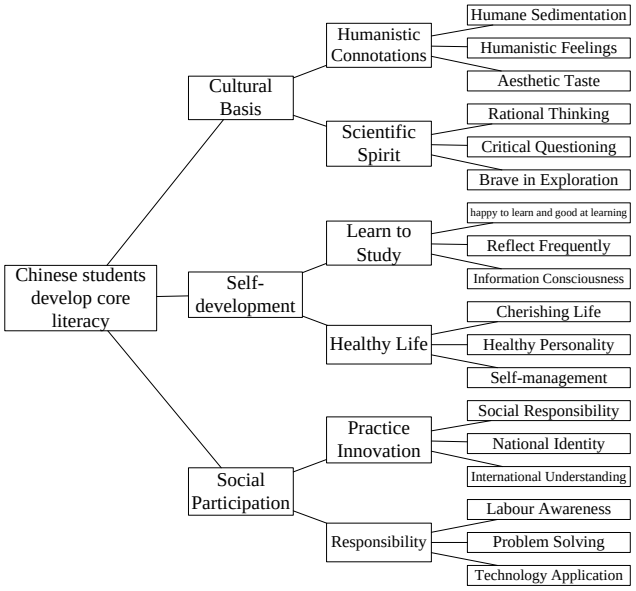

Fig.1 Chinese students develop core literacy

2. The index of core literacy evaluation for junior high school students' information technology

Under the guidance of the Party of China, education has a new direction and goal. In the new round of curriculum reform, the "core literacy of students' development" is the foothold of China's basic education goals. In 2012, "Basic Education Information Technology Curriculum Standards (2012 Edition)" is issued by the Information Technology Education Committee of China Basic Teaching Technology Association which proposed that the overall goal of the information technology course in the basic education stage ,which to train and enhance students' information literacy[4][5]. Students' information literacy is expressed in the ability to acquire, process, manage, express and exchange information by using information technology tools; Ability to evaluate processes, methods, and results of information activities; Ability to express ideas, exchange ideas, develop cooperation and solve practical problems in learning life based on familiarity and use of technical conditions and environment; Actively explore the changes brought about by the application of technology to social life, comply with relevant ethics and laws and regulations, and form values and sense of responsibility that are compatible with the information society[4][5]. In 2017, the cultivation of core literacy of information technology is proposed by China's general high school information technology curriculum standards as the core task of information technology training, which mainly includes four aspects, namely information awareness, computational thinking, digital learning and innovation ability and information society responsibility[6][7]. In 2007, the United States published the "New Edition of Student Education Technology Standards", which is equivalent to the curriculum standards for information technology education. Among them, six dimensions of competency and quality were announced, including creativity and innovation, communication and collaboration, research and information proficiency, critical thinking, problem solving and decision making, digital citizenship, technical operations and concepts, and enumerate 10 specific learning activities as 10 summary performance indicators according to different grades[8]. 21st Century Skills Partner Organization proposes "21st Century Learning Skills + 21st Century Information and Communication Tools = ICT (Information and Communications Technology) Literacy"[9]. Outlined the use of ICTs to access, manage, integrate, evaluate, create and exchange information; use ICTs to manage complex issues, solve problems and conduct critical, creative and systematic thinking; use ICTs to improve personal productivity and personal development [9].

The integration of information technology courses in various countries and regions has focused on the following aspects:

1. Develop of problem solving skills;

2.Develop of communication, communication and cooperation skills;

3. Develop students' learning ability;

4. Legal and moral education.

Therefore, it combined with the teaching objectives of China's information technology discipline, this paper pays attention to the following literacy and abilities of junior high school students in the teaching process and teaching evaluation, as shown in Figure 2.

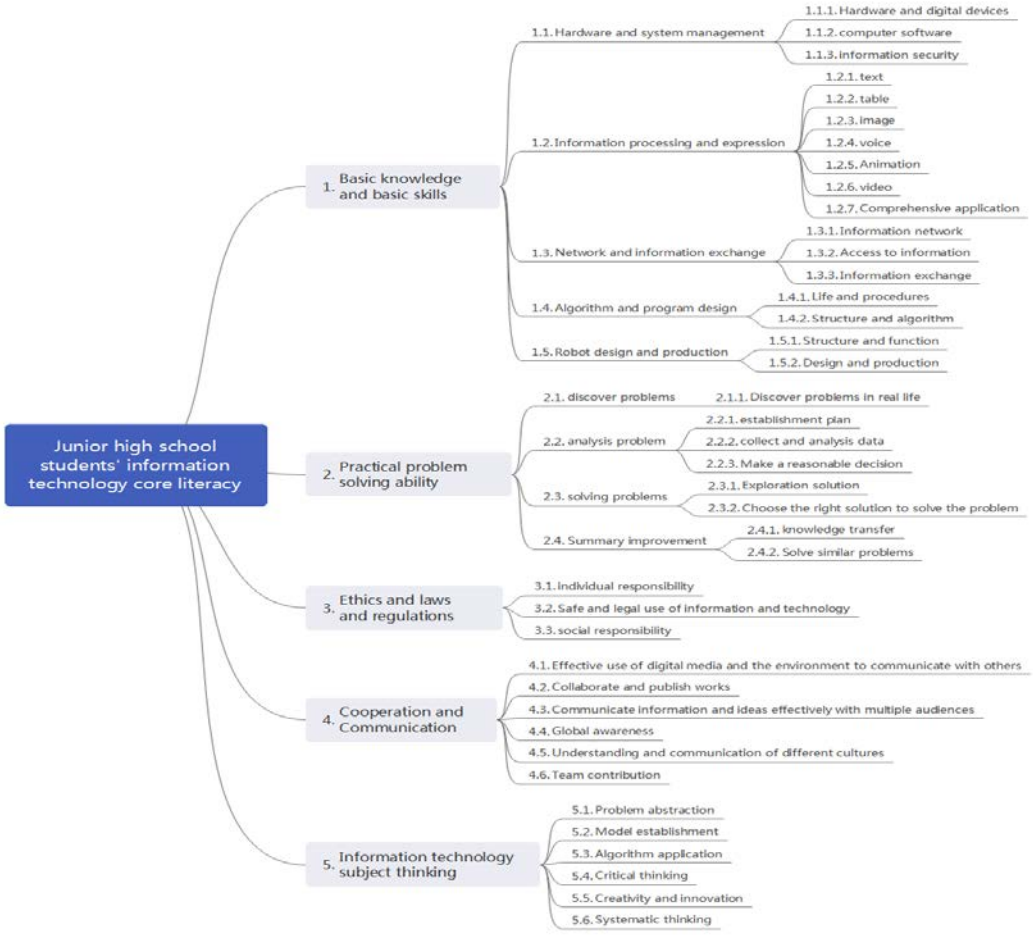

Fig.2 Core literacy evaluation indicators for junior high school students

3. Fuzzy Theory and Fuzzy Comprehensive Evaluation Model

Because it is the way for everyone to discover their brain resources, in order to achieve the purpose of exerting a variety of talent intelligence, which creating a difference between people. Therefore, according to the multiple intelligence theory is proposed by Howard Gardner who is a American educator and psychologist, we need to respect individual differences, teach students in accordance with their aptitude, and pay more and more attention to cultivating students' comprehensive literacy in the teaching process.

However, educational information has the characteristics of ambiguity and uncertainty. It is difficult for us to evaluate students' comprehensive literacy with a single, linear evaluation standard. This paper chooses fuzzy theory to describe the level of information technology literacy of junior high school students, defines the fuzzy concept in the form of fuzzy sets, uses the membership function to indicate the degree to which students reach a certain standard, and uses fuzzy quantitative to obtain a membership degree to deal with students' information literacy evaluation. Overcoming the shortcomings of the traditional linear evaluation model through fuzzy comprehensive evaluation.

3.1 Fuzzy theory

Fuzzy comprehensive evaluation is a comprehensive evaluation method based on fuzzy mathematics. This method transforms qualitative evaluation into quantitative evaluation according to the membership degree theory of fuzzy mathematics[10]. Among them, membership degree and membership matrix are the key concepts of fuzzy comprehensive evaluation.

(1)Assume $U = \{u_1, u_2, \cdots, u_m\}$ be the set of evaluation indicators, and have a corresponding evaluation weight $A(u) \in [0,1]$for any u.

(2)Assume$V = \{V_1, V_2, \cdots, V_n\}$ denote the evaluation level set of the evaluation object by the evaluator. Generally set to 3~5 levels.

(3)Fuzzy relation matrix $R = \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix}$, r_{ij} denotes the membership degree of a certain evaluated object on the level fuzzy subset v_j on the factor u_i, where $\sum r_{ij} = 1$.

(4)Fuzzy comprehensive evaluation, which uses the appropriate fuzzy synthesis operator to synthesize the fuzzy weight vector and the fuzzy relation matrix R to obtain the comprehensive rating result[11]. The model of fuzzy comprehensive evaluation is:

$$\begin{aligned} B = A \circ R &= (a_1, a_2, \cdots, a_m) \circ \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix} \\ &= (b_1, b_2, \cdots, b_n) \end{aligned} \tag{1}$$

Where b_j represents the degree of membership of the evaluated subject on the evaluation level subset element v_j.

In addition, the fuzzy synthesis operator algorithm is:

$$Q = S \circ R = \begin{bmatrix} \vee_I (s_{1I} \wedge r_{I1}) & \cdots & \vee_I (s_{1I} \wedge r_{Im}) \\ \vdots & \ddots & \vdots \\ \vee_I (s_{mI} \wedge r_{I1}) & \cdots & \vee_I (s_{mI} \wedge r_{Im}) \end{bmatrix} = (q_{ij})_{m \times m} \tag{2}$$

$$\begin{aligned} q_{ij} &= \vee_I (s_{iI} \wedge r_{Ij}) \\ &= (s_{i1} \wedge r_{1j}) \vee (s_{i2} \wedge r_{2j}) \vee \cdots \vee (s_{im} \wedge r_{mj}), (i, j = 1,2,3, \cdots, m) \end{aligned} \tag{3}$$

3.2 Fuzzy comprehensive evaluation model

(1) Determine the set of evaluation indicators

The set of core literacy evaluation indicators for junior high school students is U.

According to Figure 2, the first level of evaluation indicators:

$$\begin{aligned} U &= \{u_1, u_2, u_3, u_4, u_5\} \\ &= \begin{Bmatrix} \text{Basic knowledge and basic skills}, \\ \text{Practical problem solving ability}, \\ \text{Ethics and laws and regulations}, \\ \text{Cooperation and Communication}, \\ \text{Information technology subject thinking} \end{Bmatrix} \end{aligned} \tag{4}$$

Secondary evaluation indicator set:

Among them, the collection of basic knowledge and basic skills evaluation indicators:

$$u_1 = \{u_{11}, u_{12}, u_{13}, u_{14}, u_{15}\} = \begin{Bmatrix} \text{Hardware and system management,} \\ \text{Information processing and expression,} \\ \text{Network and information exchange,} \\ \text{Algorithm and program design,} \\ \text{Robot design and production} \end{Bmatrix} \quad (5)$$

In the same way, another set of secondary evaluation indicators u_2, u_3, u_4, u_5 can be obtained.

Three levels of evaluation indicators:

Among them, the evaluation index of hardware and system management:

$$u_{11} = \{u_{111}, u_{112}, u_{113}\} = \begin{Bmatrix} \text{Hardware and digital devices,} \\ \text{computer software,} \\ \text{information security} \end{Bmatrix} \quad (6)$$

In the same way, another set of secondary evaluation indicators $u_{12}, u_{13}, u_{14}, u_{15}, u_{21}, u_{22}, u_{23}, u_{24}$ can be obtained.

(2) Determine evaluation indicator weights

The weight set $A = \{a_1, a_2, a_3, a_4, a_5\} = \{0.25, 0.2, 0.2, 0.15, 0.2\}$ corresponding to the primary evaluation index U.

The weight set corresponding to the secondary evaluation index u_i is:

$$a_1 = \{a_{11}, a_{12}, a_{13}, a_{14}, a_{15}\} = \{0.2, 0.2, 0.1, 0.3, 0.2\} \quad (7)$$

$$a_2 = \{a_{21}, a_{22}, a_{23}, a_{24}\} = \{0.25, 0.25, 0.25, 0.25\} \quad (8)$$

$$a_3 = \{a_{31}, a_{32}, a_{33}\} = \{0.3, 0.4, 0.3\} \quad (9)$$

$$a_4 = \{a_{41}, a_{42}, a_{43}, a_{44}, a_{45}, a_{46}\} = \{0.2, 0.1, 0.2, 0.1, 0.2, 0.2\} \quad (10)$$

$$a_5 = \{a_{51}, a_{52}, a_{53}, a_{54}, a_{55}, a_{56}\} = \{0.2, 0.1, 0.2, 0.15, 0.2, 0.15\} \quad (11)$$

The weight set corresponding to the three-level evaluation index u_{ijk} is:

$$a_{11} = \{a_{111}, a_{112}, a_{113}\} = \{0.3, 0.4, 0.3\} \quad (12)$$

$$a_{12} = \{a_{121}, a_{122}, a_{123}, a_{124}, a_{125}, a_{126}, a_{127}\} = \{0.2, 0.2, 0.1, 0.1, 0.1, 0.1, 0.2\} \quad (13)$$

$$a_{13} = \{a_{131}, a_{132}, a_{133}\} = \{0.4, 0.3, 0.3\} \quad (14)$$

$$a_{14} = \{a_{141}, a_{142}\} = \{0.5, 0.5\} \quad (15)$$

$$a_{15} = \{a_{151}, a_{152}\} = \{0.5, 0.5\} \quad (16)$$

$$a_{22} = \{a_{221}, a_{222}, a_{223}\} = \{0.3, 0.3, 0.4\} \quad (17)$$

$$a_{23} = \{a_{231}, a_{232}\} = \{0.5, 0.5\} \quad (18)$$

$$a_{24} = \{a_{241}, a_{242}\} = \{0.5, 0.5\} \quad (19)$$

Weight settings are all satisfied with $\sum a_i = 1$, $\sum a_{ij} = 1$, $\sum a_{ijk} = 1$, $i = (1,2,3,4,5)$, $j = (1,2,3,4,5,6)$, $k = (1,2,3,4,5,6,7)$。

(3) Determine the evaluation level set

The rating level is seted in this article:

$$V = (V_1, V_2, V_3, V_4, V_5) = \begin{pmatrix} \text{Excellent, good, medium,} \\ \text{qualified, unqualified} \end{pmatrix} \quad (20)$$

And the score of comprehensive evaluation is excellent between 90-100, between 80-90 is good, between 70-80 is medium, between 60-70 is qualified, and below 60 is unqualified.

(4) comprehensive evaluation

The comprehensive evaluation process is establishes a single factor evaluation matrix by weighted average for the first time, and then performs a synthesis operation based on the weight vector and the normalized matrix to obtain the final one-factor evaluation matrix[12].

For example: to evaluate a student's hardware and system management capabilities, hardware and system management including hardware and digital equipment, computer software, information security. The fuzzy evaluation set is obtained by the fuzzy statistical method of normalized level questionnaire, as shown in Table 1. Among them, the fuzzy statistical method:

The degree of membership of the normalized level fuzzy set $v_i = \frac{\text{times of } u_0 \in v_i}{\text{total number of experiments N}}$.

Table 1 Relationship between evaluation factor set U11, evaluation weight vector a11 and comment level V

Evaluation factor set	Comment level				
	Excellent	*good*	*medium*	*qualified*	*unqualified*
U111 Hardware and digital devices a111=0.3	0.42	0.28	0.2	0.07	0.03
U112 Computer software a112=0.4	0.33	0.25	0.21	0.14	0.07
U113 Information security a113=0.3	0.16	0.48	0.17	0.13	0.06

$$B_{11} = a_{11} \circ R_{11} = (0.3,0.4,0.3) \circ \begin{pmatrix} 0.42 & 0.28 & 0.2 & 0.07 & 0.03 \\ 0.33 & 0.25 & 0.21 & 0.14 & 0.07 \\ 0.16 & 0.48 & 0.17 & 0.13 & 0.06 \end{pmatrix} \quad (21)$$

$$= (0.33, 0.3, 0.21, 0.14, 0.07)$$

Therefore, the single factor evaluation matrix of hardware and system management is B11=（0.33, 0.3, 0.21, 0.14, 0.07）, that is, excellent:0.33 , good: 0.3 , medium:0.21 ; qualified: 0.14 , unqualified:0.07. Then calculate the other three-level single factor evaluation matrix B_{ij} and the second-order single factor evaluation matrix B_i according to the same principle, then calculate the comprehensive evaluation result B through the evaluation matrix R, and finally defuzzify to obtain the core literacy evaluation level of the students.

For example, after calculating the secondary univariate evaluation matrix of a student, the student's core literacy of the information technology discipline is evaluated, including basic knowledge and basic skills, practical problem solving ability, ethics and laws and regulations, communication and cooperation ability, information technology discipline thinking. If the final comprehensive rating result is B = (0.37, 0.3, 0.2, 0.11, 0.02). Wherein, the evaluation level set V takes the average value of the domain, and then $V = (95 \quad 85 \quad 75 \quad 65 \quad 30)$. The system uses the center of gravity method to defuzzify the comprehensive evaluation result set B of the output, namely:

$$Q = \frac{\sum_{i=1}^{m} V_i \cdot \mu_V(V_i)}{\sum_{i=1}^{m} \mu_V(V_i)} \tag{22}$$

So, the final score $Q = V * B^T = (95 \quad 85 \quad 75 \quad 65 \quad 30) * \begin{pmatrix} 0.37 \\ 0.3 \\ 0.2 \\ 0.11 \\ 0.02 \end{pmatrix} = 83.4$ points. The core literacy level of the student's information technology discipline is good.

4. Conclusion

Based on the fuzzy theory, this paper studies a core literacy evaluation model of information technology based on fuzzy comprehensive evaluation. The core literacy indicators of information technology are analyzed and proposed, and the core literacy level of students is calculated through comprehensive evaluation methods. From the evaluation method, we respect the individual differences of students and teach students in accordance with their aptitude, Overcoming the ambiguity and uncertainty of educational information.

Acknowledgments

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References

[1] Adhere to the people of Lide and cultivate the socialist builders and successors of all-round development of morality, intelligence, art and work -2018 Capital Basic Education Scan [J]. Beijing Education (Pu Education Edition),01:4-6(2019).

[2] Ministry of Education of the People's Republic of China. "Opinions on Comprehensively Deepening the Curriculum Reform and Implementing the Fundamental Tasks of Li De Shu Ren" [EB/OL]. http://old.moe.gov.cn/publicfiles/business/htmlfiles/moe/s7054/201404/xxgk_167226.html,(2014).

[3] Lili Li. Research and Design Ideas of Ideological and Political Classroom Teaching Strategies and Evaluation System in Higher Vocational Colleges Based on Cultivating Students' Core Competence [J]. Contemporary Educational Practice and Teaching Research (Electronics), 7:782-783(2017).

[4] China Education Technology Association Information Technology Education Professional Committee. Basic Education Information Technology Curriculum Standards (2012 Edition) [EB/OL].http://www.ictedu.cn/upload/2012_05/12050408248528.pdf, 05-04(2012).

[5] Duan Qing . Interpretation of the Content Standards of the Basic Modules in the Compulsory Education Stage of the Basic Education Information Technology Curriculum Standards (2012 Edition) [J]. China Educational Technology,10:28-32(2012).

[6] Ministry of Education. Ordinary High School Information Technology Course Standard (2017 Edition) [S]. Beijing: People's Education Publishing House, (2018).

[7] Xuri Wu. Focus on core literacy, Focus on inquiry practice-Interpretation of "Ordinary High School Information Technology Curriculum Standards (2017 Edition)" [J]. Fujian Basic Education Research,07:127-129+142(2018).

[8] Xiangyong Liu.Research on Value of Information Technology Curriculum[D]. Northeast Normal University,(2010).

[9] Wei You. Re-examination of the objectives and content of the information technology curriculum- Interview with Dr. Miao Fengchun from UNESCO Asia Pacific Education Bureau [J]. Basic education course,5(2009).

[10] Yinqing Xu. Application of Fuzzy Mathematical Evaluation Method in Transformer Insulation Detection [J]. Electromechanical information,24:92-93(2013).

[11] Gongqiang Wang,Ancui Yuan. Application Research of Fuzzy Comprehensive Evaluation Method in Teaching Quality Evaluation [J]. Media age,8(2015).

[12] Lili Jin,Yuanyuan Yang. Research on Performance Evaluation Model of Private University-based on Multi-level fuzzy synthesis [J]. Corporate report,09:80-81(2016).