Teachers' Information Behavior Selection And Fuzzy Optimization Model Under Network Environment

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Keywords: Network Environment; Teachers' Information Behavior; Fuzzy Optimization Model; Weighted Variable Fuzzy Analysis Method

Abstract: In this paper, teachers' information behavior under the network environment is investigated, the characteristics of information behavior is analyzed, and suggestions and countermeasures for information service are puts forward. In view of the comprehensive influence of many factors on teachers' information behavior selection, the traditional information behavior selection model is difficult to describe the fitting relationship between behavior factors and target features, and then an optimization model of teachers' information behavior selection based on fuzzy rough set is proposed. Taking university teachers in China as the research object, this paper conducts a questionnaire survey on these teachers. Aiming at the complicated and varied factors affecting teachers' information behavior selection, combining rough set and weighted variable fuzzy analysis method, the key factors affecting teachers' information behavior selection are extracted, and the fuzzy optimization model of information behavior is constructed, which will affect teachers. The key factors of information behavior are established as a set of target features, which are calculated by one-way rough sets and standard empirical equations to determine the selection and optimization of teachers' information behavior. The results show that convenience, subjective norms, perceived usefulness, perceived ease of use, adoption attitude and behavioral intention have significant positive effects on teachers' selection of information behavior, among which perceived usefulness and perceived ease of use are the core factors affecting teachers' choice of information behavior.

1. Introduction

With the gradual deepening of the application of the school Internet, teachers' education and teaching activities are increasingly dependent on the network. Normalizing teachers' online behavior, improving teachers' work efficiency, building a green campus has become the issues that many school administrators pay more and more attention to. Scientific and effective analysis and Research on teachers' information behavior selection is an urgent issue in the development of educational informatization. According to the law of psychological change of information actors and their preferences, information behavior can be divided into such basic processes as information expectation, information demand, information motivation and information action [1]. The essence of information behavior is often manifested as the matching between multi-expectation and multi-demand, multi-demand and multi-motivation, multi-motivation and multi-action, i.e. information behavior is an activity selected according to the fitting relationship between behavior factors and target eigenvalues. The selection of information behavior is to construct a set of vector spaces from a limited number of behaviors, while the corresponding behavior target features form another set of vector spaces. Comparing the consistency between the two sets of vector spaces, we can calculate the results according to the given model and select the information behavior. The research on teachers' information behavior selection can provide a new way to solve the problems of Internet application in the process of educational informatization development, and provide a new perspective for school informatization decision-making and campus network management. It will become a hot topic in the process of promoting educational informatization application [2].

1.1. Foreign Research Status

In recent years, the research on information behavior has been developed at home and abroad. The main characteristics include: (1) the research object includes a wider range of industries and professions, but the research object is mainly focused on academic users; (2) the research methods are diversified, with emphasis on empirical research methods, such as network survey, observation and experimental methods, network. (3) In terms of research depth, the research variables are gradually increasing, and the research content is deepening. Some scholars have made in-depth research on user information query, retrieval, interaction, browsing and information service strategy. Bouazza, an American scholar, holds that information behavior is the act of using information to satisfy a person's information needs. Krikela believes that "Any activity a person engages in is information behavior when he wants to confirm that information meets his or her perceived needs".

2.2. Domestic Research Status

Deng Xiaozhao, with the help of Tormann Moore's theory model, has a more accurate and comprehensive understanding of information behavior in China. His understanding of information behavior mainly includes: information behavior is the rational behavior of users in order to meet the needs of information using various environmental factors (channels, ways and tools); information behavior follows certain rules of activity (minimum effort principle) with "cognitive" color and "learning" traces; information behavior is "trainable" and can be changed by education; in the process of implementation of this behavior, irrational behavior sometimes is inevitable. The research contents of information behavior mainly include the research of information behavior subject, the research of information behavior law, the research of information behavior influencing factors and the research methodology of information behavior. Different scholars construct their own research models according to their own research emphasis. For example, based on the Ellis model, Choo et al. constructed the information query behavior model of users under different motivations. Lau and Horvitz constructed the continuous query strategy of network users through Bayesian network model. Palmer focused on describing user information behavior models in academic communication. The existing research results are mostly focused on user information query behavior, but little in-depth study of other behaviors.

Through combing the relevant literatures, this paper uses the method of quantitative research to construct the model, and analyzes the effect relationship of the various influencing factors of teachers' information behavior selection, so as to provide theoretical support and preliminary service for improving the effect of information technology teaching.

2. Methods

2.1. Process of Key Factors Extraction

For the information records of teachers' information behaviors in the network environment, the influencing factors of teacher behaviors are summarized and analyzed, and the influencing factors are summarized by using triangular fuzzy numbers. The description is made by 1 and the defuzzification formula is used to obtain data for fuzzification:

$$x_{ij} = (l_{ij} + 4m_{ij} + u_{ij}) / 6 \tag{1}$$

The factors affecting teachers' information behavior are complex and diverse. Each factor is related to each other and cross-effects. It is necessary to remove some unrelated or unimportant influence factors from a large number of influencing factors while keeping the attributes of the influencing factors unchanged. Using the rough set to discretize x_{ij}, the decision attribute of each sample adopts 5 levels $d = \{1, 2, 3, 4, 5\}$, establishes the influence factor attribute decision table and the discrimination matrix, and seeks the kernel and reduction. The software Rosetta is used to derive the results of the kernel and reduction, and then the minimum attribute set of the influencing factors is obtained [3].

A binary comparison fuzzy decision analysis method [4] is introduced to improve the observability and reliability of the evaluation results.

A: An eigenvalue matrix x_{ij} and a standard interval matrix $I_{ab} = ([a_{ih}, b_{ih}])$ are established for n influencing factors, m eigenvalues, and c eigenvalue intervals.

B: According to the physical analysis of matrix I_{ab} and the actual situation, the relative membership degree of $[a_{ih}, b_{ih}]$ in the interval is determined to be equal to 1, i.e. $\mu_A(x_{ij})_h = 1$ -point-valued matrix M_{ih} . When M_{ih} changes linearly, the general model of point-valued of M_{ih} is:

$$M_{ih} = \frac{c-h}{c-1} a_{ih} + \frac{h-1}{c-1} b_{ih} \tag{2}$$

In the equation, a_{ih} and b_{ih} satisfy the following three boundary conditions: (1) when $h=1$ is satisfied, $M_{i1} = (a_{il} + b_{il})/2$; M = 1; (2) when $h = c$ is satisfied, $M_{ic} = a_{ic}$; (3) when $h = l = (c+1)/2$ is satisfied, $M_{il} = (a_{il} + b_{il})/2$ is applicable to both decreasing and increasing indexes.

C: The relative membership model is constructed by comparing the eigenvalue of the influencing factors with the value M_{ih} of the relative membership degree of level h index i equal to 1. Then the relative membership degree of sample j is calculated according to the variable fuzzy model [5]. The fuzzy model is as follows:

$$\mu'_{hj} = 1/(1 + (\sum_{i=1}^{m} [w_i(1 - \mu_A(x_i)_{ih})]^p / \sum_{i=1}^{m} (w_i \mu_A(x_i)_{ih})^p)))^{a/p} \tag{3}$$

In the equation, w_i denotes the index weight, $\sum_{i=1}^{m} w_i = 1$ and m denotes the characteristic parameters of the influencing factors, a denotes the optimization criterion parameters, and p denotes the distance parameters.

D: The non-normalized comprehensive relative membership matrix $U' = (\mu'_{hj})$ can be calculated by step (3) and the comprehensive relative membership matrix can be obtained by normalizing the matrix $\mu_{hj} = \mu'_{hj} / \sum_{h=1}^{c} \mu'_h$.

$$U = \mu_{hj} \tag{4}$$

E: Aiming at the inadaptability of the maximum membership principle [6] for fuzzy concepts under grading conditions, the comprehensive membership vector of each factor under four models is calculated by using the grading characteristic equation.

$$H = \sum_{h=1}^{c} \mu_h \cdot h \tag{5}$$

F: The weights of the model are solved by using binary comparison fuzzy decision analysis method, and then the optimal comprehensive level eigenvalue matrix is obtained by using the linear weighting method [7]:

$$D = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1n} \\ & \vdots & \vdots & \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{bmatrix} \tag{6}$$

From above, we can get the key influencing factor d_{mn} of teachers' information behavior selection.

2.2 Information Behavior Selection System

Information behavior selection system is mainly composed of information behavior factor set, target feature set and selection tool (standard empirical equation). Five standard empirical equations are cited:

$$E_j = (d_j - \hat{j}d_j)/(\check{j}d_j - \hat{j}d_j) \tag{7}$$

$$E'_j = (\hat{j}d_{ij} - d_{ij})/(\check{j}d_{ij} - \hat{j}d_{ij}) \tag{8}$$

$$E_{ij} = (d_{ij} - \hat{j}d_{ij}) / (\breve{j}d_{ij} - \hat{j}d_{ij}) \tag{9}$$

$$E'_{ij} = (\breve{j}d_{ij} - d_{ij}) / (\breve{j}d_{ij} - \hat{j}d_{ij}) \tag{10}$$

$$E''_{ij} = d_{ij} / (\breve{j}d_{ij} + \hat{j}d_{ij}) \tag{11}$$

Using the above five standard empirical equations, the target eigenvalue matrix D (Eq.(6)) is deduced and calculated, and the target's superiority matrix of information behavior selection with a matrix coefficient of 1 is obtained.

$$E = \begin{pmatrix} e_{11} & e_{12} & \cdots & e_{1n} \\ e_{21} & e_{22} & \cdots & e_{2n} \\ & \vdots & & \\ e_{m1} & e_{m2} & \cdots & e_{mn} \end{pmatrix} = e_{ij} \tag{12}$$

Supposing that h_i and l_o are respectively the maximum and minimum superiority choices for information behavior targets [8]. The maximum superiority is:

$$h_i = (h_{i1}, \cdots, h_{im})^T = (e_{11} \forall \cdots \forall e_{1n}, \cdots \forall e_{nm})^T = \begin{pmatrix} e_{11} \vee e_{12} \vee \cdots \vee e_{1n} \\ \vdots \\ e_{m1} \vee e_{m2} \vee \cdots \vee e_{mn} \end{pmatrix} \tag{13}$$

The minimum superiority is:

$$l_o = (l_{o1}, \cdots, l_{om})^T = (e_{11} \forall \cdots \forall e_{1n}, \cdots \forall e_{nm})^T = \begin{pmatrix} e_{11} \wedge e_{12} \wedge \cdots \wedge e_{1n} \\ \vdots \\ e_{m1} \wedge e_{m2} \wedge \cdots \wedge e_{mn} \end{pmatrix} \tag{14}$$

Let k_j denote the superior eigenvalue corresponding to the j th behavior and $\overline{k}_j$ denotes the inferior eigenvalue corresponding to the j th behavior. Then

$$\overline{k}_j = 1 - k_j \, (0 \le \overline{k}_j, k_j \le 1) \tag{15}$$

or

$$k_j = 1 - \overline{k}_j \, (0 \le \overline{k}_j, k_j \le 1) \tag{16}$$

3. Fuzzy Optimization Model of Information Behavior Selection System

3.1. Setting Weights

In Equation (12), the coefficients of the superiority matrix E of the selection target are 1, which can not reflect the actual situation. The weighting coefficient w_{ij} is introduced to obtain the weighted target's superiority matrix of information behavior selection.

$$A = \begin{pmatrix} w_{11}e_{11} & \cdots & w_{1n}e_{1n} \\ & \vdots & \\ w_{m1}e_{11} & \cdots & w_{mn}e_{mn} \end{pmatrix} = (w_{ij}e_{ij}) \tag{17}$$

In this way, the j th behavior chooses the corresponding m weight target $w_1, \cdots, w_{mj}$ to form a set of m-dimensional vector spaces.

$$w_j = (w_{1j}, \cdots, w_{mj})^T \tag{18}$$

According to the matrix constructed by Equation (17), combined with the operation results of Equation (12), Equation (13) and Equation (14), the superior objective value and the inferior objective value are obtained respectively. Where

$$h_i = (h_{i1}, \cdots, h_{im})^T = (w_{11}e_{11} \forall \cdots \forall w_{12}e_{1n}, \cdots \forall w_{1n}e_{nm})^T = \begin{pmatrix} w_{11}e_{11} \vee w_{12}e_{12} \vee \cdots \vee e_{1n} \\ \vdots \\ w_{m1}e_{m1} \vee w_{12}e_{m2} \vee \cdots \vee w_{mn}e_{mn} \end{pmatrix} \tag{19}$$

3.2. Information Behavior Selection and Fuzzy Optimization

According to equation (15) and equation (16), k_j corresponds to the superior target eigenvalue corresponding to the jth behavior, and $\bar{k}_j$ represents the inferior target eigenvalue corresponding to the jth behavior, and $k_j = 1 - \bar{k}_j$. Thus, the jth behavior chooses the corresponding m weight target value $w_{1j}, \cdots, w_{mj}$ to form a set of m-dimension vector space $w_j = (w_{1j}, \cdots, w_{mj})^T$ as shown in equation (18).

Assuming that the jth information behavior shown in equation (17) corresponds to the sum of m weight coefficients $W_j = \sum_{i=1}^{m} w_{ij} = 1$, and f_{ih} is set to represent the difference between the jth information behavior and the superior target eigenvalue. Generalized distance [9] is used for description:

$$f_{jh} = (\sum_{i=1}^{m} (w_i (hi_i - e_{ij}))^p)^{1/p} \tag{20}$$

Among them, f_{jl} represents the difference between the jth information behavior and the eigenvalues of inferior targets, which is described by the generalized distance.

$$f_{jl} = (\sum_{i=1}^{m} (w_i (e_{ij} - lo_i))^p)^{1/p} \tag{21}$$

The eigenvalue k_j of the superior target and the eigenvalue $\bar{k}_j$ of the inferior target corresponding to the jth behavior represent a weight. The weighted generalized distance is obtained by equation (20) and equation (21):

$$F_{jh} = k_j f_{jh} = k_j (\sum_{i=1}^{m} (w_i (hi_i - e_{ij}))^p)^{1/p} \tag{22}$$

$$F_{jl} = \bar{k}_j f_{jl} = (1 - k_j)(\sum_{i=1}^{m} (w_i (e_{ij} - lo_i))^p)^{1/p} \tag{23}$$

Where, $T(k_j) = F_{jh}^2 + F_{jl}^2$ and the least squares method [10] is used to optimize $T(k_j)$, to get:

$$\min T(k_j) = \min(F_{jh}^2 + F_{jl}^2) = \min\{k_j^2 (\sum_{i=1}^{m} w_i (hi_i - e_{ij}))^p + (1 - k_j)^2 (\sum_{i=1}^{m} (e_{ij} - lo_i)^p)\} \tag{24}$$

According to the necessary conditions of model optimization, let

$$\frac{\partial T(k_j)}{\partial k_j} = 0 \tag{25}$$

The equation (24) is substituted into the equation (25), and the model is obtained.

$$k_j = \frac{1}{1 + (\dfrac{\sum_{i=1}^{m} (w_i (hi_i - e_{ij}))^p}{\sum_{i=1}^{m} (w_i (e_{ij} - lo_i))^p})} \tag{26}$$

4. Experimental Simulation

In order to prove the comprehensive validity of the proposed model, it is necessary to test the performance of the proposed model. The simulation environment is: Interl (R) Core (TM) i3-2120@3.3GHz 3.29GHz CPU, 2G memory, Windows XP system, Matlab7.8, CST2011.

By stratified sampling and random sampling, 1500 valid questionnaires are collected from universities and colleges in typical provinces and municipalities in eastern, western and central China. Integrating the existing questionnaires and taking the above factors as the seven dimensions of the questionnaire, the items are scored by Likert 5-point scale. The questionnaire has high reliability and validity. In data analysis, a fuzzy optimization model is constructed by using MPLUS

7.4 to explore the relationship among various factors and predict the information behavior of teachers effectively. The fuzzy optimization model of teacher’s information behavior selection can estimate the measurement error of index variables in the process of measurement, and estimate the relationship between multiple latent variables in the fuzzy optimization model of teacher’s information behavior selection.

The key variables influencing teachers' selection of information behavior include: information selection behavior, selection intention, adoption attitude, perceived usefulness, perceived ease of use, subjective norms and convenience conditions.

K1: willingness to use positively affects selection behavior. That is, teachers' willingness to use information is more intense.

K2: adoption attitude positively affects information behavior selection intention. That is, teachers' attitudes towards Internet information are better and their willingness to choose information behavior is stronger. The key factors affecting teachers' information behavior selection are extracted, and the fuzzy optimization model of information behavior is constructed. The key factors affecting teachers' information behavior are set as a set of target features. The unidirectional rough sets and standard empirical equations are used to determine the selection and optimization of teachers' information behavior.

K3: perceived usefulness positively influences selection behavior. That is, teachers believe that the more useful the information is, the better the attitude towards information selection.

K4: perceived usefulness positively influences information selection behavior. That is, teachers believe that the more useful the information is, the better the attitude towards information selection.

K5: perceived ease of use positively affects information selection behavior. That is, teachers believe that the more useful information is, the more information behavior options are.

K6: perceived usefulness positively influences adoption attitude. That is, teachers believe that the more useful the information is, the better the attitude towards information selection.

K7: perceived ease of use positively affects perceived usefulness. That is, teachers think the information they choose is easier to use.

K8: subjective norm positively influences adoption intention. That is to say, the more positive factors the outside world chooses for teachers' information behavior, the stronger the teachers' willingness to use information technology.

K9: subjective norms positively affect perceived usefulness. That is, the more positive factors outside the teacher's information selection behavior, the more useful the teachers think of information technology.

K10: convenience conditions positively affect willingness to use. That is to say, the more convenient conditions are provided to teachers, the stronger the teachers' willingness to choose information technology.

The 20 items of the questionnaire are processed by SPSS21.0. The standard deviation is between 0.019 and 0.033, indicating that the subjects' responses to most items are between neutral and complete agreement. In terms of skewness, the distribution of attitudes and behavioral intentions is negative skewness. In terms of kurtosis, perceived ease of use and convenience conditions are of lesser value. The distribution of sample data is not normal distribution.

The fuzzy optimization model of behavior choice is evaluated by confirmatory factor analysis. Because the sample data is not normal distribution, and the type is 5-order discontinuous data, MLR parameter estimation method can make the result more accurate. The analysis results of confirmatory factor are shown in Table 1.

Table 1. Results of fuzzy optimization model for information behavior selection

Dimension	Item	Normalized loading value	R2	AVE	Cronbach's alpha
Use behavior	Using the Internet to search for information and enrich teaching contents	0.805	0.523	0.587	0.809

	Selecting appropriate network information for teaching purposes	0.773	0.586	-	-
Behavioral intention	The plan adopts network information technology in teaching	0.945	0.888	0.890	0.94
	It hopes there are many opportunities to use network information technology in the future	0.532	0.908	-	-
Adoption attitude	Using network information technology	0.898	0.785	0.818	0.899
	Eager to use network information in Teaching	0.890	0.855	-	-
Perceived ease of use	Multimedia teaching, computer assisted instruction and network teaching.	0.705	0.498	-	-
	Understand how to apply network information technology to teaching effectively	0.677	0.498	-	-
Perceived usefulness	The influence of information technology on teaching effect is very significant	0.720	0.518	0.590	0.78
	Using information technology can improve teaching efficiency	0.802	0.672	-	-
	Assistant teaching is very helpful for itself.	0.789	0.628	-	-
Subjective norm	School leaders believe that teachers should choose information behavior in teaching.	0.750	0.565	0.579	0.799
	Getting an affirmation from influential people is important for my continued use of information technology	0.728	0.536	-	-
Convenience	Almost every classroom in universities has wireless networks	0.600	0.445	0.630	0.89
	If you encounter technical problems, you can get help in time	0.720	0.478	-	-

The standardized path coefficients of model factor load range from 0.600 to 0.908, which indicates that the measurement model had high validity. In addition, most of the R2 values are above 0.40, indicating that each item has more than half of the explanatory variance of its latent variables, and the Cronbach's alpha of each dimension is above 0.8, indicating that the data reliability is high. According to the reference model fitting evaluation criteria, the reliability of the model is high.

Discriminant validity means that when there are multiple different potential variables in a measurement mode, if any two potential variables are different, it can indicate that the measurement mode has different validity. Discriminant validity is obtained through the correlation between the square root of mean variance and other variables. If the square root of the mean variance of a latent variable is larger than the correlation coefficient of each variable, it shows that each variable has a high discriminant validity. Table 2 is a matrix of correlation coefficients between variables in which the square root of the mean variance of the latent variable is replaced by the diagonal value 1.

Table 2. Discriminant validity of the model

Dimension	Use behavior	Behavioral intention	Adoption attitude	Perceived usefulness	Perceived ease of use	Convenience	Subjective norm
Use behavior	0.765	-	-	-	-	-	-
Behavioral intention	0.390**	0.950	-	-	-	-	-
Adoption attitude	0.352**	0.942**	0.904	-	-	-	-
Perceived usefulness	0.677**	0.413**	0.404**	0.774	-	-	-
Perceived ease of use	0.625**	0.158**	0.245**	0.542**	0.726	-	-
Convenience	0.310**	0.115**	0.112**	0.260**	0.336**	0.662	-
Subjective norm	0.440**	0.186**	0.174**	0.390**	0.354**	0.822**	0.760

Fitting evaluation index of behavioral fuzzy optimization model is as follows: when CMIN/DF is less than 2, the fitness of the model is better; if it is less than 1, the model is over-fitted; if it is more than 5, the model needs to be improved; CFI is fitness index, greater than or equal to 0.9 indicates that the model fits better; SRMR is a standardized RMR, which makes the residual value unaffected by the measurement unit scale. If the residual value is less than 0.1, the model fits well. RMSEA is the root mean square of progressive residual and is regarded as the most important fitness index. RMSEA less than 0.08 indicates that the model fits reasonably and takes it as the evaluation index. The evaluation result is shown in Figure 1.

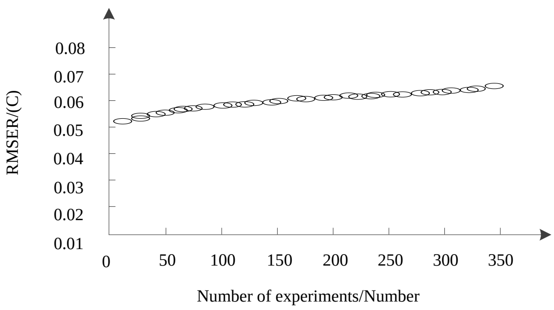

Figure 1. Fitting degree of model.

5. Discussion

A Polymerization validity refers to the degree of similarity of measurement results when different measurement methods are used to measure the same characteristics, that is, different measurement methods should be aggregated in the same characteristics of the measurement, and the average variance extraction is commonly used for analysis. The study shows that the average variance is greater than 0.5, and the item has higher convergent validity. Table 1 shows that the AVE of each variable is greater than 0.5, indicating that each variable has higher aggregation validity.

B The discriminant validity of each variable in the model shows that the average variance extracted by the latent variable is larger than the correlation coefficient between this variable and other variables, which indicates that each variable has a higher discriminant validity.

C The fitting degree of the proposed model shows that RMSEA is always less than 0.08 with the increasing number of experiments, which indicates that the fitting degree of the model is getting better and better.

Conclusions

The degree of education informatization in China needs further improvement, and research on the main organizers and implementers of educational informatization is essential. Based on the existing theoretical models, a fuzzy optimization model which affects teachers' information behavior selection is constructed. The model has higher fitting degree and can effectively predict the selection behavior of teachers' information technology. It is found that convenience, subjective norms, perceived ease of use, perceived usefulness, adoption attitude and behavioral intention have direct or indirect positive effects on information choice behavior. Among them, intermediary variables have the greatest influence on perceived usefulness and perceived ease of use. Only by providing convenience for teachers and strengthening subjective norms to enhance their understanding of the ease of use and usefulness of information technology, can teachers use information technology more effectively in teaching and further improve the level of education informatization in China.

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