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Constructing an Evaluation Index of Teaching Ability for Financial Literacy Education Based on TPACK Using the AHP Approach

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INTRODUCTION

This study explored the evaluation index of teaching ability of financial literacy education through the theoretical framework of TPACK (Technology Pedagogic Content Knowledge), which refers to the subject knowledge of integrated technology. The research results can specifically put forward the empirical model of innovative development of teaching ability evaluation and solve the shortcomings of teaching ability research of financial literacy education.

METHODOLOGY

A. Participants

This study conducted a questionnaire survey for experts. A total of 12 questionnaires were sent out and 10 were returned, with a return rate of 83.33%. The 10 experts were selected for three rounds of the Delphi method. The experts included two financial experts, two primary and secondary school teachers, four university professors and two information and technology experts, and included five males and five females with an average age of 43.5 years.

B. Instrument

This study adopted the TPACK theoretical framework, developed by Koehler and Mishra (2013) [5], to construct the evaluation index of teaching ability for financial literacy education. There are three core elements: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), and four composite elements: Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK) and Technological Pedagogical Content Knowledge (TPACK). Expert choice software is used as the data analysis tool to provide a quantitative basis by comparing the importance of various related factors layer by layer through the analytic hierarchy process (AHP).

C. Data analysis

The purpose of the AHP is to compare and evaluate each other in pairs at the same level. According to the importance of the evaluation scale, the weights of the questionnaire are compared in pairs to establish the comparison matrix and to calculate its eigenvalue and characteristic dimension. The larger the number, the higher the degree of importance [6].

RESULTS

The AHP approach was used to conduct the evaluation index of teaching ability for financial literacy education. Paired comparisons were conducted on the 10 experts' surveys to evaluate the relative importance of these seven indices. They must conduct 21 paired comparisons of importance, and the values of consistency analysis must be less than or equal to 0.1. Then, the geometric average of the analysis proportion of each respondent was calculated to build the relative weight of the data matrix, as shown in Table 1.

TABLE 1. RELATIVE WEIGHT OF THE DATA MATRIX

	CK	PK	TK	PCK	TCK	TPK	TPACK
CK	1	0.813	0.541	0.549	0.552	0.483	0.469
PK	1.23	1	1.099	0.472	0.469	0.518	0.446
TK	1.85	0.91	1	0.366	0.435	0.345	0.448
PCK	1.82	2.12	2.73	1	0.595	0.69	0.377
TCK	1.81	2.13	2.3	1.68	1	0.461	0.606
TPK	2.07	1.93	2.9	1.45	2.17	1	1
TPACK	2.13	2.24	2.23	2.65	1.65	1	1

After the pairwise comparison matrix is constructed, its eigenvector and maximum eigenvalue need to be calculated using numerical analysis method. The purpose of this step is to calculate the relative weight of each element, and to use the eigenvalue solution commonly used in numerical analysis to obtain the maximum eigenvalue of comparison matrix A (λ_{max}) and the corresponding eigenvector (W_i). Characteristic vector W_i is calculated as follows:

$$W_i = \frac{\left[\prod_{j=1}^{n} a_{ij}\right]^{\frac{1}{n}}}{\sum_{i=1}^{n}\left[\prod_{j=1}^{n} a_{ij}\right]^{\frac{1}{n}}}$$

The maximum eigenvalue (λ_{max}) is to multiply the obtained eigenvector W and the A value of the paired comparison matrix to obtain another vector value W, then to divide each element in W' by the corresponding element in W, and finally to take the arithmetic mean of the obtained value, which is the maximum eigenvalue (λ_{max}), the calculation formula is as follows:

$$W' = A \times W_i$$

$$\lambda_{max} = \frac{1}{n}\left(\frac{W'_1}{W_1} + \frac{W'_2}{W_2} + \cdots + \frac{W'_n}{W_n}\right)$$

From the above formula, the maximum eigenvalue of matrix A can be obtained, which is the weight of each index.

As shown in Table 2, the C.I. value of 0.04 is less than 0.1, which shows that the analytic hierarchy process results are consistent. The ranking of importance is TPACK (22.444%), TPK (21.704%), TCK (15.942%), PCK (14.365%), PK (8.898%), TK (8.615%) and CK (8.032%). The weight values of the four composite indices are higher than the three core indices, which is consistent with the research hypothesis of the TPACK theoretical framework. It shows that the importance of the composite indices of teaching ability for financial literacy education is higher than that of each single core index.

TABLE 2. EIGENVECTORS, WEIGHT VALUES AND IMPORTANCE RANKING

	Characteristic vector	Weight value	Importance ranking	λ_{max}	C.I.
CK	0.562	8.032%	7	7.242	0.04
PK	0.623	8.898%	6		
TK	0.603	8.615%	5		
PCK	1.006	14.365%	4		
TCK	1.116	15.942%	3		
TPK	1.519	21.704%	2		
TPACK	1.571	22.444%	1		

Consistency Ratio (C.R.) was used to measure the consistency of the pairwise comparison matrix. Saaty (1980) suggested that if C.R. < 0.1, it means that the consistency of the paired comparison matrix is within the acceptable range. On the contrary, if C.R. > 0.1, the comparison matrix must be re-evaluated [4].

The consistency ratio (C.R.) is used to verify whether the hierarchical structure is consistent. The random index (R.I.) indicates that different consistency indicators are generated under n. the corresponding R.I. value can be found according to the matrix order.

$$C.I. = (\lambda_{max} - n)/(n-1)$$

TABLE 3. SUMMARY OF CONSISTENCY INSPECTION RESULTS

Maximum characteristic root	C.I.	R.I.	C.R.
7.242	0.04	1.36	0.03

According to the hypothesis of AHP theory, the comparison of paired matrices should meet the transitivity of preference relationship and strength relationship. If there is a gap between the research results and the actual situation, it will lead to wrong decision-making. Therefore, Saaty (1980) suggested that the consistency index (C.I.) and consistency ratio (C.R.) were used to detect the consistency of paired comparison matrices. When C.I. approaches 0, the higher the consistency of the evaluator's judgment before and after, the greater the C.I. value, and the higher the inconsistency. Saaty (1980) suggested that when C.I. ≤ 0.1, the weight distribution is reasonable. If C.I. > 0.1, the evaluator's judgment is inconsistent and shall be corrected in real time [6]. According to the questionnaire analysis results, the overall C.I. value is 0.04 ≤ 0.1 and the overall C.R. value is 0.03 ≤ 0.1, as shown in Table 3, which is in line with the principle of consistency. It shows that the experts' opinions obtained in this study are consistent.

CONCLUSIONS

A. Findings and Contributions

Among the composite indices, TPACK is the most important, followed by TPK, then TCK, and finally PCK. The ranking of the importance of composite indices shown in the survey confirms that the importance of each composite index is closely related to that of a single index. In terms of ranking, the Technological Pedagogical Content Knowledge (TPACK) ranks first, because TPACK not only integrates each single element, but also integrates information technology. It is a comprehensive evaluation and overall requirement for financial literacy education.

B. Implications and Novelty

As this study adopted the analytic hierarchy process (AHP) to construct the evaluation index of financial literacy, this method can assign the weight of each level, and point out the importance of each dimension in the form of quantification. It is more scientific and feasible for evaluating teachers' financial literacy education. The index system can provide a new reference for future research.