

Construction of Teacher Personal Knowledge Management Model Based on Data Mining Algorithm from TPACK Perspective

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Abstract: With the renewal of teaching concept and the development of educational technology, educational practice has put forward higher requirements for teachers' teaching level. The amount of knowledge has become the core indicator to measure teachers' teaching level. The research on teachers' personal knowledge management is of great significance to promote teachers' teaching level. Therefore, this paper studied the teacher PKM, constructed the teacher PKM model, proposed the teacher PKM strategy based on the perspective of Technological Pedagogical Content Knowledge (TPACK) and educational cybernetics, and the teacher's personal knowledge acquisition method based on Expectation-Maximization algorithm (EM). At the same time, this paper conducted an experimental study on teachers' personal knowledge management, and obtained the following proof through the experimental study. The average personal knowledge management evaluation score of teachers was 6.525. The average feasibility evaluation score of experts on teachers' personal knowledge management strategy was 7.65, and the average effectiveness evaluation score of experts on teachers' personal knowledge management strategy was 8.575. At this stage, teachers' personal knowledge management ability still needed to be improved, and the strategies proposed in this paper had certain practical value.

1. Introduction

With the development of information technology and network technology, human society has entered the era of knowledge economy. For teachers, effective knowledge management activities are conducive to promoting their own development, improving their professional quality, and improving the teaching quality and school competitiveness. Therefore, based on TPACK and educational cybernetics, this paper studies teachers' personal knowledge management using EM algorithm.

Many scholars have carried out research on personal knowledge management. Wang Xinyu established the evaluation index system of teacher knowledge management by using the analytic

hierarchy process, and evaluated the level of teacher knowledge management [1]. Sha Iszurin investigated the PKM capabilities of apprentices in technical and vocational education and training institutions [2]. Ranjbar Mukhtar investigated the impact of self-guidance on school administrators' personal knowledge management through self-guidance scale and personal knowledge management scale [3]. Ghiasvand Nasrin believed that PKM ability was closely related to employment ability, and he discussed the role of personal knowledge management in the employment of engineering students [4]. Jarrahi Mohammad Hossein studied the concept of PKM using data obtained from digital nomad research, and explored the combination of personal knowledge management activities and digital technologies supporting these activities [5]. Schmitt Ulrich believed that effective personal knowledge management can promote the enhancement of individual capabilities [6]. To sum up, many scholars have studied personal knowledge management and put forward some valuable suggestions.

Data mining algorithms are widely used in knowledge management. Zain M. S. I. M. briefly described the concept of data mining and discussed the application of data mining technology in organizational knowledge management [7]. Meghji Areej Fatemah combined data mining with knowledge management and analyzed the application of data mining and knowledge management in the field of education [8]. Cooper Paul discussed the relationship between data, information, knowledge and wisdom, and described the application of data mining technology in the field of knowledge management [9]. Mohd Selamat Siti Aishah made an in-depth review on data mining in knowledge management of SMEs in the transportation industry [10]. Saeed Tariq discussed the relationship between innovation, technology, knowledge management, direct marketing and data mining, and reached relevant conclusions [11]. Rezaeenour Jalal discussed the application of text mining in managing online digital resources [12]. Gupta Yogita conducted a detailed investigation on the latest progress in the application of data mining and knowledge management tools [13]. The above research shows that data mining algorithms can play an important role in the field of knowledge management.

In order to enhance teachers' knowledge management ability and promote the improvement of education quality, this paper proposed the teacher PKM model, the teacher PKM strategy based on TPACK and cybernetics perspective, and the teacher's personal knowledge acquisition method based on EM algorithm. It conducted experimental research from three aspects: teachers' views on teachers' PKM problems, teachers' PKM level and experts' evaluation of teachers' PKM strategies.

2. Problems in Teachers' Personal Knowledge Management

This article summarized the problems of some teacher PKM, as shown in Figure 1, including lack of knowledge management awareness, insufficient knowledge management ability, obstacles to knowledge sharing channels and teachers' lack of knowledge reflection ability.

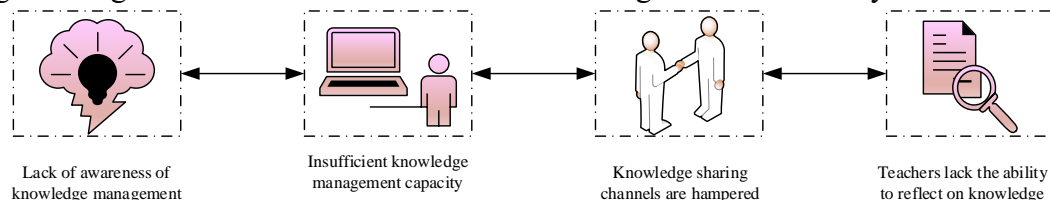


Figure 1: Problems in the management of teachers' personal knowledge

(1) Lack of knowledge management awareness

Teachers can get in touch with a lot of knowledge management content in the education work, but teachers fail to establish the awareness of knowledge management due to the inadequate

training of educational institutions, teachers' backward ideas and other factors. The progress of productivity makes the frequency of knowledge generation higher and higher, which makes the degree of knowledge transmission higher and higher, but also leads to the shorter and shorter half-life of knowledge. For teachers, if they lack attention to knowledge updating and store effective knowledge irregularly in their educational work, they would lose the opportunity to obtain a lot of effective information, and even cause the phenomenon of being out of touch with the times. On the contrary, if teachers have good knowledge management and knowledge renewal awareness, it would help to improve their knowledge literacy and enhance their educational ability [14].

(2) Insufficient knowledge management ability

Teachers' knowledge management ability is the basis for teachers to realize information education. Teachers' knowledge management ability can not only improve teachers' information management level, but also play an important role in enhancing teachers' professional ability. At this stage, many teachers are still used to using traditional means to record and sort out information, so as to achieve the integration, transformation and management of knowledge. However, due to the development of modern information technology, a large part of the information received by teachers belongs to electronic information. In this case, the traditional way of recording and sorting information that teachers have mastered can no longer meet the actual needs. In addition, with the increase of teachers' working hours, their own TPACK model would become larger and larger. The traditional way of recording and sorting information has some limitations. Some teachers, especially those with long teaching experience, are lack of ability to use modern technology, and novice teachers cannot effectively combine the content of knowledge management with modern technology. These are all manifestations of teachers' insufficient knowledge management ability.

(3) Obstacles to knowledge sharing channels

Theoretically, teachers can achieve the transformation of explicit and tacit knowledge through sharing, which is also conducive to teachers to continuously improve their own knowledge management system. However, in fact, some teachers are not willing to share knowledge subjectively, resulting in obstacles to the channels of knowledge sharing.

(4) Teachers lack the ability to reflect on knowledge

Knowledge reflection ability is one of the important factors to enhance innovation ability. Reflection is conducive to activating knowledge and improving teachers' personal knowledge literacy. In the process of education, many teachers only rely on their own knowledge and experience to explain knowledge to students and complete the education work step by step, but do not pay attention to the reflection of knowledge.

3. Factors Affecting Teachers' Knowledge Management

The factors that affect teacher knowledge management mainly include system factors, school culture factors and information technology factors, as shown in Figure 2.

Institutional factors: The establishment of school knowledge management institutions can reflect the importance that schools attach to teachers' knowledge management, which is conducive to teachers' strengthening their knowledge management capabilities. Reasonable and effective assessment system for teachers' knowledge management level, balanced and perfect reward and punishment system for teachers' knowledge management and other institutional factors are conducive to improving teachers' knowledge management level. School culture factor: teachers are both producers and absorbers of knowledge. In the environment of rapid knowledge updating, the knowledge content in textbooks may be out of line with the times. This situation makes teachers need to constantly update their knowledge base to ensure that their knowledge reserves do not lag behind the speed of knowledge updating, so as to enhance the effectiveness of classroom education.

If teachers are in the campus cultural environment of mutual cooperation and common progress, then teachers can establish close cooperation with other teachers and achieve friendly exchanges between teachers. This situation is conducive to expanding teachers' information channels, ensuring that teachers can maintain the speed of knowledge updating, and enhancing their knowledge management capabilities. Information technology factor: Information technology is one of the important factors that affect teachers' knowledge management. Factors such as teachers' views on information technology, teachers' proficiency in using information technology, and the ease of application of information technology itself would affect teachers' knowledge management behavior and knowledge management level.

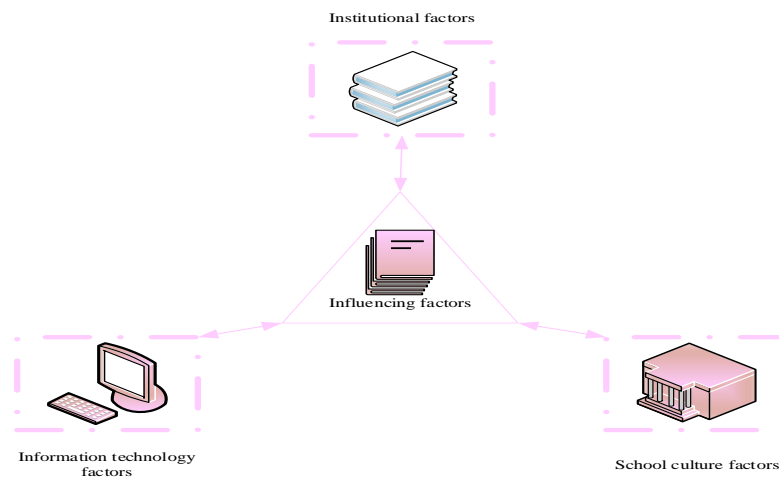


Figure 2: Factors influencing teachers' knowledge management

4. PKM Model for Teachers Based on Data Mining Algorithm

(1) Teacher PKM model

The teacher PKM model consists of six parts, as shown in Figure 3. These six parts are respectively knowledge acquisition, storage, sharing, application, innovation and identification.

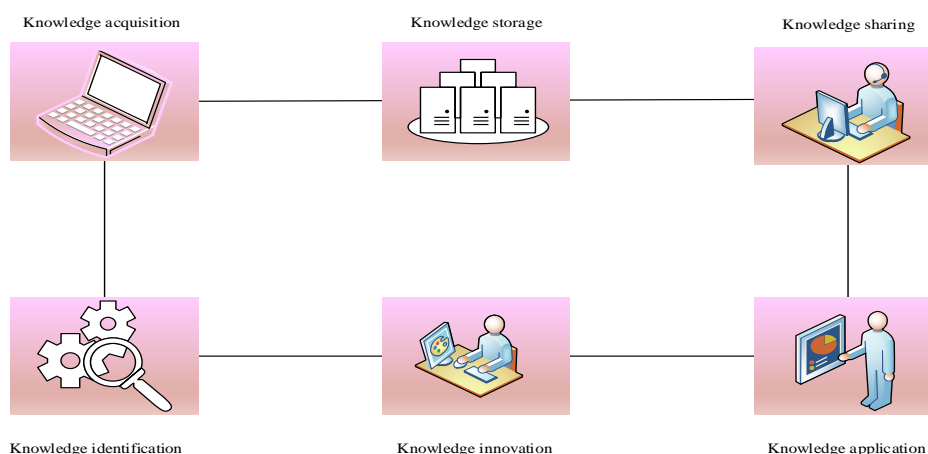


Figure 3: Teacher personal knowledge management model

Knowledge acquisition: knowledge acquisition is the initial stage of teachers' knowledge management activities, and the follow-up content of knowledge management is closely related to knowledge acquisition. The types of knowledge acquired by teachers include explicit knowledge

and implicit knowledge. The channels for acquiring personal knowledge include knowledge warehouse, knowledge community, network, newspaper, journal, lecture, educational reflection, etc. Knowledge storage: teachers' explicit knowledge storage can be realized by building a knowledge base, which can be divided into individual knowledge base and public knowledge base, and can also be further divided into document base, media base, etc. Knowledge sharing: In terms of invisible knowledge sharing, teachers can share invisible knowledge through knowledge communities, instant messaging tools and other forms. Knowledge application: knowledge application is the meaning and purpose of knowledge management, and teachers' knowledge management is to better realize knowledge application. The application of knowledge can promote the circular transformation between teachers' individual explicit knowledge and teachers' individual implicit knowledge. Knowledge innovation: the degree of teachers' personal knowledge innovation reflects the effect of knowledge management and the comprehensive competitiveness of teachers. The channels of teachers' personal knowledge innovation include knowledge combination and knowledge exchange. Knowledge combination is a process of improving and integrating existing knowledge by means of knowledge clustering, knowledge mining and other technical means. Knowledge exchange is a process of knowledge exchange between teachers. Knowledge exchange activities can stimulate teachers' inspiration and promote knowledge innovation. Knowledge identification: knowledge identification is a teacher's overall grasp of personal knowledge management activities. Through knowledge identification, teachers can clarify their own knowledge needs, so as to adjust the direction and content of knowledge acquisition. Teachers can also analyze the operation of each link in the knowledge management process through knowledge identification, so as to adjust the knowledge management strategy in a timely manner.

(2) Teacher PKM strategy based on TPACK and cybernetic perspectives

TPACK is composed of subject knowledge, method knowledge and technical knowledge, which emphasizes the coordination of the three. Based on TPACK perspective, teachers should not only master specific subject knowledge and method knowledge, but also cultivate knowledge management awareness, and use technical means to expand knowledge acquisition channels and enhance knowledge management capabilities. Teachers can acquire knowledge through search engines, communication communities and other ways, and can also store and share personal knowledge through modern technology tools. Educational cybernetics is a discipline that integrates the ideology and methods of cybernetics into the field of education to promote the development of education [15]. Based on the perspective of educational cybernetics, teachers should actively carry out knowledge acquisition and knowledge sharing activities, so as to obtain more effective feedback information and increase their own knowledge reserves. Teachers should also actively carry out knowledge map navigation, knowledge statistics, knowledge evaluation and other knowledge identification activities to ensure the integrity and order of their own personal knowledge management system.

(3) Teacher's Personal Knowledge Acquisition Based on EM Algorithm

Data mining is an important part of teachers' knowledge acquisition. It can help teachers extract potentially useful knowledge that teachers need from huge amounts of data. For this reason, this paper studies the EM algorithm.

The clustering of data is regarded as a multi-dimensional Gaussian distribution, and the density function is:

$$g_i(\alpha | v_i, \sum_i) = \frac{1}{\sqrt{(2\pi)^e |\sum_i|}} \exp\left(-\frac{1}{2}(\alpha - v_i)^s (\sum_i)^{-1} (\alpha - v_i)\right) \quad (1)$$

ν_l is the center of Gaussian distribution; \sum_l is the covariance of the Gaussian distribution. Set a weight coefficient for each multi-dimensional Gaussian distribution, then:

$$\sum_{l=1}^c \mu_l = 1 \quad (2)$$

Transform the clustering process of knowledge data into the process of estimating appropriate parameters:

$$\sigma = \left\{ (\mu_l, \nu_l, \sum_l), l=1, \dots, c \right\} \quad (3)$$

To maximize the log likelihood value of the dataset to be clustered, there are:

$$H(\sigma) = \sum_{\alpha \in E} \log \left(\sum_{l=1}^c \nu_l * g_l(\alpha | \nu_l, \sum_l) \right) \quad (4)$$

E represents the original dataset to be clustered.

The execution process of the EM algorithm is:

First, for each data record α in E , calculate the probability that α belongs to cluster l :

$$\mu_l^h(\alpha) = \frac{\mu_l^h * g_l(\alpha | \nu_l^h, \sum_l^h)}{\sum_{p=1}^c \mu_p^h * g_p(\alpha | \nu_p^h, \sum_p^h)} \quad (5)$$

Secondly, update the parameters of the hybrid model:

$$\mu_l^{h+1} = \sum_{\alpha \in E} \mu_l^h(\alpha) \quad (6)$$

$$\nu_l^{h+1} = \frac{\sum_{\alpha \in E} \mu_l^h(\alpha) * \alpha}{\sum_{\alpha \in E} \mu_l^h(\alpha)} \quad (7)$$

$$\sum_l^{h+1} = \frac{\sum_{\alpha \in E} \mu_l^h(\alpha) (\alpha - \nu_l^{h+1}) (\alpha - \nu_l^{h+1})^S}{\sum_{\alpha \in E} \mu_l^h(\alpha)} \quad (8)$$

Finally, if $|H(\sigma^l) - H(\sigma^{l+1})| < \varepsilon$, the estimated parameters conform to the distribution of the dataset, and the algorithm stops.

5. Experimental Research on Teachers' Personal Knowledge Management

175 teachers from A school were selected and divided into 5 groups, which were called T group, F group, V group, B group and H group respectively. The 175 teachers were interviewed about the problems with teacher PKM, and 5 of them were evaluated as their personal knowledge management level. The evaluation indexes include knowledge acquisition evaluation, knowledge storage evaluation, knowledge sharing evaluation, knowledge application evaluation, knowledge

innovation evaluation and knowledge identification evaluation. The weights of the six evaluation indicators are set as 0.2, 0.1, 0.15, 0.2, 0.2, 0.15 respectively through expert consultation. In addition, four experts were invited to evaluate teachers' personal knowledge management strategies. The basic characteristics of 175 teachers participating in the study are shown in Table 1.

Table 1: Basic characteristics of faculty involved in research

	Group T	Group F	Group V	Group B	Group H
Mean age (years)	42.34	45.36	47.26	43.97	45.67
Number of male teachers (person)	25	16	22	30	24
Number of female teachers (person)	10	19	13	5	11
Average years of education (years)	4.5	6.54	3.27	4.58	5.65

As shown in Table 1, the average age of teachers in Group T is 42.34 years old, and the number of male teachers is 25. The number of female teachers is 10, and the average teaching age is 4.5 years. The average age of F group teachers was 45.36 years old, and the number of male teachers was 16. The number of female teachers is 19, and the average length of teaching is 6.54 years. The average age of teachers in Group V was 47.26 years, and the number of male teachers was 22. The number of female teachers is 13, and the average length of teaching is 3.27 years. The average age of group B teachers is 43.97 years old, and the number of male teachers is 30. The number of female teachers is 5, and the average length of teaching is 4.58 years. The average age of group H teachers is 45.67 years old, and the number of male teachers is 24. The number of female teachers is 11, and the average length of teaching is 5.65 years.

(1) Teachers' perceptions of problems with teacher PKM

Set the problem as lack of knowledge management awareness, lack of knowledge management ability, obstacles to knowledge sharing channels, lack of knowledge reflection ability and other five items. Each teacher can select only one option, as shown in Figure 4.

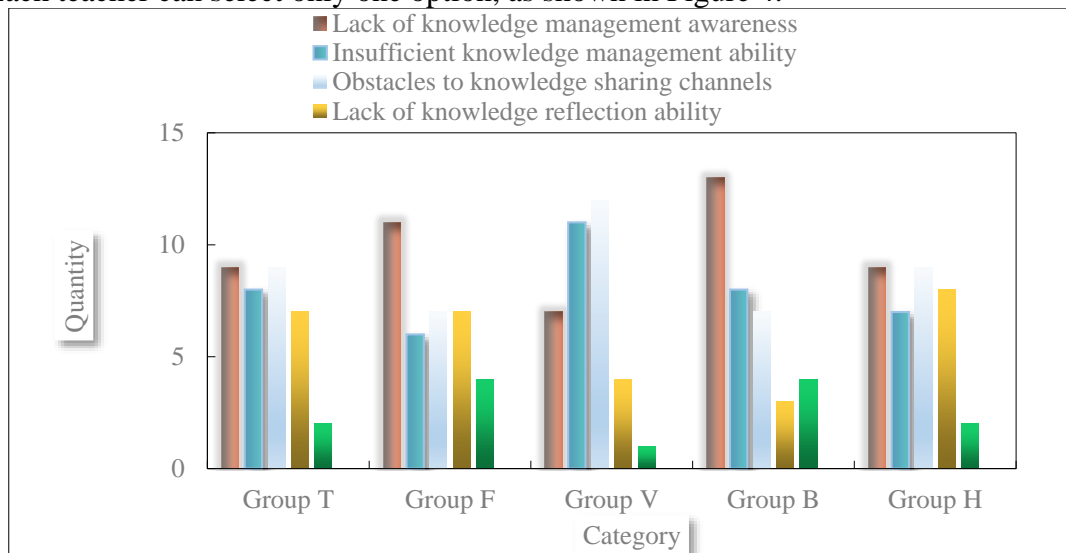


Figure 4: Teachers' perceptions of problems with teachers' personal knowledge management

As shown in Figure 4, 9 teachers in group T believe that teachers PKM has a lack of knowledge management awareness, and 8 teachers believe that there is a lack of knowledge management ability in teachers' personal knowledge management. There are 9 people who believe that there are obstacles to knowledge sharing channels in teachers' personal knowledge management. There are 11 teachers in Group F who believe that there is a lack of knowledge management awareness in

teachers' PKM, and 7 teachers believe that there is a problem of obstacles to knowledge sharing channels in teachers' personal knowledge management. Seven people believe that teachers' PKM lacks the ability to reflect on knowledge. Seven teachers in Group V believed that there was a lack of awareness of knowledge management in teachers' personal knowledge management. There are 11 people who believe that teachers' personal knowledge management has the problem of insufficient knowledge management ability, and 12 people who believe that teachers' PKM has the problem of obstacles to knowledge sharing channels. 13 teachers in Group B believe that there is a lack of knowledge management awareness in teachers' PKM, and 8 teachers believe that there is a lack of knowledge management ability in teachers' personal knowledge management. There are 7 people who believe that there are obstacles to knowledge sharing channels in teachers' personal knowledge management. Nine teachers in Group H believed that there was a lack of awareness of knowledge management in teachers' personal knowledge management. There are 9 people who believe that teachers' PKM has the problem of obstacles to knowledge sharing channels, and 8 people who believe that teachers' PKM has the problem of lack of knowledge reflection ability. From the data, it can see that the lack of knowledge management awareness, insufficient knowledge management ability, and obstacles to knowledge sharing channels are all problems in teacher PKM.

(2) Teacher PKM level

Each group randomly selects one teacher to evaluate their PKM level, and calls them Teacher P, Teacher Q, Teacher R, Teacher S, and Teacher E. The evaluation score range is 1-10, and the specific results are shown in Figure 5.

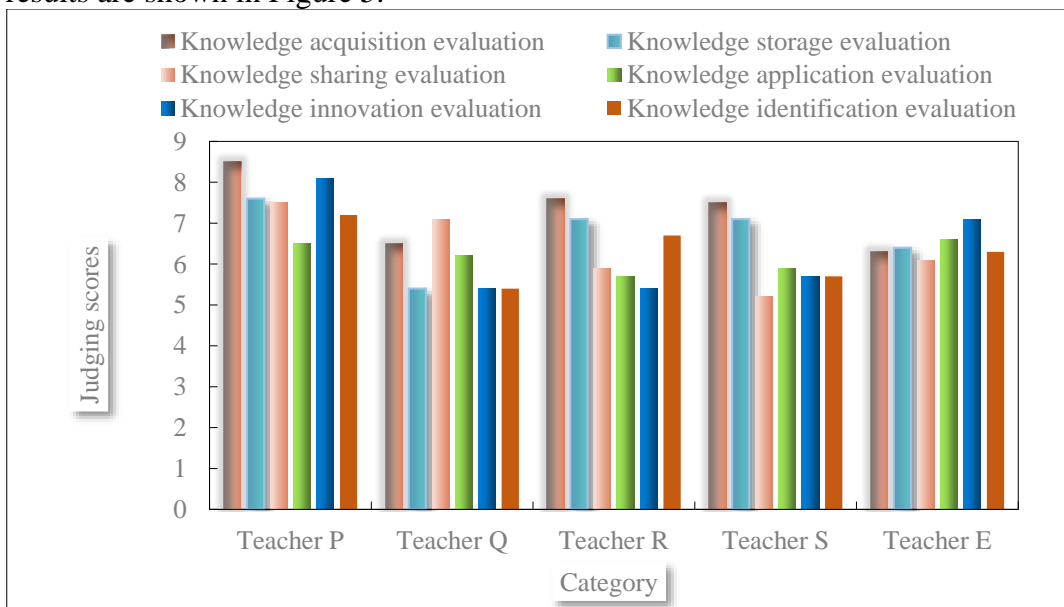


Figure 5: Teacher's personal knowledge management level

As shown in Figure 5, Teacher P's knowledge acquisition evaluation score is 8.5, knowledge storage evaluation score is 7.6, and knowledge sharing evaluation score is 7.5. The score of knowledge application evaluation is 6.5, the score of knowledge innovation evaluation is 8.1, and the score of knowledge identification evaluation is 7.2. Teacher Q's knowledge acquisition evaluation score is 6.5, knowledge storage evaluation score is 5.4, and knowledge sharing evaluation score is 7.1. Knowledge application evaluation score is 6.2, knowledge innovation evaluation score is 5.4, and knowledge identification evaluation score is 5.4. Teacher R's knowledge acquisition evaluation score is 7.6 and knowledge storage evaluation score is 7.1. Knowledge sharing evaluation score is 5.9, knowledge application evaluation score is 5.7, knowledge innovation evaluation score is 5.4, and knowledge identification evaluation score is 6.7. Teacher S's

knowledge acquisition evaluation score is 7.5, knowledge storage evaluation score is 7.1, and knowledge sharing evaluation score is 5.2. Knowledge application evaluation score is 5.9, knowledge innovation evaluation score is 5.7, and knowledge identification evaluation score is 5.7. Teacher E's knowledge acquisition evaluation score is 6.3, knowledge storage evaluation score is 6.4, and knowledge sharing evaluation score is 6.1. The score of knowledge application evaluation is 6.6, the score of knowledge innovation evaluation is 7.1, and the score of knowledge identification evaluation is 6.3. It can be seen from the calculation that the evaluation score of teachers' personal knowledge management level of Teacher P is 7.585, and that of Teacher Q is 6.035. Teacher R's personal knowledge management score is 6.34, and Teacher S's personal knowledge management score is 6.165. Teacher E's personal knowledge management evaluation score is 6.5, and the average personal knowledge management evaluation score of five teachers is 6.525. The above data shows that the personal knowledge management level of teachers at this stage is still not high enough, and teachers need to enhance their knowledge management ability.

(3) Four experts' evaluation of teachers' personal knowledge management strategies

The four experts are called expert C, expert D, expert J and expert L respectively. The evaluation score range is 1-10. The evaluation results of experts are shown in Figure 6.

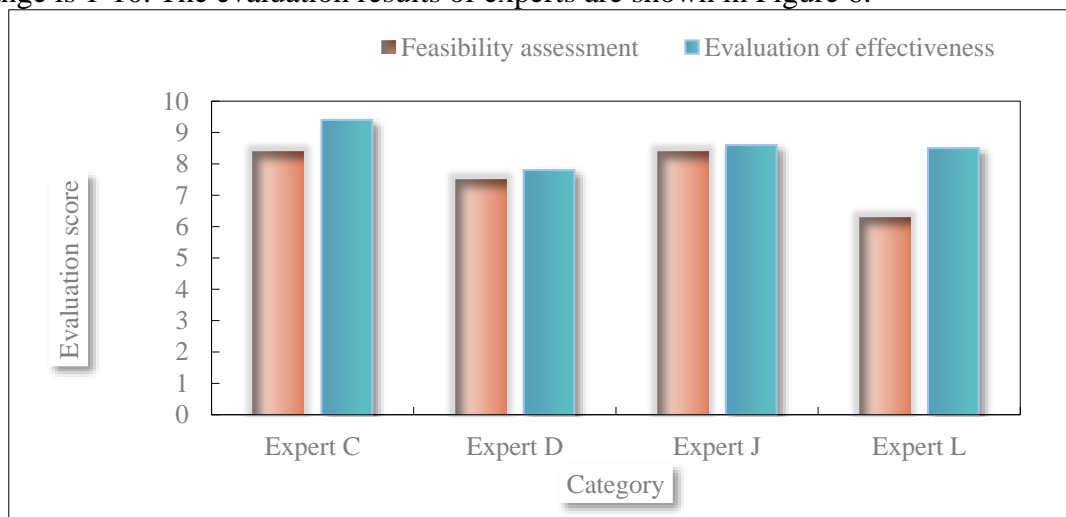


Figure 6: Expert evaluation of teachers' PKM strategies

As shown in Figure 6, Expert C scored 8.4 for the feasibility of the teacher PKM strategy and 9.4 for the effectiveness of the teacher PKM strategy. Expert D scored 7.5 on the feasibility of teacher PKM strategy and 7.8 on the effectiveness of teacher PKM strategy. Expert J scored 8.4 on the feasibility of the teacher PKM strategy and 8.6 on the effectiveness of the teacher PKM strategy. Expert L scored 6.3 on the feasibility of the teacher PKM strategy and 8.5 on the effectiveness of the teacher PKM strategy. The average feasibility evaluation score of teachers' personal knowledge management strategy and 8.575 for teachers' PKM strategy was 7.65. The above data show that the teacher PKM strategy proposed in this paper has certain effectiveness.

6. Conclusions

This paper summarized the problems of teacher PKM such as lack of knowledge management awareness and insufficient knowledge management ability, analyzed the factors affecting teacher knowledge management such as institutional factors and information technology factors, and conducted experimental research on teacher PKM after proposing teacher PKM model and management strategy. Research has proved that the lack of knowledge management awareness and insufficient knowledge management ability are all problems in teachers' PKM; PKM proficiency

among teachers is still not high enough; teachers' personal knowledge management strategies play a role. The research in this paper provides a reference path for the research of PKM for teachers.

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