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EVALUATION OF CURRICULUM IMPLEMENTATION EFFECTIVENESS OF HIGHER VOCATIONAL EDUCATION BASED ON COLLABORATIVE FILTERING ALGORITHM

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Abstract. The conventional evaluation method for the effectiveness of curriculum implementation mainly focuses on the complete orientation analysis of students' curriculum content, which does not reflect the value of the educational curriculum and affects the effectiveness of evaluation. Therefore, an evaluation method of curriculum implementation effectiveness of higher vocational education based on a collaborative filtering algorithm is designed. Identify the practical focus of evaluating the implementation of the higher vocational education curriculum and discover the educational curriculum's significance. Qualitative evaluation of curriculum implementation degree based on collaborative filtering algorithm, find out the hidden characteristics of curriculum implementation evaluation to effectively evaluate higher vocational education curriculum implementation. Using case analysis, it is verified that the method is more effective and can be applied in real life.

Key words: Collaborative filtering algorithm; Higher vocational education; Curriculum implementation; Effectiveness; Evaluation method;

1. Introduction. The educational theory is constantly changing. The scientific demonstration effect of its logic theory is concentrated in the aspect of curriculum evaluation, which provides a scientific orientation for teaching curriculum theory. The promotion of professional courses is related to many variables such as students' learning ability, teachers' professional ability, students' professional skills, and learning process [11, 22, 5].

Education and training are prerequisites for students to recognize and enter society. Adhering to the concept of "natural education", it is the curriculum learning process for students. It sets students' self-learning and self-evaluation function for ensuring they have specific knowledge and skills. Scientific curriculum implementation evaluation contains basic assumptions. Among the total multiple evaluation groups, only minority groups are outstanding, and most of them are at normal level [15, 8].

The motivation behind the work lies in recognizing the limitations of conventional evaluation methods for assessing the effectiveness of curriculum implementation in higher vocational education. The existing approaches primarily focus on analyzing the completion and orientation of students' curriculum content, often neglecting the value and significance of educational curriculum. This limitation hinders the accurate evaluation of curriculum implementation and compromises the quality of teaching in higher vocational education.

To address this gap, the authors of this work were motivated to propose a novel evaluation method based on the collaborative filtering algorithm. This algorithm, commonly used in recommendation systems, offers a fresh perspective on evaluating curriculum implementation effectiveness. By leveraging collaborative filtering, the method aims to identify the practical focus of evaluating curriculum implementation, uncover the hidden characteristics of the evaluation process, and provide a more comprehensive assessment of higher vocational education curriculum effectiveness.

The motivation also stems from the desire to improve teaching quality in higher vocational education. The authors aim to enhance accountability, ensure quality assurance, and promote continuous improvement in teaching practices by developing a more effective evaluation method. The evaluation method provides educators with valuable feedback and insights to reflect on their teaching strategies, make evidence-based decisions, and tailor instruction to meet the diverse needs of students.

The evaluation of curriculum implementation is to select a few outstanding people, let them experience the happiness of success, and promote the exceptional people to be more outstanding using incentives. Throughout

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the evaluation procedure, it is essential to guarantee fairness and objectivity in the assessment, it is necessary to make the evaluation value neutral, and the evaluated cannot participate in the evaluation process to ensure the accuracy of the evaluation [16, 3, 12]. This article will focus on evaluating curriculum implementation and finding the best curriculum implementation plan to improve teaching quality. To conduct a more precise assessment of the efficacy of curriculum implementation in higher vocational colleges, this paper uses a collaborative filtering algorithm to design an evaluation method for the effectiveness of curriculum implementation in higher vocational education.

The work described proposes a novel evaluation method for assessing the effectiveness of curriculum implementation in higher vocational education. The conventional evaluation methods typically focus on analyzing the orientation and completion of students' curriculum content, which fails to capture the true value of educational curriculum and consequently impacts the accuracy of the evaluation.

The authors designed an evaluation method based on the collaborative filtering algorithm to address this limitation. This approach aims to identify the practical focus of evaluating the implementation of higher vocational education curricula and uncover the significance of educational curricula. By employing qualitative evaluation techniques, the method assesses the degree of curriculum implementation based on the collaborative filtering algorithm, allowing for discovering hidden characteristics in the evaluation process.

The main contributions of this work can be summarized as follows:

1. The work introduces a new evaluation method that considers the collaborative filtering algorithm, providing a fresh perspective on assessing the effectiveness of curriculum implementation in higher vocational education.
2. The proposed method emphasizes identifying the practical aspects of evaluating the implementation of higher vocational education curricula. This allows for a more targeted evaluation process that aligns with the real-life requirements of vocational education.
3. By utilizing the collaborative filtering algorithm, the method uncovers the true significance of the educational curriculum. This helps in understanding the value and impact of curriculum implementation on students' learning outcomes.
4. The work incorporates qualitative evaluation techniques to assess the degree of curriculum implementation. This approach provides a deeper understanding of the evaluation process and facilitates the identification of hidden characteristics that influence effectiveness.
5. Through case analysis, the authors validate the effectiveness of the proposed method and demonstrate its applicability in real-life scenarios. This contributes to bridging the gap between theory and practice in evaluating the implementation of higher vocational education curriculum enumerate

The design of the evaluation method for curriculum implementation effectiveness in higher vocational education, based on the collaborative filtering algorithm, is a key contribution of this work. This innovative method aims to overcome the limitations of conventional evaluation approaches that primarily focus on the analysis of students' curriculum content orientation.

The key steps involved in designing the evaluation method are as follows:

1. The method leverages the collaborative filtering algorithm, which is widely used in recommendation systems, to evaluate curriculum implementation effectiveness. Collaborative filtering analyzes patterns of student behavior and preferences to make predictions and recommendations.
2. The evaluation method identifies the practical focus for evaluating curriculum implementation in higher vocational education. This involves understanding the curriculum's specific objectives, requirements, and outcomes and aligning the evaluation criteria accordingly.
3. The method incorporates qualitative evaluation techniques to assess the degree of curriculum implementation. This may involve gathering feedback from teachers, students, and other stakeholders through surveys, interviews, or observations. The qualitative evaluation helps uncover hidden characteristics and subjective aspects of curriculum implementation.
4. By employing the collaborative filtering algorithm, the method explores the significance of the educational curriculum. It seeks to understand how the curriculum contributes to students' learning outcomes, skill development, and overall educational experience.
5. The evaluation method aims to identify hidden characteristics of curriculum implementation evaluation.

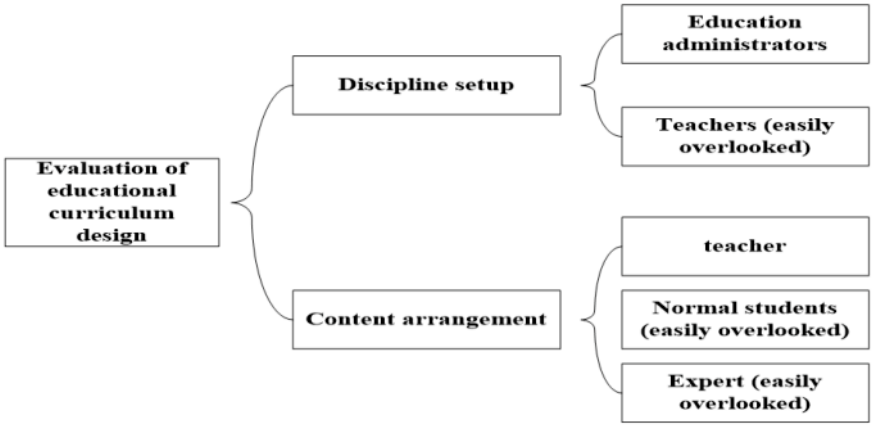

Fig. 1.1: Overview of Education Curriculum Design Evaluation

This involves analyzing various factors that influence the effectiveness of curriculum implementation, such as teaching methods, instructional materials, assessment strategies, and student support services. The collaborative filtering algorithm helps reveal patterns and relationships among these characteristics.

6. The evaluation method measures the effectiveness of curriculum implementation based on the insights obtained through collaborative filtering and qualitative evaluation. It provides a comprehensive assessment of how well the curriculum is implemented, highlighting strengths, weaknesses, and areas for improvement.
7. The proposed method is validated through case analysis. Real-life examples of higher vocational education curriculum implementation are examined to demonstrate the effectiveness and practical application of the evaluation method. This step ensures that the method is theoretically sound and applicable in real-world contexts.

1.2. Determine the functional orientation of curriculum implementation evaluation of higher vocational education. The evaluation of educational curriculum implementation evaluates the value of a teacher education curriculum. The assessment of the design, implementation, and impact of teacher education curriculum is the key aspect of curriculum evaluation in higher vocational education [24, 14, 17]. To assess the effectiveness of curriculum implementation, it is essential to establish a clear agenda for evaluation and analyze the planning process of the educational curriculum [25, 9, 23]. The evaluation overview is shown in Figure 1.1.

As shown in Figure 1.1, education curriculum design is the standard for evaluating the implementation of teaching curriculum, and the evaluation standard is the criterion for value judgment in the implementation evaluation process. Therefore, reviewing educational curriculum design is the primary function of curriculum implementation evaluation. In the evaluation process, the principles of appropriateness, effectiveness, feasibility, and accuracy are always followed [4, 18, 7]. The evaluation of course implementation reflects the fundamental characteristics of professional practice courses in higher vocational colleges, and the ideal evaluation grade is obtained with the expected evaluation standard to improve the overall quality of teaching.

1.3. Qualitative evaluation of course implementation based on collaborative filtering algorithm. In curriculum implementation the orientation of curriculum implementation takes many forms. No matter which form it takes, it will affect the effectiveness of evaluation [1]. This paper analyzes the evaluation orientation of curriculum implementation in higher education settings from three perspectives of technology, politics, and culture, as shown in Table 1.1.

As shown in Table 1.1, this paper regards curriculum implementation evaluation as a kind of technology from the perspective of technology. The curriculum implementation evaluation is the process of implementing

Table 1.1: Curriculum implementation orientation of higher vocational education

Implementation orientation	Fidelity orientation Technological outlook	Mutual adaptation orientation Political outlook	Curriculum Creation Orientation Cultural outlook
Basic assumptions	Implementation is a technical task, and the key lies in finding the best means to achieve curriculum evaluation	Implementation is a two-way social interaction process, and consensus is reached through implementation orientation evaluation	Implementation is a nonlinear and complex evaluation evolution process
Evaluation focus	The rationality of educational curriculum implementation; Degree and efficiency of curriculum implementation	Interactions between school scenarios and evaluation plans to adapt the implementation of the evaluation process	The content and impact of school context and creation
Implementation evaluation	Application of specialized knowledge; RD&D mode	Flexible evaluation; RAND mode	Grassroots evaluation, TORL mode
Evaluation method	Quantitative evaluation	Quantitative+qualitative evaluation	Qualitative evaluation

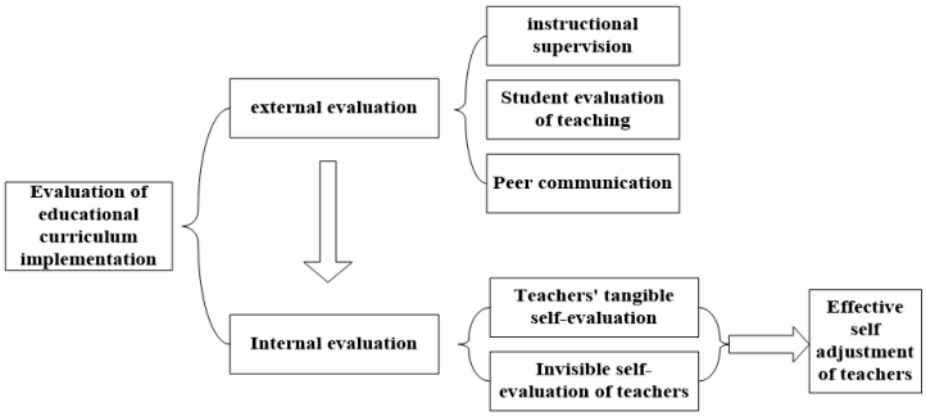

Fig. 1.2: Overview of Education Curriculum Implementation Evaluation

the scheduled plan, and the measurement standard is the degree of achievement of teaching objectives. From the political point of view, the curriculum implementation evaluation is regarded as the interest competition between groups, and different competitive relationships maintain different attitudes towards the curriculum implementation evaluation [2, 6, 20]. From the culture perspective, curriculum implementation evaluation is regarded as cultural regeneration, and curriculum implementation evaluation is the process of promoting teachers to think over teaching arrangements. Analyzing the impact of curriculum implementation assessment from diverse viewpoints holds significance in enhancing the efficacy of curriculum implementation evaluation [19]. An overview of the implementation evaluation of educational courses is shown in Figure 1.2.

As shown in Figure 1.3, the assessment of the implementation of the curriculum in higher vocational education is predominantly grounded on the merits of the content and the worth of self-reflection, which empowers

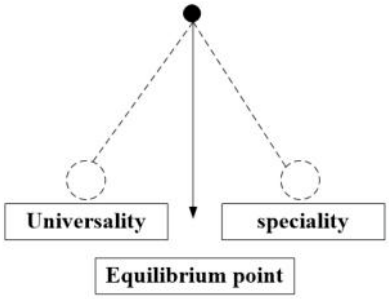

Fig. 1.3: Curriculum Orientation of Higher Vocational Education

instructors to leverage their pedagogical aptitude and students to reinforce their cognitive competence [13]. This paper employs the collaborative filtering algorithm to enhance the effectiveness of evaluating curriculum implementation in higher vocational education, which analyzes similarities among curricula. The formula is as follows:

$$sim(a,b) = \cos(a,b) = \frac{a*b}{\|a\|*\|b\|} \tag{1.1}$$

In formula 1.1, $sim(a,b)$ is the similarity vector of the courses that students like; $\cos(a,b)$ is cosine similarity; a, b two students; $\|a\|*\|b\|$ in the position of denominator, the smaller the product, the student a with students b the higher the similarity of the courses they like. Putting students a with students b learning in the same class can improve the degree of curriculum implementation. As far as the collaborative filtering algorithm is concerned, the relationship between the two variables is used to weigh the similarity of students' preferences for the curriculum to provide students with a good curriculum implementation environment [10]. According to students a with students b the linear correlation of $sim(a,b)$ the value range of is set between - 1 and 1, and the linear correlation formula is:

$$sim(a,b)' = \frac{\sum_i (R_{a,i} - \overline{R})(R_{b,i} - \overline{R})}{\sqrt{\sum_{i\in I}(R_{a,i} - \overline{R})^2}\sqrt{\sum_{i\in I}(R_{b,i} - \overline{R})^2}} \tag{1.2}$$

In formula 1.2, $sim(a,b)'$ for the similarity of students' interest in the process of curriculum implementation; $R_{a,i}$ for students a for the i evaluation of the performance of the courses; $R_{b,i}$ for students b for the i evaluation of the implementation of the courses; $\overline{R}$ is an index for evaluating the balance. After analyzing the degree of students' interest in curriculum content in the course of curriculum implementation, this paper establishes adjacent sets. Hypothetical students a the adjacent set of is N_a, students a be interested in a course i the estimated predictive value of is $P_{a,i}$ a the formula for evaluating the implementation of courses in the neighborhood set of is as follows:

$$P_{a,i} = \overline{R} + \frac{\sum_{n\in N_a} sim(a,n)' * (R_{n,i} - \overline{R})}{\sum_{n\in N_a}(|sim(a,n)'|)} \tag{1.3}$$

In equation 1.3, $P_{a,i}$ for students a be interested in a course i the predicted estimated value of; $sim(a,n)'$ for new students n with students a satisfactory similarity of curriculum implementation; $R_{n,i}$ for students n for the i evaluation of the implementation of the courses. When applying the collaborative filtering algorithm to evaluate the performance of a higher vocational education curriculum, analyzing the nearest neighbor of the target course is critical. In the neighbor evaluation step, find the neighbor set of the target curriculum and measure the implementation similarity of each curriculum [21]. The hidden characteristics of curriculum implementation are analyzed, as shown in Figure 1.3.

As shown in Figure 1.3, this paper finds out the hidden features of curriculum implementation by analyzing the degree of interest of students in the curriculum and reduces the dimensions of more complex student evaluation content to obtain simple and easy-to-operate hidden features. The matrix decomposition expression is:

$$\overline{R}_{m\times n} = {P^t}_{m\times k} \times Q_{k\times n} \tag{1.4}$$

In equation 1.4, $\overline{R}_{m\times n}$ original scoring matrix for m students to implement n courses; ${P^t}_{m\times k}$ find out k hidden features for m students and then evaluate the t-th education curriculum; $Q_{k\times n}$ integrate the score items of matrix Q with k hidden features for n courses. In order to ensure the effectiveness of education curriculum implementation evaluation, this paper uses the loss function to reduce evaluation error and adds regularization terms to prevent overfitting. The loss function is expressed as follows:

$$V = \sum_{(a,i)\in R} (R_{ai} - {P^t}_{m\times k} - Q_i)^2 + \gamma \sum_a \left\| {P^t}_{m\times k} \right\|^2 + \gamma \sum_i \|Q_i\|^2 \tag{1.5}$$

In formula 1.5, V is the loss function expression; R_{ai} is the evaluation error; Q_i is a regular scoring item; γ is a cross parameter. This paper determines the feasible implementation effectiveness d, so that it will decline along the fastest defense line gradient, then:

$$P_a = P_a + d(Q_i - \gamma P_a) \tag{1.6}$$

In formula 1.6, P_a for students a the evaluation and optimization indicators of curriculum implementation. Collaborative filtering algorithms can be used to improve the accuracy of student evaluations by identifying hidden features of curriculum implementation. By analyzing previous evaluations and identifying patterns, collaborative filtering algorithms can find relationships between different aspects of curriculum implementation and student ratings. This can assist in pinpointing regions that require enhancement and give an understanding into which elements are crucial in evaluating the execution of a curriculum.

Collaborative filtering algorithm for higher vocational education:

1. Input:
   (a) Curriculum data (courses, teaching materials, assessments, etc.)
   (b) User data (students' historical behavior, preferences, feedback)
   (c) Evaluation criteria and metrics
2. Data Preprocessing:
   (a) Normalize user preferences and curriculum data to ensure consistency and comparability.
   (b) Handle missing data, if any, through imputation techniques.
3. User-Based Collaborative Filtering:
   (a) Compute the similarity between target users and other users based on their curriculum-related behavior and preferences (e.g., courses taken, grades obtained, feedback provided).
   (b) Select a set of similar users based on similarity threshold or top-K nearest neighbors.
4. Item-Based Collaborative Filtering:
   (a) Compute the similarity between target curriculum components (e.g., courses, teaching materials) based on user preferences and feedback.
   (b) Select a set of similar curriculum components based on similarity threshold or top-K nearest neighbors.
5. Predicting Effectiveness:
   (a) For user-based collaborative filtering:
      i. Aggregate the curriculum-related feedback and ratings of similar users.
      ii. Predict the effectiveness of curriculum components for the target user based on the aggregated feedback.
   (b) For item-based collaborative filtering:
      i. Aggregate the user preferences and feedback for similar curriculum components.
      ii. Predict the effectiveness of the target curriculum component based on the aggregated feedback.

Table 2.1: Talent Training Specifications of M Higher Vocational Colleges

Type	Talent training specifications
Quality requirements	Love national culture; Abide by laws and regulations, school rules and regulations; Have good professional ethics and innovative practical spirit; Having aesthetic taste, sound psychology, and healthy physique; Have solid professional knowledge and ability; Have a good sense of service and team spirit; Strong communication and organizational skills
Knowledge requirements	Master comprehensive knowledge of listening, speaking, reading, and writing; Proficient in computer knowledge; Master professional theories on installation, commissioning, maintenance, repair, and management of electromechanical equipment; Familiar with mechanical manufacturing theory; Master electrical technology operation, etc
Capability requirements	Basic Chinese language skills and written expression skills; Ability to analyze and troubleshoot mechanical structures; Ability to read and draw mechanical drawings; Ability to detect and maintain electrical equipment; Equipped with basic bench work operations; Ability to control, install, debug, and operate common electrical equipment

6. Evaluation:
   (a) Compare the predicted effectiveness with the predefined evaluation criteria and metrics.
   (b) Assess the degree of curriculum implementation effectiveness based on the evaluation results.
7. Output:
   (a) Evaluation results indicating the effectiveness of curriculum implementation for different curriculum components.
   (b) Personalized recommendations for students based on their preferences and predicted effectiveness.

2. Example analysis.

2.1. Overview of higher vocational colleges. In order to verify whether the curriculum implementation evaluation method designed in this paper can be applied to real life, this article utilizes M vocational college as a case study to examine the aforementioned approaches. With the teaching characteristics of serving the rail transit industry, the teaching theme of serving the equipment manufacturing industry, and the form of "double closed-loop control", it established a teaching quality assurance system with local characteristics, providing employment security for students in the college. With the popularization of online education mode, M Higher Vocational College has unified the teaching content, occupation, competition, and assessment standards, and combined the requirements for students with enterprises. It has formed more than 50 social organizations such as the "assistant group", "reporter group", and "military band", providing students with rich spare time life. The talent training specifications of higher vocational colleges are shown in Table 2.1.

As shown in Table 2.1, M higher vocational college is an automobile repair college, mainly setting up electromechanical equipment maintenance and management specialty, electromechanical integration technology, etc., to create strong practical ability and innovation promotion for students. Provide the market with advanced technical applied talents from the installation, commissioning, maintenance, repair, sales, management, and other aspects of electromechanical equipment. Colleges and universities mainly cultivate students' comprehensive ability from the aspects of quality requirements, knowledge requirements, ability requirements, etc. From the student level, establishing a correct concept of learning can become, promote students to develop learning habits. In order to improve the learning effect of students, and based on the identified relationships, the algorithm can provide insights into the effectiveness of the implementation of educational courses and suggest improvements if needed. An example of collaborative filtering evaluation is shown in Figure 2.1.

As shown in Figure 2.1, student A likes courses A and C; Student B likes course B; Student C likes courses A, C, and D. In this paper, student C is regarded as the neighbor of student A, and can be recommended

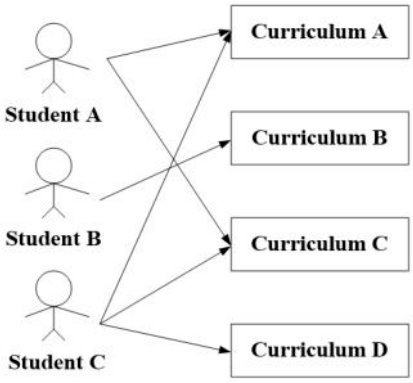

Fig. 2.1: Example of collaborative filtering evaluation

Table 2.2: Application Results

Variable	sexual distinction	mean value	standard deviation	T value	P value
Course Functions	man woman	4.160 4.279	0.615 0.514	-3.358	0.001
Course structure	man woman	3.814 3.764	0.830 0.780	1.044	0.096
Course content	man woman	3.858 3.749	0.782 0.771	2.351	0.068
Teaching methods	man woman	4.135 4.263	0.621 0.574	-3.650	0.000
Course evaluation	man woman	4.030 4.125	0.735 0.656	-2.217	0.027
course management	man woman	3.801 3.809	0.985 0.985	0.125	0.090

to student A what student A has not learned, so as to ensure that students can recommend courses to each other, which is conducive to the implementation of courses. Evaluate the implementation of educational courses according to student's preference for the courses to ensure the effectiveness of the implementation evaluation.

2.2. Application results. Under the above conditions, this paper randomly selects variables such as curriculum function, structure, content, teaching methods, evaluation, management, etc.. It analyzes the differences in curriculum implementation degrees between men and women under different gender conditions. The application results evaluate the effectiveness of curriculum implementation based on the change of T value and P value. The application results are shown in Table 2.2.

As shown in Table 2.2, teachers of different sexes have different degrees of implementation in terms of curriculum functions, teaching methods, curriculum evaluation, etc., and the T value is negative. According to the standard deviation, female teachers are significantly higher than male teachers in terms of curriculum functions, teaching methods, curriculum evaluation, etc. The P value shows the evaluation result of the degree of curriculum implementation. The smaller the P value, the higher the evaluation effectiveness of educational curriculum implementation; The higher the P value, the lower the effectiveness of the evaluation of educational curriculum implementation. It can be seen from the table that after using the effectiveness evaluation method designed in this paper, the P value < 0.1, the evaluation effectiveness of the implementation of educational courses is relatively high, and the education situation of M vocational colleges can be clearly analyzed.

3. Conclusion. In recent years, higher vocational colleges have emerged as crucial institutions for providing practical education and training to students. It is imperative to continually enhance curriculum implementation and evaluation methods to ensure students receive the best possible education. The evaluation of curriculum implementation in higher vocational institutions often involves a combination of qualitative and quantitative methods. These evaluation standards consider various factors that influence the quality of education, aiming to enhance the effectiveness of curriculum implementation and foster value-added educational outcomes. Higher vocational education plays a vital role in cultivating employment-oriented talents, with professional practice courses serving as essential conduits for practical skill development. The evaluation of curriculum implementation directly influences the degree to which talent training objectives are achieved, significantly impacting students' future employability. To further enhance students' learning outcomes, this study utilizes the collaborative filtering algorithm to design an evaluation method for assessing the effectiveness of curriculum implementation in higher vocational education. It is important to emphasize that curriculum evaluation should be an ongoing process, continuously adapting to meet the evolving needs of industries and society as a whole. This includes evaluating the degree of curriculum implementation and addressing other relevant aspects. By engaging in continuous evaluation, higher vocational institutions can ensure that their curriculum remains relevant and effective, providing students with a solid foundation for their future employment.

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