Personalized Recommendation Method of Innovation and Entrepreneurship Education Resources Based on Social Network Platform

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Abstract. Innovation and entrepreneurship education is an education aimed at training creative thinking and entrepreneurial ability. Due to the increasing types of educational resources, the accuracy of recommendation of educational resources is low, which can not meet the personalized learning needs of learners. Therefore, a personalized recommendation method of innovation and entrepreneurship education resources based on social network platform is proposed. Analyze the relationship between learners and innovation and entrepreneurship education resources, and use information such as resource evaluation, download, and viewing time to continuously update the learner's interest model. Based on the social network platform, the characteristics of users' knowledge needs are extracted, and the knowledge achievements are displayed through the knowledge relationship network. For learners with similar resource preferences and interactive discussion forums, use social relationships to build educational resource learning groups. Find out user groups with similar interests to the target user or project sets with similar characteristics to the target project, and recommend the top 10 innovation and entrepreneurship education resources that are similar to the learner's interest vector model to the learner. The test results show that the personalized recommendation method of innovation and entrepreneurship education resources based on social network platform has high accuracy and can be applied to the personalized recommendation system of innovation and entrepreneurship education resources to meet the personalized learning needs of learners.

Keywords: Social network platform · Innovation and entrepreneurship · Educational resources · Personalized recommendation · Recommendation method · Social relationship

1 Introduction

As a specific form of educational practice in human society, entrepreneurship education aims to cultivate the innovative consciousness, innovative spirit and innovative ability of educational objects, and its emergence and development have reasonable purpose and regularity. Learning resources are one of the important factors that determine the effect of teaching. With the development of learning methods, the requirements for learning

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resources are also increasing. The quantity and quality of learning resources have been paid more and more attention by national education authorities and researchers. As an important part of higher education, entrepreneurship education involves the repositioning of higher education personnel training functions, the reform of education forms, the adjustment of education content, etc., reflecting the innovative development of education reform. Online educational resources are organized and provided centered on educational platforms. It is impossible for learners to traverse all platforms to retrieve educational resources. On the one hand, learners' personalized learning needs cannot be matched with the most suitable educational resources. On the other hand, high-quality education resources are also not fully utilized. While adhering to its basic theoretical basis, the disciplinary development of entrepreneurship education needs to inject new and beneficial "elements". We should learn from the theories of other disciplines to enrich and deepen our own theories and meet the needs of practice [1]. Equate entrepreneurship education with employment education. Among the majority of teachers and students, the marginalization of entrepreneurship education is difficult to change. While a large number of learning resources bring more optional space to learners, the problem of "information overload" also arises. Because in the process of online learning, teachers and learners are relatively separated in time and space, learners can not get teachers' guidance in time, which is easy to be confused in a large number of information resources. Judging from the various aspects of the current entrepreneurship education, there is a general lack of attention to the internal mechanism of entrepreneurship education. The personalized push of learning resources for innovation and entrepreneurship education will greatly improve the learning quality of online learning, and personalized education has become the development trend of future education. From the perspective of management research, innovation and entrepreneurship education needs to strengthen all aspects, such as increasing the proportion of practical courses, launching various innovation competitions, increasing basic courses in entrepreneurship education, and setting corresponding innovation credit awards [2]. It is very difficult for students to find the resources they are interested in in the massive information. Facing the fields they are not familiar with, it is difficult to identify what content is worth learning, which in turn affects the quality of learning. The basic courses of entrepreneurship education are inseparable from the management of teaching resources. Through personalized recommendation of resources, the coupling between students and professional courses, practical courses and other teaching contents can be improved to meet the practical needs of innovative and entrepreneurial talents training. In the era of mobile Internet, each user occupies a network node, and multiple nodes are connected to form a social network. The relationship and structure are the "trunk" of the whole social network, while knowledge is the "blood" flowing in the social network. The relationship chain formed between nodes, that is, the social network relationship, is the channel to ensure the rapid flow of knowledge. According to the user's historical data and behavior data, the personalized recommendation model of educational resources is established, and the resources that users are really interested in are selected from the huge information resource database and recommended to users. Whether in real life or in the network environment, the strength of a user's social relationship will directly affect the user's knowledge behavior. Users with strong connections in the network are usually groups with the same interests or similar viewpoints, and it is easier for them to establish trust and reciprocal relationships, and to transmit information more efficiently. Based on the social network platform, this paper proposes a personalized recommendation method for innovation and entrepreneurship education resources, which provides certain theoretical support and practical basis for the practice of entrepreneurship education in colleges and universities.

Therefore, a personalized recommendation method of innovation and entrepreneurship education resources based on social network platform is proposed. Through the behavior of learners, analyze the types of innovation and entrepreneurship education of learners. Based on the communication function of the social platform, extract the characteristics of users' knowledge needs. Using the interactivity and similarity between learners, construct learning groups of educational resources. Recommend relevant resources to learners through their evaluation of educational resources.

2 Personalized Recommendation Method of Innovation and Entrepreneurship Education Resources Based on Social Network Platform

2.1 Correlation Analysis Between Learners and Innovation and Entrepreneurship Education Resources

The learner's behavior is mainly divided into two types: explicit feedback behavior and implicit feedback behavior, to a certain extent, it determines the level of the score. Explicit feedback behaviors are mainly learners' evaluation and scoring of learning resources. Implicit feedback behaviors mainly include the number of times the learner clicks on each link, the browsing time of a certain web page, the learner's download of resources, and the learner's operations on a certain part of the document, such as copying and marking. Learners' repeated learning of a certain learning resource or some learning resources is of great help to understand learners' behavior and interests. The traditional collaborative filtering recommendation algorithm mainly depends on whether learners have learned some learning resources and their preferences for learners. It is lack of considering the learning times of different learners. As long as the learned resources are simple, it is considered that learners are interested in the resources. Innovation and entrepreneurship education resources are stored in the resource base of colleges and universities, and have the characteristics of digital processing, network transmission, large storage capacity, diversified retrieval, autonomous learning, and diversified presentation.

The resources of the resource library are rich and diverse. The resources involved in this article include documents, pictures, texts, videos and other types of resources generated in innovation and entrepreneurship projects. Usually, the number of learner's learning of the same resource or the same type of resource represents different degrees of preference, so the number of learning of the resource is a good measure of the degree of preference of the learner. Unlike search engines that require precise keywords, personalized recommendation methods aim to discover a user's underlying preferences and provide a personalized recommendation list based on a user's past activities and profiles. Based on the above analysis, this paper proposes a learner-innovation and entrepreneurship education resource association model, and defines the learner set as: $A = \{a_1, a_2, \cdots, a_x\}$, and the innovation and entrepreneurship education resource set as $B = \left\{b_1, b_2, \cdots, b_y\right\}$. Therefore, a binary relationship matrix consisting of the learner set and the innovation and entrepreneurship education resource set can be obtained, as shown below:

$$W_{xy} = \begin{bmatrix} w_{11} & w_{21} & \cdots & w_{x1} \\ w_{12} & w_{22} & \cdots & w_{x2} \\ \vdots & \vdots & \cdots & \vdots \\ w_{1y} & w_{2y} & \cdots & w_{xy} \end{bmatrix} \tag{1}$$

In formula (1), W_{xy} is the binary relationship matrix composed of the learner set and the innovation and entrepreneurship education resource set, the row vector represents the learner, and the column vector represents the learner learning the resource. w_{xy} represents the matrix element. These behaviors can reflect the interests of learners. In order to improve the accuracy of recommendation, this paper adopts a combination of explicit and implicit methods to construct a learner interest model. In the registration interface, let the learner choose the interest label that interests him, and then build the initial interest model according to the learner's choice. The frequency of learning a resource cannot be ignored. The learning frequency of learners to learning resources can reflect different degrees of preference, and the average frequency of resource learning can be defined as:

$$f'(a_x) = \frac{\sum_y f\left(a_x, b_y\right)}{c(a_x)} \tag{2}$$

In formula (2), $f\left(a_x, b_y\right)$ represents the total number of times that learner a_x has learned innovation and entrepreneurship education resources;$f'(a_x)$ represents the average number of times that a_x uses innovation and entrepreneurship education resources; c represents the number of innovation and entrepreneurship education resources that a_x has learned. In the learning process of learners, the explicit and implicit feedback information of learners, such as: evaluation of resources, downloads, viewing time, etc., are collected, and the learner's interest model is continuously updated according to this information. The resources of the resource library are metadata generated according to unified standards and specifications, which facilitates the sharing, management and retrieval of resources. If a learner has studied a certain learning resource more often, it can be considered that the learner has a high degree of attention to the resource or this type of resource. The resources of the resource library can be constantly updated and changed dynamically. Learners can search for learning resources in the resource library, and at the same time upload and share their useful resources to the resource library, so as to ensure the continuous development of the resource library [3]. Taking the average use times $f'(a_x)$ of innovation and entrepreneurship education resources as the critical value is the classification analysis of the recommendation model. When the learning frequency exceeds $f'(a_x)$, learners have a high degree of attention to this type of innovation and entrepreneurship education resources, and tend to recommend this type of resources.

2.2 Extracting User Knowledge Demand Characteristics Based on Social Network Platform

Social networking platforms provide users with the functions of acquiring and exchanging knowledge resources. The social network platform has the integration of virtual and real, fairness and pertinence. It uses Internet technology to create a huge place for knowledge exchange, and provides professional knowledge resources to specific users, thereby avoiding communication barriers caused by differences in identity and status. A social network refers to a collection of social actors and their interactions. A social network is often composed of multiple social actors and their relatively stable relationships due to their interactions and connections. In this process, the social network platform obtains user information and user search information, which is the user's knowledge demand information, which can be used to meet and predict user needs. After the service is over, users evaluate the social networking platform according to their own satisfaction and user experience [4]. A social network platform includes both an individual network of actors and a group network of actors. Among them, the individual network focuses on the network position and role of the individual user, as well as the status of interaction with others; the subgroup network studies how groups connect users through "bridges", and understands the interaction within each subgroup and between subgroups. Therefore, in the process of providing services on social network platforms, users directly express their knowledge needs, and also express their satisfaction with knowledge services.

The services provided by social network platforms are generally knowledge browsing, knowledge query and knowledge push. The interaction of innovation and entrepreneurship education resources on social network platforms is essentially a relationship based on information sharing, mutual assistance and collaboration. Knowledge demand is a sense of dissatisfaction with knowledge generated by social network platform users in a specific situation, and this sense of dissatisfaction or lack can help users achieve a certain goal [5]. Weak ties in social networking platforms expose users to different communities and organizations, provide users with more opportunities to acquire heterogeneous resources, and lay the foundation for interaction and cooperation between

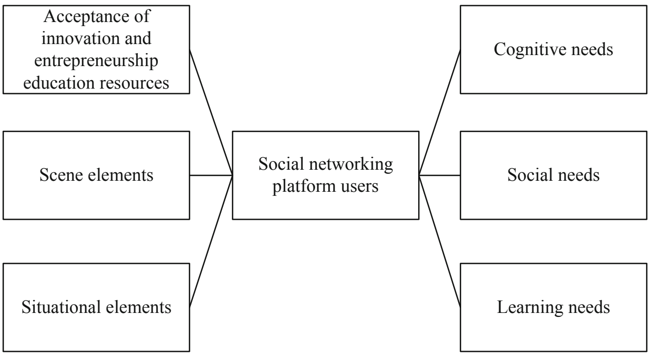

Fig. 1. Types of social network platform requirements

users. At different times and in different places, the knowledge needs of users are constantly changing. The types of requirements for social networking platforms are shown in Fig. 1.

Different from traditional knowledge community, user relationship is not only to maintain social relationship, but to further realize knowledge sharing, exchange and knowledge interaction through social relationship. In the social network platform, users can choose users who have the same interests, hobbies, and goals as their communication objects to communicate and interact with them. The strong relationship in the social network platform is a social relationship based on acquaintances composed of friends, relatives and colleagues. They have more homogeneity. Mutual trust is the premise of participating in social interaction. This trust relationship is embedded into the social interaction network structure, making the relationship between users more stable. The social demand comes from users seeking users with the same knowledge interests and knowledge preferences in order to meet the purpose of knowledge exchange, thus forming a knowledge relationship network, and through the knowledge relationship network to display knowledge achievements, publish knowledge and maintain the knowledge relationship network. User social demand motivation and results are shown in Fig. 2.

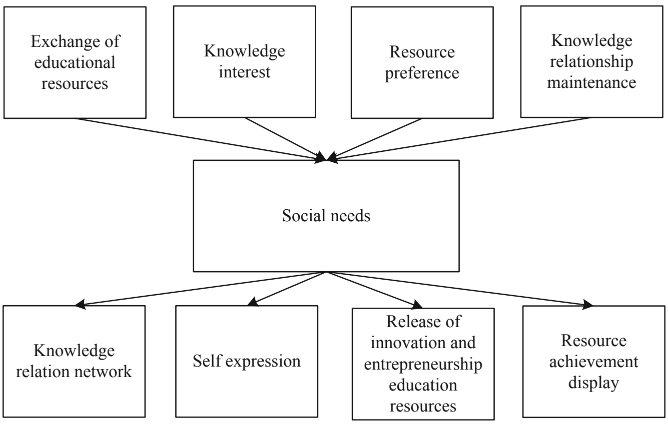

Fig. 2. User social needs

Information interaction is reflected in the interaction between learners and teaching elements, and is a crucial link in the interaction process. It mainly includes three forms of interaction between learners and learning resources, learners and learners, and learners and teachers. The openness of knowledge exchange also enables continuous updating of professional knowledge resources to ensure that the dynamic needs of user groups can be met at all times. Knowledge services provided by social networking platforms are driven by user needs. From the request of the service, the user browses through the knowledge provided by the social network platform or uses a search tool to retrieve it, and the user directly interacts with the social network platform.

2.3 Building Educational Resource Learning Groups Based on Social Relationships

In order to enhance the accuracy of innovation and entrepreneurship education resource recommendation, this paper considers the interaction and similarity between learners and constructs a multi-dimensional social relationship network graph model. For social network platforms, the knowledge needs of knowledge subjects and the realization of the value of knowledge subjects have become the driving force for the development of recommendation services on social network platforms. Social network platforms need to improve the recommendation function and provide users with innovative knowledge service models. Construct a weighted undirected graph, convert the learner model into points in the space, and at the same time divide and combine them according to different dimensions to form different subspaces, so as to describe the relationship between learners in a deeper and multi-dimensional way. At the same time, it can be projected to the specified dimension as required to obtain the learner relationship information in a specific low-dimensional space. Educational resource learning groups are composed of common users with the same views and interests on a topic, or a collaborative community based on a specific task. The users in the social network platform have knowledge needs, and the platform contains a lot of knowledge, which will form the knowledge flow between the platform and the users, that is, the knowledge flows from the platform group with more content to the user, thus forming a potential energy difference [6]. The feature combination descriptions with similar resource preferences and interaction in the discussion forum or similar resource preferences and similar common login locations can correspond to the projected dimensions in the graph model. This paper defines the key nodes in the social relationship graph as authoritative learners, and uses the calculation of degree centrality to find the core nodes. Authoritative learners have influence and prestige in educational resource learning groups, and the communication within and between groups realizes the flow of overall social network information. Node degree centrality can be calculated as follows.

$$u(p) = \frac{v(p)}{|\chi| - 1} \tag{3}$$

In formula (3), p represents the node; $u(p)$ represents the degree centrality value of p; $v(p)$ represents the number of nodes directly connected to the node p through the edge; χ represents the projection result of the point set under the specified dimension. The final degree centrality value is obtained by normalizing the number of nodes in the graph except for the point p itself. Authoritative learners are willing to share innovation and entrepreneurship education resources, and social network platforms are highly recognized. In the process, authoritative learners' sense of achievement is enhanced, and they are willing to contribute resources to social network platforms, thus forming a virtuous circle. Knowledge published by knowledge publishers on social networking platforms is recommended by the platform, which can enhance the knowledge publisher's sense of achievement and enhance others' trust in the publisher. After obtaining the learner feature representation in the two-dimensional space, perform the KMeans algorithm to cluster similar learners according to the spatial distance. In the iterative process, each sample point is firstly assigned to the nearest center point according to the distance, and the Gaussian kernel function is used as the distance to define the edge weight. The specific calculation method is shown in formula (4).

$$h(a_1, a_2) = e^{-\eta \|a_1 - a_2\|^2} \tag{4}$$

In formula (4), $h(a_1, a_2)$ represents any two points in the learning user sample set; e is a natural constant; η represents the parameters of the Gaussian function used in constructing the adjacency matrix. Calculate the average coordinate value in the space according to the newly divided category, update the center point corresponding to each category, and output the final clustering result after the classification result is stable. The platform understands the information matching degree, system function deficiencies and service defects through user feedback information, and more accurately understands user needs. Users can avoid possible wrong operations during interaction by browsing other people's feedback. For learners, attributes such as their professional background, learning resource preferences, forum responses, and common login locations can be used. Learners with more common or similar attributes can be considered to be more closely related. User-generated information is generated from the interaction process between users, and a large amount of content containing users' opinions and ideas generated by users during the interaction process not only enriches the information resources of the academic community, but also enhances the community's knowledge innovation ability. For learners with similar resource preferences and interaction in the discussion area, there is a high probability that they have similar learning and research directions and needs for the same type of resources, and such characteristics can be used to recommend learning partners to each other.

2.4 Design a Personalized Recommendation Model for Innovation and Entrepreneurship Education Resources

In the personalized recommendation of innovation and entrepreneurship education resources, this paper mainly updates the learner's interest vector model through the learners' evaluation of text resources. In this paper, there are five types of evaluation: not interested, not very interested, general, more interested, very interested. The update process of the learner interest vector model is as follows. The learner behavior, that is, the preference information representation part, collectively represents each learner's overall choice information about the educational resources he chooses. The collaborative attribute representation part mainly includes two parts: learner clustering and educational resource category information representation, that is, the number of learning groups divided by learners and the total number of educational resource categories. In the multi-combination structure of learning resource characteristics, it mainly includes innovation and entrepreneurship education resources, knowledge objectives or learner concepts corresponding to the resources, the difficulty level of the resources being set, and the learning time for which the resources are set [7]. Establish a text collection of innovation and entrepreneurship education resources that learners have browsed and evaluated, and extract the text vector model of each text from the resource library. The coding in this part adopts the one-hot coding method after converting the numerical features into continuous features, and the numbers are represented by the corresponding group labels and preset course categories. Traverse all the texts in the text set, and merge the feature word information of the text with the current learner interest vector model. The calculation formula of the feature word weight value is as follows:

$$\varpi = \frac{\ln(t_1 - t_2)}{b} + \vartheta \varepsilon \mu \tag{5}$$

In formula (5), ϖ represents the weight of the feature word; t_1 is the current date of the social network platform; t_2 is the date when the learner's interest vector model last modified the keyword; b represents the half-life, which is set to 7 in this article, which means that people's interest will decay to half of the original after seven days; ϑ represents the learning rate, which is 0.5 in this article; μ represents the keywords of interest points; ε represents the learner The scores corresponding to the evaluation of innovation and entrepreneurship education resources are $-2, -1, 0, 1,$ and 2, respectively. In the multi-group structure of learner's characteristics, it mainly includes the learner, the desired learning goal, the level of difficulty of learning expectations, the upper and lower limits of the expected learning time, and the type of media and content. Since learners are used to recommend resources to each other, it is necessary to consider the diversity of resources accepted by learners, the weight of each learner in the resource recommendation process, whether learners participate in the recommendation process and the proportion of participation. Corresponding constraints can be added to ensure that enough learners participate in resource sharing while maximizing the interests of resource acquirers. Sort the n-dimensional vectors of the learner's interest vector model from large to small according to the size of the feature word weight value, and take the top 20 items with the largest weight value and normalize them. Find user groups with similar interests to the target user or item sets with similar characteristics to the target item. The cosine similarity formula is used to calculate the similarity between the text vector model and the learner's interest vector model. The calculation formula is as follows:

$$\sigma(g_1, g_2) = \frac{\sum_x g_1 g_2}{\sqrt{\sum_x g_1^2}\sqrt{\sum_x g_2^2}} \tag{6}$$

In formula (6), $\sigma(g_1, g_2)$ represents the similarity between the text vector model and the learner interest vector model; g_1 is the weight value of keywords in the text vector model of innovation and entrepreneurship education resources; g_2 is the weight value of keywords in the learner interest vector model. Since different users have different interest characteristics, their preferences for resources have strong subjective factors, resulting in different scoring scales. By improving the cosine similarity algorithm, the user's average score for all resources can be subtracted when calculating the user's score for an item, so that the similarity calculation can be more accurate. The text vector model of innovation and entrepreneurship education resources is compared with the learner's interest vector model, and the top 10 learning resources that are more similar to the learner's interest vector model are recommended to the learners. Based on the above process, the design of the personalized recommendation method for innovation and entrepreneurship education resources based on the social network platform is completed.

3 Experimental Studies

3.1 Experiment Preparation

In order to verify that the personalized learning resources of innovation and entrepreneurship education resources recommended by this method meet the needs of learners, an experimental test is carried out. Experimental data includes not only learning resource data, but also historical data of learners' learning. In existing public datasets, such as edX, World UC and other datasets, they provide dozens of attributes, including course data, learning learner information and learner behavior data. This paper extracts some online learning data information from a university student innovation and entrepreneurship resource database system. At present, the number of users who have successfully registered in the innovation and entrepreneurship resource database system is 268. Users with low downloads are removed through user filtering. There are 237 valid users, 692 project resources, and 1068 project ratings. Combined with the actual situation of learners and learning resources, some data are completed to form the experimental data set of this paper.

3.2 Results and Analysis

In the experimental data set, with the accuracy of recommendation as the evaluation standard, the higher the accuracy, the better the recommendation effect. This paper randomly selects 50–250 users in increments of 50 each time, and the length of the fixed recommendation list is 10. A total of 5 rounds of experiments were conducted, with 10 tests in each round, and the final results were averaged. In this way, with the increase of the number of users, the performance of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is verified. In this experiment, the accuracy is selected as the evaluation standard to measure the overall effect of the recommended method. The accuracy index often uses F1 score value to reflect the quality of the index. It is the harmonic average calculated by accuracy rate and recall rate. Both the former two are taken into account. At present, this index has been widely used in recommendation performance verification. Therefore, this study also uses the F1-score value to evaluate the recommendation accuracy. The verification results of the design method in this paper on the data set are compared with the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning and multi-source data fusion, so as to make an accurate evaluation of the recommendation method. The personalized recommendation results of innovation and entrepreneurship education resources for 50–250 users are shown in Table 1, Table 2, Table 3, Table 4 and Table 5.

In the test of 50 users, the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is 0.8005; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on multi-source data fusion is 0.7853; While the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is 0.8328,

Table 1. Recommendation accuracy for 50 users

Testing frequency	Personalized recommendation method of innovation and entrepreneurship education resources based on social network platform	A personalized recommendation method for innovation and entrepreneurship education resources based on deep learning	A personalized recommendation method for innovation and entrepreneurship education resources based on multi-source data fusion
1	0.8245	0.8079	0.7840
2	0.8387	0.7983	0.7785
3	0.8264	0.8096	0.7867
4	0.8151	0.8065	0.7931
5	0.8322	0.7957	0.8058
6	0.8418	0.7846	0.7926
7	0.8356	0.8013	0.7815
8	0.8325	0.8028	0.7772
9	0.8493	0.8009	0.7823
10	0.8322	0.7982	0.7720

Table 2. Recommendation accuracy for 100 users

Testing frequency	Personalized recommendation method of innovation and entrepreneurship education resources based on social network platform	A personalized recommendation method for innovation and entrepreneurship education resources based on deep learning	A personalized recommendation method for innovation and entrepreneurship education resources based on multi-source data fusion
1	0.7856	0.7549	0.7333
2	0.7823	0.7448	0.7416
3	0.7946	0.7569	0.7265
4	0.7888	0.7481	0.7387
5	0.7967	0.7642	0.7274
6	0.7924	0.7576	0.7301
7	0.7775	0.7417	0.7251
8	0.7893	0.7525	0.7292
9	0.7952	0.7403	0.7268
10	0.7815	0.7545	0.7136

which is 0.0322 and 0.0474 higher than that of deep learning and the personalized recommendation method based on multi-source data fusion.

In the test of 100 users, the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is 0.7515; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on multi-source data fusion is 0.7292; While the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is 0.7884, which is 0.0368 and 0.0592 higher than that of deep learning and personalized recommendation method based on multi-source data fusion.

Table 3. Recommendation accuracy for 150 users

Testing frequency	Personalized recommendation method of innovation and entrepreneurship education resources based on social network platform	A personalized recommendation method for innovation and entrepreneurship education resources based on deep learning	A personalized recommendation method for innovation and entrepreneurship education resources based on multi-source data fusion
1	0.7540	0.7134	0.7089
2	0.7587	0.7268	0.7167
3	0.7468	0.7186	0.7036
4	0.7536	0.7243	0.7023
5	0.7555	0.7115	0.6905
6	0.7511	0.7301	0.6818
7	0.7410	0.7227	0.7144
8	0.7472	0.7155	0.7071
9	0.7525	0.7292	0.6952
10	0.7469	0.7166	0.6858

In the test of 150 users, the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is 0.7208; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on multi-source data fusion is 0.7006; While the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is 0.7507, which is 0.0298 and 0.0501 higher than that of deep learning and personalized recommendation method based on multi-source data fusion.

In the test of 200 users, the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is 0.6775; The average accuracy of the personalized recommendation method of

Table 4. Recommendation accuracy for 200 users

Testing frequency	Personalized recommendation method of innovation and entrepreneurship education resources based on social network platform	A personalized recommendation method for innovation and entrepreneurship education resources based on deep learning	A personalized recommendation method for innovation and entrepreneurship education resources based on multi-source data fusion
1	0.7208	0.6845	0.6548
2	0.7146	0.6787	0.6415
3	0.7285	0.6764	0.6577
4	0.7367	0.6851	0.6686
5	0.7231	0.6815	0.6752
6	0.7255	0.6646	0.6663
7	0.7322	0.6573	0.6521
8	0.7213	0.6725	0.6532
9	0.7179	0.6858	0.6475
10	0.7122	0.6892	0.6506

innovation and entrepreneurship education resources based on multi-source data fusion is 0.6567; While the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is 0.7233, which is 0.0457 and 0.0665 higher than that of deep learning and personalized recommendation method based on multi-source data fusion.

In the test of 250 users, the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is 0.6287; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on multi-source data fusion is 0.6130; While the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is 0.6868, which is 0.0581 and 0.0738 higher than that of deep learning and personalized recommendation method based on multi-source data fusion.

According to Table 1, Table 2, Table 3, Table 4 and Table 5, the average accuracy of the three methods is compared, and the comparison results are shown in Fig. 3.

It can be seen from Fig. 3 that the average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on deep learning is between 0.6287 and 0.8005; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on multi-source data fusion is between 0.6130 and 0.7853; The average accuracy of the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is between 0.6868 and 0.8328, which is higher than the average accuracy of the comparison method, which proves that

Table 5. Recommendation accuracy for 250 users

Testing frequency	Personalized recommendation method of innovation and entrepreneurship education resources based on social network platform	A personalized recommendation method for innovation and entrepreneurship education resources based on deep learning	A personalized recommendation method for innovation and entrepreneurship education resources based on multi-source data fusion
1	0.6946	0.6244	0.6047
2	0.6882	0.6387	0.6287
3	0.6765	0.6465	0.6165
4	0.6822	0.6236	0.6122
5	0.6853	0.6355	0.6051
6	0.6916	0.6424	0.6090
7	0.6949	0.6312	0.6166
8	0.6875	0.6248	0.6233
9	0.6754	0.6176	0.6028
10	0.6921	0.6023	0.6114

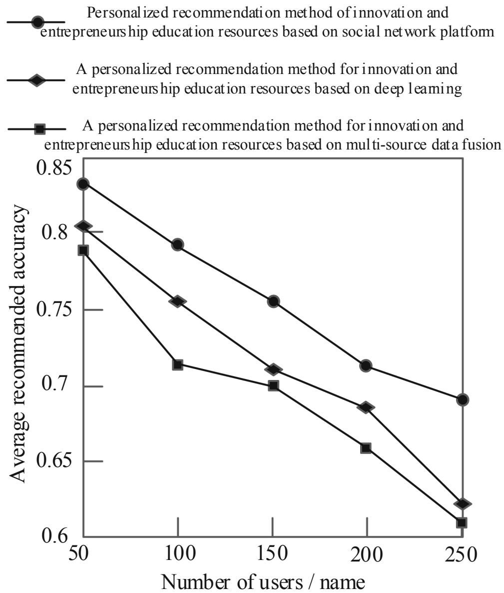

Fig. 3. Average recommendation accuracy of three methods

the personalized recommendation method of innovation and entrepreneurship education resources based on the social network platform is better.

It can be seen that the personalized recommendation method for innovation and entrepreneurship education resources designed in this paper is better than other recommendation methods in terms of F1-score value, which verifies the adaptability of this method to different scale data sets. The experimental results show that the method proposed in this paper is consistent and pertinent with the actual innovation and entrepreneurship education resource recommendation problem.

4 Conclusion

Innovation and entrepreneurship education is a practical education to consciously cultivate the entrepreneurship consciousness of college students and the innovative ideas of entrepreneurs. The rapid development of educational big data enriches learners' learning methods, but it also makes it difficult for learners to obtain suitable learning resources from massive online learning resources for learning. It is necessary to introduce personalized recommendation technology to provide learners with appropriate learning resources. Taking innovation and entrepreneurship education as the research object, this paper proposes a personalized recommendation method of innovation and entrepreneurship education resources based on social network platform. The combination of traditional platform recommendation and Resource Recommendation and sharing among learners makes the learning process more efficient. The experimental results show that this method is feasible and accurate to recommend personalized innovation and entrepreneurship education resources to learners, it can be applied to the recommendation system of innovation and entrepreneurship education. There is still much room for improvement in the work related to social relationship analysis and learning partner recommendation in this study. In future work, learners' negative feedback behavior can be considered and applied to recommendation methods.

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References

1. Shi, L., Li, J.: Innovation and entrepreneurship education in colleges and universities: connotation, dilemma and path optimization. Heilongjiang Res. High. Educ. **39**(2), 100–104 (2021)
2. Wang, Z., Wang, T.: A study on the construction of an innovation and entrepreneurship education ecosystem: the role and function of China's higher education. J. Hangzhou Teach. Coll. (Soc. Sci. Ed.) **43**(5), 63–69 (2021)
3. Li, X., Liang, H., Feng, J., et al.: Design of personalized learning resource recommendation system for online education platform. Comput. Technol. Dev. **31**(2), 143–149 (2021)

4. She, X., Zhan, Q., Wu, C.: Multi-node information resource allocation recommendation algorithm based on collaborative filtering. Comput. Simul. **38**(6), 419–423 (2021)
5. He, Y., Xu, W.: Research and application of personalized education resource recommendation algorithm based on high-dimensional tensor decomposition. WuxianHulian Keji **18**(10), 114–115 (2021)
6. Yang, X.: Research on the application of user portrait in the personalized recommendation of educational resources. Fujian Comput. **37**(1), 52–53 (2021)
7. Wu, Y., Cai, Q., Liu, Z., et al.: Digital resource recommendation based on multi-source data and scene similarity calculation. Data Anal. Knowl. Discov. **5**(11), 114–123 (2021)