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Research on the Application of Knowledge Graph in Constructing Ecological Chain of Supply of Lifelong Learning Resource Base

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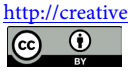

Abstract

Online learning has become the most important mode of lifelong learning and one of the important directions of education transformation. Online learning needs the support of digital resources. The digital learning resource library is an important part of the new infrastructure of education in the digital era, which plays an important role in supporting online education, promoting the reform and transformation of education digitalization, and promoting the construction of the lifelong education system. The application of new technologies can promote the construction of digital resources and form an ecological chain of resource base construction and supply. Interdisciplinary knowledge association, presentation and intelligent push are constructed through open domain knowledge graph technology to form effective utilization of large resources and generate learning paths and resource association distribution map, which is of great significance to promote the application of big data in education and the development of intelligent education research.

Subject Areas

Education Big Data Application and Intelligent Education Research

Keywords

Knowledge Graph, Artificial Intelligence, Lifelong Learning, Digital Resources, Intelligent Recommendation

1. Introduction

Lifelong learning has become the consensus of most countries in the world. In 2020, China's online learning users exceeded 400 million (CNNIC), and global

online learning users exceeded 1.5 billion. The development trend of online learning on such a scale also puts forward higher requirements for the support of digital learning resources. In July 2021, the Ministry of Education and other six departments issued the "Guidance on Promoting the Construction of new education Infrastructure and Building a high-quality education Support system". Digital learning resources, as the core element of information education development, have become one of the key deployment contents of new education infrastructure. It is clearly pointed out in the opinions that we should optimize the resource supply service, establish a great educational resource service mechanism, construct the discipline knowledge graph, upgrade the resource search engine, and provide users with massive high-quality resources and accurate resource services [1] [2].

In recent years, under the background of continuous construction of a lifelong education system, universities and educational institutions at all levels have invested heavily in the construction of digital learning resources. Although the resources have begun to take shape, it has not fundamentally solved the problem of lack of educational resources. The main problems are as follows: first, a large number of high-quality digital learning resources have not been effectively gathered; Second, the lack of accurate resource service mode, high-quality resources cannot reach the masses, does not change the current social lifelong learners' demand for high-quality education resources; Third, the mechanism of resource co-construction and sharing has not yet been formed, and the quality of resource construction and technology application needs to be improved.

We have invested a large amount of capital in building a huge resource base, but it is still far from meeting the needs of the development of a learning society. The main reason is that resources are not fully utilized, and the construction and supply of resource bases have not formed a healthy ecological chain. How to present huge digital resources to learners in real-time, dynamically and accurately, and effectively provide resource services and supplies requires the full use of advanced artificial intelligence technologies such as knowledge graphs and deep learning [3].

Fortunately, in recent years, knowledge graph technology has developed rapidly in the field of big data mining. Especially, a knowledge graph based on an open domain has a good performance of sustainable optimization in intelligent resource push and interdisciplinary knowledge aggregation and presentation, which is conducive to realizing intelligent resource aggregation and accurate supply. Therefore, the research based on the knowledge map of lifelong learning intelligence gathering and accurate supply services of digital resources research will contribute to the high-quality learning resources construction cycle, promotes the construction and development of lifelong education system, help people to high quality, high level of education and the contradiction between the shortage of education resource supply, at the same time, It is also an important research topic under the background of new education infrastructure.

Literature research has found that it has become a consensus to promote the construction of the lifelong education system through the application of new technologies such as artificial intelligence in the construction of digital learning resources. The application of knowledge graph technology in digital learning resources has become a research hotspot in the field of educational informatization in the past two years, which has changed the traditional resource recommendation mode. Knowledge map with powerful semantic processing capacity, with intuitive formal, structured to provide knowledgeable service, the traditional curriculum discourse study Internet (web page) into the knowledge points and their mutual relationship between the Internet (knowledge) of the study, greatly improving the learning efficiency and learning experience, innovation of knowledge organization methods. In 2020, Fu *et al.* (2020) proposed the HAO Map, which integrates human intelligence (HI), artificial intelligence (AI) and organizational intelligence (OI), to achieve real-time generation and visualization of text and speech knowledge maps, which enables researchers to see the application prospect of knowledge maps in the field of digital learning resources application. With the globalization of lifelong learning and the development of online learning, the mining of digital learning resources based on knowledge graphs, especially the graph construction of audio and video resources based on open fields, urgently needs the attention and in-depth research of educators and educational resource developers [4] [5].

2. Lifelong Learning Digital Resource Library Supply Ecological Chain Construction

This study takes Zhejiang Province's lifelong learning digital resource database as the entity and uses knowledge graph, NLP, deep learning and other technologies to conduct specific research on resource content, resource form, resource operation, learners and co-construction and sharing alliance in the resource database. The database has gathered nearly 50,000 high-quality learning resources covering higher education, vocational education, continuing education and community education, providing high-quality learning resources for more than 1 million people in education for senior citizens, community education, rural education and artisan training. The resource library basically realizes the functions of efficient resource management, standardized resource description, open resource aggregation, and cloud concept resource service and so on. However, the intelligent resource recommendation service and multi-terminal resource visual presentation need to be further developed. Based on this, this study will make use of the latest artificial intelligence technology to build a knowledge graph model in line with the research perspective, realize the visual presentation of resources and intelligent recommendation system, and build the ecological chain of resource supply on this basis. At the same time, based on the research content and research framework, under the guidance of lifelong education theory, integrating learning scientific principles, improving the training model, and based on the effectiveness of the knowledge graph application system, build-

ing the key links of the ecological chain of resource library operation and supply, and improving the construction of the entire ecological chain of resource library [6].

Research in Zhejiang province is based on the digital repository, lifelong learning, the use of artificial intelligence technology such as knowledge map to change the supply of digital resources application pattern, improve resource utilization, and from the resources used to collect data on resource distribution and the analysis of application requirements, etc., through qualitative increment, with construction, form a virtuous cycle, effectively promote education reform, digital To serve the construction of a learning society, promote the construction of a lifelong education system, and promote the construction of "new resources" under the background of the development of new education infrastructure. The ecological chain architecture of lifelong learning resource library construction and operation is shown in Figure 1.

The core architecture concept of this ecological chain mainly includes three aspects:

1) Create a new mode of resource development and application with the goal of technological application innovation and concept upgrading. Using relevant knowledge map, the field of artificial intelligence technology developed for visualization of resources, and can realize resource intelligent recommendation and question answering system, recommend resources in the right way to need most learners, according to the coverage in the face of various fields to provide lifelong learning resources, resource requirements, and use the "block chain + credit bank" record learning outcomes. At the same time, the node characteristics

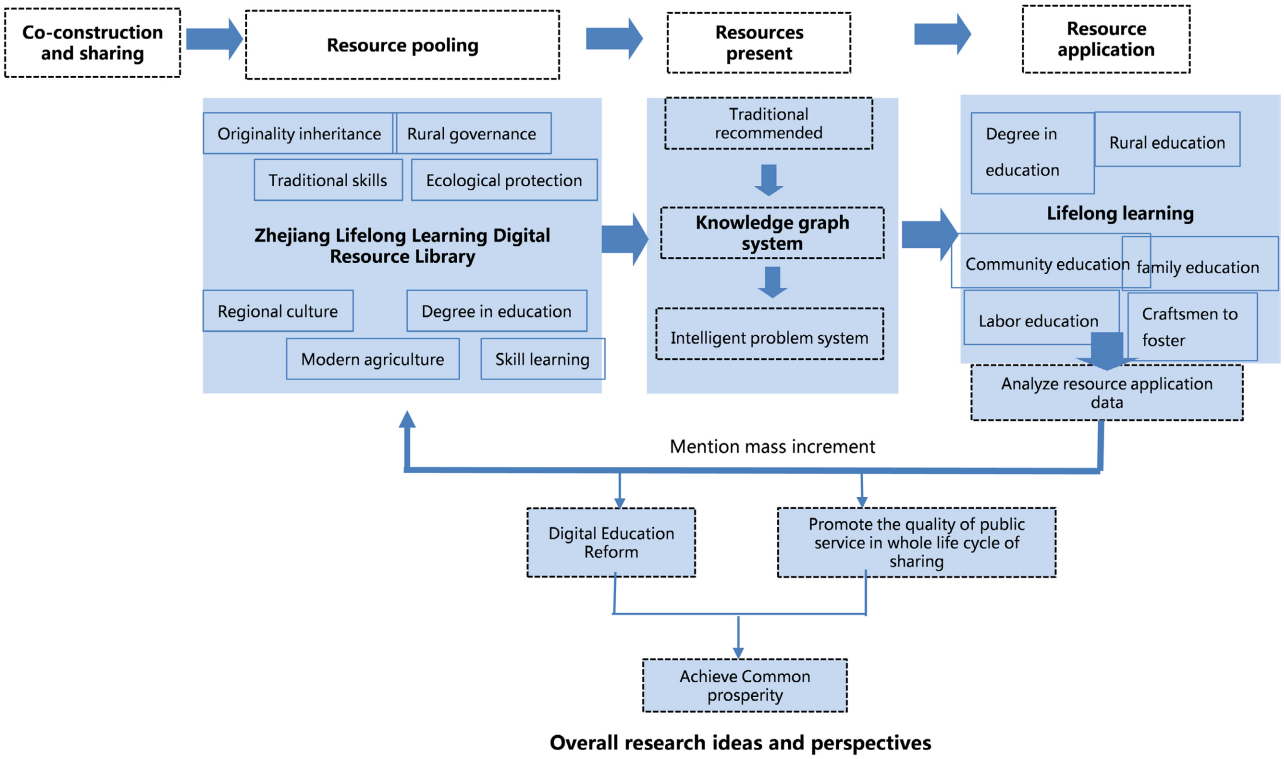

Figure 1. Ecological chain architecture of resource library construction and operation.

of the Neo4j graph database are conducive to generating user learning paths, collecting user data, providing a basis for the improvement and increment of the resource database, and forming positive feedback for the construction and management of resource database [7].

2) To realize the scientific construction and evaluation of learning resources by integrating learning principles and quantifying indicators. Providing scientific learning is a prerequisite for the construction and utilization of learning resources. One of the theoretical chains of this study is how to integrate the indicators of lifelong education theory and principles of learning into the development, presentation and evaluation of digital learning resources after quantification and form positive feedback on resource library improvement and increment. Specifically, it includes three aspects:

Firstly, the knowledge chain of meaningful learning is established by using the principle of active processing. In the process of lifelong learning, using relevant material to form a coherent representation and the choice of materials and activate the original knowledge in long-term memory, with knowledge map visualization and intelligent push for resources, realize the suitable scheme of active learning, let learners according to the knowledge map of knowledge increment of selective coherent study, The learned knowledge is intuitively integrated with the learner's original knowledge.

Secondly, the circulation chain of resource reorganization and aggregation is established based on dual channels. The language channel of processing speech materials and the visual channel of processing graphic materials are used to design and utilize multimedia resources, and the micro-class and short video resources are designed and developed based on the limited capacity. The scientific principles of learning are integrated into the development of knowledge points [8].

Thirdly, the ecological chain of theoretical grafting of new technology applications and knowledge graphs is established. The explosive growth of artificial intelligence technology is inseparable from deep learning, and the uninterpretability of deep learning inhibits the application of artificial intelligence. The combination of knowledge graphs and deep learning technology enhances the interpretability and controllability of technology applications. Integrating lifelong learning theory and learning science principles into machine learning and algorithm improvement, constantly improving model construction, and improving the ecological chain of lifelong learning resource library construction and operation through technology.

3) Build an ecological chain of lifelong learning resources based on open sharing and deep application of resources. To achieve high-quality resources sharing, solve the shortage of high-quality resources, multi-channel multipath open high-quality education resources sharing, security education investment to the countryside, tilt, weak schools, poor areas to improve the function, strengthen integration, enlarge high-quality resources effect, deepening the study achievement in talent assessment, employment and recommend scenarios

of collaborative innovation, let more people enjoy the high-quality service resources.

3. Construction of Knowledge Graph Model of Lifelong Learning Resource Base Based on Open Domain

Current knowledge graph research is mainly focused on vertical domain knowledge graph research, such as the construction of curriculum or discipline knowledge graph research. However, in the field of lifelong learning, learners' learning of a knowledge point need not be limited to a certain course or discipline, which is not conducive to the retrieval and learning transfer of full knowledge. Therefore, it is necessary to develop an interdisciplinary knowledge graph model based on the open domain for lifelong learners. The construction and application framework of knowledge graph is shown in Figure 2. There are four main tasks: knowledge extraction, knowledge fusion, knowledge reasoning and graph application [9].

In terms of data storage, this research adopts a high performance, embedded and lightweight graph engine Neo4j graph database and stores data on the network to form a knowledge graph. Its application can be extended to the visual presentation of knowledge points, question and answer of resource retrieval, intelligent recommendation system, annotation of video resource knowledge points, semantic retrieval of video resources, cross-resource association of knowledge

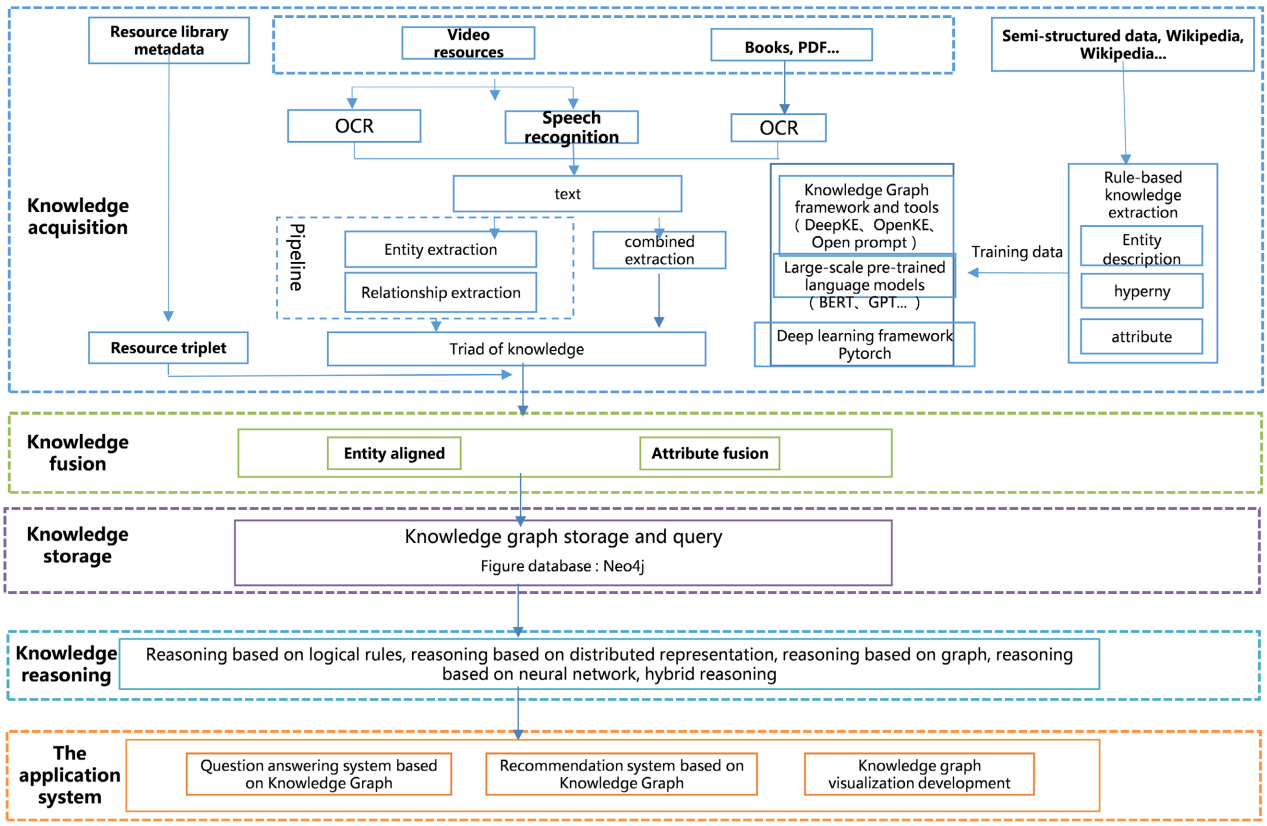

Figure 2. Knowledge graph construction and application framework.

points and other application fields. The graph model will be constantly trained and optimized through practical application [10].

1) Knowledge extraction

Knowledge extraction is a key task in atlas construction. It can be implemented in three steps: entity extraction (NER), relation extraction (RE) and attribute extraction. For attribute extraction, websites such as Baidu Encyclopedia and Wikipedia can be crawled by Python crawler as the basic corpus. There are a variety of entity extraction methods. This study mainly adopts the current mainstream keyword extraction technology based on TextRank. The TextRank value calculation method is as follows:

$$S\left(v_i\right)=\left(1-d\right)+d\sum_{\left(j,i\right)\in\varepsilon}\frac{w_{ji}}{\sum_{v_k\in out\left(v_j\right)}w_{jk}}S\left(v_j\right)$$

In the process of building this model, the joint extraction method and Pipeline method are comprehensively used in relation to extraction. Joint extraction is to model entity extraction and relation extraction in a unified way and extract header and tail entities and relation triples at the same time. The difficulty of joint extraction lies in how to strengthen the interaction between the entity model and relational model. It is found that the current popular deep learning method can be used to directly extract the Pipeline method to extract entities first, and then the entity data obtained from Baidu Encyclopedia can be used as training data for keyword extraction. Then, the large-scale pre-trained language model is invoked by Prompt Learning to complete the relation extraction. At present, the commonly used large-scale pre-training language models are relatively mature, such as BERT, GPT, T5, etc.

BERT can be understood as a very large trained language model, covering as much knowledge as possible, which can be used as a pre-processing module for many tasks, similar to the pre-processing module.

GPT is more used for natural language generation, such as writing articles, writing poems and other creative tasks, and it is essentially a language model. A language model is basically a machine learning model that can predict the next word based on the part of a sentence. The most famous language model is the phone keyboard, which prompts you for the next word based on what you type.

T5 is a masterpiece that incorporates many of the developments since Bert.

2) Knowledge fusion and reasoning

Knowledge fusion mainly includes entity alignment and attribute fusion. The purpose of knowledge fusion is to merge data from different sources and complete the fusion of the schema layer and data layer. In this study, the fusion of data layers mainly includes entity alignment, verification and evaluation of new entities and relationships so as to ensure the consistency and accuracy of the knowledge graph. Specific tasks include Disambiguation, Entity Resolution and co-reference Resolution. Knowledge reasoning is mainly based on rule reasoning, and the rule methods used are adjoint reasoning and reverse reasoning [11].

3) Solution of cold start problem in atlas model construction

Compared with the vertical domain, the first problem to be solved in the construction of an open domain knowledge graph is the cold start problem. Taking the construction of lifelong learning digital resource database knowledge graph as an example, through preliminary research, it has been found that using the Prompt learning technology is a feasible solution. The Prompt learning method is naturally suitable for low-resource scenarios, and has obvious gains in the direct prediction of NLP tasks under semi-supervised, few samples or even zero samples conditions. Using prompt-learning technology, therefore, in the task in the existing knowledge extraction to join the training language models of large-scale, prompt improvement template, in less time, under the condition of single even zero learning, stimulate large-scale semantic understanding potential training language model, the potential knowledge into a comprehensible form of knowledge map visualization, Use resources effectively by mining knowledge association.

4. Application of Interdisciplinary Knowledge Graph Based on Open Domain

Based on the above technical scheme and model, according to the characteristics of the digital resource database, the text processing of more than 40,000 audio and video resources in the resource database is carried out by using personalized recommendation, crawler technology, information extraction, multimedia text parsing, text clustering, speech recognition and other technologies, and a corpus and algorithm tool library is established. The knowledge concept recognition, knowledge concept relation recognition and knowledge graph visualization are realized. The following figure is the algorithm effect diagram of automatically constructing a knowledge graph based on the unstructured text in the resource library. The model-related algorithms will be further optimized according to subsequent applications.

The key technologies and corresponding tools used in the research mainly include Prompt learning based on remote supervision large-scale pre-training model, deep learning technology, text data mining and other technologies. Related applications include Open Prompt, Open KE and Pytorch deep learning. With the improvement of the knowledge graph model, its main applications include the following three aspects:

1) Develop an intelligent resource recommendation and visual presentation system based on a knowledge graph.

Based on the existing provincial lifelong learning digital resource base of the project, the paper innovates the resource presentation and recommendation mode through knowledge graph and other technologies, avoids the shortcomings of traditional resource recommendation methods such as passive search and inability to carry out resource association, and fundamentally improves resource utilization and learning efficiency [12].

2) The application of cross-resource association, cross-resource retrieval and

visual presentation of knowledge points. Based on the interdisciplinary knowledge graph, the video resources in the resource library are taken as the basis, and multi-source heterogeneous data are fused. The resources in the resource library are digitized by OCR/ASR and other technologies. The digital resources are structured by natural languages processing technologies such as entity mining, relation extraction and attribute complement. Construct a multi-level knowledge graph from curriculum to curriculum group to cross-major [13].

3) Generate a learning path and resource application distribution map. In this study, the knowledge graph is constructed using the Neo4j graph database, which is a high-performance, embedded and lightweight graph engine that can store data on the network, which is an important attribute to promoting the application of knowledge graph. The applications of the interdisciplinary knowledge graph model based on the open domain include a visual presentation of knowledge points, question answering and an intelligent recommendation system for resource retrieval, and extended applications such as annotation of video resource knowledge points, semantic retrieval of video resources, and cross-resource association of knowledge points. Applications such as user learning path, video resource knowledge point annotation and knowledge point cross-resource association are generated based on the characteristics of the Neo4j graph database, which are also important research to promote educational intelligence and educational resource evaluation.

5. Conclusions

After the knowledge graph model is constructed, the graph visualization system, intelligent recommendation and question answering application system can be developed. In a knowledge graph visualization system, entities and entity relations of the knowledge graph are mainly presented. Entities are represented as nodes, and entity relationships are represented as edges between nodes. In the lifelong digital resource knowledge graph, the entity nodes can be divided into three types: course entity node, resource entity node and knowledge entity node. The course entity node represents the course, the resource entity node represents the resource, and the knowledge entity node represents the domain knowledge entity related to the resource. The development of a knowledge graph visualization system is only the first step of the application. In order to better promote the application of resources and fully exert the power of the knowledge map, we also need to develop applications based on the extension of the knowledge map; follow-up study mainly includes intelligent recommendation and question answering system; this system not only can quickly solve the learner's question, but also can better connection and spread knowledge, related knowledge introduction and targeted recommend teaching resources, Help users learn systematically. Three features are highlighted in the research and design process:

1) Realistic and leading. This study takes Zhejiang Province's lifelong learning digital resource library as the entity in order to better realize the effective utilization of resources, improve the construction and supply of resource libraries, and

better serve the construction of a learning society. The visual presentation and supply mode of digital learning resources can be changed by technical means so as to promote the construction and form a positive feedback loop to improve the quality and increase of the resource library. So that schools, communities, villages and other levels of application can find the corresponding field resources, enabling the digital reform of education, serving the construction of a learning society, to achieve common prosperity.

2) Persistence and ductility. The development and application of knowledge graphs have strong application development value; relying on knowledge graphs can generate a lot of related applications, such as intelligent question answering systems, knowledge graph recommendation systems and so on. These systems can promote data collection and analysis, improve the effective utilization of digital resources, and further improve the function of resource libraries [14].

3) Pioneering and demonstrative. The knowledge graph model and related applications based on lifelong learning digital resources can be made public on Open KE and other open source knowledge graph platforms. At the same time, the open source platform can be used to further improve and optimize the model and contribute to the research on the application of knowledge graphs in the open field. To become a pioneer in the development and application of the knowledge graph model of lifelong learning digital resources in open source platforms.

Found Project

Project Source 1: Lifelong Education Project of Zhejiang Open University in 2011, Research on Digital Learning Resource recommendation based on Knowledge graph (Project No.: ZSJY202102)

Project Source 2: The first batch of Ideological and political demonstration courses in colleges and universities of Zhejiang Province, the course name is "Introduction to Artificial Intelligence".

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Fang, Z.C. (2016) The Important Support of Digital Learning Resources in Lifelong Education Activities. *Continuing Education*, **30**, 8-10.

[2] Ke, Q. (2021) Construction of Digital Lifelong Education System in the Era of Artificial Intelligence. *China Adult Education*, No. 15, 12-15.

[3] Liu, Z.C. (2017) Further Study and Implement the Spirit of the 19th National Congress of the CPC to Accelerate the Construction of a Powerful Country in Education. *Educational Research*, **38**, 4-13.

[4] Ren, F.Q. and Huo, Y.Q. (2017) The Essence and Evaluation of Educational Equity. *Educational Research*, **38**, 159.

[5] Ren, W.M. (2007) Learning Society, Digital Learning Port and Public Service Sys-

tem. *Open Education Research*, **13**, 9-13.

[6] Zhao, J.N. (2015) Research on Course Digital Resource Recommendation Method Based on Knowledge Graph. Beijing University of Posts and Telecommunications, Beijing.

[7] Zhu, J. (2021) The Form and Logic of Digital Citizenship Education from the Perspective of Lifelong Education. *Modern Distance Education*, No. 04, 76-82.

[8] Isinkaye, F.O., Folajimi, Y.O. and Ojokoh, B.A. (2015) Recommendation Systems: Principles, Methods and Evaluation. *Egyptian Informatics Journal*, **16**, 261-273. https://doi.org/10.1016/j.eij.2015.06.005

[9] Kampffmeyer, M., Chen, Y., Liang, X.D., Wang, H., Zhang, Y.J. and Xing, E.P. (2019) Rethinking Knowledge Graph Propagation for Zero-Shot Learning. 2019 *IEEE/CVF Conference on Computer Vision and Pattern Recognition* (*CVPR*), Long Beach, 15-20 June 2019, 11479-11488. https://doi.org/10.1109/CVPR.2019.01175

[10] Khusro, S., Ali, Z. and Ullah, I. (2016) Recommender Systems: Issues, Challenges, and Research Opportunities. In: Kim, K. and Joukov, N., Eds., *Information Science and Applications* (*ICISA*) 2016, Springer, Singapore, 1179-1189. https://doi.org/10.1007/978-981-10-0557-2_112

[11] Lin, Y.K., Liu, Z.Y., Sun, M.S., Liu, Y. and Zhu, X. (2015) Learning Entity and Relation Embeddings for Knowledge Graph Completion. *Twenty-Ninth AAAI Conference on Artificial Intelligence*, **29**, 2181-2187. https://doi.org/10.1609/aaai.v29i1.9491

[12] Lyons, K.B. (2014) A Recommender System in the Cyber Defense Domain. Air University, Maxwell Air Force Base.

[13] El-Moemen Mohamed, S.A., Soliman, T.H.A. and Sewisy, A.A. (2016) A Context-Aware Recommender System for Personalized Places in Mobile Applications. *International Journal of Advanced Computer Science and Applications*, **7**, 442-448. https://doi.org/10.14569/IJACSA.2016.070360

[14] Paulheim, H. (2017) Knowledge Graph Refinement: A Survey of Approaches and Evaluation Methods. *Semantic Web*, **8**, 489-508. https://doi.org/10.3233/SW-160218