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# Research Status and Trend Analysis of Learning Resource Aggregation in the Era of Big Data\*

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*Abstract*—In the era of big data, the learning resources in the network are becoming more and more abundant, but it is difficult for learners to find suitable resources. Therefore, through resource aggregation, learners can accurately locate resources and utilize resources to optimize resource allocation and avoid waste. This paper systematically reviews the theories, technologies, and methods of learning resource aggregation, reviews the existing researches and practices, and proposes future research trends.

Keywords—learning resources; resource aggregation; semantic web; aggregation technology

#### I. INTRODUCTION

With the development of big data technology, the learning resources in the network are greatly enriched and expanded, which brings learners the autonomy and diversification of resource selection. At the same time, it also brings the problem of choosing the lost and cognitive overload. Faced with the highly decentralized and disordered learning resources, how to dynamically link learning resources, provide personalized and intelligent and efficient learning support services that can meet the needs of learners, and build an interrelated learning resource service system that needs to be solved urgently. To this end, the concept of learning resource aggregation has been proposed by scholars and put into practice by learning organizations and research institutions.

"Aggregation" refers to the relevant websites to select, analyze, and classify the vast amount of information on the Internet, and finally provide excellent and useful and more targeted information for netizens. Learning resource aggregation is the integration of learning resources through relevant technical means. Scholars at home and abroad have carried out a lot of explorations in theory and practice around the theory and methods of learning resource aggregation and the practice of resource aggregation. Yue Wang College of Humanities & Sciences of Northeast Normal University Changchun, China

#### II. THE THEORY OF LEARNING RESOURCE AGGREGATION

With the development of big data technology and learning theory, learning resource aggregation no longer relies solely on text clustering based on link and text content analysis represented by Google and Baidu, and is influenced by social context and user environment, so it is socialized. Interaction-centric aggregation research is gaining attention.

Chatti et al. analyzed the development trend of Elearning to the knowledge community, pointing out that traditional learning and knowledge management systems fail to bring great competitive advantages to organizations or individuals because their focus is often on technical issues. It should be seen as a social interaction between adults and people [1]. Singh explores the method of aggregating information based on social networks, pointing out that the aggregation of information based on social networks will be a new paradigm for learners and learners to solve problems together in the future [2].

Yu Shengquan put forward the idea of "learning meta", as a new type of learning resource organization, with reusable features, support learning process information collection and learning cognitive network sharing, and can realize the development of miniaturization and intelligence of self-evolutionary digital learning resources [3]. Zhao Wei et al. proposed the concept of "learning is the link of knowledge" and shifted the focus of research from resource aggregation technology to resource aggregation, transforming the main body of aggregation from "system" to "learner". Rely on the powerful semantic understanding and processing power of "person", and aggregate open learning resources [4]. Zhang Jianping proposed the idea of designing a new learning environment by using the social network model as a resource aggregation and recommendation framework, and analyzed the learning environment design elements such as individual learning space, learning resource aggregation mode and personalized recommendation engine construction. [5].

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## III. THE METHOD OF LEARNING RESOURCE AGGREGATION

## A. Metadata Level Based Aggregation

In the field of educational resources, metadata is applied to realize the discoverability of resources in the network, and it is expected to change from "people looking for resources" to "resources looking for people." Abel et al. of L3S Research Center in Hannover, Germany, studied the sharing model of distributed learning resources in Web2.0 environment, and compared the cluster-based, metadatabased, community-based knowledge information aggregation strategy [6]. Cao Shujin et al. summarized the metadata specification of content aggregation metadata RSS and ATOM, and explored the framework model of Web2.0 content aggregation metadata [7]. Huang Wenbi [8] believes that metadata association is an achievable way to collect resources in collections. On the basis of expounding the feasibility of using metadata to realize the aggregation of collection resources, this paper proposes to realize the semantic association of the collection resource objects.

## B. Aggregation Based on Associated Data

Linked data is a lightweight implementation model of the Semantic Web, which has attracted widespread attention in the academic world since Tim was introduced in 2006. The associated data uses the RDF data model, which uses URI named data entities to publish and deploy instance data and class data, so that the data can be revealed and obtained through the HTTP protocol. Bratsas and others use the wiki platform and content management system Drupal to personalize and develop, and publish the learning resources in the university as related data to facilitate the integration, sharing and utilization of network learning resources [9]. Wu Pengfei used the learning meta-platform as an example to use the associated data related technology to realize the semantic mapping of learning relationship data to RDF data in the learning meta-platform, thus constructing the semantic association of learning resources [10].

#### C. Aggregation Based on Recommendation System

The recommendation system is considered to be one of the most promising and effective tools for solving information overload problems. It collects and stores product and user information, analyzes current and past user behaviors, and provides users with content that meets user preferences based on the analysis results. Mainstream recommendation algorithms include recommendations based on collaborative filtering, content-based recommendations, and tag-based recommendations. Tang et al. proposed a new E-learning intelligent recommendation system, which can self-evolve. This system not only realizes the adaptability to learners, but also realizes the adaptation to the open network environment [11]. Chakraborty et al. investigated the use of user tags in the knowledge recommendation system, analyzed the methods of using tags to improve the performance of recommendation systems, and realized the semantic aggregation of knowledge information through the application of social tags and popular taxonomy [12]. Wang

Honglei took the lead in constructing a similar learning partner recommendation system model based on social tagging technology [13]. Bai Xue et al. use social tags to personally recommend learning resources, complete the effective aggregation of learning resources, and form learners' learning paths [14]. Xiong Huixiang et al. [15] proposed that the application of tags enables users with the same or similar characteristics to better aggregate information with each other and actively aggregate the personalized information of interest for users.

## D. Aggregation Based on Human Interaction

With the advent of the Web 3.0 era, more and more interpersonal resources and generative resources have attracted attention and are included in the scope of learning resources. Yang Xianmin et al. [16] proposed that the inclusion of information elements such as learning activities, interpersonal information, generative information, and semantic ontology into the scope of learning resource sharing has become a new trend in the development of learning resource aggregation models. Zhang Sainan [17] believes that "the Internet has changed from "interconnection of information" to "interconnection of people". People and their knowledge are bundled together and become a node in the Internet, which makes "people" both learning resources in the network. Consumers also become contributors to learning resources in the network." Resource aggregation based on interpersonal interaction has become a research direction for resource aggregation in the future.

Zhao Wei [4] believes that interpersonal network autonomous aggregation refers to the interpersonal resources that are useful to the learner's learning process through the learner's needs and personality characteristics, and aggregate into a social network. Xu Liujie et al. [18] proposed that learners as nodes in the network learning space not only acquire resources and knowledge, but also serve as a channel for resource and knowledge circulation. Therefore, interpersonal interaction can improve the development and utilization efficiency of resources.

## E. Aggregation Technology and Tools

The technologies for learning resource aggregation mainly include RSS, Mashup technology, data mining technology and semantic technology. RSS technology was first used in education. Subsequent mashup technology, by recombining different data sources, can generate a lot of added value, so RSS technology is gradually replaced by mashup technology. In addition, researchers use cluster analysis technology to provide personalized recommendation and optimization and improvement of information service technology for learning resource aggregation. The above several technologies for resource aggregation have their own characteristics. RSS technology is currently used less and is used for simple and linear information recommendation. Mashup technology has a great advantage in combining information from multiple websites and then pushing it to learners; clustering Analysis is often used for the processing of resource search results and personalized resource recommendations; Semantic Web technology has technically forward-looking advantages.

#### IV. THE PRACTICE OF LEARNING RESOURCE AGGREGATION

The learning resources in the network are increasingly rich. In the face of open and diversified learning resources, Chinese and foreign scholars have conducted fruitful research on the construction, utilization and aggregation methods of learning resources.

Tom designed and developed the "Real Travel" travel knowledge system in the Semantic Web environment to aggregate travel-related information. [19] The Newcastle University of England, JISC provides fund-supported curriculum resource aggregation project - dynamic learning map, in the BB platform, the use of semantic ontology technology, the effective integration of formal curriculum maps and personal learning files, realized The course content is centered on the effective aggregation of course resources. [20][21]

In China, Yu Shengquan and others use the concept of "learning meta" to learn theories and methods in related fields such as natural language processing and data mining, and use KNS network to aggregate learning resources. [3] Xiong Huixiang uses Widget's easy-to-produce features to define independent standards between different platforms and applications, making them compatible and aggregating cross-platform learning resources. [15] Han Xibin et al. based on the knowledge sharing theory, designed the organizational mechanism and technical framework of the "Tsinghua Education Online Resource Sharing Alliance", developed a resource integration platform, and aggregated high-quality learning resources. [22]

#### V. CONCLUSION

Throughout the Chinese and international research, many scholars and research institutions have carried out a large number of theoretical explorations and technical practice research around the issue of learning resource aggregation. However, the existing research is mostly based on the integration of external characteristics of resources, and the research of a small amount of semantic-based resource aggregation is not efficient. Therefore, future research should develop from the following aspects.

## A. Study on Learner Needs of Learning Resource Aggregation

The continuous and rapid development of information technology, especially the development of social networks, has greatly changed the way of learning. The interaction status of learners has also undergone new changes. The demand for learning resources has changed in terms of aggregation, correlation, and complexity. The acquisition of learning resources is also moving towards precision, personalization and intelligence. Learner needs research is a precursor condition for aggregating resources. Learners' cognitive levels, cognitive characteristics, and needs vary widely. Only by accurately understanding the learner's characteristics and preferences, such as the retrieval method, the way of obtaining resources, and the form of demand for resources, can the system accurately locate and recommend suitable resources to learners. At the same time, the dynamic change and tracking of learner preferences is also the focus of future research to be broken.

## B. Semantic-based Learning Resource Aggregation Research

The Semantic Web is an extension of the traditional Internet, and its development has brought new opportunities for the description, organization, retrieval and utilization of learning resources. Information in the Semantic Web is additionally given a clear, machine-readable meaning that enables better interaction and collaboration between people and machines. The basic condition for realizing the aggregation of learning resources is to discover the semantic association between resources and their intrinsic, and the way of resource organization established through semantic analysis and ontology. The aggregation of learning resources based on semantics is the aggregation and fusion of individual resources with intrinsic logical associations, making them a meaningful resource structure that helps to promote learning. Semantic technology provides a good guiding ideology for the realization of learning resource aggregation in terms of resource organization, reuse and sharing. The semantic organization of learning resources is the trend of the times. Therefore, the research on the aggregation of learning resources needs to introduce semantic technology appropriately to improve the quality and effect of resource aggregation. [23]

## C. Research on Learning Resource Aggregation for Learners

In the network environment, the learner's demand for learning resources is aggregated and related, that is, to acquire a wide range of resources around a specific topic, and to have associated resources of utilization value. In such an environment, the aggregation of learning resources should be directed to the needs of learners, aiming to change the existing simple linear knowledge chain presentation model and deepen it into knowledge association, structure association and knowledge evolution association model constructed according to learner ontology. On this basis, this study explores the use of knowledge visualization methods (such as knowledge maps) to present learning resources to learners in multiple dimensions.

## D. Empirical Study on Learning Resource Aggregation

Learning resource aggregation is not only a theoretical problem, but also a real problem. Its research needs to be verified in practice. On the basis of semantic aggregation resources, it is further to carry out personalized recommendation for learners, knowledge visualization navigation, knowledge deep integration and discovery. Empirical research requires theoretical researchers to work in



conjunction with specific work, thus deepening and verifying the theory and serving the learning practice.

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