Academic Education
Publishing House
-AEPH-

Exploration of Models for Cultivating Data Literacy in University Students by Academic Librarians in the Context of Big Data: A Case Study of Inner Mongolia University of Science & Technology

Lili Zheng*, Wenzhi Hai

Inner Mongolia University of Science & Technology, Baotou, Inner Mongolia, China
*Corresponding Author.

Abstract: This paper investigates the role of academic librarians in enhancing the data literacy of university students within the context of big data, with a focus on Inner Mongolia University of Science & Technology. By defining data literacy and assessing its current state among university students, the study elucidates the critical mission of librarians. It proposes a variety of instructional models, including $ng, training seminars, practical activities, and online learning. Additionally, it outlines strategies for reinforcing librarian capacity, integrating resources, promoting collaborative efforts, and establishing feedback mechanisms. These approaches aim to elevate the data literacy skills of university students to align with the evolving demands of the information age.

Keywords: Big Data; Academic Librarians; University Students; Data Literacy

1. Introduction

The rapid advancement of information technology has ushered in the era of big data with overwhelming force[1]. Data is growing at an explosive rate, and with the aid of the Internet, vast amounts of information from news, entertainment, advertising, and technology are being produced at a pace that far exceeds individual capacity for information processing[2,3]. University students, as the core force of the new era, are immersed in this data deluge, where data has become a crucial resource for them. Consequently, data literacy among university students is of paramount importance[4]. Data literacy encompasses the abilities to collect, organize, and analyze data, as well as critical thinking and ethical awareness[5-7].

As centers of knowledge and academic pursuit[8,9], university libraries hold an unshirkable responsibility in fostering data literacy among students. Serving as crucial bastions of education and vital vehicles for cultural dissemination[10], they play an indispensable role in this endeavor[11]. Librarians, equipped with professional knowledge and skills and leveraging the rich resources of libraries, are well-positioned to provide education and guidance in data literacy. Therefore, in conjunction with the realities of Inner Mongolia University of Science & Technology, it is highly significant to deeply explore the modes through which librarians in the context of big data can cultivate students' data literacy. This involves defining data literacy, examining the current state and challenges of data literacy among university students, elucidating the responsibilities and missions of librarians, and proposing effective training models and strategies.

2. Definition of Data Literacy

Data literacy is a multifaceted and complex concept, defined by scholars both in China and internationally from various perspectives. American scholars Mike Eisenberg and Bob Berkowitz, drawing from the information problem-solving model, proposed that data literacy refers to the ability to acquire, evaluate, and utilize information from data, encompassing various stages such as data collection, analysis, and interpretation. For instance, when researchers handle vast amounts of experimental data, they must precisely gather useful information and apply appropriate analytical methods to interpret the data and draw research conclusions. Australian scholar James Herring, on the other hand, believed that data literacy includes multiple dimensions such as data awareness, data knowledge, and data processing skills. Data

awareness reflects a keen perception of the value of data, such as a businessperson swiftly recognizing the critical role of market data in corporate decision-making. Data knowledge encompasses an understanding of data types and structures, such as distinguishing between structured and unstructured data. Data processing skills include tasks like data cleaning and the use of data analysis tools.

Chinese scholars also offer diverse interpretations. Some define data literacy as an individual's comprehensive ability to acquire, understand, evaluate, and apply data within a specific data awareness framework. For instance, in the era of big data, individuals must sift through vast amounts of information to extract valuable data, correctly comprehend and assess it, and apply it to real-world problem-solving. An example of this is how librarians in the construction of smart libraries optimize development based on operational data. Other scholars emphasize that data literacy refers to the ability to process and apply data within the context of data culture, highlighting the importance of data culture's essence, including the recognition of data's value and data ethics. For example, during data sharing, ethical guidelines must be followed to properly handle and apply data, ensuring the prevention of data leakage and misuse.

In summary, this paper defines data literacy as a comprehensive system of knowledge, skills, and attitudes that enables individuals, in the context of the big data era, to keenly perceive the value of data, thoroughly understand fundamental data principles and types, and proficiently master techniques such as data acquisition, processing, analysis, and visualization. This must be done while adhering to data ethics and legal regulations to effectively utilize data for solving real-world problems, supporting decision-making, and innovating knowledge. For instance, in university students' research projects, students need to recognize the importance of experimental data to their projects (data awareness), understand methods for collecting data under different research conditions (data knowledge), and be able to use relevant software to organize and analyze the data (data skills). When citing data, they must strictly adhere to academic norms, ensuring the proper acknowledgment of sources without altering the data (data ethics), thus arriving at scientifically sound conclusions that can be used for academic dissemination or practical applications.

3. The Current State of Data Literacy among University Students in the Context of Big Data

Survey and Analysis of Data Literacy Among Undergraduates at Inner Mongolia University of Science & Technology. To gain a deeper understanding of the current state of data literacy among undergraduates at Inner Mongolia University of Science & Technology, a questionnaire survey was conducted. The survey targeted randomly selected students from various colleges and academic years on campus. The questionnaire covered a range of topics, including data awareness, data knowledge, data skills, and data ethics. The results revealed a significant disparity in the data literacy levels of the undergraduates, with overall improvement needed. The specific findings are as follows:

Weak Data Awareness: Undergraduates generally lack an active awareness of data collection and engagement in the areas relevant to their major or personal interests. They have not fully recognized the importance of data information and show a relatively low sensitivity to data. When making decisions, they tend to rely more on experience and intuition rather than using data collection and analysis to obtain accurate information and solutions.

Limited Data Knowledge: Undergraduates have insufficient understanding of basic data concepts, types, and sources. They are unclear on how to obtain high-quality data, and they have not mastered effective methods for analyzing and interpreting data. Additionally, they struggle to assess the accuracy and completeness of the data they encounter.

Inadequate Data Skills: In terms of data processing, analysis, and visualization, undergraduates demonstrate limited skill levels. Most are only capable of using basic tools like Excel for fundamental data processing, and their familiarity with more complex, specialized data analysis software such as SPSS or Python remains minimal.

Lack of Data Ethics: The awareness of data privacy and security among undergraduates is relatively weak. During data collection, usage, and sharing, they show a lack of understanding

and adherence to data ethics. For example, when citing data from others, they often fail to properly reference the source, and they overlook data privacy and security protections during data processing.

4. The Mission and Role of University Librarians in Cultivating Data Literacy Among Students

4.1 Librarians as Navigators of Information: Crafting the Blueprint of Data Knowledge

In the digital age, data is growing exponentially, sourced from a myriad of origins, encompassing a variety of formats and quality levels. University librarians hold the crucial mission of guiding students through the vast expanse of data with precision. Leveraging their expertise in integrating and curating information resources, they filter out authoritative, reliable, and academically valuable data from the abundance. By systematically classifying and deeply integrating library databases, electronic journals, academic reports, and open-access online data, librarians construct clear resource directories and navigation systems. For instance, they create specialized data resource navigation pages tailored to different academic disciplines. These pages detail commonly used data resource websites, database names, data types, and methods of access within each field, enabling students to quickly and accurately locate the necessary data resources. Essentially, librarians craft an accurate knowledge blueprint for students, empowering them to embark on their data exploration journey efficiently.

4.2 Librarians as Catalysts of Education: Igniting the Flame of Data Literacy

As educational catalysts, librarians are indispensable in fostering data literacy among university students. They organize a rich array of educational activities to embed the concepts and knowledge of data literacy into students' learning processes. One approach is to host specialized data literacy lectures, inviting data experts, scholars, or experienced data analysts from within and outside the university to elucidate core concepts of data literacy, its importance, and its broad applications across various academic fields and professional careers. Additionally, librarians offer data

literacy training courses that cover the fundamentals of data, the use of data processing tools, data analysis methodologies, and practical case studies. For instance, by offering basic Excel data processing courses, they teach students methods for data cleaning, sorting, filtering, and creating simple data charts, gradually enhancing their data manipulation skills and igniting their passion for data literacy. This solid foundation enables students to use data effectively in their academic research and future careers to solve real-world problems. Moreover, librarians can integrate data literacy content into information retrieval courses, instructing students on how to effectively acquire, evaluate, and utilize data resources, and organize practical activities to enhance their data literacy through hands-on experience.

4.3 Librarians as Guides in Practice: Accompanying the Journey of Data Exploration

When university students engage in data-related research projects, academic competitions, or course design, librarians serve as reliable mentors, accompanying them throughout their journey. With their extensive experience in data processing and professional knowledge, librarians provide practical guidance and technical support. For instance, when students undertake big data-based market research projects, librarians can assist in designing effective survey questionnaires to ensure the collection of valid and representative data. They help select appropriate data collection tools and platforms, such as using online survey software or web scraping technologies. In the data processing phase, librarians teach students how to clean, organize, and analyze data using statistical analysis software, such as conducting descriptive statistics and correlational analysis with SPSS. During the data visualization stage, librarians guide students in selecting the appropriate types of charts based on the data characteristics and analysis objectives, such as using bar charts to compare data categories or line graphs to show data trends. This enables students to present complex data in a clear and intuitive manner, significantly enhancing their practical data skills and problem-solving abilities. Thus, librarians support students through the challenges of data exploration,

helping them achieve significant results.

4.4 Librarians as Cultivators of Literacy: Shaping Data Ethics

Librarians are also the cultivators of comprehensive data literacy, bearing the responsibility of shaping students' ethical conduct regarding data. In the process of fostering data literacy, they focus not only on enhancing students' data knowledge and skills but also on cultivating their awareness of data ethics and moral standards. By organizing activities such as data ethics seminars and case studies, librarians guide students to deeply reflect on the ethical issues related to data collection, usage, and sharing. For example, using the case of "social media data privacy breaches", they facilitate discussions on how to safeguard user privacy during data collection and the ethical principles and legal regulations that should be followed in data usage and sharing. This helps students to profoundly understand the importance of data ethics. Furthermore, librarians integrate data ethics requirements into the rules for library data services and resource usage, clearly stipulating the norms for citing data and maintaining data confidentiality. Through everyday services and management practices, they subtly nurture students' ethical awareness and moral behavior, ensuring that students naturally adhere to data ethical standards in their future data applications. This holistic approach ultimately molds them into high-quality individuals with sound data literacy and ethical integrity.

5. Models for Cultivating Data Literacy Among University Students by Librarians

5.1 Course-based Teaching Model: Establishing Relevant Courses with Clear Content and Methods

The creation of data literacy courses has been designed to comprehensively cover aspects such as data awareness, data knowledge, data skills, and data ethics. These courses include modules on data retrieval and usage, data analysis methods and tools, and data visualization. At Inner Mongolia University of Science & Technology Library, data literacy content is seamlessly integrated into the information retrieval curriculum. The teaching method combines theoretical lectures with practical exercises. In the theoretical lectures, foundational knowledge of data literacy concepts, significance, and principles, as well as fundamentals of data analysis methods and tools, are incorporated into the information literacy curriculum. Additionally, practical sessions are increased to allow students to engage in data retrieval, analysis, and visualization operations using real-world cases, thereby enhancing their hands-on skills. Furthermore, the inclusion of group discussions and project assignments helps foster team collaboration and innovative thinking among students.

5.2 Training Seminar Model: Conducting Regular Seminars with Specific Themes and Formats

The library regularly organizes data literacy training seminars, covering a broad range of topics such as data management, data analysis, data visualization, and data ethics. These seminars employ diverse formats, including expert lectures, case studies, and interactive exchanges. For example, inviting data field specialists to give lectures, where they share their research findings and practical experiences; employing case studies to illustrate the application of data literacy in real-world scenarios; and setting up interactive sessions encouraging students to ask questions, thereby promoting communication and discussion with experts and peers. Through these seminars, students not only acquire knowledge and skills related to data literacy but also develop an increased appreciation and interest in the subject.

5.3 Practical Activity Model: Organizing Practical Activities with Defined Types and Steps

The library actively organizes a variety of data literacy practical activities, which include data analysis competitions, data visualization contests, and data project practices. The implementation process is divided into several stages: activity planning, promotion, registration, training and guidance, submission of work, and evaluation and award ceremonies. Taking the data analysis competition as an example, the competition theme and rules are first determined, followed by multi-channel promotion through the library's website, WeChat official account, and in-library digital screens to attract student participation. During

the competition, students receive training and guidance to enhance their data analysis skills. Finally, the submitted works are reviewed, and outstanding entries are selected and awarded in a ceremony.

5.4 Online Learning Model: Building an Online Platform with Comprehensive Functions and Resources

The library focuses on developing an online learning platform for data literacy, which is equipped with comprehensive features that include course learning, online testing, discussion forums, and resource downloads. In terms of resources, the platform provides a rich array of content, such as course videos, lecture slides, case studies, and practice exercises related to data literacy. Students can choose learning materials and progress at their own pace based on their individual needs and schedules. Furthermore, the platform includes functions for online testing and discussion forums, allowing students to assess their learning outcomes, interact with peers, and effectively improve their learning efficiency and convenience.

6. Strategies for University Librarians to Cultivate Data Literacy among Students

6.1 Enhancing Personal Data Literacy: Acquiring Knowledge and Improving Practical Skills

Librarians must continuously enhance their own data literacy by proactively learning relevant knowledge. This can be achieved by participating in various data literacy training courses, seminars, and academic exchange activities to stay abreast of the latest developments and techniques in data management, data analysis, and data visualization. Additionally, improving practical skills is crucial; librarians should engage in hands-on activities and project practices to become proficient in using data retrieval, analysis, and visualization tools, thereby strengthening their data processing and application capabilities. For instance, participating in university research projects allows librarians to apply data literacy skills to provide data support and analysis services, thus continually improving their data literacy through practical application.

6.2 Integrating Data Literacy Educational Resources: Collection and Organization to Establish a Resource Library

Librarians should actively integrate data literacy educational resources by extensively collecting and meticulously organizing various materials such as textbooks, lecture slides, case studies, and practice exercises related to data literacy. Collaboration with other university libraries, data institutions, and enterprises can help in acquiring superior educational resources. Establishing a data literacy education resource library, which includes tutorials on data retrieval, guides for using data analysis software, and collections of data visualization case studies, ensures that there are ample learning materials available for cultivating data literacy among university students.

6.3 Fostering Collaboration and Exchange: Internal Cooperation and External Engagement

Internal Cooperation: Librarians should collaborate closely with other departments within the university to jointly promote the cultivation of students' data literacy. By working with the academic affairs office, data literacy education can be integrated into the professional course curriculum. Collaboration with the scientific research department can provide data support and services for faculty and students' research projects. Additionally, partnering with the student affairs office to host data literacy-themed activities can further develop students' capabilities in this area.

External Engagement: Actively engaging in exchanges and collaborations with external institutions can broaden the channels and resources for data literacy education. Sharing resources and experiences with libraries from other universities can help explore effective models for cultivating students' data literacy. Partnering with data enterprises to invite industry experts to conduct lectures and training sessions on campus can expose students to the latest developments and demands of the data industry. Establishing internship bases with these enterprises offers students opportunities for practical data experience. Furthermore, collaborating with research institutions on data literacy-related projects can elevate the level and quality of data literacy education.

6.4 Establishing Evaluation and Feedback Mechanisms: Setting Standards and Collecting Feedback

Librarians should build a scientifically sound evaluation and feedback mechanism to ensure the effectiveness of data literacy cultivation among university students. Developing data literacy evaluation standards can clarify the goals and requirements for students in areas such as data awareness, knowledge, skills, and ethics. Students' data literacy can be assessed through various methods such as exams, assignments, and project practices, allowing for a timely understanding of their learning progress and the issues they face. Collecting students' feedback extensively is also essential to gauge their needs and suggestions regarding data literacy education, which can then be used to continuously optimize teaching content and methods. For example, organizing satisfaction surveys on data literacy courses at the end of each semester and adjusting the curriculum and teaching methods based on the feedback can significantly improve the quality of education.

7. Conclusion and Outlook

As big data technology continues to evolve, the demand for data literacy among university students will inevitably increase. University librarians, as architects of data knowledge frameworks, educators, practical guides, and cultivators of literacy, must continuously enhance their professional expertise and delve deeply into specialized skills to build a more comprehensive data knowledge navigation system. This system should aim to offer students more precise recommendations for data resources. In terms of teaching, it is essential to continuously update the content and methods to align with the needs of the big data era, focusing on cultivating students' innovative thinking and practical abilities. Librarians should guide students in using data to solve real-world problems. Through practical guidance, assisting students in selecting appropriate data analysis methods and tools, and actively organizing various data literacy activities can spark students' interest and enthusiasm for learning. In the cultivation of literacy, it is crucial to not only elevate students' data literacy skills but also emphasize the cultivation of data ethics and moral standards. In summary, in the context of big data, university librarians hold a significant and honorable mission in fostering data literacy among students. Looking ahead, they will continuously explore innovations and strive tirelessly to enhance students' data literacy, making extraordinary contributions to meet the evolving demands of the information age.

Acknowledgments

References

[1] Jiao Jiao. Research on Data Literacy Education in University Libraries in the Big Data Era. Library Work and Research, 2020, (03): 81-84.
[2] Liu Zhongbao. Research on Cultural Big Data Governance from the Perspective of Data Ecology. Library, 1-8 [2024-12-04].
[3] Zhang Yao, Long Heping. Research on the Construction and Improvement Strategies of Data Literacy Models for University Librarians. Information Science, 1-5 [2024-12-04].
[4] Ren Yanli, Zhang You. Survey on Data Literacy Education for Students in Application-Oriented Universities: A Case Study of Beijing Union University. Journal of Beijing Union University, 2024, 38(05): 41-47.
[5] Yang Wenjian, Deng Lijun. Research on Situational Optimization for Data Literacy Education for University Students. Library, 2024, (06): 22-29.
[6] Schield M. Information Literacy, Statistical Literacy and Data Literacy. Iassist Quarterly, 2004, 28(2/3): 6-11.
[7] Mandinach E B, Gummer E S. A Systemic View of Implementing Data Literacy in Educator Preparation. Educational Researcher, 2013, 42(1): 30-37.

[8] Liang Chunyan. Challenges and Responses of Local University Libraries in the Information Age. The Library Journal of Henan, 2024, 44(05): 59-62.

[9] Hua Chunhua, Yuan Yan, Yuan Yi. The Dilemmas and Resolutions in Building Future Learning Centers in University Libraries. Library World, 2024, (05): 81-85.

[10]Ke Ping, Li Xiaoying, Sun Xuan, et al. The Preparation of the "15th Five-Year Plan" for Chinese Libraries: Constructing a Strategic Goal System Based on Environmental Scanning and Demand Analysis. Journal of Agricultural Library and Information Science, 1-16 [2024-12-04].

[11]Yang Feng, Zhu Li, Hu Lin. Constructing a Model of Integrated AI Literacy Education: Insights from the Responses of Foreign University Libraries. Library Forum, 1-10 [2024-12-04].