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Trajectory of Research Method Usage in the Academic Careers of Scholars in the Library and Information Science

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Abstract

Research methodologies constitute an indispensable tool for scholars engaged in scientific inquiry. Investigating the trajectory of methodological usage throughout scholars' academic careers can illuminate distinctive patterns in their adoption of research methods, thereby offering valuable insights for novice researchers in selecting appropriate methodologies. This study employs a comprehensive dataset comprising full-text journal articles and bibliographic records from the Library and Information Science (LIS) domain. Utilizing an automated classification model based on full-text cognitive analysis, the research methods employed by LIS scholars are systematically identified. Subsequently, author name disambiguation is performed, and academic age is calculated for each scholar. The study focuses on a cohort of 435 senior scholars with an academic age exceeding 14 years and a consistent publication record at five-year intervals, encompassing a total of 6,116 articles. The findings reveal a trajectory in methodological selection characterized by an initial increase followed by a gradual decline over the course of scholars' careers. Furthermore, scholars exhibit a propensity for combining multiple research methods, including both conventional and unconventional pairings. Notably, the research methods most commonly used by researchers change with age and seniority.

Introduction

The scholarly endeavors of researchers serve as a driving force behind scientific progress. Investigating the characteristics of scholars themselves provides valuable insights into the mechanisms that shape modern science. Age, as a significant attribute of scholars, exerts a discernible influence on their academic performance. As scholars advance in age, their cognitive abilities and academic perspectives undergo expansion (Wang et al., 2017), thereby shaping their research interests, methodological choices, and the output of their scholarly contributions.

Given the unique and complex nature of academic research, prior studies have adopted the lens of academic age to more precisely delineate and comprehend the developmental trajectories and stage-specific characteristics of scholars within their respective fields. Academic age is typically calculated based on the timing of a scholar’s first publication (Costas et al., 2015). This metric has been extensively linked to various dimensions of scholarly activity, including research productivity (Abramo et al., 2016; Győrffy et al., 2020), academic influence (Sugimoto et al., 2016), and collaborative networks (Bu et al., 2018; Kumar & Ratnavelu, 2016; Wang et al., 2017). Understanding how scholars select and shift their research focus over time is of paramount importance, as it has implications for the training of scientists, the allocation of scientific funding, the organization and discovery of knowledge, and the recognition and reward of excellence (Jia et al., 2017). Academic age also

serves as a critical metric for distinguishing different stages of an academic career. Empirical studies reveal that as scholars progress in academic age, they accumulate greater resources and exhibit a heightened propensity to explore diverse research topics, accompanied by an increase in productivity (Abramo et al., 2016; Simoes & Crespo, 2020; Zeng et al., 2019). However, disparities exist between scholars of different ages. While senior scholars possess advantages in experience, funding, and collaboration, their knowledge base tends to stabilize in the later stages of their careers. This stabilization is often accompanied by the use of relatively outdated concepts (Liang et al., 2020; Milojević, 2012; Packalen & Bhattacharya, 2019), a diminished receptivity to novel ideas (Azoulay et al., 2019), and engagement in less prominent research areas (Cui et al., 2022). Consequently, scholars at different stages of their academic careers exhibit distinct cognitive behaviors and research patterns.

Research methods, as the cognitive frameworks guiding scientific inquiry, constitute an indispensable scientific element in the formation of any academic discipline. Serving as a cornerstone of scientific research, their significance and the urgency for innovation have become increasingly pronounced. Studies have revealed notable age-related differences in the research methods employed by scholars at various stages of their academic careers. Senior scholars exhibit a predilection for qualitative research, while their junior counterparts tend to favor quantitative methodologies (Lou et al., 2021). Consequently, there is a compelling need to explore the trajectory of methodological choices throughout scholars' academic careers. Previous research has predominantly examined the impact of academic age through the lenses of team collaboration, scholarly output, and related dimensions, or has focused on the classification, identification, and application of research methods. However, there is a notable gap in integrating academic age with the use of research methods to provide a comprehensive analysis of methodological evolution across the entirety of a scholar’s career. This oversight has led to the neglect of fundamental questions, such as what research methods scholars employ during their careers and the underlying logic and influencing factors driving these choices. Investigating the trajectory of methodological usage in scholars' academic careers can unveil distinctive patterns in their adoption of research methods, thereby offering valuable insights and guidance for early-career researchers in selecting appropriate methodologies for their scholarly pursuits.

This study employs journal literature as its primary data source to investigate the trajectory of research method usage among scholars in the Library and Information Science (LIS) domain, with a focus on individual scholars. The research aims to address the following questions:

RQ1: What differences exist in the research methods employed by LIS scholars at various stages of their academic age?

RQ2: What patterns characterize the trajectory of research method usage throughout the academic careers of LIS scholars?

Literature review

This paper aims to explore the trajectory of research method selection in the academic careers of scholars in a specific field. Given the relatively limited body of

research on scholars' academic trajectories, this study will focus on two key dimensions: academic age and the utilization of research methods.

Academic age of scholars in specific fields

Research on the academic age of scholars in specific fields can be divided into two main areas: the definition of academic age and the various dimensions of academic age research.

Regarding the calculation of academic age, existing studies predominantly rely on two metrics: the timing of a scholar's first publication and the year of doctoral graduation. However, the scale of these studies varies significantly. Research utilizing the first publication date to determine academic age encompasses a wide range of sample sizes. Smaller-scale studies span diverse fields, such as 137 scholars in information systems (Liao, 2017) and 472 top economists (Simoes & Crespo, 2020). Larger-scale studies include 21,562 scientists across five disciplines and ten core journals (Milojević, 2012), 94,000 scientists from 43 countries (Chan & Torgler, 2020), and even 222,925 authors (Robinson-Garcia et al., 2020) or 1.7 million author records from the Web of Science platform (Aref et al., 2019).

In contrast, studies using the year of doctoral graduation to calculate academic age typically involve smaller samples, often numbering in the hundreds (Badar et al., 2014; Chan & Torgler, 2020; Coomes et al., 2013) or thousands (Perianes-Rodriguez & Ruiz-Castillo, 2015; Sugimoto et al., 2016). For instance, van den Besselaar and Sandström (2016) examined 243 researchers applying for early-career grants in the Netherlands, while Perianes-Rodriguez and Ruiz-Castillo (2015) analyzed 2,530 economists working in 81 top global economics departments. Costas et al. (2015) utilized a real-world dataset of professors in Quebec to evaluate the feasibility of these two metrics and concluded that the first publication date is a more suitable indicator of a researcher's academic age. Similarly, Nane et al. (2017) identified the year of first publication as the best linear predictor of a scholar's age. Consequently, this study defines the starting point of a scholar's academic career as the timing of their first publication.

In research, academic age is often examined in conjunction with scholars' academic or professional trajectories and is explored from multiple perspectives, as illustrated in Table 1.

Table 1. Different research perspectives integrating scholars' academic careers.

Authors	*Perspective*	*Main findings*
Milojević (2012)	Reference citation behaviour	Similar citation behavior with senior and junior researchers citing references at comparable rates and consistent re-citation patterns
Aref et al. (2019)	Researcher mobility	Hypermobility analysis categorizing scholars at early mid and late career stages by academic age and identifying destination countries
Simoes and Crespo (2020)	Performance assessment	Publication productivity showing longer careers linked to higher output and prolific authorship
Robinson-Garcia et al. (2020)	Career trajectories	Career stage biases revealed through academic age and author contribution statements indicating variations in scientific trajectories
Ao et al. (2023)	Patterns of scientific creativity	Disruption index trends with both male and female scholars showing a "high peak" creativity pattern and a small subset of females exhibiting an "early peak"
Zhang et al. (2024)	Changes in research direction	Research direction shifts with women changing direction less frequently than men and experiencing less negative performance impact

It is evident that the use of academic age as an individual characteristic of scholars has matured significantly. This study integrates the metric of academic age to examine the trajectory of research methods employed by scholars at different stages of their academic careers.

Overview of research on the use of research methods in specific fields

Investigating and analyzing the use of research methods in academic papers can reveal and reflect the fundamental trends in the application and development of methodologies within a discipline. Table 2 summarizes studies on the use of research methods by scholars in the Library and Information Science field, highlighting diverse analytical perspectives. For instance, Järvelin and Vakkari (1990) categorized research methods in LIS core journal articles into nine research strategies and ten data collection methods. Chu (2015) classified LIS research methods into 16 categories based on data collection techniques. Hayman and Smith (2020) analyzed the use of mixed methods in articles, examining the extent of mixed methods research in LIS over the past decade (2008–2018) and the volume of such studies in health-related contexts. Additionally, some scholars have explored trends in the evolution of research methods. Lund and Wang (2021) employed visualization techniques to examine changes in the use of various research methods, finding that the diversity of methods used in articles has increased over time. Lou et al. (2021)

investigated how researchers in different age groups employ research methods over time. Järvelin and Vakkari (2021) expanded on their earlier work by summarizing the methodological evolution in LIS over the past 50 years, noting that LIS research has become increasingly methodologically diverse, with more varied approaches to analyzing research subjects. Zhang et al. (2023) conducted a longitudinal study on the frequency and diversity of research methods in LIS, revealing a shift from conceptual to empirical research strategies over 31 years.

In summary, the heightened attention scholars have paid to the use of research methods has contributed to the refinement of methodological paradigms within the field. However, few studies have integrated research methods with scholars' academic careers to explore their usage trajectories. Therefore, this study adopts a broader, dynamic perspective to investigate the evolution of research method selection throughout scholars' academic careers, uncovering the underlying mechanisms that drive these choices. This approach aims to provide valuable insights and recommendations for scholars regarding the application of research methods.

Table 2. Studies on the use of research methods.

Authors	*Perspective*	*Main findings*
Järvelin and Vakkari (1990)	Classification of research methods	Systematic categorization of research methods into 9 strategies and 10 data collection techniques
Chu (2015)	Classification of research methods	LIS research methods classified into 16 categories based on data collection
Hayman and Smith (2020)	Use of mixed research methods	Mixed methods in LIS showing small but significant growth over the past decade
Lund and Wang (2021)	Changing trends in the use of various research methods.	Increasing method diversity with data analysis and qualitative methods dominating recent publications
Lou et al. (2021)	Researchers in different age groups use research methods over time	Rise in quantitative methods driven by younger researchers and senior scholars
Järvelin and Vakkari (2021)	Research evolution in the field of LIS	Methodological fragmentation in LIS over 50 years reflecting diversified analytical approaches.
Zhang et al. (2023)	Frequency and diversity of application of research methods	Shift in LIS research strategies from conceptual to empirical over 31 years

Data and methodology

This section outlines the research framework and key steps for investigating the trajectory of research method selection among scholars in a specific field throughout

their academic careers. The framework encompasses data sources, classification of research methods, and the acquisition of academic career data for scholars in the specified field.

Framework

This study aims to explore the trajectory of research method selection in the academic careers of scholars in the LIS field. Firstly, full-text journal articles and related bibliographic records from the specified field serve as the primary data sources. Machine learning techniques are employed to identify research methods within these texts, enabling the construction of a comprehensive research method corpus for the field. Secondly, name disambiguation is carried out on the authors in the collection of academic papers, and information such as the academic age of scholars is calculated. Then, research on the trajectory of research method selection is conducted according to the relevant data of the selected senior scholars.
The research framework is shown in Figure 1.

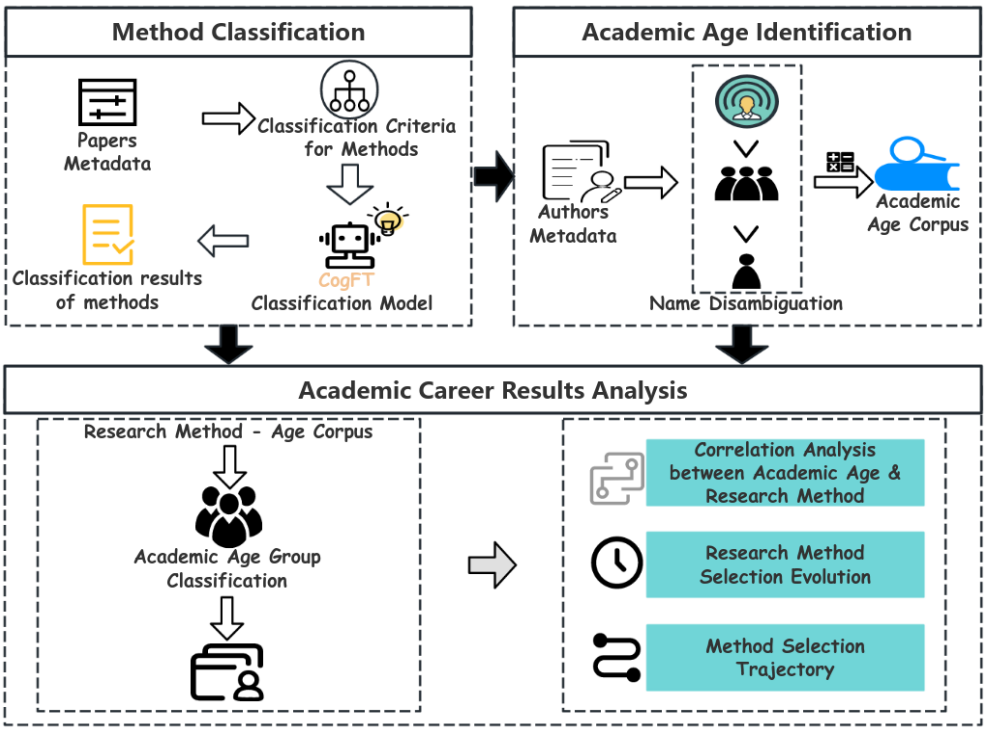

Figure 1. Framework of this study.

Data sources

The focus of this study is scholars in the Library and Information Science field, and the data sources are academic journals within this domain. In prior research, Järvelin and Vakkari (1993) conducted extensive studies on research methods and identified 31 representative academic journals in LIS based on the research topics covered in their articles. Building on this foundation, this study integrates the list of

representative journals identified by Järvelin and colleagues with the 2023 Journal Citation Reports (JCR) LIS category, which includes core journals across quartiles Q1 to Q4. This process resulted in the selection of 14 high-quality, representative LIS journals. Consequently, the full-text data collection for this study encompasses scholarly articles published in these 14 high-quality LIS journals. The data types collected include both metadata and full-text data, covering the period from 1990 to 2023. Full-text data were obtained from the official websites of each journal and converted into Word document format using conversion tools. These documents were then processed and parsed using Python to generate standardized full-text data. For cases where metadata were incomplete, bibliographic data for all articles published in the 14 journals over the 34-year period were downloaded from the Web of Science (WoS) [https://www.webofscience.com], and missing metadata were supplemented using DOI matching. In total, this study compiled full-text and metadata for 26,677 academic articles published in LIS journals between 1990 and 2023. The number of articles per journal is detailed in Table 3.

Table 3. Number of academic articles in high quality representative journals in the field of LIS.

No.	*Journal name*	*Abbreviation*	*Number of Articles*
1	*Aslib Journal of Information Management*	AJIM	1356
2	*College & Research Libraries*	CRL	1330
3	*Information Processing & Management*	IPM	3063
4	*Information Technology and Libraries*	ITL	546
5	*International Journal of Information Management*	IJIM	1891
6	*Journal of Documentation*	JOD	1450
7	*Journal of Information Science*	JIS	1510
8	*Journal of Librarianship and Information Science*	JLIS	887
9	*Journal of the Association for Information Science and Technology*	JASIST	3928
10	*Library & Information Science Research*	LISR	783
11	*Library Quarterly*	LQ	502
12	*Online Information Review*	OIR	1684
13	*Scientometrics*	SCIM	5926
14	*Electronic Library*	TEL	1821

Among the 14 journals, the three journals with the highest number of data entries are *Scientometrics*, *Journal of the Association for Information Science and Technology*, and *Information Processing & Management*. These journals collectively account for 12,917 articles, representing nearly 50% of the total dataset.

Classification of research methods for academic papers in the LIS field

Based on the constructed full text corpus of academic papers in the field of LIS, this study classifies and identifies the research methods employed in these articles. The process involves two main steps. Firstly, a suitable classification system of research methods is selected. Secondly, based on the classification system, a technique of automatic classification of research methods is used to identify the research methods of academic papers in the corpus and obtain the results of classification of research methods.

Classification system of research methods for academic papers in the field of LIS: Regarding the framework for research methods in the LIS field, the mainstream classification systems currently used in research primarily include two approaches. The first is the classification system proposed by Järvelin and Vakkari (1990). These scholars initially introduced a framework encompassing research strategies and methods, encoding data collection methods in academic papers from a methodological perspective. This system has been consistently updated in subsequent studies, though its core content remains largely unchanged (Järvelin & Vakkari, 1990; Järvelin & Vakkari, 1993; Järvelin & Vakkari, 2021). The second is the classification system proposed by Chu and Ke (2017), which focuses on data collection methods. By analyzing articles published in three prominent LIS journals—JASIST, LISR, and JOD—they developed a classification system comprising 16 data collection methods. Considering factors such as the granularity of the classification systems and their historical development, this study adopts the methodological framework proposed by Zhang et al. (2023) to identify research methods in the corpus of academic papers. The specific classification system is detailed in Table 4.

Table 4. Classification system of research methods in LIS discipline (Zhang et al., 2023).

No.	*Method*	*Definition*
1	Bibliometrics	Bibliometrics is a method used for collecting publication and citation data.
2	Content analysis	Content analysis refers to collecting data by conducting systematic examination of texts or other passages in the contexts of their use.
3	Delphi study	The Delphi method is generally used for collecting data with a questionnaire from a group of experts to address a research problem in order to reach consensus and make forecasts via several rounds of exchanges.
4	Ethnography/field study	Ethnography and field study share many characteristics in data collection. Both can be applied when collecting data using multiple techniques, such as observation and interview, in a natural setting where participants live or work.
5	Experiment	Experiment is an established method for collecting data by following a procedure to test what is studied in either a laboratory or field setting, corresponding to laboratory experiments and field experiments described in(Palvia et al., 2007) list of research methods.
6	Focus groups	As a research method, focus groups refer to data collection via discussion of a research problem between a moderator and a group of participants.
7	Historical method	Historical method refers to collecting data by examining, synthesizing, summarizing, and interpreting existing published and unpublished materials related to a historical research problem.
8	Interview	Interview is a data collection technique where individual participants are asked questions relating to a research problem.
9	Observation	Observation is a method for gathering data via carefully and attentively watching and making notes on the subject being studied.
10	Questionnaire	Questionnaire, often known as survey, is a technique for data collection using a predefined list of questions.
11	Research diary/journal	Research diary or journal is a technique used to gather data about events, activities, thoughts, reflections, or other aspects by an individual who keeps the diary over a period of time.
12	Theoretical approach	Theoretical approach, as a research method, is a technique for gathering data through conceptual analysis, theoretical examination, or similar activities.

13	Think aloud protocol	Think aloud protocol is a research method intended to collect data about participants' cognitive activities via the verbal reports of their thoughts, called think alouds, while taking part in an experiment or performing some task.
14	Transaction log analysis	Transaction log analysis, as a research method, gains momentum when computerized systems are used for information processing and access.
15	Webometrics	Webometrics is defined as bibliometrics in the web environment, where webpages and websites are generally regarded as publications; with inlinks (i.e., links a webpage or site receives) being considered as citations and outlinks (i.e., links a webpage or site makes to others) being considered as references.
16	Other methods	Research methods other than the 15 mentioned above.

Selection of the classification model for research methods in LIS academic papers: Previous studies have primarily relied on manual coding to identify research methods in academic papers, a process that is both time-consuming and labor-intensive, while also heavily dependent on expert knowledge (Chu & Ke, 2017; Järvelin & Vakkari, 1993). Given the substantial scale of the full-text corpus of LIS academic papers constructed in this study, an automated approach to research method classification is employed to identify the primary research methods at the document level for each paper. Inspired by the CogLTX model designed by Ding et al. (2020), Zhang et al. (2023) adapted this model for the task of research method classification, developing the CogFT (Cognize Full Text) model. This model demonstrates superior performance compared to traditional deep learning models based on pre-trained language models. Specifically, the CogFT model effectively extracts full-text features of academic papers while mitigating the noise introduced by irrelevant descriptions of research methods. Consequently, this study adopts the CogFT model for the task of document-level research method identification.

Since a single paper may employ multiple research methods, the total number of identified methods exceeds the number of academic papers. Using the CogFT model to automatically classify research methods in the full-text corpus, the study ultimately obtains the classification results. The final classification yielded 31,401 distinct methodological instances drawn from 26,677 articles. Notably, 3,074 articles were found to incorporate multiple research methods. As illustrated in Figure 2, the top five research methods used in the papers are bibliometrics, experiment, questionnaire, theoretical approach, and content analysis, collectively accounting for over 75% of the total methods identified.

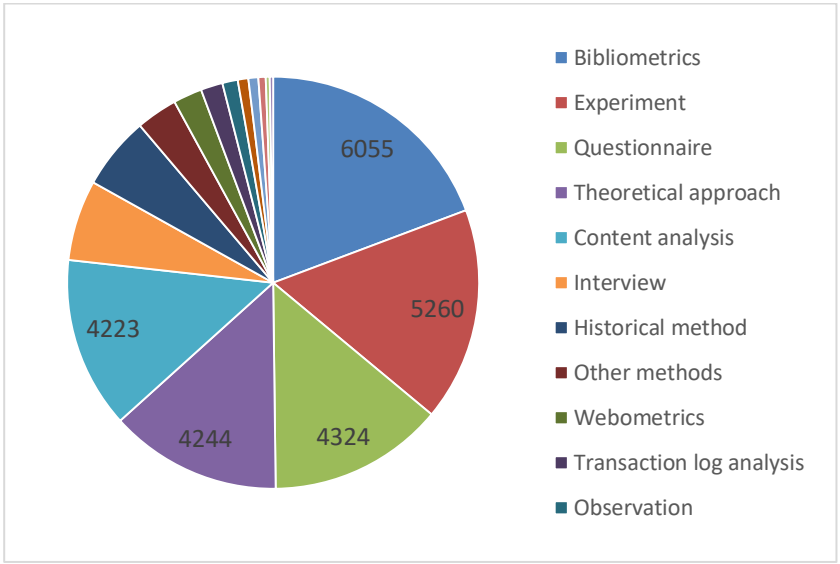

Figure 2. Classification results of research methods based on academic papers.

Data processing for scholars' academic careers in the LIS field

This study investigates the trajectory of research method selection among scholars in a specific field at different stages of their academic careers. In addition to the research methods identified earlier, it is necessary to perform author name disambiguation, calculate scholars' academic age. Based on these steps, we will select a subset of scholars to explore the trajectory of their methodological choices throughout their careers.

Scholar name disambiguation: To examine the trajectory of research method selection in scholars' academic careers, complete and accurate personal information is essential. This study utilizes OpenAlex [https://openalex.org/] to accomplish the task of author name disambiguation. OpenAlex is a free, open-access, large-scale scholarly resource indexing database that provides unique identifiers for various academic entities, including publications, authors, and institutions. It also offers multiple user-friendly API access methods. Among these, publication information can be retrieved using DOIs. Therefore, this study uses the DOIs from the metadata of academic papers to query OpenAlex, obtaining corresponding publication information and the unique identifiers of authors associated with each paper. These identifiers are then recorded and compared. Through this process, the study achieves accurate author name disambiguation results.

Calculation of academic age of scholars: To standardize the measurement of academic careers, this study defines a scholar's academic age as the time elapsed since their first publication. After completing the author name disambiguation process, the earliest publication of each author is retrieved from OpenAlex using their name. The publication year of this first paper is then extracted and used as the starting point for calculating academic age. Based on this starting point, the academic

age of a scholar at the time of publishing a subsequent paper is calculated by taking the difference between the publication year of the paper and the year of their first publication, then adding one. The formula for calculating academic age is as follows:

$$AAS = PYA - EPY + 1 \quad (1)$$

Where, AAS stands for Academic Age of Scholar, PYA stands for Publication Year of Article, and EPY signifies the Earliest Publication Year. It is important to note that a scholar's academic age does not necessarily correspond to a specific range in their actual chronological age, as the real age at which scholars publish their first paper may vary. Therefore, this study employs academic age as the metric for investigating the use of research methods throughout scholars' academic careers.

Criteria for selecting research method data in LIS scholars' academic careers: After the above processing steps, the author has obtained the data of scholars' papers. Next, we will select scholars and summarize the relevant data of the papers they published during their research careers.

First, to ensure the completeness and comprehensiveness of the data, this study considers both the first author and the corresponding author of each academic paper. In the corpus of academic papers used in this study, 14,856 articles have the same individual as the first author and corresponding author, while 8,471 articles have different individuals in these roles. Accordingly, when counting authors, this study considers both the first author and corresponding author for articles where these roles are distinct. For articles where the first author and corresponding author are the same, the author is counted as a single individual.

Second, to ensure the validity and reliability of the data, it is necessary to remove outliers in scholars' academic age. The Interquartile Range (IQR) method, which is based on the quantiles of the data, is effective in excluding extreme values and is not influenced by outliers. Therefore, this study employs the IQR method to identify and remove outliers in academic age. The academic age data of the scholars were first sorted from smallest to largest. Formula (2) calculates the inter - quartile range. Q1 represents the lower quartile, which is the value at the 25th percentile. Q3 represents the upper quartile, which is the value at the 75th percentile. Second, values in the academic - age data that are less than the lower limit or greater than the upper limit may be regarded as outliers. Formula (3) and Formula (4) calculate the upper and lower limits of the academic age respectively.

Finally, the calculated outliers of the authors' academic ages are eliminated, and a total of 14,622 authors' data are obtained.

$$IQR = Q3 - Q1 \quad (2)$$

$$Upper = Q3 + 1.5 * IQR \quad (3)$$

$$Lower = Q1 - 1.5 * IQR \quad (4)$$

As shown in Figure 3, the distribution of academic age of all authors is demonstrated. Among the authors, those with an academic age of 1 constitute the largest group, significantly outnumbering authors at other academic ages.

In this study, to analyze the relationship between authors' academic age and their use of research methods, a reasonable classification of academic age was established. Prior to categorizing scholars, to ensure the validity of academic age, the 95th percentile value of academic age was selected as the upper limit, setting the maximum academic age at 61 years. Building on prior research, authors were divided into three categories based on academic age. Authors with an academic age less than 7 were defined as young scholars. Those with an academic age between 7 and 14 were middle - aged scholars. Those with an academic age greater than 14 were senior scholars (Chowdhary et al., 2024).

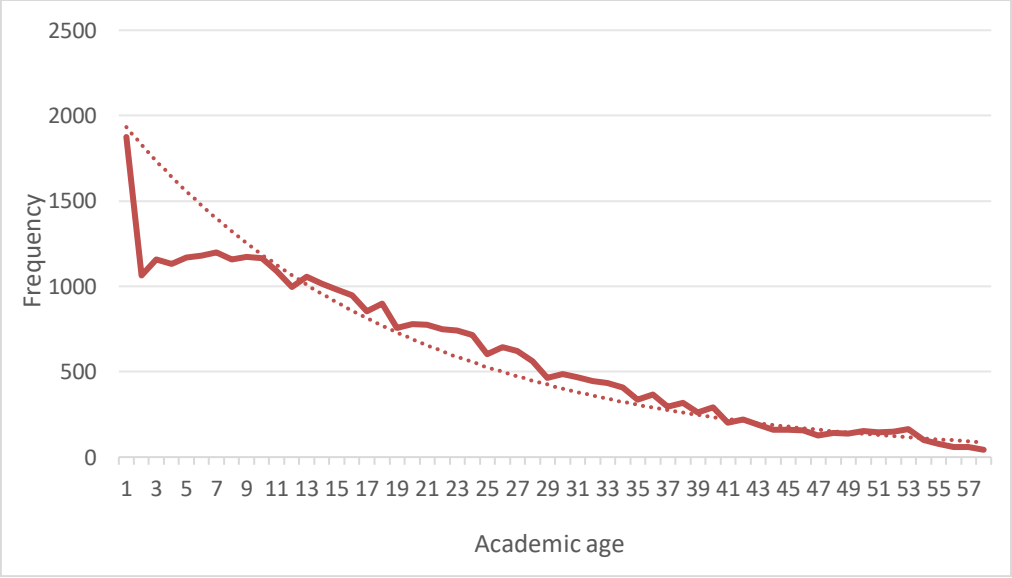

Figure 3. Distribution of authors' academic age.

Finally, the selection of scholars was conducted. Given the variability in the trajectory of research method selection across scholars' academic careers, this study focuses on scholars with longer and more active academic careers to capture the overall trends in methodological choices. Therefore, senior scholars with an academic age greater than 14 years and a consistent publication record at five-year intervals were selected. This resulted in a cohort of 435 senior scholars, encompassing 6,116 published articles.

Results

Correlation analysis of academic age and research methods of scholars in the field of LIS

In this section, we address ***RQ1*** by exploring whether differences exist in the selection of research methods among scholars at different academic ages. To achieve

this, statistical methods for difference analysis and testing are applied. Common methods for difference analysis include the t-test, analysis of variance (ANOVA), and the chi-square test. The chi-square test is suitable for scenarios where both independent and dependent variables are categorical. Therefore, this section employs the chi-square test to measure the frequency differences in method selection among scholars belonging to three distinct academic age groups. Each research method is independently subjected to a chi-square test. Since an article can only select a specific method once, the number of articles completed by scholars in different academic age groups serves as the basis for calculating expected frequencies. Figure 4 presents the results of the chi-square statistics.

Within the specific field, the usage proportions of different research methods exhibit significant variation. Among these, bibliometrics has the highest proportion at 30.02%, indicating that this method is the most commonly employed by scholars in the field. In contrast, focus groups, ethnography/field study, think aloud protocol, research diary/journal, and delphi study are used very infrequently, each accounting for less than 1% of the total. This suggests that these methods are rarely adopted in research. Out of the 16 research methods examined, only 6 show no significant differences in selection frequency across academic age groups. This indicates that scholars at different stages of their academic careers exhibit distinct preferences in their choice of research methods. When scholars are in the early stage of their academic careers, that is, when their academic age is less than 7, there are 3 methods they tend to choose. When scholars' academic age is between 7 and 14, there are 6 methods they prefer. When scholars' academic age is greater than 14, there are 4 methods they are inclined to select. Obviously, scholars in their middle - aged period tend to choose a larger variety of methods. In addition, this paper uses the chi - square value to judge the degree of significance of differences in method selection at different stages of the academic career. The top three methods with the largest chi-square values are webometrics (Chi2=114.8354***), bibliometrics (Chi2=43.3623***) and think aloud protocol (Chi2=11.5278**). Webometrics and bibliometrics are the methods preferred by academics in their younger and middle-aged years. Think aloud protocol is the method preferred by academics in their senior years.

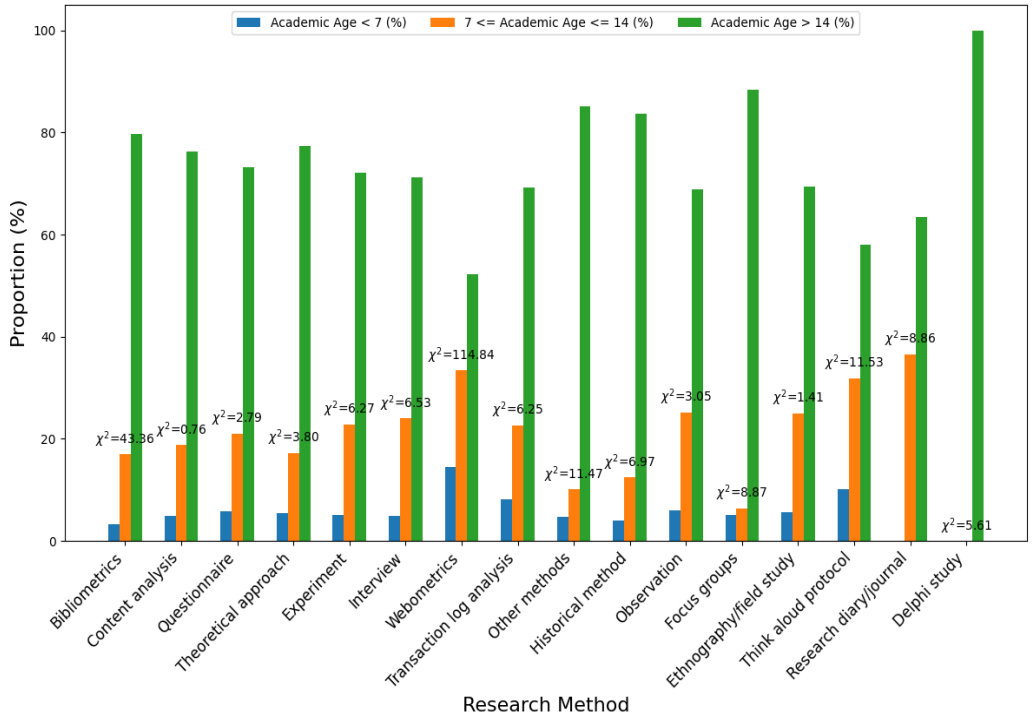

Figure 4. Statistical differences in the frequency of method selection among scholars in different academic age groups.

Differences in research methods used by scholars of different academic ages in different periods

To delve deeper into the variations in research method usage among scholars at different academic ages across various time periods, this study first examines the types of research methods employed by scholars at different career stages over time. It then focuses on the top five methods used by scholars in each academic age group and explores the evolving trends in the frequency of method usage based on publication years.

Types of research methods used by scholars in different academic age groups across publication periods: To investigate the diversity of research methods used by scholars at different career stages over time, this study constructs a heatmap based on five-year intervals of publication years and academic age groups. Since the number of publications varies across time periods, the data on the types of research methods used are normalized to ensure comparability.

As shown in Figure 5, the darker regions are predominantly concentrated in the period from 2000 to 2024 and among scholars with academic ages ranging from 1 to 50 years. This indicates that since 2000, scholars across various academic age groups have increasingly adopted a more diverse range of research methods. Furthermore, for each publication period after 2000, the number of research methods used initially increases and then decreases as scholars progress in their academic age.

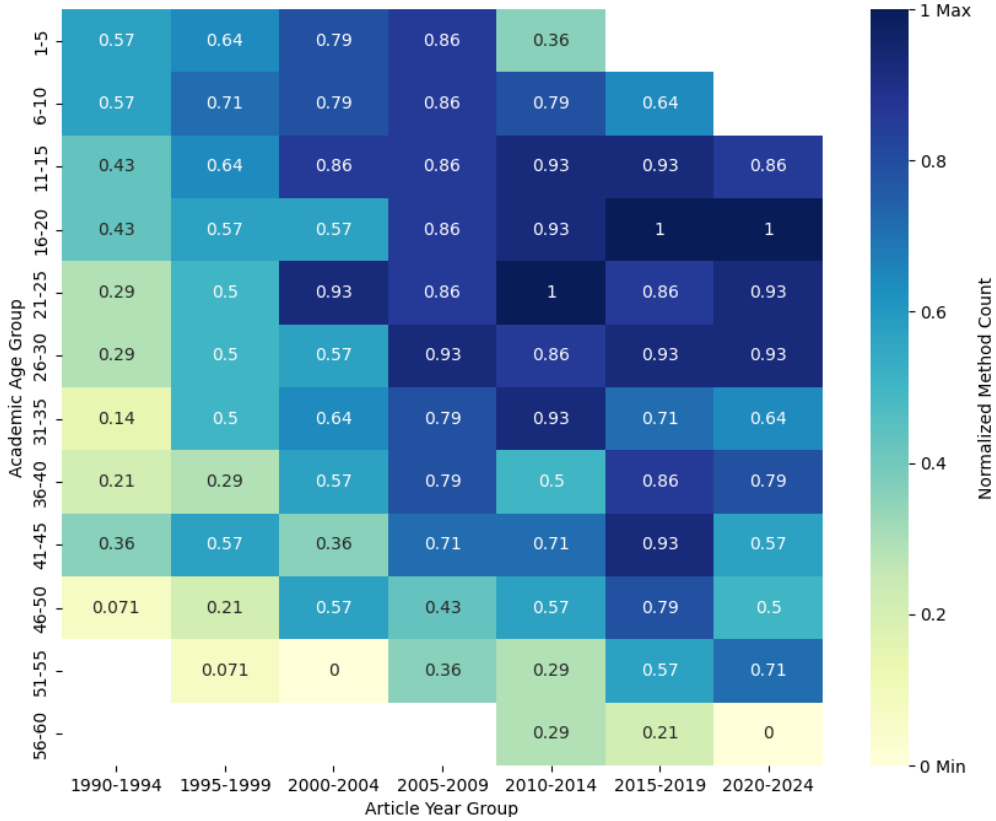

Figure 5. Heat map of the types of research methods used.

During the early period of 1990–1994, most academic age groups are represented by light green or light yellow hues. This suggests that, regardless of academic age, scholars during this time employed a relatively limited variety of research methods. From 2000 to 2014, the colors gradually deepen, particularly among scholars in the 11–45 academic age range, where the values reach as high as 0.93 or even 1. This indicates that scholars in this range utilized nearly all available types of research methods, reflecting a significant diversification in their methodological approaches. In the period of 2015–2024, the color distribution shifts again, with the hues for the 31–50 academic age group becoming lighter. The trend for the 11–30 academic age group shows that these scholars maintained a high diversity in research method usage over an extended period, likely due to their being in the prime of their academic careers, where they possess the capability and resources to experiment with a wide range of methodologies.For scholars in the 46+ academic age group, the overall number of research methods used is relatively low. This may be attributed to their methodological preferences having stabilized or to physical and other constraints limiting their ability to employ certain methods.

As shown in Figure 5, the diversity of research methods used exhibits dynamic changes across different academic age groups and publication periods. Over time, there is an overall trend toward increased methodological diversity, though the extent and timing of these changes vary among academic age groups. The middle - aged academic age group has maintained a high level of research method diversity over a

long period. Young scholars are continuously increasing the number of types of research methods they use, while senior scholars remain relatively stable.

Top five research methods used by scholars of different academic age groups: In order to deeply analyse which types of research methods are more popular among scholars at different stages of their academic careers, this paper summarizes the annual percentage of the top five research methods used by different academic age groups. The specific situation is shown in Figure 6.

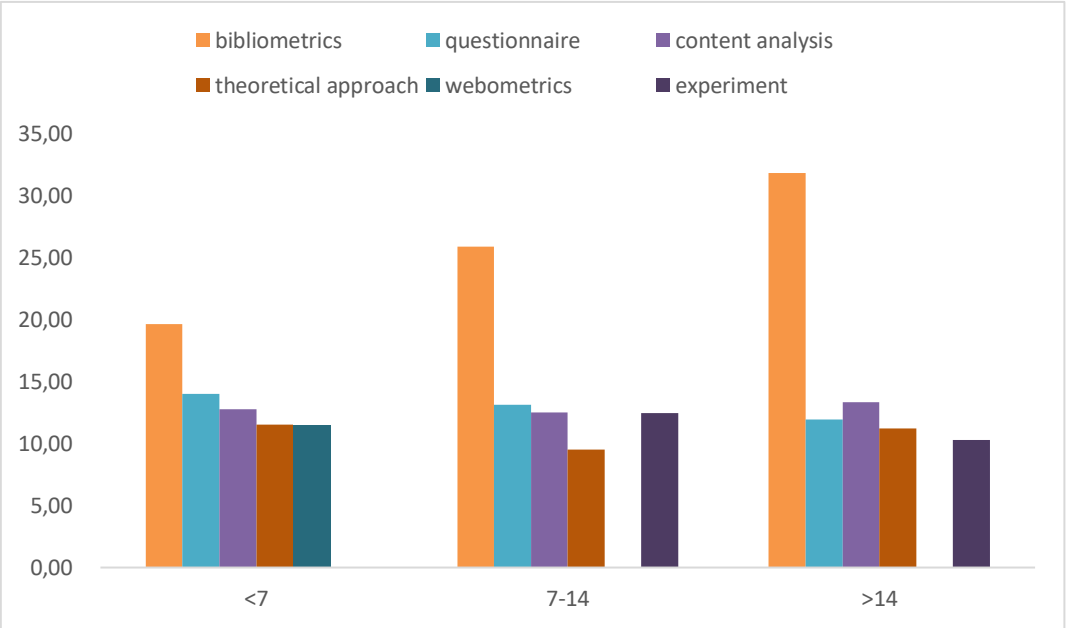

Figure 6. Top five research methods by usage proportion across different academic age groups.

As depicted in Figure 6, the most frequently used research methods among scholars remain relatively consistent across different academic age groups. For senior scholars, bibliometrics consistently ranks first in usage, with its proportion showing an upward trend. This indicates that bibliometric is highly favored by scholars, effectively aiding those engaged in long-term research endeavors with tasks such as literature analysis. It also underscores the dominant role of bibliometrics in the field of information science. Questionnaire and content analysis maintain stable usage proportions across all academic age groups, consistently ranking second and third, respectively. This reflects the broad applicability and enduring demand for these methods. Theoretical approach also persists throughout scholars' academic careers, highlighting the guiding role of theoretical research in academic inquiry. Webometrics ranks fifth in usage among younger scholars, indicating its popularity within this group. Meanwhile, experiment exhibits relatively stable usage proportions among mid-career and senior scholars, ranking fourth and fifth, respectively. This suggests that experiment becomes an important research tool as scholars accumulate experience and enhance their research capabilities.

The usage proportions of research methods among scholars in different academic age groups also vary over time. Specific details are illustrated in Figure 7.

As shown in Figure 7, the trend of the top five research methods in terms of percentage of use varies slightly across different academic ages in different periods of time. Bibliometrics covers the range of academic careers of scholars in all periods of time and is consistently high in terms of percentage of use. It is followed by content analysis, experiment and questionnaire. This confirms the trend of the overall top five used research methods as reflected in Figure 6. Since 2000, webometrics has been highly favored by young scholars, and it ranked fifth among the methods used by middle - aged scholars from 2005 to 2009. This may be attributed to the fact that young scholars from 2000–2004, as they advanced in age and experience, transitioning into middle - aged scholars, retained their preference for bibliometrics. For theoretical approach, the method was highly preferred by scholars at all academic career stages from 1990-2000, with a share of around 20%. However, its ranking gradually declined after 2000 and disappeared from the top five list after 2015. This shift may be linked to the rise of emerging technologies, such as machine learning models, which have increasingly been applied in academic papers, potentially displacing other traditional methods. Certain methods, such as transaction log analysis and focus groups, appear prominently only in specific periods and academic age groups. This may reflect the methodological preferences of particular scholars during those times.

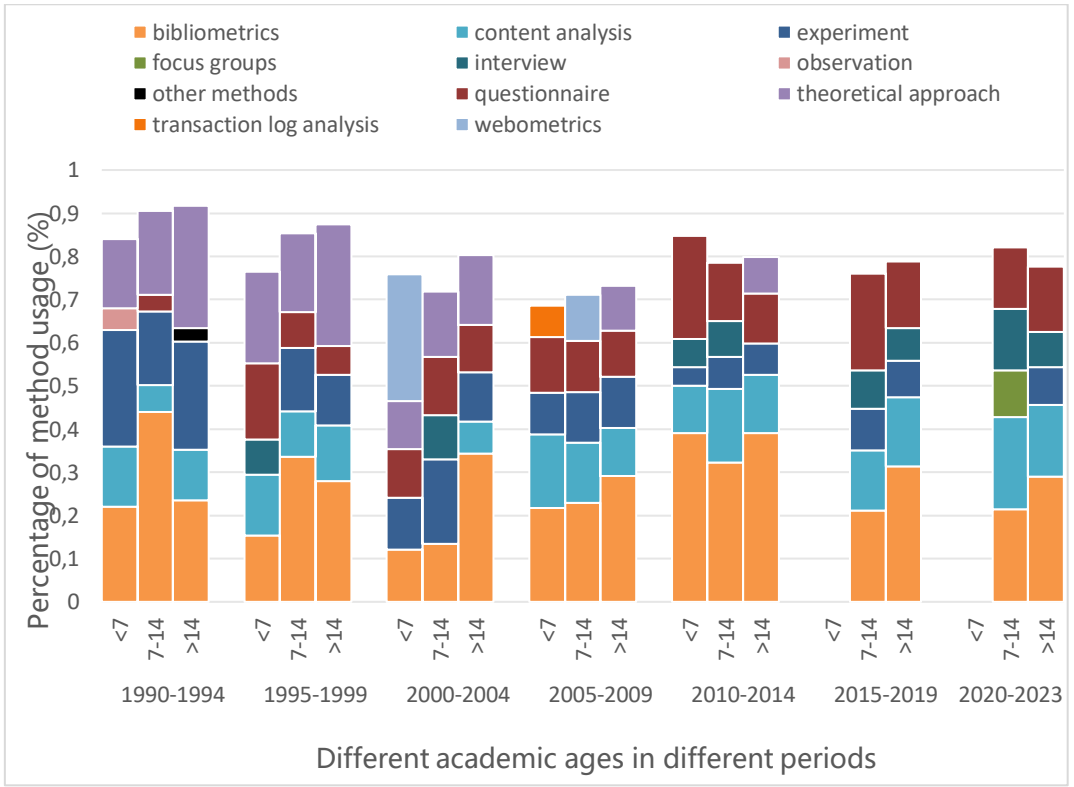

Figure 7. Top five research methods used by different academic age groups.

Overall, scholars in different academic age groups exhibit variations in their use of research methods across different time periods. Over time, the usage proportions of certain methods, such as bibliometrics and content analysis, have gradually increased across all academic age groups. In contrast, the usage proportions of more traditional methods, such as interview and theoretical approach, have declined. These shifts reflect broader trends in academic research and the influence of technological advancements on methodological preferences.

Evolution of research method usage among scholars at different career stages: Figure 8 presents the evolving trends in the frequency of usage for the 16 research methods among scholars in different academic age groups. Overall, the usage frequency of most methods shows significant fluctuations between 1990 and 2020. This indicates that scholars' adoption of research methods has not been stable over the years, likely influenced by factors such as shifts in research hotspots, technological developments, and interdisciplinary integration. These fluctuations underscore the diversity and dynamism of research methodologies in academic inquiry. Moreover, for each research method, the trends in usage frequency appear consistent across the three academic career stages. This may be attributed to the inherent characteristics of the methods themselves, where a method gaining popularity in a particular period leads to its widespread adoption by scholars across all age groups.

Figure 8. Evolutionary trends in the use of different research methods by scholars at different stages of their academic careers.

In papers published by scholars in the senior stage of their careers, the use of methods such as bibliometrics, content analysis, interview, and questionnaire exhibits a pronounced upward trend. Notably, bibliometrics, which had relatively low usage frequency from 1990 to 1995, experienced rapid growth starting in 1995 and maintained high usage frequency between 2010 and 2020. This trend may be linked to the rapid development of scientometrics and the increasing emphasis on literature analysis in academia. In contrast, the use of experiment and theoretical approach remains relatively stable, indicating that theoretical research continues to hold a significant position in academic inquiry. During the period of 2005–2010, methods such as experiment, historical method, interview, observation, and transaction log analysis reached a notable peak in usage. This suggests that scholars during this five-year period were inclined to employ a diverse range of research methods rather than limiting themselves to commonly used or popular approaches.

Apart from the aforementioned methods, most other methods do not exhibit significant trends in usage frequency due to their inherently low adoption rates. When scholars are in the early stages of their careers, the use of webometrics shows a leading trend. This can be attributed to the influence of internet technology on academic research methods, as well as the greater willingness of younger scholars to adopt and apply emerging technologies. When scholars are in their middle age, the frequency of using all kinds of research methods increases compared with that in their younger age. This may be because scholars' careers are relatively stable in middle age and the valuation risk is relatively reduced. Therefore, scholars will try to use a variety of research methods to achieve self - breakthroughs and enhance their academic influence.

As shown in Figure 8, the trends in the usage frequency of different research methods between 1990 and 2020 vary significantly. Emerging methods, such as webometrics, exhibit rapid growth trends driven by technological advancements. In contrast, more traditional methods, such as questionnaire and theoretical approach, maintain relatively stable usage frequencies. The adoption of research methods is influenced by a variety of factors, including disciplinary developments, technological progress, and shifts in research hotspots. Scholars adapt their methodological choices over time to align with the practical demands of their research.

Trajectory of research method usage in LIS scholars' academic careers

In this section, we address ***RQ2*** by exploring the trajectory of research method usage in the academic careers of LIS scholars, both at the aggregate and individual levels. Building on the earlier analysis of the types of research methods used by scholars during their careers, this study examines the overall differences in method usage from 1990 to 2023. However, specific trends in the trajectory may be obscured by factors such as the popularity of certain methods. Therefore, this subsection focuses on scholars who published their first paper between 1970 and 1979. This cohort was selected to minimize the generational effects of academic age differences on method usage and because scholars in this decade produced a higher volume of publications compared to other ten-year intervals, making them particularly valuable for analysis.

Aggregate trajectory of research method usage in LIS scholars' academic careers: Figure 9 illustrates the evolving trends in research method usage among scholars who published their first paper between 1970 and 1979, as their academic age increased. Methods such as bibliometrics, content analysis, experiment, questionnaire and theoretical approach were widely used across different academic ages. Notably, experiment was more frequently employed when scholars were between 13 and 28 academic years old, while questionnaire became more prevalent after scholars reached 29 academic years of age. Over the course of their academic careers, scholars exhibited a trend toward greater diversity in the types of research methods they used as they aged.

To better demonstrate this relationship, we created an interactive heatmap [https://jiayihao - njust.github.io/tra/]. This interactive graph collected data from the group of scholars whose earliest publication time was from 1970 to 1979. It can dynamically display the changes in the research methods used by scholars each year as their academic age increases. At the bottom of the interactive graph, there is a "Pause" button, which allows users to pause at any time to view the usage trajectories of research methods in the academic careers of scholars in the LIS field in any specific year from 1990 to 2023. The detailed information of the selected scholars for this graph can be found in Table A of Appendix.

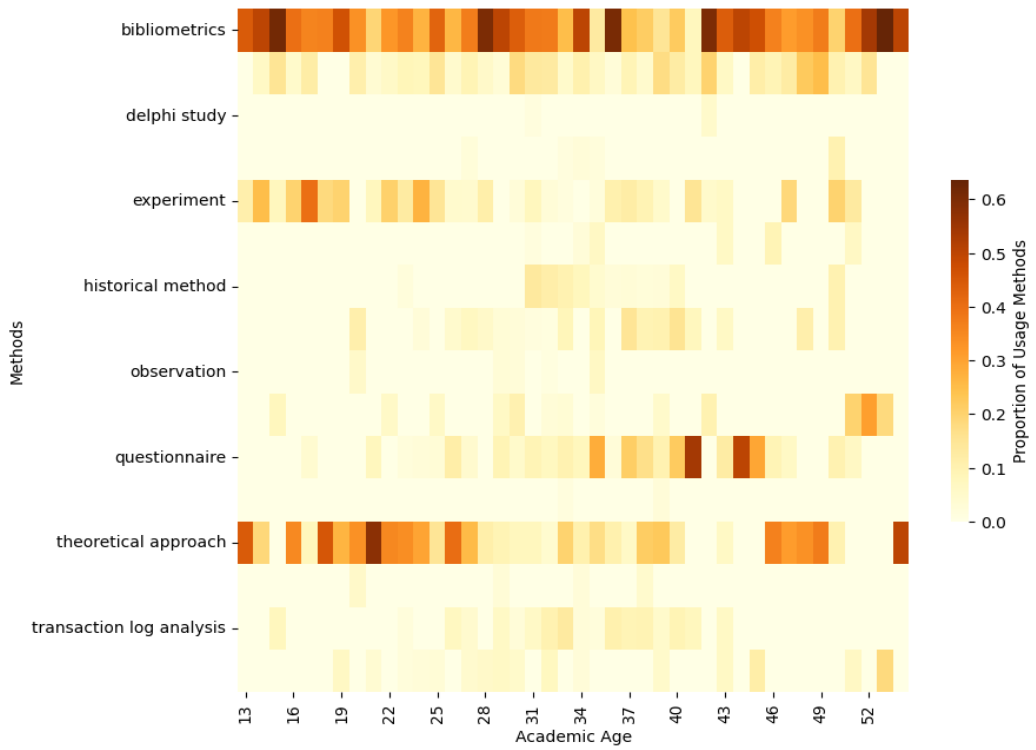

Figure 9. Evolution of research method usage among scholars at different career stages.

Individual trajectories of research method usage in scholars' academic careers: To further explore the characteristics of research method usage in scholars' academic careers, this study randomly selects four senior scholars and conducts a detailed analysis of their methodological trajectories. Due to limited data availability, the analysis of these scholars' careers is based on their publications in the 15 selected journals between 1990 and 2023.For each scholar, the analysis focuses on the following aspects:the most frequently used research methods, the combination of methods employed, and the trends in changes to their research method usage over time.

Mike Thelwall is a male scholar whose first publication appeared in 2000. Over the course of his academic career, he has employed eight research methods, with the most frequently used being bibliometrics, webometrics, and content analysis. He has also utilized combined methods in his research, primarily pairing commonly used methods. During his early-career stage, he predominantly relied on webometrics. As he transitioned into the mid-career stage, his methodological repertoire expanded to include webometrics and content analysis, and he began incorporating combined methods into his research. In his senior-career stage, his most frequently used methods were bibliometrics, webometrics, and content analysis, with an increased reliance on combined methods. This demonstrates that his selection and use of research methods evolved in stages as he advanced in age and experience.

Amanda Spink is a female scholar whose first publication appeared in 1992. Throughout her academic career, she has employed ten research methods, with the most frequently used being transaction log analysis, questionnaire, content analysis, experiment, and theoretical approach. She has also employed combined methods in her research, including combinations of commonly used methods as well as pairings of common and less common methods. In some publications, she used up to four combined methods. Notably, the diversity of methods she employed remained consistent across different stages of her academic career, indicating her proficiency and habitual use of various methodologies to support her research endeavors.

Noa Aharony is a female scholar whose first publication appeared in 2006. Over her academic career, she has employed four research methods, with the most frequently used being questionnaire and content analysis. She has also utilized combined methods in her research, pairing commonly used methods with less common ones. During her early-career stage, her primary methods were questionnaire and content analysis. As she transitioned into the mid-career stage, the use of questionnaire increased significantly, while the use of content analysis declined relatively. She began employing combined methods and other methodologies during this period. In her senior-career stage, her most frequently used method was questionnaire. This suggests that, while her methodological choices exhibited a brief period of diversification during her mid-career stage, they ultimately stabilized. This stability may be attributed to the constraints of her research topics or her habitual preferences in method selection.

José Ortega is a male scholar whose first publication appeared in 2003. Throughout his academic career, he has employed four research methods, with the most frequently used being webometrics, content analysis, and bibliometrics. He has also

utilized combined methods in his research, primarily pairing commonly used methods. During his early-career stage, his sole research method was webometrics. In his mid-career stage, his methodological choices evolved from webometrics to content analysis, then to a combination of content analysis and bibliometrics, and finally back to bibliometrics. In his senior-career stage, his most frequently used methods were content analysis and bibliometrics. This indicates a notable trend of methodological diversification during his mid-career stage.

From the trajectories of research method usage among the four scholars described above, it is evident that during the mid-career stage, scholars exhibit a tendency to employ a diverse range of research methods, accompanied by an increase in publication output. The most frequently used research methods shift as scholars advance in age and experience, likely influenced by the popularity of certain methods and research topics during different periods. Throughout their academic careers, scholars experiment with various combinations of research methods, whether pairing commonly used methods or combining less common methods with popular ones. This reflects their flexibility and adaptability in applying research methodologies to their work.

Discussion

Research implications

Theoretical implications: The basic aim of this study was to explore the trajectory of research methodology use in scholars' academic careers based on journal articles in the field of LIS. Additionally, this study makes two unique contributions to the understanding of research method usage.

First, we combine the automatic categorization of research methods with scholars' academic careers to explore the relationship between scholars' academic age and research use. From the perspectives of cognitive and sociological theories, scholars of different academic ages may have different personal cognitive understandings that affect their choice and use of research methods. Scholars of different academic ages also have different preferences in the use of research methods.

Second, this study provides a comprehensive and dynamic overview of research method usage among LIS scholars from 1990 to 2023. It highlights innovative directions and the application of cutting-edge research methods within the LIS field, offering theoretical insights and guidance for disciplinary development and innovation.

Practical Implications: From the perspective of individual scholars, by examining the differences in research method usage among scholars of different academic ages, scholars can learn from the methodological trajectories of senior scholars with similar backgrounds or research interests. Scholars at different stages of their academic careers may choose different research methods based on their evolving research interests and the contextual demands of their time. On a personal level, paying attention to the research topics and methods favored by scholars of different academic ages can help uncover hidden patterns in the relationship between academic age and methodological choices. Additionally, young scholars can learn

from the use of research methods by senior scholars, thus enriching the variety of research methods used in their own academic research and promoting their personal career development.

From an institutional perspective, this study offers recommendations for developing academic guidance programs that promote methodological diversity. The findings reveal that scholars of different age groups exhibit distinct preferences for research methods, with certain methods gaining varying levels of popularity across academic age groups. However, the LIS field is characterized by methodological diversity, and scholars at different academic ages may exhibit varying degrees of methodological specialization, sometimes leading to a narrow focus on specific methods. This study enhances understanding of such dynamics and provides insights for institutions to design academic guidance programs that encourage methodological diversity and innovation.

Research limitations

The study of research method usage trajectories in the academic careers of LIS scholars still faces several challenges. First, the scope of this study is limited, as it only includes data from 14 LIS journals published between 1990 and 2023. Future research aims to expand the data sources to encompass the complete publication records of scholars throughout their academic careers. Second, while this study collected and visualized data on research method usage in scholars' academic careers, it did not delve into the underlying reasons for their methodological choices. Structural factors—such as funding dynamics, the influence of journal policies, and broader disciplinary trends—remain underexplored. In subsequent work, additional factors such as research topics, scholar gender, and country of origin will be incorporated to explore the influences on scholars' selection and use of research methods. Finally, due to time constraints, this study analyzed the methodological trajectories of only a subset of scholars. Future research will consider including a larger cohort of senior scholars in the field to comprehensively explore research method usage trajectories and derive a paradigm for methodological practices in scholars' academic careers.

Conclusions and future research

We draw on data from 14 authoritative journals in the LIS field published between 1990 and 2023, selecting a subset of scholars to explore the trajectory of research method usage in their academic careers.

Based on the results, several conclusions can be drawn about the two research questions posed in this study. We found that the research methods commonly used by scholars in the field of LIS will change with the growth of age and seniority, which may be affected by factors such as popular research methods and research topics at different times. Over the course of their academic careers, scholars exhibit an initial increase followed by a decline in the diversity of research methods used. They also demonstrate a tendency to combine multiple methods, whether pairing commonly used methods or integrating less common methods with popular ones, reflecting their flexibility and adaptability in applying research methodologies.

Scholars' use of research methods is influenced by a variety of factors, including disciplinary developments, technological advancements, and shifts in research hotspots. As a result, scholars adapt their methodological choices over time to align with the practical demands of their research.

In future work, we intend to incorporate information such as research topics, genders, and research backgrounds into the study. Building upon initial findings from chi-square tests, which reveal statistically significant variations in methodological preferences across career stages, we will employ more advanced analytical techniques to identify causal mechanisms underlying these patterns. In addition, we would like to expand the data sources, starting from individual scholars, to obtain the papers published by scholars during their academic careers that cover a wider range of journals.

Acknowledgments

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References

Abramo, G., D'Angelo, C. A., & Murgia, G. (2016). The combined effects of age and seniority on research performance of full professors. Science and Public Policy, 43(3), 301–319.

Ao, W., Lyu, D., Ruan, X., Li, J., & Cheng, Y. (2023). Scientific creativity patterns in scholars' academic careers: Evidence from PubMed. Journal of Informetrics, 17(4), 101463.

Aref, S., Zagheni, E., & West, J. (2019, November). The demography of the peripatetic researcher: Evidence on highly mobile scholars from the Web of Science. In International conference on social informatics (pp. 50-65). Cham: Springer International Publishing.

Azoulay, P., Fons-Rosen, C., & Zivin, J. S. G. (2019). Does Science Advance One Funeral at a Time? American Economic Review, 109(8), 2889–2920.

Badar, K., M. Hite, J., & F. Badir, Y. (2014). The moderating roles of academic age and institutional sector on the relationship between co-authorship network centrality and academic research performance. Aslib Journal of Information Management, 66(1), 38–53.

Bu, Y., Murray, D. S., Xu, J., Ding, Y., Ai, P., Shen, J., & Yang, F. (2018). Analyzing scientific collaboration with "giants" based on the milestones of career. Proceedings of the Association for Information Science and Technology, 55(1), 29–38.

Chan, H. F., & Torgler, B. (2020). Gender differences in performance of top cited scientists by field and country. Scientometrics, 125(3), 2421–2447.

Chowdhary, S., Gallo, L., Musciotto, F., & Battiston, F. (2024). Team careers in science: formation, composition and success of persistent collaborations. arXiv preprint arXiv:2407.09326.

Chu, H. (2015). Research methods in library and information science: A content analysis. Library & Information Science Research, 37(1), 36–41.

Coomes, O. T., Moore, T., Paterson, J., Breau, S., Ross, N. A., & Roulet, N. (2013). Academic Performance Indicators for Departments of Geography in the United States and Canada. The Professional Geographer, 65(3), 433–450.

Costas, R., Nane, G. F., & Lariviere, V. (2015). Is the Year of First Publication a Good Proxy of Scholars Academic Age?. In International Conference on Scientometrics &

Informetrics (pp. 988-998). Retrieved from https://www.issi-society.org/proceedings/issi_2015/0988.pdf
Cui, H., Wu, L., & Evans, J. A. (2022). Aging scientists and slowed advance. arXiv preprint arXiv:2202.04044.
Ding, M., Zhou, C., Yang, H., & Tang, J. (2020). Cogltx: Applying bert to long texts. Advances in Neural Information Processing Systems, 33, 12792-12804.
Győrffy, B., Csuka, G., Herman, P., & Török, Á. (2020). Is there a golden age in publication activity?—An analysis of age-related scholarly performance across all scientific disciplines. Scientometrics, 124(2), 1081–1097.
Hayman, R. & Smith, E. (2020). Mixed Methods Research in Library and Information Science: A Methodological Review. Evidence Based Library and Information Practice, 15(1), 106–125.
Heting Chu & Qing Ke. (2017). Research methods: What's in the name? Library & Information Science Research, 39(4), 284–294.
Järvelin, K., & Vakkari, P. (1990). Content Analysis of Research Articles in Library and Information Science. Library & Information Science Research, 12, 395-421.
Järvelin, K., & Vakkari, P. (1993). The evolution of library and information science 1965–1985: A content analysis of journal articles. Information Processing & Management, 29(1), 129–144.
Järvelin, K., & Vakkari, P. (2021). LIS research across 50 years: Content analysis of journal articles. Journal of Documentation, 78(7), 65–88.
Jia, T., Wang, D., & Szymanski, B. K. (2017). Quantifying patterns of research interest evolution. Nature Human Behaviour, 1(4), 0078.
Kumar, S., & Ratnavelu, K. (2016). Perceptions of Scholars in the Field of Economics on Co-Authorship Associations: Evidence from an International Survey. PLOS ONE, 11(6), e0157633.
Liang, G., Hou, H., Ding, Y., & Hu, Z. (2020). Knowledge recency to the birth of Nobel Prize-winning articles: Gender, career stage, and country. Journal of Informetrics, 14(3), 101053.
Liao, C. H. (2017). Reopening the Black Box of Career Age and Research Performance. In J. Zhou & G. Salvendy (Eds.), Human Aspects of IT for the Aged Population. Applications, Services and Contexts (Vol. 10298, pp. 516–525). Springer International Publishing.
Lou, W., Su, Z., He, J., & Li, K. (2021). A temporally dynamic examination of research method usage in the Chinese library and information science community. Information Processing & Management, 58(5), 102686.
Lund, B. D., & Wang, T. (2021). An analysis of research methods utilized in five top, practitioner-oriented LIS journals from 1980 to 2019. Journal of Documentation, 77(5), 1196–1208.
Milojević, S. (2012). How Are Academic Age, Productivity and Collaboration Related to Citing Behavior of Researchers? PLoS ONE, 7(11), e49176.
Nane, G. F., Larivière, V., & Costas, R. (2017). Predicting the age of researchers using bibliometric data. Journal of Informetrics, 11(3), 713–729.
Packalen, M., & Bhattacharya, J. (2019). Age and the Trying Out of New Ideas. Journal of Human Capital, 13(2), 341–373.
Palvia, P., Pinjani, P., & Sibley, E. H. (2007). A profile of information systems research published in Information & Management. Information & Management, 44(1), 1–11.

Perianes-Rodriguez, A., & Ruiz-Castillo, J. (2015). Within- and between-department variability in individual productivity: The case of economics. Scientometrics, 102(2), 1497–1520.

Robinson-Garcia, N., Costas, R., Sugimoto, C. R., Larivière, V., & Nane, G. F. (2020). Task specialization across research careers. eLife, 9, e60586.

Simoes, N., & Crespo, N. (2020). A flexible approach for measuring author-level publishing performance. Scientometrics, 122(1), 331–355.

Sugimoto, C., Sugimoto, T., Tsou, A., Milojevic, S., & Larivière, V. (2016). Age stratification and cohort effects in scholarly communication: A study of social sciences: Scientometrics, 109.

van den Besselaar, P., & Sandström, U. (2016). Gender differences in research performance and its impact on careers: A longitudinal case study. Scientometrics, 106, 143–162.

Wang, W., Yu, S., Bekele, T. M., Kong, X., & Xia, F. (2017). Scientific collaboration patterns vary with scholars' academic ages. Scientometrics, 112(1), 329–343.

Zeng, A., Shen, Z., Zhou, J., Fan, Y., Di, Z., Wang, Y., Stanley, H. E., & Havlin, S. (2019). Increasing trend of scientists to switch between topics. Nature Communications, 10(1), 3439.

Zhang, C., Tian, L., & Chu, H. (2023). Usage frequency and application variety of research methods in library and information science: Continuous investigation from 1991 to 2021. Information Processing & Management, 60(6), 103507.

Zhang, L., Qi, F., Sivertsen, G., Liang, L., & Campbell, D. (2024). Gender differences in the patterns and consequences of changing research directions in scientific careers. Quantitative Science Studies, 5(4), 882–905.

Appendix

Table A. Information on scholars with first publications between 1970 and 1979.

Earliest pub year	*Author name*	*Number of publications (1990-2023)*
1970	E. Michael Keen	10
1970	J. A. García	49
1970	Jaime A. Teixeira da Silva	12
1970	V.K. Singh	21
1970	W. W. Hood	14
1971	Anthony F. J. van Raan	25
1971	Barrie Gunter	12
1971	David Nicholas	55
1971	Michael E. D. Koenig	12
1971	Peter Vinkler	26
1972	Donald O. Case	10
1972	Peter Hernon	14
1973	Henry Small	12
1973	Ian Ruthven	12
1973	Jennifer Rowley	56
1973	M. H. Heine	10
1973	Peter Williams	16
1974	Mingyang Wang	11
1975	Gangan Prathap	17
1976	G.E. Gorman	56
1976	Maria Pinto	76
1976	R. Rada	16
1977	Birger Hjørland	29
1977	Howard D. White	34
1977	Hsin Hsin Chang	11
1977	Mark E. Rorvig	20
1978	Blaise Cronin	36
1978	Jin Zhang	34
1978	Leo Egghe	226
1978	Peter Willett	27
1979	Jin Ha Lee	13
1979	Nigel Ford	23
1979	Philip M. Davis	16