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Altmetrics mentioned in WeChat articles: Evolution, topic, context and comparison with scholarly publications

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ABSTRACT

[Purpose/Significance] The purpose is to explore the use of WeChat official accounts articles (referred to as WeChat articles) as a type of Chinese altmetrics data source, and reveal the attention and discussion surrounding altmetrics in the social media environment, as well as discover the similarities and dissimilarities compared to that of scholarly publications. [Methodology/Procedure] Using WeChat articles that are relevant to altmetrics as the research object, statistical analysis, quantitative analysis, and text mining were used to explore the pattern of attention and discussion of altmetrics in WeChat articles. Meanwhile, scholarly publications of altmetrics were collected for scientometric analysis. The similarities and dissimilarities as regards the degree of attention, topic distribution and developing trend were compared between these two datasets. [Results / Conclusions] (1) Number of WeChat articles that mention altmetrics is increasing rapidly, although there is a time lag between the first WeChat article and the first scholarly publication of altmetrics. (2) Types of WeChat official accounts that pay attention to altmetrics are very diversified and go beyond the academia. (3) WeChat articles relevant to altmetrics mainly focus on 4 topics, i.e. the introduction of the latest publications of altmetrics, information of relevant scholarly activities and scholarly meetings, informetrics research and scientific evaluation that involve altmetrics, and introduction of altmetrics monographs. (4) Four major types of context where altmetrics is mentioned by WeChat articles are identified. They are to introduce the concept, theory, knowledge system, and technical methods of altmetrics, to discuss the data sources and research objects of altmetrics, to discuss the construction and application of altmetrics indicators, and to discuss the meaning and value of altmetrics. (5) In contrast, scholarly publications of altmetrics are more centered on systematic research, including the theories of altmetrics, the construction of altmetrics indicators, the application of altmetrics indicators, impact evaluation, and the relationship between altmetrics and traditional informetrics. These results are useful for further developing the Chinese altmetrics data source and understanding the relationship between altmetrics and bibliometrics.

KEYWORDS

Altmetrics; Social Media; WeChat Official Accounts; WeChat; Altmetrics Indicator

1 Introduction

With the thriving new types of scholarly outputs and the increasing amount of online scholarly activities, the traditional citation analysis framework is inadequate to capture academic activities and assess impact of publications comprehensively and accurately. Altmetrics indicators complement the citation analysis framework with more diversified types and richer context (Priem et al., 2010). Twitter altmetrics is regarded as one of the most important altmetric indicators in measuring academic output's social impact, because it has diversified user groups and potentially could reflect the use of scholarly outputs by to the wider public. Policy document mention of scholarly publications is also an effective way for measuring the social impact of academic outputs (Wang, 2018), because the convergence of policy concern and research focus has reflected the interaction between the academia and the society (Drongstrup et al., 2020).

To track and investigate the academic activities in social media is an integral part of showcasing the social value (for example, widespread science communication and social impact) of scholarly publications. It is also important for evaluating the researcher's scholarly impact. Chinese scholars have explored the feasibility of establishing a domestic altmetrics database taking into account the context of altmetrics data and following the construction mechanism of altmetrics indicators system. Nevertheless, few empirical studies are seen. Yu et al. (2016) revealed the distribution pattern of Weibo altmetrics. Zhao and Wei (2017) proposed the WeChat communication index to assess the academic impact of WeChat by combining the data from the popular WeChat platform.

In the Internet era, apps for news outlets, information sharing and mobile communication have been thriving to satisfy the public's information need. Twitter and Facebook are the most popular social media platforms around the world but are restricted in China. WeChat is a platform launched by Tencent in 2011 and has become one of the most important social media platforms in China. With the exponential growth of user traffic and data, WeChat not only plays an important role in social networking and instant messaging, but also has been extended to more diverse application scenarios for the public to seek differentiated content and obtain personalized services.

WeChat official accounts platform has become an essential channel for accurate delivery, information acquisition, and information service by tapping into readers' reading preference. The academic community and the public users who are keen to follow science and technology information have generated substantial information need and massive traffic, leading to the emergence of more and more high-quality academic Wechat official accounts and science and technology articles on WeChat platform. Promotion via Wechat platform has great positive effect for disseminating academic papers, and the effect may have disciplinary difference (Zong & Zhao, 2020). Many journals indexed by CSSCI and CSCD have established WeChat official accounts as a promotional channel for academic information sharing (Zhang et al., 2018). However, WeChat official accounts platform has a strong sense of circle and privacy, and does not allow direct communication among their followers. It is only allowed that authors of Wechat official accounts communicate with the followers, having seriously limited the scope of scholarly communication and dissemination (Hu & Qin, 2019). However, as a pivotal information channel, WeChat has become one of the most active social network platforms for communication in China.

Articles delivered by the WeChat official accounts are referred to as WeChat articles in this

study. WeChat article has become an essential information channel for the community. To study how scholarly topics are discussed on WeChat would be helpful to the development of Chinese altmetrics data sources.

This paper investigates the attention and discussion of altmetrics on WeChat platform by using statistical analysis, quantitative analysis, and text mining. Publications of altmetrics were also analyzed to compare the similarities and dissimilarities with WeChat articles. The aim is twofold, to explore the WeChat articles as a Chinese altmetrics data source, and to reveal the characteristics of WeChat altmetrics data. Two main questions are as follows.

(1) How is altmetrics mentioned on WeChat platform? This research question can be decomposed into more specific questions. To what extent and by whom is altmetrics mentioned? What is the main focus of WeChat article that mention altmetrics? And in what context is altmetrics mentioned?

(2) What are the similarities and dissimilarities of focus on altmetrics between WeChat articles and scholarly publications? While scholarly publications reflect the focus of academic community, WeChat articles have reflected attention of various types of users. The comparison may help reveal the characteristics of WeChat altmetrics data and enlighten the further application.

2 Methodology

2.1 Data source

WeChat is a mobile program application and does not provide a unified API, making it difficult to collect the data. Fortunately, via partnership, the Sogou search engine has provided the access to WeChat data (https://weixin.sogou.com/) and is selected as the data source of this study. Sogou's WeChat search provides both accounts search and articles search. This study conducted keywords-based articles search to obtain relevant data.

Altmetrics was selected for two reasons: Firstly, the terminology of altmetrics is highly distinctive with almost no semantic ambiguity. Secondly, altmetrics is an emerging research topic of informetrics and scientometrics. It is relevant and interesting for the informetrics community to investigate the perception of altmetrics in the social media environment.

Both English term altmetrics and corresponding Chinese terms (three different translations 替代计量学, 补充计量学, 选择性计量学) were used as keywords. The search was conducted on December 7, 2020, using double quotation marks for precise search. There were 378 records, 116 records, 13 records, and 2 records for the keywords respectively. The corresponding data were harvested through the crawler program. In total, the metadata and source text data of 509 WeChat articles were obtained. The extracted data items were article title, release time, name of WeChat official accounts, the introduction of WeChat official accounts, owner of the accounts, and source text of WeChat article. The illustration of the search result of WeChat articles and the corresponding extracted data items are shown in Figure 1.

Meanwhile, in order to measure the dissemination capability and general impact of the WeChat official accounts, the WeChat communication index from Qingbo Big Data (www.gsdata.cn) and the fans data of WeChat official accounts from the Xiguaji data platform (data.xiguaji.com) were crawled.

In order to compare scholarly publication of altmetrics with WeChat articles, this study retrieved scholarly publications from CNKI database. CNKI is a comprehensive full text database in China. It is the largest Chinese bibliometrics database and is commonly used for

Figure 1 Illustration of the search result and extracted data items of WeChat article.

scientotmetrics and informetrics studies. Only Chinese publications were considered for comparison's sake because WeChat is basically working under Chinese environment. Both English term altmetrics and three Chinese translations (i.e. 替代计量学, 补充计量学, 选择性计量学) were used to search on December 12th, 2020. In total, data of 450 publications were obtained after data cleaning. These data were exported in NoteExpress format for further analysis.

2.2 Process of Crawling the WeChat Data

Bibliographic data can be more easily retrieved from the academic database. In contrast, there are many barriers to obtain WeChat articles and their relevant data. Although Sogou search has provided search for WeChat data, it has set many anti-crawling mechanisms. The encountered difficulties and corresponding solutions are summarized below.

(1) The calibration of cookies. After crawling the link displayed on the Sogou's WeChat query page and directly accessing the WeChat article page, there will be a CAPTCHA block. It

can be circumvented by setting a series of headers and cookie values, generally by building SUV, SUID, and SNUID. Local tests with postman set headers=Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/87.0.4280.88 Safari /537.36 with SUV = 0074178B73C13FEB5A1BC4917B21D967 in COOKIE can be accessed, but the CAPTCHA still comes out for multiple visits.

(2) URL redirection. The timestamp and signature fields in the article detail page URL are randomly and dynamically generated, in order to prevent the crawler from crawling the accounts home page address. The solution is to use a Selenium web driver to simulate the human click action. When the actual article page appears, the URL is fixed.

(3) Dynamic generation of the verification code. When the request exceeds a certain number of times or exceeds the capability of human requests that are pre-defined by the system, Sogou will use the four-digit English verification code for human verification. Obtaining this verification code is difficult because each visit will generate a new picture, even saving the picture will also request a new picture. The solution is to save the picture for further processing through the screenshot function of the Selenium web driver.

(4) IP blocking for frequent access in short period. When crawling multiple times in a short period, or when the page is continuously refreshed, Sogou's IP blocking mechanism will be triggered. At that time, the verification code needs to be entered. There are two solutions that were used for this problem. On one hand, Chaojiying coding platform (a python package for constructing the corresponding functions) was used to generate the correct verification code to unblock the IP. On the other hand, proxy service (Kuaidaili proxy, https://www.kuaidaili.com/free) was used to construct a proxy pool to for the crawler.

(5) Article detail page is filled with ajax. Some of the data on the article page is filled with ajax dynamically. HTTP clients obtaining the page source code cannot get the corresponding data. Selenium web driver simulation crawl was used. The disadvantage is that the efficiency is relatively low. But it is sufficient for small-scale empirical research.

2.3 Steps of data processing

The data processing is shown in Figure 2. After selecting the data source and collecting the data, we perform data preprocessing, including removing the duplicated records, cleaning,

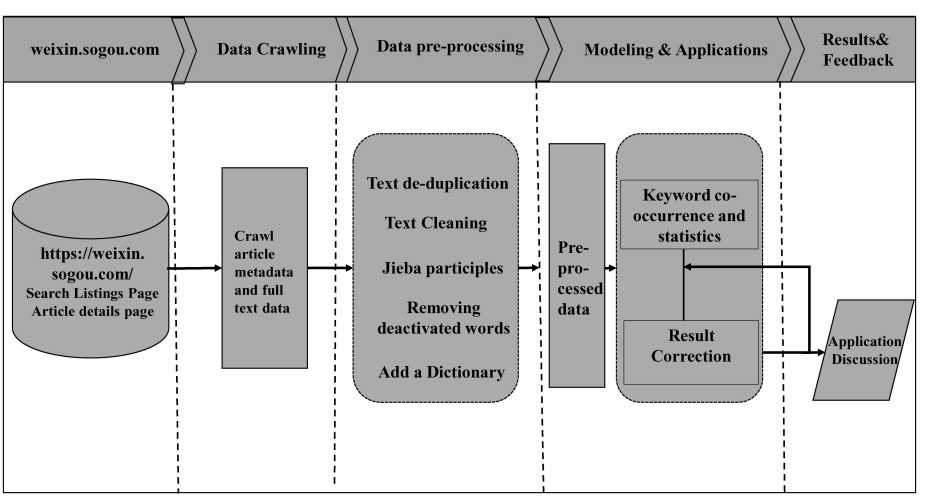

Figure 2 Flow chart for data processing

and word segmentation of the text. Then we carry out word frequency statistics, matrix construction and network analysis. Finally, we interpret and discuss the results. In the study, LDA model was also used to detect the topic distribution, but results of co-occurrence network analysis turned out to be more interpretable and reasonable.

Specifically, the following four steps in the data processing section are important to get the correct analysis results.

(1) After retrieving the scholarly publications of altmetrics from CNKI database, we calculated keyword frequencies, extracted keyword co-occurrence relationships, identified collaborative author entities, and compared with WeChat articles.

(2) In the text pre-processing, the keywords of publications obtained from CNKI are used as an expanded dictionary for word segmentation, in order to prevent the specialized terms from being segmented and ensure the accuracy of segmented words. Meanwhile, the dictionary and the stop list are continuously adjusted according to the results of the segmented words to ensure the accuracy. The reliable result is basis for the subsequent text mining.

(3) Based on the segmented words, the co-occurrence frequency is calculated by title and paragraph respectively to explore the relationship between topics.

2.4 Steps of data analysis

(1) Statistical analysis was used to reveal the temporal distribution and account distribution of relevant WeChat articles, reflecting the overall developing trend of discussing altmetrics on WeChat official accounts.

(2) Titles of relevant WeChat articles are used as data source to reveal the topic distribution, because the title is summary of the article content and can effectively represent the overall theme of the article. In selecting text processing methods, topic word segmentation and word frequency statistics are the basic models of text processing, reflecting the different topics of WeChat articles and corresponding hotness. However, the primacy frequency statistics ignore the association and weight of topic words. And it cannot tap into the thematic community of social media attention. In addition, the fundamental frequency statistics cannot reveal the similarities and dissimilarities of topic attention and thematic trends. In this study, we choose co-occurrence analysis to explore the association between topics and themes, and the hot topic communities.

(3) Paragraphs that mention altmetrics are used as data sources to reveal the specific context of the WeChat mentions. WeChat articles that mention altmetrics do not necessarily focus exclusively on the topic of altmetrics but may mention only certain aspects of altmetrics. Therefore, we extracted the paragraphs that mention altmetrics to capture the context and explore what relevant aspects of altmetrics are receiving attention.

(4) The above analysis results are compared with those based on scholarly publications data, in order to reveal the similarities and dissimilarities of the focus on altmetrics between informal and formal scientific communication.

3 Results

3.1 Time distribution of WeChat articles mentioning altmetrics

The temporal distribution of WeChat articles that mention altmetrics is shown in Figure 3. From Figure 3, it can be seen that the number of WeChat articles mentioning altmetrics is increasing annually. The number of related articles in 2019 and 2020 is even doubling, indicat-

ing that altmetrics is gaining substantial social attention.

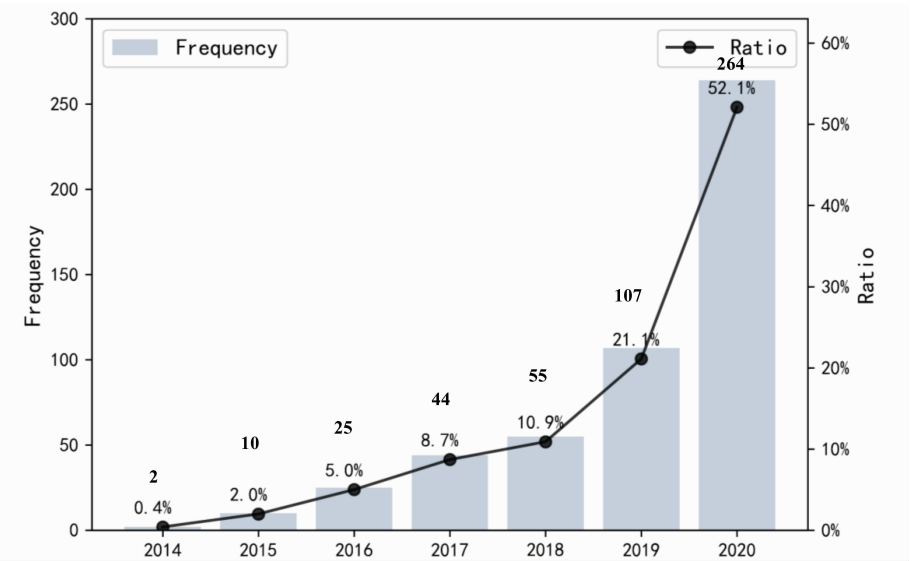

Figure 3 Time distribution of WeChat articles mentioning altmetrics.

Table 1 lists the earliest ten relevant WeChat articles. As can be seen from Table 1, in terms of mentioning form, WeChat articles mentioning altmetrics range from introduction of national and international papers (#1, #2, #3, #7, #8, #10), message of the upcoming events (#4), to review articles (#5, #6) and news reports (#9). In terms of mentioned topics, the two main topics covered are science communication and scientific evaluation. In terms of mentioning reasons, two main reasons are to convey front research and to introduce altmetrics as a new source of method or tool. In terms of account owners, the types are rich, including universities, journals, newspapers, publishers, and blog sites, which are mainly from non-library information fields. It shows that altmetrics has attracted a wide range of attention from the WeChat official accounts.

Table 1 WeChat articles that mention altmetrics (Earliest top 10).

Serial number	Title of WeChat articles	Main content	Reason for mentioning	Account name	Account owner	Year
#1	Does a paper´s social media buzz lead to higher citations?	Share the core findings of the articles and promote the frontiers of foreign lan-	Translation of cited foreign language papers (Wang et al., 2014)	瓜太学术帮	Xi´an Guatai E – commerce Co.	2014
#2	Is peer review really fair?	Contribute articles by foreign research scholars, translate and introduce peer review	Exploring the advantages and disadvantages of peer review using alternative metrics (altmetrics) as an academic theme	科研圈	Global Science Magazine Co.	2014

Serial number	Title of WeChat articles	Main content	Reason for mentioning	Account name	Account owner	Year
#3	[OA Roundup] Open Change in Scholarly Publishing: A Review of Open Access Developments in Europe and the United States in 2014	Reprint domestic academic articles	Citing altmetrics to explore research evaluation systems	科技与出版	Science, Technology and Publishing Magazine	2015
#4	April 2015 Library Reader Training Notice	Exploring open access	Introduction to academic lecture information including alternative metrics (altmetrics)	天津大学图书馆	Tianjin University	2015
#5	How Nature Publishing Group replied to German scientists´4–point criticism of the Nature Index	Forecast of academic lectures and	Mentions the value of altmetric.com´s data	科学网	China Science News Agency	2015
#6	Repairing fractured science communication	Popularization of science activities	Citing altmetrics to explore new models of science communication	科学媒介中心	China Institute of Popular Science (China Center for Science, Technology and Social Development)	2015
#7	The expanding peer review community: Insights from the ISMTE 2015 annual meeting	Republishing the Science Network blog	Review of Kudos platform–related presentations in the conference, mentioning altmetrics scores	Wiley	John Wiley & Sons Business Services (Beijing) Co.	2015
#8	Taking stock of 10 years of China´s publishing industry listing — " Publishing + Internet" : cross–border mergers and acquisitions and media innovation of European and American publishing groups	Exploring the advantages and disadvantages of natural indices	Cited paper (Ren 2015) mentioning the promise of Altmetrics as a new method for assessing the academic impact	科技与出版	Science, Technology and Publishing Magazine	2015
#9	Impact Factor is useless, and new academic evaluation standards are needed—Global Science interview with Elizabeth Marincola, CEO of PLOS.	Public editorial articles on the history and development of science communication	Images from the website platform (http://altmetrics.org/) are cited in the interview when discussing comprehensive academic impact evaluation methods	科研圈	Global Science Magazine Co.	2015
#10	Focus on Optimizing the Research Evaluation Mechanism of Universities	Share the core findings of articles and discuss peer review in –depth	Alternative metrics (Altmetrics) is discussed in comparison with citation analysis and co–citation analysis when discussing a comprehensive quantitative evaluation system.	中国大学教育	The main body of the account is an individual from Shandong; the account shares the latest development of university education, service higher education reform, etc.	2015

3.2 Account distribution of WeChat articles mentioning altmetrics

Active WeChat official accounts usually have a clear scope and have stable range of topics for the released articles. Accordingly, the WeChat users who follow these WeChat official accounts can be regarded as being interested in these related topics. Therefore, analysis of the WeChat official accounts can reveal the main user groups who pay attention to altmetrics. WeChat official accounts of all relevant WeChat articles were counted. In total, there are 256 WeChat official accounts that have mentioned altmetrics. The accounts that published the highest number of relevant articles are shown in Table 2.

Table 2 WeChat official accounts that published the highest number of articles mentioning altmetrics (top 15).

R.	Accounts	N.W.A.	N.F.	A.N.H.R	A.N.H.L	W.A.N.P.	WCI
1	图情会	40	5462	324	2	16	415.2
2	图书情报知识	21	8329	633	7	3	417.04
3	农业图书情报	16	3040	374	2	3	—
4	科研圈	14	292,300	21891	57	43	1218.33
5	林墨	14	11,700	731	1	1	499.94
6	情报学报 ISSN10000135	13	8,438	492	0	3	374.66
7	图情招聘	11	73,700	4128	6	33	674.06
8	科学观察	10	537	30	0	3	175.7
9	科学网	10	435,400	30492	58	25	1126.32
10	科学知识前沿图谱	8	12,800	747	3	10	634.8
11	科技与出版	6	4,893	252	1	10	212.53
12	中国科讯	5	16,300	1118	6	39	390.99
13	三思派	5	13,900	739	7	5	395.16
14	Wiley	5	3,984	216	2	17	454.89
15	科研管理	5	4,489	285	1	10	—

R. is ranking. N.W.A is number of WeChat articles mentioning altmetrics. N.F. is number of fans for the WeChat official account. A.N.H.R. is average number of headline readers. A.N.H.L is average number of headline likes. W.A.N.P. is weekly average number of posts. WCI is WeChat communication index, developed by Qingbo Big Data to measure the comprehensive impact of WeChat official accounts.

From Table 2, we can see that 图情会 (LIS meetings) has posted the highest number of articles mentioning altmetrics. As its own introduction says, 图情会 (LIS meetings) mainly collects information on conferences in the fields of library science, information science, archive science, and information resource management at home and abroad. These include conference calls for papers, conference schedules, and conference reports with the aim to provide timely information and communication platform for educators, students, scholars, and practitioners in the field. With the rise of altmetrics, more and more meetings and reports relevant to altmetrics are posted.

Ranking the second, third, and sixth position are 图书情报知识 (Documentation, Information & Knowledge), 农业图书情报 (Journal of Library and Information Science in Agriculture) and 情报学报 ISSN10000135 (Journal of the China Society for Scientific and Technical Infor-

mation), respectively. The above three accounts are curated by three library and information science (LIS) journals. They mainly disseminate articles published on their own journal. They also post other types of academic information of the library and information science field. Majority of LIS journals have established the WeChat official accounts to facilitate their readers to access the latest journal issues. This is also regarded as an attempt to engage with the wider scope of users and broaden their impact. These three accounts' mention of altmetrics could be mainly from the perspective of scholarly publications relevant to altmetrics.

In addition to the above accounts that belong to LIS field, altmetrics is also mentioned by accounts from a wide range of sources. For example, 科研圈 (Research Community) is maintained by the Global Science (Chinese edition) and is aimed to provide academic information to the audience. 科学网 (ScienceNet) is established by the top Chinese academic institutions and has been the major scientific community in China. WeChat mentions from 科研圈 and 科学网 indicates the interest on altmetrics from the wider academic community.

To investigate the background of all WeChat official accounts that have mentioned altmetrics, the industry distribution of these relevant accounts is demonstrated in Figure 4. The industry to which the WeChat official accounts belong is obtained from the Xiguaji data (data.xiguaji.com).

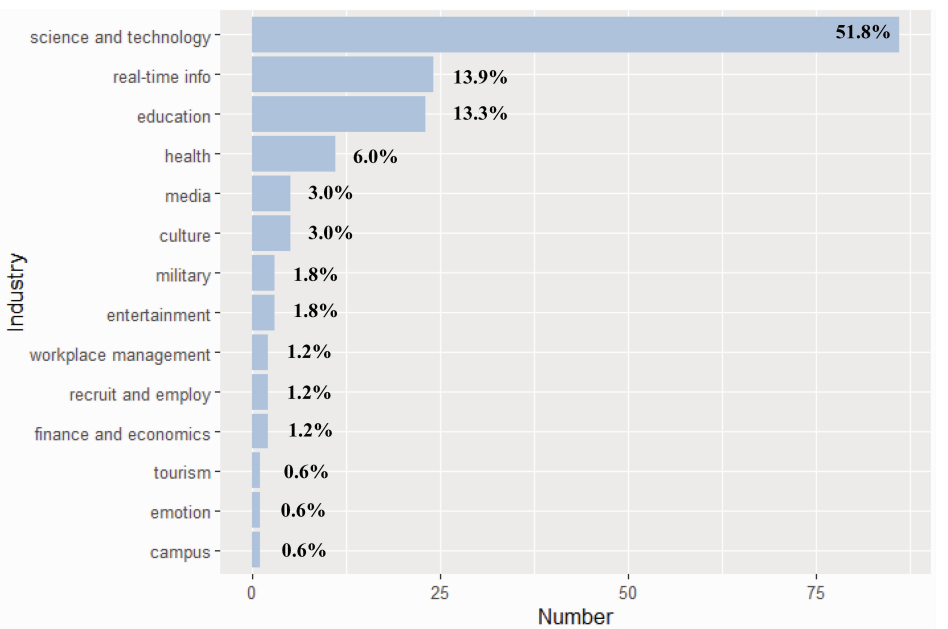

Figure 4 Industry distribution of WeChat official accounts that mention altmetrics.

As can be seen from Figure 4, science and technology accounts rank the first, followed by information, education, health and culture. In addition, WeChat articles that mention altmetrics are also found in accounts from entertainment, military and workplace management areas.

3.3 Topic distribution of WeChat articles mentioning altmetrics

Titles of each WeChat article that has mentioned altmetrics were segmented to extract the

topic words. The co-occurrence frequency between each pair of topic words were calculated. Then VOSViewer was used to perform co-occurrence analysis to identify the topics of these WeChat articles. The result is shown in Figure 5. Each node is a topic word and each line indicates the co-occurrence relationship between the connected nodes. The size of node is proportional to the frequency of topic words, and the thickness of line is proportional to the co-occurrence strength.

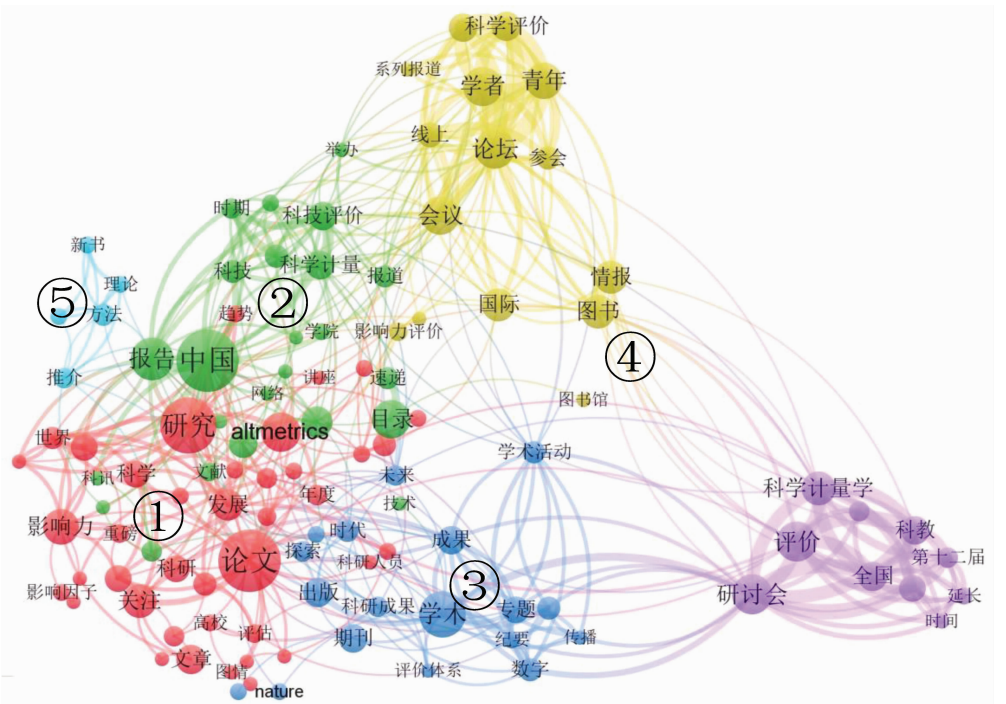

Figure 5 Co-occurrence network of topic words from the title of WeChat articles mentioning altmetrics.

As shown in Figure 5, five clusters are identified from the WeChat articles mentioning altmetrics. They can be interpreted as five topics by combining the source data.

Topic 1: Introduction of evaluation research or evaluation result that incorporate altmetrics. The core nodes are 研究 (research) and 论文 (paper). The strongly connected topic words are altmetrics, 影响力 (impact), 科研 (scientific research), 发展 (development), and so on. This topic has seen the evaluation result based on Altmetric data, for example, Altmetric: Top 3 Most Popular Papers in the World and Altmetric Releases 2019 Most Popular Papers List, Top 3 Reveals Current Hot Topics. This topic has also seen the latest hot research and papers that involve altmetrics, for example, WeChat article with the title 2020 Issue 4 Cover Article - Research on the Impact Evaluation of Academic Papers Based on the Scientific Communication Process, and Altmetrics Perspective on the Impact Evaluation of Academic Monographs in Humanities and Social Sciences - A Comparative Analysis Based on BKCI , Amazon and Goodreads.

Topic 2: Frontier research of scientometrics and S&T (scientific and technical) evaluation in China. The core nodes are 中国 (China) and 报告 (report). The strongly connected nodes in-

clude 科学计量 (scientometrics), 科技评价 (S&T evaluation), 研究 (research), and 报告 (report). This topic mainly reports the frontier output of domestic scientometrics and S&T evaluation research. For example, Report on 'Scientometric and Science and Technology Evaluation in the New Era' Paper Series, Focus on the release of China's World Impact Index of Science and Technology Journals Research Report.

Topic 3: Academic activities relevant to altmetrics. The core node is 学术 (academic). The strongly connected nodes include 学术活动 (academic activities), 科研成果 (scholarly outputs), 专题 (special issue), 纪要 (summary), and so on. It mainly reports on altmetrics theme-related academic activities and shares information on academic topics. For example, Event|' Ephemeral Digital Scholarship: Social Media and the Dissemination of Scholarly Results' Symposium Series, Non-Academic Impact of University Research Results and Their Evaluation: What, Why, and How?.

Topic 4: Notice and report of conferences that involve altmetrics. The core nodes are 研讨会 (symposium) and 论坛 (forum). The strongly connected nodes are 科学计量学 (scientometrics), 评价 (evaluation), 青年学者 (young scholars),信息计量 (informetrics), 科学评价 (scientific evaluation), and so on. This topic notices, reports, and promotes academic conferences and forums related to altmetrics. The reason for the emergence of this topic is the presence of a large number of announcements, postings, and reprints of information about the participation in the Scientometrics Symposium and the Young Scholars Forum on Scientific Evaluation. For example, Call for Papers for the 11th National Symposium on Scientometrics and Scientific Evaluation and Attendance|Young Scholars Forum on Informetrics and Scientific Evaluation 2020(06.20, online conference).

Topic 5: Promotion of domestic monographs of altmetrics. The core nodes are 替代计量学 (Altmetrics) and 新书 (new monographs). The strongly connected nodes are 理论 (theory), 方法 (method), and 推介 (recommendation). When a new monograph of altmetrics is published, there is WeChat article that pay attention to it and introduce it to readers, mainly by introducing the monograph, the author's profile, and the outline. For example, Altmetrics: Theory, Methods, and Applications (by Siluo Yang) and Altmetrics: Theory and Practice (by Rongying Zhao) received more attention, reprint, and recommendation.

The above analysis shows that the titles of WeChat articles are based on their intrinsic characteristics, highlighting the key point and new elements of the articles through concise but highly cohesive description. These titles are likely to stimulate the reading interest of the public and play an important role in promoting the dissemination and introduction of academic concepts to the public.

3.4 Context of WeChat mentions of altmetrics

Paragraphs that mention altmetrics and three Chinese translations (i.e. 替代计量学, 补充计量学, 选择性计量学) were extracted. The co-occurrence relationship is considered to exist if the segmented topic words appear in the same sentence. The co-occurrence frequency is calculated. The co-occurrence relationship is visualized using VOS Viewer, as shown in Figure 6.

From Figure 6, four major types of context in which altmetrics is mentioned can be identified. The more specific analysis of each type of context is as follows.

Type one context: To introduce altmetrics as a novel topic by mentioning its concept and theories, knowledge framework and technical methods, as well as the status quo of domestic and international research and the research frontiers. The core nodes are altmetrics and 研究 (research). The strongly connected nodes are 科学计量学 (scientometrics), 指数(index), 方法

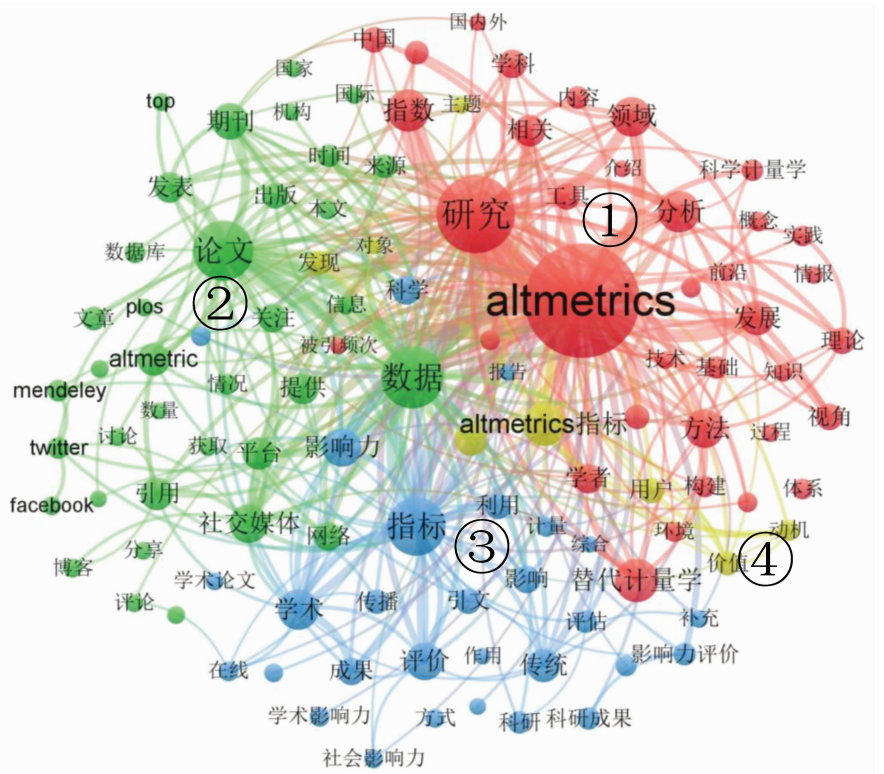

Figure 6 Co-occurrence network of topic words from paragraphs of WeChat articles mentioning altmetrics.

(method), 领域 (field), 前沿 (frontier) and 发展 (development). The main focus is on the concept of altmetrics, the relationship with scientometrics, the meaning of altmetrics, the development of the altmetrics as an independent field, the construction of altmetrics indicators, the evaluation of the scholarly impacts, and the system of altmetrics methods and tools.

Type two context: To explore the data sources and research objects of altmetrics. With 论文 (paper) and 数据 (data) as the core nodes, the strongly connected core nodes are 社交媒体 (social media), 平台 (platform), 期刊 (journal) and 数据库(database). Data sources and research objects of altmetrics were discussed which include social media (i.e. Twitter, Facebook, blogs) where scholarly outputs are widely discussed, reposted, shared, and cited in a non-traditional way. Bibliometric databases like WoS or journals like PLoS could provide detailed fields and original data of scholarly publications. Meanwhile, data aggregators like Altmetric or PlumX have integrated and captured data about mentions of scholarly outputs in the social media platforms, including in which way and by whom the scholarly outputs are mentioned.

Type three context: To discuss the construction and application of altmetrics indicators for evaluating the impact (both scholarly impact and societal impact) of scholarly outputs as compared with traditional citation indicators. This cluster has 指标 (indicators) as the core node. The strongly connected nodes are 传统 (traditional), 引文 (citation), 评价 (evaluation), 利用(utilization), 评估(assessment), 学术影响力 (scholarly impact) and 社会影响力 (societal impact).

Type four context: To introduce one specific research topic of altmetrics, the user's motiva-

tion of engagement of scholarly outputs and its underlying value. This cluster has 用户 (user) as the core node. The strongly connected nodes are Altmetrics 指标 (altmetrics indicators), 价值 (value), and 动机 (motivation). The analysis of the nature and meaning of altmetrics indicators from the perspective of user's motivation will help make the application of altmetrics more scientific and reasonable.

3.5 Scholarly publications of altmetrics in comparison

In order to identify the relative focus of the academia and the social media on the altmetrics field, a comparative analysis of the two was conducted in terms of the number of WeChat articles versus academic publications, WeChat official accounts versus publishing academic institutions, and topic distribution.

(1) Number of scholarly publications of altmetrics in China

The time distribution of Chinese publications of altmetrics is shown in Figure 7. The number of publications increased significantly from 2012 to 2015. Then it grew steadily from 2015 to 2020 and became a hot research topic for scientometrics and informetrics.

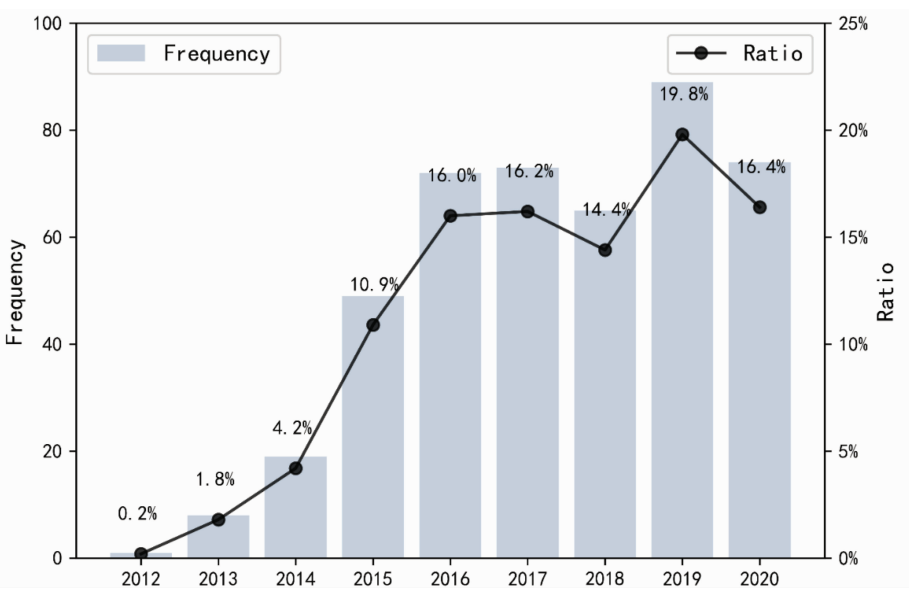

Figure 7 Time distribution of Chinese publications of altmetrics.

The development trend is different from the rapid growth in the number of WeChat articles mentioning altmetrics. Two underlying reasons are as follows. Firstly, the number of scholarly publications of altmetrics becomes stable, indicating that mature research community and corresponding research topics have emerged. Afterwards, the knowledge of altmetrics has gradually gone beyond the academia and attracted wider attention from the social media. Secondly, the affordance of WeChat official account has been improved significantly in 2018, attracting more and more users to register and use. Therefore, the overall usage of WeChat official account is growing rapidly. It may partly explain the surge in the number of WeChat articles mentioning altmetrics. However, it is undoubtedly that the growth does reflect the increased level of interest in altmetrics from the WeChat platform.

(2) Institutions that publish scholarly articles of altmetrics

The distribution of institutions that publish articles of altmetrics is shown in Table 3. School

of information management from Wuhan university has published the highest number of articles in the altmetrics field. It is followed by the department of library information and archives management from school of economics and management affiliated to university of Chinese academy of sciences, and the institute of science and technology management and WISE laboratory affiliated to Dalian university of technology. The school of information management from Nanjing university, the library of China medical university, and school of economics and management, Nanjing university of science and technology are also core research institutions in this field.

Table 3 Top ten institutions of Altmetrics topic posting.

R.	Institutions	N.
1	School of information management, Wuhan university	63
2	Department of library information and archives management, University of Chinese academy of sciences	31
3	WISE Lab, Institute of Science of Science and S&T Management, Dalian University of Technology	21
4	School of information management, Nanjing University	13
5	Library of China medical university	13
6	Department of information management, Nanjing university of science and technology	12
7	School of government management, Beijing Normal University	10
8	School of information management, Sun Yat–sen university	8
9	Institute of science and technology information, Shandong university of technology	8
10	Library of Tianjin normal university	7

Figure 8 has shown the collaboration relationship between institutions that publish in the altmetrics field. From Fig. 8, it is found that the school of information management of Wuhan university is in a more critical position of the whole research network in altmetrics field.

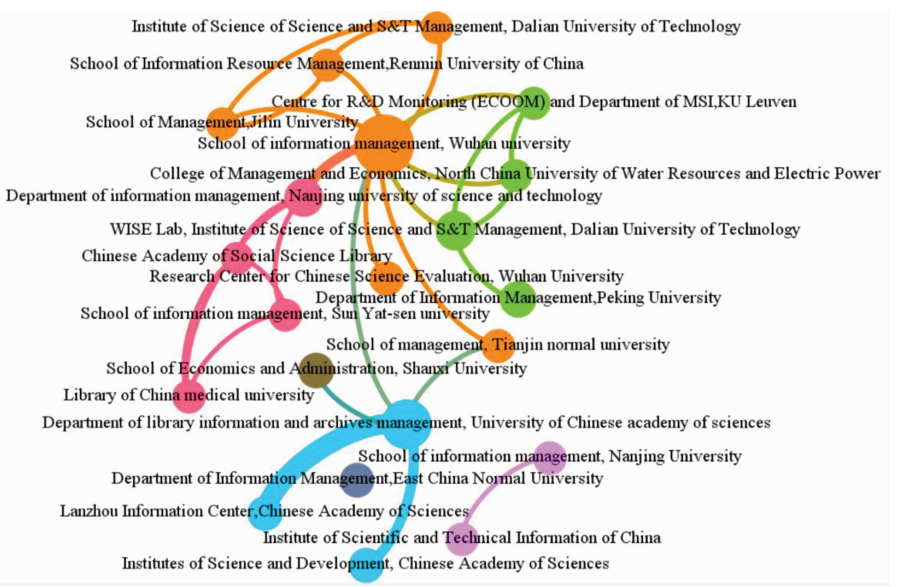

Figure 8 Collaboration of institutions that publish articles in altmetrics field.

In comparison to WeChat official accounts that mention altmetrics, most of these institutions have established their own WeChat official accounts but none of them is seen to have mentioned altmetrics. To our observation, WeChat official accounts maintained by these institutions mainly disseminate the important information and activities of their own to promote themselves.

(3) Research topics of altmetrics

The frequency of keywords were calculated as shown in Table 4. Table 4 shows that the term altmetrics (English word together with two types of Chinese translations) indicating the field of research is most frequently used. Furthermore, it is found that in altmetrics literature, the essential concern is the evaluation of multidimensional impact, as reflected by the keywords 学术影响力 (scholarly impact), 社交影响力 (societal impact) and 科学评价 (scientific evaluation).

Table 4 Top ten keywords of altmetrics papers.

Ranking	Keywords	English translation	Frequency
1	Altmetrics	/	187
2	替代计量学	Altmetrics	87
3	学术影响力	Scholarly impact	57
4	补充计量学	Altmetrics	39
5	社会影响力	Societal impact	37
6	文献计量学	Bibliometrics	26
7	机构知识库	Institutional repository	23
8	社交媒体	Social media	22
9	科学评价	Scientific evaluation	22
10	科研评价	Scientific and research evaluation	21

Keyword co-occurrence analysis was used to reveal the major topics of altmetrics research, as shown in Figure 9. From Figure 9, altmetrics publications can be divided into seven clusters.

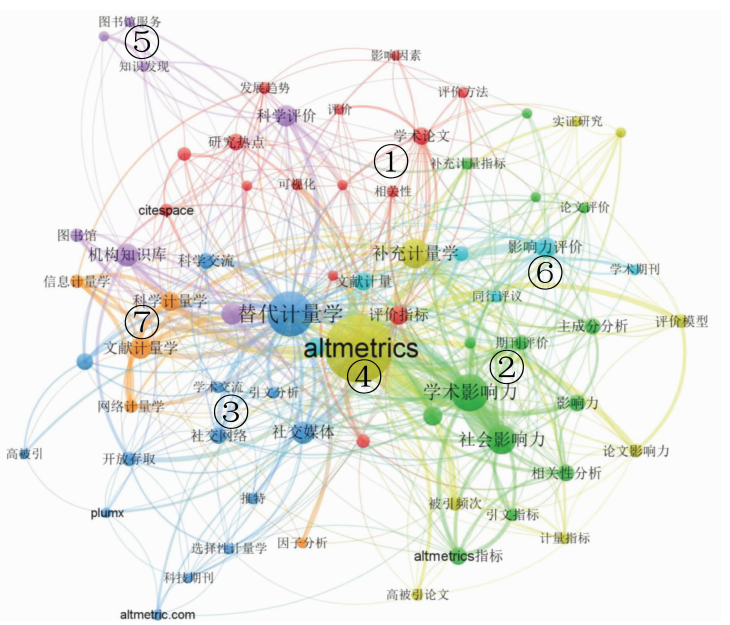

Figure 9 Keyword co-occurrence mapping of altmetrics publications.

Topic 1: Research frontiers and development trends of scientometrics and scientific evaluation. This cluster takes 学术论文 (scholarly publications) and 研究热点 (research hotspots) as the core nodes, and the associated keywords are 评价方法 (evaluation methods), 评价指标 (evaluation indicators), 影响因素 (influential factors), 研究前沿 (research frontier), and 发展趋势 (development trend).

Topic 2: Impact evaluation research involving altmetrics. This topic takes 学术影响力 (scholarly impact) and 社会影响力 (societal impact) as the core nodes, and the related keywords are altmetrics 指标 (altmetrics indicators), 引文指标 (citation indicators), 论文评价 (paper evaluation), 期刊评价 (journal evaluation),主成分分析 (principal component analysis), etc.

Topic 3: Empirical study of altmetrics in the social media environment. This cluster has 替代计量学 (Altmetrics) as the core node, and the associated keywords are 社交媒体 (social media), 社交网络 (social networks), 学术交流 (scholarly communication), 开放存取 (open access), 科技期刊 (scientific journals), PlumX, altmetrics.com, etc.

Topic 4: Altmetrics indicators and the application in empirical studies. This topic has altmetrics as the core node, and the associated keywords are 实证研究(empirical studies), 论文影响力 (paper impact), 被引频次 (citation frequency), and 计量指标 (metrics), etc.

Topic 5: The application of altmetrics in institutional repositories and library services (research evaluation is one application direction). This topic has 科研评价(scientific research evaluation) and 科学评价 (scientific evaluation) as core nodes. The associated keywords are 图书馆 (libraries), 图书馆服务(library services),机构知识库 (institutional repository), 知识发现 (knowledge discovery), etc.

Topic 6: Comparison of peer review and bibliometrics in research evaluation and impact evaluation of open access journals. This topic has 替代计量 (altmetrics) and 文献计量 (bibliometrics) as core nodes, and the associated keywords are 学术期刊 (academic journals), 开放存取 (open access), 同行评议 (peer review), etc.

Topic 7: Research progress and development trend of five metrics (i.e. bibliometrics, scientometrics, informetrics, webometrics, and knowledgometrics) area. This topic takes 文献计量学 (bibliometrics), 科学计量学 (scientometrics), 信息计量学 (informetrics), 网络计量学 (webometrics) as the core nodes.

In summary, the scholarly publications have systematically investigated the concept, theory, methodological framework, indicators construction, as well as application and value of altmetrics. In contrast, WeChat articles would go less deep or systematic but be oriented to broader audience.

4 Conclusion and Outlook

Altmetrics has special focus on the communication and evaluation of scholarly outputs in the non-citation environment. But compared to international altmetrics data sources, Chinese altmetrics data sources have seldom been explored. This paper has explored WeChat, a widely used and important communication platform in China, as a type of data source for altmetrics study. The situation of how altmetrics is mentioned on WeChat platform was analyzed and compared with the scholarly publications of altmetrics. Major conclusions are drawn as follows.

(1) WeChat article mentions of altmetrics has lagged behind the accumulation of scholarly altmetrics publications. However, in recent years, the number of WeChat articles mentioning altmetrics has increased rapidly with continuously rising hotness. This indicates that

altmetrics is gathering more and more attention in social media.

(2) WeChat official accounts that pay attention to altmetrics come from very broad areas. Professional accounts from library and information science field and science popularization field play the dominant role. Meanwhile, many accounts are seen from the science, technology, information and education industries. There would also be accounts from tourism, finance, and emotion areas. It suggests that altmetrics has received broad attention from the society. The top five WeChat official accounts posting about altmetrics were 图情会 (LIS meetings), 图书情报知识 (Documentation, Information & Knowledge), 农业图书情报 (Journal of Library and Information Science in Agriculture), 科研圈 (Research Community) and 林墨 (Linmo).

(3) WeChat articles mentioning altmetrics are mainly focused on five topics. These topics are the introduction of evaluation research or evaluation result that incorporate altmetrics, the frontier research of scientometrics and S&T (scientific and technical) evaluation in China, the academic activities relevant to altmetrics, the notice and report of conferences that involve altmetrics, and the promotion of domestic monographs of altmetrics. For the academic professionals, these WeChat articles are highly relevant to share the latest research output, inform academic activities (conferences, lectures, essays), and provide ways for researchers to broaden their social influence (e.g., research sharing, new book promotion, lecture introduction, etc.). For the massive public audience, these WeChat articles are useful in science popularization of academic knowledge and potential application of scientific and technical progress. This is strong evidence that altmetrics is highly relevant to the broad society.

(4) Four major types of context of WeChat mentions of altmetrics are identified. They are to introduce altmetrics as a novel topic, explore the data sources and research objects of altmetrics, discuss the construction and application of altmetrics indicators for evaluating the impact as compared with traditional citation indicators, and introduce research about user's motivation of engagement of scholarly outputs. These specific types of context have reflected the specific focus of WeChat articles that mention altmetrics in a more intuitive and clear way.

(5) In contrast, the number of scholarly publications of altmetrics has become stable after many years of growth. The core research institutions and research topics can be identified. The research topics of altmetrics mainly include frontiers and development of scientometrics and scientific evaluation, impact evaluation research involving altmetrics, empirical study of altmetrics in the social media environment, altmetrics indicators and their application in empirical studies, the application of altmetrics in institutional repositories and library services (with research evaluation as one application area), comparison of peer review and bibliometrics in research evaluation, impact evaluation of open access journals, and research progress and development trend of five metrics (i.e. bibliometrics, scientometrics, informetrics, webometrics, and knowledgometrics) area.

(6) Compared with scholarly publications, WeChat official account focuses more on the value and application of altmetrics, while scholarly publications are more concerned about building knowledge system of altmetrics. To be specific, the WeChat official account is more concerned about the construction and application of altmetrics indicators, the development of altmetrics and its relevant application fields, and the evaluative function of altmetrics indicators. In contrast, scholarly publications pay more attention to the systematic research in the discipline. For example, the concept of altmetrics, the construction of altmetrics indicators, the impact evaluation, and the difference as well as connection between altmtrics and

traditional scientometrics.

This study has made an in-depth investigation and discussion on the WeChat article mentions and scholarly publications of altmetrics. The results could provide reference for the study of other similar types of social media platforms, such as Zhihu (https://www.zhihu.com/), Weibo, and Douban (https://www.douban.com/). Moreover, it is observed that the motivation of mentioning altmetrics on WeChat platform differs according to the mentioning context, subjects of the accounts and types of articles. There will be at least three types of motivations, including academic information sharing and dissemination, promoting the impact of scientific research and supporting popular science. In the future study, we may consider to further explore the topic evolution and life cycle of social media mentions and scholarly publications of a certain field. We endeavor to identify social media mentions of scholarly outputs in the Chinese environment, so as to develop a mature tracking, measurement and evaluation system, and contribute to the construction of high-quality Chinese altmetrics data source.

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