Application of Article-Level Classification Systems to Journal Disciplinary Structure Analysis (Postprint)

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Abstract

Abstract: [Objective] Journal disciplinary layout is one of the key issues in the current stage of journal development in China. To address the limitations of journal-level disciplinary classification systems in disciplinary layout analysis, this paper proposes to introduce a paper-level disciplinary classification system. [Methods] Using a comparative analysis approach, we demonstrated the advantages of the paper-level disciplinary classification system in journal layout-related research. [Results] In the analysis of journal disciplinary distribution, the paper-level classification system effectively revealed significant differences in disciplinary distribution and disciplinary focuses between comprehensive journals Nature and Science Bulletin, as well as between professional comprehensive journals Science China-Chemistry and Journal of the American Chemical Society. In the analysis of disciplinary evolution, through exploration with the paper-level classification system, we revealed that Sensors has expanded from being primarily centered around sensor-related research into a journal spanning research content across multiple disciplinary fields. For the analysis of journal topic overlap, we found that Acta Oceanologica Sinica and Advances in Atmospheric Sciences, two journals belonging to different disciplines, overlap in many research topics. In the analysis of journal impact, taking JCR statistics and probability field journals as an example, we analyzed the differences in journal impact rankings under the two classification systems; the paper-level classification system can more effectively eliminate citation differences within disciplines, providing a more objective classification reference for journal impact evaluation. [Conclusion] Compared with journal-level classification systems, paper-level classification systems classify at the paper level, featuring finer granularity, faster updates, and being more suitable for research practice in journal disciplinary layout.

Full Text

The Application of Paper-level Discipline Classification System in Journal Discipline Layout Analysis

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Abstract

[**Purpose**] Journal discipline distribution represents a critical issue in China' s current journal development. To address the limitations of journal-level discipline classification systems in analyzing journal discipline layouts, this paper introduces a paper-level discipline classification system. [**Methods**] Through comparative analysis, we demonstrate the advantages of paper-level classification systems in journal layout research. [**Results**] In journal discipline distribution analysis, the paper-level classification system effectively reveals distinct disciplinary distribution differences and emphases among multidisciplinary journals such as *Nature* and *Science Bulletin*, as well as discipline-specific comprehensive journals like *Science China-Chemistry* and *Journal of the American Chemical Society*. In discipline evolution analysis, our mining of the paper-level classification system reveals that *Sensors* has expanded from focusing primarily on sensor-related research to becoming a journal spanning multiple disciplinary fields. Regarding journal topic overlap analysis, we find that *Acta Oceanologica Sinica* and *Advances in Atmospheric Sciences*—journals belonging to different disciplines—exhibit substantial overlap across numerous research topics. In journal impact analysis, we examine ranking differences under both classification systems using JCR Statistics & Probability journals as examples. The paper-level classification system more effectively eliminates citation differences within disciplines, providing a more objective classification reference for journal impact evaluation. [**Conclusion**] Compared with journal-level discipline classification systems, paper-level systems classify individual papers as the unit of analysis, offering finer granularity, faster updates, and greater suitability for research practice in journal discipline layout analysis.

Keywords: Discipline classification system; Paper-level discipline classification system; Journal layout; Discipline distribution

1 Issues with Classification Systems in Journal Discipline Layout

The layout of scientific journals constitutes a significant challenge in journal development. A rational journal layout enhances the efficiency of academic resource utilization, promotes the rapid and orderly development of China' s academic journals, elevates their international influence, facilitates scientific communication and progress, strengthens China' s international academic discourse power, and safeguards national academic resource security [1]. Current journal layout research primarily addresses two aspects: (1) journal discipline distribution, focusing on disciplinary gaps [2][3][4][5] and disciplinary balance [6][7][8]; and (2) journal characteristic analysis, encompassing topic homogenization [7][9] (overlap), impact stratification (e.g., quartiles, impact factors), journal type diversification (e.g., comprehensive vs. specialized journals, OA vs. non-OA) [5][6][10], and language variations [6][11] (English vs. Chinese journals, Tibetan vs. Chinese journals).

1.1 Problems in Journal Discipline Distribution Analysis

Research on journal discipline distribution relies on discipline classification systems. Current studies predominantly employ journal-level classification systems that categorize entire journals. For instance, in Web of Science' s Subject Categories scheme [12], journals and disciplines maintain a many-to-many relationship, with each journal averaging 1.58 disciplines. Interdisciplinary comprehensive journals are assigned to the Multidisciplinary category, while discipline-specific comprehensive journals use disciplinary subdivisions or subcategory synthesis. Scopus' s ASJC classification system adopts a similar approach [13], with each journal averaging 2.32 disciplines. In these systems, a single journal typically belongs to multiple disciplines, while comprehensive journals are grouped under the same multidisciplinary category, overlooking their varying emphases across different disciplines.

Journal discipline distribution evolves dynamically. These expert-constructed journal-level classification systems represent highly abstracted and generalized domain knowledge, forming relatively stable knowledge structures that are more readily accepted by administrators, decision-makers, and funding agencies [14]. However, such classification systems themselves update slowly, and adjustments to journal-discipline correspondences update even more slowly, making them unsuitable for investigating dynamic changes in journal disciplines.

In summary, journal discipline distribution analysis depends on classification systems, yet journal-level systems—due to their disciplinary subdivisions, comprehensive category settings, and slow updates—fail to account for journal disciplinary emphases and prove inadequate for analyzing dynamic disciplinary changes. Therefore, journal discipline distribution analysis requires a more suitable classification system.

1.2 Problems in Journal Characteristic Analysis

In journal characteristic analysis, research topic overlap and journal impact represent two crucial features. From a journal development perspective, investigating topic overlap helps avoid excessive homogenized competition. Researchers primarily using journal-level classification systems have identified issues such as an overabundance of comprehensive journals in education research [15] and philosophy and social sciences [6]. However, journal-level classification systems feature coarse granularity, ignoring journals' varying emphases across research topics and failing to effectively reveal topic overlap. Some studies have utilized journal textual content for differentiation analysis. For example, Fan Guangbing et al. [16] employed TDA bibliometric software to examine content differences among five Chinese geography English journals, finding concentrated distribution in physical geography, environmental science, human geography, and geographic information science. Zhang Baolong et al. [17] proposed a quantitative method for measuring journal differentiation from a difference perspective, analyzing content differentiation among library and information science journals. Currently, text-based journal differentiation analysis remains limited to certain journals within a single discipline, lacking comprehensive coverage of all journals and a complete disciplinary system perspective. Research indicates that local disciplinary content analysis differs significantly from full-disciplinary content analysis [18].

Journal impact (e.g., impact factors and quartiles) constitutes one of the most discussed topics among journal professionals, scientific communities, and research management. Impact measurement primarily relies on citations, yet citation behaviors vary significantly across disciplines—for instance, medical fields exhibit much higher citation density than mathematics. Therefore, comparative impact analysis must be confined within disciplines sharing similar citation behaviors. Current impact evaluation and analysis primarily employ journal-level classification systems (e.g., WoS, Scopus, and CSSCI). However, Eck et al. [19] note that citation counts within WoS Subject Categories also vary substantially; for example, clinical intervention studies in clinical neurology typically receive fewer citations than basic and diagnostic research. Shen et al. [4] found that in WoS' s Statistics & Probability category, probability-related journals generally have lower impact factors than statistics-related journals. Beyond insufficient disciplinary granularity, disciplinary subdivisions also create problems for impact analysis by directly comparing papers from different disciplines, introducing systematic bias into journal impact analysis.

1.3 Structure of This Paper

In analyzing journal discipline distribution and characteristics, researchers primarily employ journal-level classification systems. However, existing research reveals that issues such as disciplinary subdivisions, comprehensive category settings, coarse granularity, and slow updates prevent these systems from meeting research demands in journal discipline layout. A new classification sys-

tem is urgently needed—one that accounts for journal disciplinary emphases, offers finer granularity, and updates more promptly. Regarding granularity alone, some classification schemes already meet article-level classification needs, such as the universal Chinese Library Classification system and the physics-specific PACS (Physics and Astronomy Classification Scheme). However, both rely on top-down expert construction, update infrequently, and domain-specific schemes like PACS lack systematic coverage of all disciplines, failing to meet cross-disciplinary comparison needs. With advances in computing power and accumulation of citation and textual data, bottom-up constructed paper-level classification systems have matured [20][21], offering new analytical perspectives for journal discipline layout research. This paper introduces the application of paper-level classification systems in analyzing journal discipline layouts and their differences from journal-level systems. Section 2 briefly introduces construction methods for paper-level classification systems. Section 3 presents case studies demonstrating applications and advantages in journal discipline distribution and evolution analysis. Section 4 discusses applications and advantages in journal characteristic analysis. Section 5 concludes, discusses limitations, and outlines future research directions.

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2 Paper-level Classification System and Its Construction Method

A paper-level classification system categorizes individual papers rather than journals. In scientometrics, researchers construct citation networks using inter-paper citation relationships, apply community detection techniques from complex network analysis to cluster closely-cited papers into topics, and map these topics to disciplines and fields, thereby building paper-level discipline classification systems (hereafter referred to as paper-level classification systems). Such systems have been applied to disciplinary citation normalization, journal impact evaluation [22], and institutional research topic and impact analysis [23].

2.1 Paper-level Classification System

The core concept of paper-level classification systems relies on the principle that papers sharing the same research topic and discipline exhibit tighter citation relationships and greater content similarity. Using computer algorithms, these systems cluster papers bottom-up (see [Figure 1: see original paper]). Consequently, paper-level classification systems feature three main characteristics: (1) individual articles as classification units; (2) bottom-up algorithmic construction; and (3) classification results comprising multiple paper clusters.

2.2 Construction Process

The construction process involves three steps (see [Figure 2: see original paper]). First, build a relational network using all WoS papers and their citation

relationships ([FIGURE:2(a)]). Second, apply community structure detection methods to partition the network into paper clusters ([FIGURE:2(a)]). Third, construct a multi-level disciplinary structure: by setting different resolution parameters, obtain paper clusters at various hierarchical levels ([FIGURE:2(b)]). Papers without citation relationships can be incorporated through text similarity calculations based on titles, abstracts, and keywords.

Currently, Leiden University' s CWTS [20], Elsevier' s Scival platform [24], and Clarivate' s Incites platform all provide paper-level classification systems for disciplinary classification and related research. This paper uses Incites' Citation Topics [21] as an example. Incites' paper-level classification system—Citation Topics—comprises a three-level hierarchy including macro, meso, and micro levels (see), with annual updates.

3.1 Comparative Analysis of Journal Discipline Distribution

Journal discipline distribution represents a key issue in discipline layout. We selected four typical comprehensive journals to analyze discipline distribution differences under both journal-level and paper-level classification systems. *Nature* and *Science Bulletin* are typical interdisciplinary comprehensive journals with broad research scopes, publishing top-tier scientific achievements across various disciplines. *Science China-Chemistry* and *Journal of the American Chemical Society* (JACS) are comprehensive chemistry journals.

In WoS and Scopus platforms based on journal-level classification systems, all four journals are assigned to multidisciplinary categories or subdivided across multiple disciplines (see). From these journal-level classifications, we can only determine that *Nature* and *Science Bulletin* are interdisciplinary/multidisciplinary comprehensive journals, while *Science China-Chemistry* and JACS are chemistry-specific comprehensive journals, but cannot discern their disciplinary emphases.

Mapping the four journals' five-year (2016-2020) publications onto Citation Topics (meso-level) disciplinary maps yields [Figure 3: see original paper]. *Nature* and *Science Bulletin* show broader disciplinary distributions than the two chemistry journals. However, significant differences exist between the two interdisciplinary journals: *Nature* emphasizes life sciences, physical sciences, and earth/environmental sciences, while *Science Bulletin* focuses primarily on physical sciences. Moreover, *Nature*' s disciplinary coverage is notably broader, particularly in social sciences and mathematics/computer science, which *Science Bulletin* has barely entered. *Science China-Chemistry* and JACS, both chemistry comprehensive journals, mainly publish in natural sciences and engineering/technology. However, JACS' s publication volume far exceeds *Science China-Chemistry*, and JACS features substantial research in biomedical and health sciences, whereas *Science China-Chemistry* rarely involves other fields.

Using comprehensive journals as examples, we compared disciplinary coverage under both systems. The paper-level classification system reflects journal coverage of scientific research from the paper perspective, effectively revealing disciplinary emphases.

3.2 Journal Discipline Evolution Analysis

Scientific research advances rapidly. Tracking journal discipline evolution trends provides crucial intelligence support for strategic development and decision-making [25]. Paper-level classification systems, with individual papers as classification units and timely updates, enable such dynamic tracking.

Using *Sensors* as an example—an open-access journal published by MDPI covering sensor science and technology—the journal has been consistently subdivided into Chemistry, Analytical; Electrochemistry; and Instruments & Instrumentation since its JCR listing in 2002, with its disciplines adjusted in 2019 to Chemistry, Analytical; Engineering, Electrical & Electronic; and Instruments & Instrumentation. However, Citation Topics meso-level analysis reveals significant changes in research topic coverage and emphasis since 2005 (see [Figure 4: see original paper]). Initially focused on sensor-related research such as biosensors and electrical sensors/monitoring, both topics have substantially decreased in proportion over time. *Sensors* has now expanded into a multidisciplinary journal covering telecommunications, computer vision/graphics, gait/posture, optoelectronics/engineering, and more. Notably, *Sensors* papers never involved electrochemistry in Citation Topics, consistent with JCR' s recent adjustment removing electrochemistry from its classification.

Paper-level classification systems provide a reliable solution for journal discipline evolution analysis, enabling us to track research direction changes to support strategic layout while helping researchers identify frontier topics and make informed submission decisions.

4.1 Journal Research Topic Overlap

From a journal development perspective, investigating topic overlap in discipline layout helps avoid excessive homogenized competition.

Using *Acta Oceanologica Sinica* and *Advances in Atmospheric Sciences* as examples, WoS' s journal-level classification system assigns them to oceanography and meteorology/atmospheric science respectively, revealing no overlap. However, the paper-level classification system shows overlap across multiple topics, particularly in "Oceanography, Meteorology and Atmospheric Sciences," where *Advances in Atmospheric Sciences* dedicates 84% of its publications and *Acta Oceanologica Sinica* 31%—an extremely high overlap proportion.

To deeply investigate this overlap, we expanded the meso-level "Oceanography, Meteorology and Atmospheric Sciences"topic to micro-level research topics (see).

Both journals show substantial overlap in ENSO (El Niño-Southern Oscillation), internal waves, and clouds.

Through meso-level and micro-level analysis using the paper-level classification system, we confirmed substantial topic overlap between these two journals, providing valuable reference for their development strategies.

4.2 Journal Impact Analysis

Journal impact analysis must account for disciplinary citation differences, as normalized impact varies significantly across classification systems. To compare impact differences under both systems, we selected JCR Statistics & Probability journals. Using Citation Topics (micro-level) normalized impact from Incites and Web of Science normalized impact, we calculated rankings under both systems, where lower rank indicates higher impact (see [Figure 6: see original paper]).

The two systems show high overall correlation in normalized impact rankings, but with notable outliers. Probability journals generally fall below the diagonal, indicating systematic underestimation under journal-level classification. Two particularly deviant probability journals are marked: *Law, Probability and Risk* (LPR) and *Probability in the Engineering and Informational Sciences* (PEIS). LPR ranks far lower under paper-level classification, with 40% of its papers belonging to high-citation-density fields like chemistry and clinical medicine, conferring citation advantages. Conversely, 40% of PEIS papers belong to low-citation-density mathematics fields, creating citation disadvantages. The finer-grained paper-level classification eliminates such advantages/disadvantages, producing substantial ranking differences. By grouping each paper with others having more similar content and citation behaviors, paper-level classification provides more accurate classification references for impact evaluation.

5.1 Conclusion

This paper comparatively analyzed journal-level and paper-level classification systems from perspectives of journal discipline distribution and characteristic analysis, demonstrating advantages of paper-level systems in journal discipline layout analysis.

In journal discipline distribution analysis, paper-level classification effectively revealed distinct disciplinary distribution differences and emphases among four comprehensive journals. In discipline evolution analysis, we found *Sensors* expanded from sensor-focused research to multidisciplinary coverage. Topic overlap analysis—using *Acta Oceanologica Sinica* and *Advances in Atmospheric Sciences* as examples—revealed substantial overlap between journals from different disciplines. In impact analysis, using JCR Statistics & Probability journals, we

demonstrated that paper-level classification more effectively eliminates intra-disciplinary citation differences, providing more objective references for impact evaluation. Classifying individual papers to build a full-discipline system with finer granularity and faster updates, paper-level classification fundamentally solves the problem of ignoring disciplinary emphases in traditional systems, provides better analytical tools for discipline evolution analysis, and offers a unified framework for content differentiation and impact evaluation.

5.2 Discussion

This paper discussed advantages of paper-level classification in key journal discipline layout issues through case studies, but did not systematically compare the two systems' construction methods and differences in full-disciplinary journal layout analysis. Future work will apply paper-level classification to analyze China' s English scientific journal discipline layout and systematically compare results with those from journal-level classification.

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Author Contributions:
Liao Yu: Designed the research framework, wrote the initial draft, revised and finalized the manuscript;

Shen Zhesi: Determined the research topic, reviewed and revised the manuscript;
Li Li: Conducted data analysis and revised the manuscript;
Yang Liying: Guided the paper structure and revised the manuscript.

Note: Figure translations are in progress. See original paper for figures.