Influencing Factors and Driving Mechanisms of WeChat Official Account Communication Effects for Popular Science Journals: A Case Study of China' s Excellent Popular Science Journals (2020)

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Abstract

Purpose To investigate the influencing factors and driving mechanisms of communication effectiveness of popular science journals' WeChat Official Accounts, and to provide recommendations for improving their operational strategies and enhancing their dissemination capacity. Methods Taking the latest edition of China' s Excellent Popular Science Journals (2020) as a case study, and proceeding from four dimensions—environment, technique, content, and interaction —this study employs an ordered Logit regression model to analyze the factors influencing the communication effectiveness of their WeChat Official Accounts, and subsequently utilizes the fsQCA method to explore the driving mechanisms underlying their effective communication. Results The communication effectiveness of popular science journals' WeChat Official Accounts is comprehensively influenced by multiple factors, among which content and interaction constitute core-level influences, while environment and technique represent peripheral-level influences; three driving mechanisms for achieving effective communication exist: environment-prioritized type, strategy-oriented type, and comprehensively-driven type. Conclusion To enhance the communication effectiveness of popular science journals'WeChat Official Accounts, it is essential to leverage environmental advantages and optimize platform construction; establish marketing concepts and perfect publishing strategies; adhere to knowledge leadership and innovate content output; and maintain user connections while emphasizing interactive communication.

Full Text

Influencing Factors and Driving Mechanisms of Communication Effect of WeChat Official Accounts of Scientific Popularization Journals: Taking Excellent Scientific Popularization Journals in China (2020) as Examples

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Abstract

[**Purpose**] This study aims to explore the influencing factors and driving mechanisms of communication effect of WeChat official accounts of scientific popularization journals, providing recommendations for improving operational strategies and enhancing communicative power. [**Methods**] Taking the latest edition of China' s Excellent Scientific Popularization Journals (2020) as examples, we analyzed factors influencing the communication effect of their WeChat official accounts from four dimensions—environment, techniques, content, and interaction —using an ordered Logit regression model. Furthermore, we employed fsQCA (fuzzy-set qualitative comparative analysis) to explore the driving mechanisms that produce favorable communication effects. [**Findings**] The communication effect of WeChat official accounts of scientific popularization journals is influenced by multiple factors, with content and interaction serving as core dimensions while environment and techniques play marginal roles. Three driving mechanisms—environment-priority type, strategy-oriented type, and comprehensive-driving type—enable scientific popularization journals to achieve favorable communication effects. [**Conclusions**] To enhance communication effects, scientific popularization journals should leverage environmental advantages to optimize platform construction, establish marketing concepts to improve publishing strategies, adhere to knowledge leadership to innovate content output, and maintain user connections to emphasize interactive communication.

Keywords: scientific popularization journals; WeChat official accounts; communication effect; influencing factors; driving mechanisms

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Science and technology popularization (hereinafter referred to as "science popularization") constitutes a crucial activity for disseminating scientific knowledge,

improving national scientific literacy, and advancing national science popularization capacity building. The "14th Five-Year Plan for National Science and Technology Popularization Development" proposes leveraging the advantages of new media networks—including fast dissemination, strong interactivity, and broad coverage—to support the creation and dissemination of science popularization content adapted to new media characteristics [1]. Currently, the WeChat public platform has become an important breakthrough for the integrated development of publishing media, owing to its universal audience, precise push capabilities, simple interaction, and convenient usage.

To actively adapt to digital and mobile reading trends, scientific popularization journals have widely utilized WeChat official accounts to provide services such as journal subscriptions and knowledge push notifications. However, practical operations still face problems including insufficient attention, content homogenization, inadequate modal transformation, and outdated language expression [2], resulting in unsatisfactory communication effects. Therefore, this paper analyzes the factors influencing the communication effect of WeChat official accounts of scientific popularization journals and deeply examines the driving mechanisms behind specific communication effects, aiming to propose more targeted operational recommendations to enhance communication effects and promote the popularization of scientific knowledge.

1 Literature Review

Since its launch, WeChat official accounts have become an important aspect of new media research, with applications spanning education, healthcare, government affairs, military affairs, and other fields. Communication effect refers to the changes in audience' s 思想观念 (ideological concepts), emotional attitudes, and behavioral patterns after receiving information from communicators [3]. To improve the communication effect of WeChat official accounts, it is essential to identify clear directions for effort. Numerous scholars have conducted research from two aspects—influencing factors and driving mechanisms—to improve operational strategies accordingly.

Existing research on influencing factors of WeChat official account communication effects can be categorized into three dimensions: communicator, communication information, and audience. First, the communicator dimension primarily considers the influence of subject popularity and operator competence. For instance, university level is a core factor affecting the communication effect of university social science journal WeChat official accounts [4], and operators' information literacy is a key factor influencing information dissemination effects [5]. Second, the communication information dimension focuses on comparing the influence of peripheral information versus central information. For example, peripheral information such as article position and layout form is more critical than central information like article theme and emotional color [6], and audiences are more easily influenced by peripheral paths than central paths [7]. Third, the audience dimension emphasizes individual differences and opinion leader influence.

For example, males tend to prefer knowledge-intensive articles while females prefer entertainment-oriented ones [8], and corporate WeChat official account articles containing spokesperson effects achieve better communication effects than those without [9].

The driving mechanism of WeChat official account communication effects refers to the path through which communicators combine various elements of WeChat official accounts in certain ways to coordinately promote the achievement of specific communication effects. Existing research on driving mechanisms for specific communication effects often draws on theoretical models such as the TOE framework [10], information ecology theory [11], heuristic-systematic model [12], and addiction model [13], employing fuzzy-set qualitative comparative analysis methods. Research primarily focuses on two aspects: first, the dissemination of emergency event information, including implementation paths for emergency information communication effects [10-11], dissemination paths of online rumors during emergencies [14-15], and triggering mechanisms of online public opinion during emergencies [16-18]; second, the dissemination of cultural new media, including action paths for communication effects of university social science journal WeChat official accounts [4], implementation paths for high dissemination power of new media platforms for intangible cultural heritage [19], mechanisms of dissemination power of archives WeChat official accounts [20], and paths for achieving favorable communication effects of public library short videos [21].

Currently, research on WeChat official account communication effects is relatively abundant, providing a rich theoretical foundation for this paper. However, research on WeChat official accounts of scientific popularization journals is still in its infancy, mostly discussing their communication characteristics [22-23], operational problems [24-25], and improvement strategies [26-27] from qualitative perspectives. Quantitative studies on their communication effects mostly examine the influence of single factors using quantitative methods [28-29], neglecting the interaction among influencing factors [30]. In view of this, this paper takes China' s Excellent Scientific Popularization Journals (2020)—which have broad coverage and strong representativeness—as examples, constructs an ordered Logit regression model from four dimensions (environment, techniques, content, and interaction) to explore factors influencing communication effects, and employs fsQCA—which combines advantages of qualitative and quantitative methods—to examine the complex mechanisms behind specific communication effects, thereby proposing more targeted practical operational recommendations to improve communication effects.

2.1.1 Ordered Logit Regression Model

The communication effects of WeChat official accounts exhibit considerable heterogeneity and can be divided into five ordered increasing intervals: very low, low, average, strong, and very strong. Therefore, the ordered Logit regression model can effectively characterize the factors influencing the communication effects of scientific popularization journals' WeChat official accounts. Its func-

tional form is as follows:

팽표 y≤k = ln 1− y≤k = α +

Where: k represents the grade range of the dependent variable, m represents the number of influencing factors; the dependent variable represents relevant variables of article i; represents the intercept term; represents the slope coefficient of article' s communication effect.

2.1.2 Fuzzy-Set Qualitative Comparative Analysis Method

Qualitative Comparative Analysis (QCA) is a research method based on Boolean algebra and set theory, oriented toward case quantitative analysis, capable of identifying core factors influencing specific outcomes and discovering explanatory paths and mechanisms of different condition combinations on cases [31]. Since some condition variables in this study cannot be simply dichotomized, we adopt fuzzy-set qualitative comparative analysis (fsQCA), which can handle partial membership and degree problems, to deeply explore the complex causal relationships behind favorable communication effects of scientific popularization journals' WeChat official accounts.

2.2 Variable Design

Through observation of actual WeChat official account operations and drawing on condition selections from literature [6, 8, 10-11, 32-34], we categorize condition factors influencing the communication effects of scientific popularization journals' WeChat official accounts into four dimensions—environment, techniques, content, and interaction—and measure them through 16 variables. Simultaneously, we take WeChat official account communication effect as the outcome variable, measured by calculating the Single Tweets Communication Index (STCI).

2.2.1 Condition Variables

(1) Environmental Factors. Environmental factors refer to the environment in which the official account operates, manifested as the credibility and popularity of its supporting entity, which can be examined from three aspects: verification status [32], supporting unit level, and city level [32]. First, verification status is an important criterion for measuring authority and credibility, potentially affecting users' attention, reading, and sharing. Second, supporting unit level reflects the audience scope of the official account, thereby determining communication breadth. Third, city level reveals resource investment in the official account, thereby influencing content quality and services.

(2) Technique Factors. Technique factors refer to strategies for attracting reading interest and enhancing reading experience, which can be divided into publishing time [11], position [8], title techniques [33], presentation techniques

[34], and layout techniques [34]. First, publishing time directly affects article exposure rate and probability of being clicked and read by users. Second, position determines article visibility—generally, the more forward the position, the more attention it attracts. Third, title techniques can stimulate users' reading interest and promote active reading. Fourth, presentation techniques can improve article readability through the use of audio, video, and other elements. Fifth, layout techniques can highlight article priorities and enhance reading experience through font and color matching.

(3) Content Factors. Content factors refer to factors influencing users' judgment of information content value, which can be divided into official account type, article theme [32], article length [34], external links [6], and originality [6]. First, official account type reflects the science popularization field, and its target group scope can affect communication breadth. Second, whether the article theme meets user needs relates to readers' value recognition of the article. Third, article length represents information volume and required time investment, which can affect reading experience. Fourth, external links can enrich article information and help readers conduct in-depth reading and understanding. Fifth, originality directly affects users' evaluation of article quality.

(4) Interaction Factors. Interaction factors refer to communication between official accounts and users, and among users themselves, which can affect communication effects by increasing user stickiness. This paper examines two methods: official account push frequency [34] and comment section interaction [32]. First, activity level is an important indicator for evaluating official account value, affecting user recognition and attention. Second, comment status can add information volume to articles and attract more user exchanges. Third, reply status directly affects users' sense of participation and satisfaction.

2.2.2 Outcome Variable

The WeChat Communication Index (WCI) is a multi-dimensional indicator for measuring the overall communication power and influence of WeChat official accounts, widely applied in academic circles [35-36]. The outcome variable in this paper is the communication effect of WeChat official accounts, focusing on the communication effect of single articles, including three indicators: reading count (R), "wow" count (Z), and like count (L). Drawing on the index weight division and standardization method calculation in the WCI (V14.2) formula for average communication power per article [37], we propose the calculation method for the Single Tweets Communication Index (STCI) [38], shown in Formula 2. Higher STCI values indicate better communication effects of single articles.

2.2.3 Variable Assignment

Drawing on variable assignments from literature [6, 8, 10-11, 32-34] and combining practical experience, we established classification standards for each variable

and conducted preliminary statistics on the sample. We continuously revised and improved the assignment process according to data characteristics to ensure that each situation in the research sample could be uniquely classified into a specific category [39]. The final variables and assignments are detailed in Table 1 .

Supporting unit level City level Table 1 Related Variables and Assignments Verified=1; Not verified=0 National level=1; Non-national level=0 First-tier city=1; Non-first-tier city=0 7:00-9:59=1; 10:00-12:59=2; 13:00-15:59=3; 16:00-18:59=4; 19:00-21:59=5; 22:00-23:59=6 Headline position=1, other positions sequentially 2, 3···No special wording=1; Sentence pattern adaptation=2; Terminology conversion=3; Use of internet buzzwords=4; Flexible verb usage=5 With audio or video=1; Without=0 Same font and color=1; Different fonts same color=2; Same font different colors=3; Different fonts different colors=4 Official account type (Article word count) (Monthly article volume)

2.3 Data Sources

We selected 50 excellent scientific popularization journals from the China Science Popularization Journal Association' s list of China' s Excellent Scientific Popularization Journals (2020) as case sources for the following reasons. First, they cover multiple fields including astronomy, geography, and family medicine, demonstrating broad coverage and representativeness. Second, their strict peer-review system ensures academic quality, authority, and professionalism. Third, the corresponding WeChat official accounts exhibit significant differences in communication power, meeting heterogeneity requirements.

Data collection and preprocessing procedures were as follows: First, we searched for the official accounts corresponding to the 50 journals, excluding those without official accounts or with suspended updates for more than half a year, ultimately obtaining 35 valid official accounts (as of March 15, 2023). Second, we determined the supporting unit level based on the journal's sponsoring organization and collected data on verification status, city level, official account type, and February 2023 article volume. Third, we accessed articles published by the 35 official accounts in February 2023, collecting data on publishing time, position, title techniques, layout techniques, originality, article length, comment status, reply status, as well as reading count, "wow" count, and like count. Fourth, we used Excel' s custom formulas to calculate STCI, ultimately obtaining field information for 1,030 articles.

3.1 Descriptive Statistical Analysis

Descriptive statistical analysis results are shown in Table 2 . No extreme values exist among variables, and overall values are relatively stable. The variance inflation factors of all independent variables are less than 10, and tolerance values are greater than 0.1, indicating no multicollinearity. The P-value of the likelihood ratio test is less than 0.01, indicating model validity. The P-values of

both Pearson and deviance tests are greater than 0.05, indicating good model fit.

Table 2 Descriptive Statistical Analysis of Related Variables Supporting unit level City level Official account type

3.2 Empirical Analysis Based on Ordered Logit Model

The ordered Logit regression results using Stata17 are shown in Table 3 . The P-values of verification status, city level, and layout techniques are greater than 0.1, indicating insignificant effects, while other condition variables pass the tests, indicating significant influence on the communication effects of scientific popularization journals' WeChat official accounts.

Table 3 Ordered Logit Regression Results of Influencing Factors of WeChat Official Accounts of Scientific Popularization Journals Supporting unit level City level Official account type 1.229*** -0.361*** -0.814*** 0.139* 0.902*** 0.555*** 0.119** 0.296*** -0.454** 0.492*** 0.545*** 0.974*** 1.190*** Note: , , represent significance at 1%, 5%, and 10% statistical levels respectively.

3.2.1 Analysis of Environmental Variables

WeChat official accounts with national-level supporting units achieve better communication effects than non-national-level ones. On one hand, national-level units possess stronger media literacy and financial foundations, operating official accounts more proactively and enthusiastically. For example, "China National Geography"has contracted photographers and design teams for content production and sufficient funds to organize field investigation activities, while "Global Youth Geography" only conducts journal promotion and small-scale online activities. On the other hand, higher supporting unit levels correlate with greater popularity and credibility, strengthening public willingness to read and share articles and bringing attention dividends to official accounts.

Additionally, verification status and city level do not significantly affect article communication effects. Possibly because verification information appears on the account details page rather than the article interface, it may bring traffic to the official account but does not enhance article communication effects. Moreover, the studied official accounts are all located in first- and second-tier cities, which may not differ significantly in public appeal and thus have no significant effect on communication effects.

3.2.2 Analysis of Technique Variables

Among technique factors, except for layout techniques, publishing time, position, title techniques, and presentation techniques all significantly affect communication effects. First, people' s comprehension is stronger in the morning; timely publication of science popularization articles can effectively disseminate complex

scientific knowledge. Meanwhile, official accounts often fix publishing times to cultivate user reading habits and enhance user stickiness. Second, articles in more forward positions attract more user clicks and reads. Particularly, high-quality articles in headline positions satisfy users' information needs, reducing the probability of subsequent articles being read. Third, appropriate use of title techniques can stimulate users' reading interest. For example, flexible verb usage increases 趣味性 (interest), internet buzzwords shorten distance, terminology conversion improves comprehensibility, and sentence pattern adaptation enhances readability. Fourth, audio and video convey information more intuitively and vividly, satisfying readers' diverse perceptual needs and enabling deep reading. Additionally, layout techniques have no significant effect on article communication effects, possibly because article layout considerations are relatively complex, such as color matching and paragraph arrangement, and minor differences in fonts and colors do not directly affect communication effects.

3.2.3 Analysis of Content Variables

Among content factors, official account type, article theme, article length, external links, and originality all significantly affect communication effects. First, different official account types have different audience scopes, directly affecting communication breadth. For example, medicine and health categories target mass audiences, while military categories only attract users interested in military affairs. Second, science popularization articles stimulate people' s curiosity and thirst for knowledge and are often related to daily life and social issues, gaining widespread attention; whereas journal promotion and event themes have relatively limited communication effects. Third, long science popularization articles can deeply explain complex scientific knowledge, enhance comprehensibility, demonstrate scientificity and professionalism, and increase readers' willingness to share and disseminate. Fourth, external links mostly promote products, which may cause user annoyance and unfollows. For example, "Parents Must Read" typically links to shopping malls after product promotion, resulting in low reading volume. Fifth, original articles are usually carefully planned with high quality and value; not only are readers willing to read and share them, but other authors and media may also cite or republish them.

3.2.4 Analysis of Interaction Variables

Among interaction factors, activity level, comment status, and reply status all significantly affect article communication effects. Activity level is mainly reflected in monthly article volume; maintaining article push frequency cultivates user reading habits and increases user stickiness. For example, "Family Doctor" and "Aviation Knowledge" both publish more than 84 articles monthly, achieving over 10,000 daily average reading volume through daily updates. Additionally, more article comments indicate greater information volume, which more easily triggers readers' emotional resonance and improves communication effects. Meanwhile, timely replies enhance readers' sense of recognition and stimulate

their participation desire and investment level. For example, "Nature" receives reader comments and author replies on almost every article, consistently achieving over 10,000 reading volume. However, currently, most scientific popularization journal official accounts have not enabled comment exchange functions.

4.1 Data Calibration

Before fsQCA analysis, variables need to be calibrated into fuzzy membership degrees between 0 and 1; values closer to 1 represent higher membership degrees to the outcome variable. Binary variable data already range between 0 and 1 and require no calibration. Among multi-category variables, verification status, city level, and layout techniques were not significant in regression results, so calibration only targets remaining variables. We adopt the direct calibration method, setting three qualitative anchors: full membership (0.95), crossover point (0.5), and full non-membership (0.05) [40], using maximum and minimum values as full membership and full non-membership points, and mean values as crossover points [41]. Calibration anchors are shown in Table 4 . Since publishing time and position have negative effects on communication effects, their minimum values serve as full membership points and maximum values as full non-membership points.

Variable Type First-level Variable Full Non-membership Table 4 Variable Calibration Anchors Supporting unit level Official account type

4.2 Necessity Analysis of Single Conditions

Necessity analysis of single conditions can determine whether necessary conditions for outcomes exist. Conditions with consistency greater than 0.9 [40] and coverage greater than 0.5 [42] are generally identified as necessary conditions for producing specific outcomes. Importing calibrated data into fsQCA 4.0 software for necessity analysis yields results shown in Table 5 . No condition variable' s consistency exceeds 0.9, indicating that single conditions do not constitute necessary conditions for WeChat official accounts to achieve favorable communication effects; rather, they are influenced by combinations of multiple factors.

Table 5 Single-Factor Necessity Analysis Results Supporting unit level ~Supporting unit level ~Publishing time ~Position ~Title techniques ~Presentation techniques Official account type ~Official account type ~Article theme ~Article length ~External links ~Originality ~Comment status ~Reply status Note: Adding symbol "~" before variable names indicates the absence of condition variables.

4.3 Sufficiency Analysis of Condition Configurations

Configuration analysis can explore whether combinations of different antecedent conditions can sufficiently explain outcome variables. Constructing a truth table

in fsQCA software, we set the case threshold at 7, raw consistency threshold at 0.8, and PRI consistency threshold at 0.75, ultimately producing three solutions: complex, intermediate, and parsimonious. Following academic conventions, we present the intermediate solution based on reference to parsimonious and complex configurations [31], obtaining five configurations (H1, H2, H3, H4, H5) for scientific popularization journals' WeChat official accounts to achieve favorable communication effects, shown in Table 6 .

Table 6 Condition Variable Configuration Results Supporting unit level Official account type Raw Coverage Unique Coverage Configurations for Achieving Favorable Communication Effects Overall Coverage Overall Consistency Note: " " represents core condition presence, " " represents peripheral condition presence, " " represents core condition absence, " " represents peripheral condition absence.

Configuration H1 indicates that for national-level supported scientific popularization journal official accounts, publishing articles at appropriate times and forward positions will win public trust and attention. If the articles can meet public demand for science popularization themes with original content, strictly control article length and external links, and actively participate in reader interaction, then favorable communication effects will be achieved. A typical case of this configuration is headline articles published on "Nature."

Configuration H2 indicates that scientific popularization official accounts with broad audiences and high push frequency, if they choose appropriate timing and forward positions when publishing articles, will have higher exposure rates. Under these circumstances, the key to achieving favorable communication effects is ensuring article quality and interaction enthusiasm, including article originality, providing external links, and displaying and replying to comments. Headline articles published by "Family Doctor" are typical representatives of this configuration.

Configuration H3 indicates that national-level supported scientific popularization official accounts with broad audiences and high push frequency can still achieve favorable communication effects even lacking certain publishing techniques, as long as they ensure appropriate article length and reliable external links. For example, non-science popularization articles published by "China National Geography" and "Aviation Knowledge."

Configuration H4 indicates that national-level supported scientific popularization official accounts with broad audiences and high push frequency, if article themes are user-interested, introducing external links and displaying comments are core factors for achieving favorable communication effects. Additionally, audio-video presentation also enhances reading experience. For example, science popularization articles from "China National Geography."

Configuration H5 indicates that scientific popularization official accounts with broad audiences and high push frequency, if articles are published at appropriate times with themes matching user interests, then original articles, providing external links, and displaying and replying to comments play key roles in achieving

favorable communication effects. For example, non-headline articles published by "Family Doctor."

4.4 Configuration Integration and Analysis

To explore configuration patterns and achieve classification purposes, we re-categorized 13 condition variables into four dimensions—environment, techniques, content, and interaction—for comprehensive analysis. Dimensions with core conditions present are called core dimensions, while those with only peripheral conditions present are called peripheral dimensions. Table 6 shows that content and interaction are core dimensions in all configurations, while environment or techniques serve as peripheral dimensions. Based on differences in peripheral dimensions, the five configurations are divided into three driving mechanisms for scientific popularization journals' WeChat official accounts to achieve favorable communication effects: environment-priority type, strategy-oriented type, and comprehensive-driving type.

(1) Environment-Priority Type. Configuration H3' s peripheral dimension only involves the environment dimension, characterized by environment + content + interaction. The mechanism of environment-priority type is guiding attention through environmental identity, enriching content to meet demands, and fixed pushing to increase stickiness, thereby forming a stable readership. It emphasizes the auxiliary role of supporting unit level throughout the communication process, primarily leveraging public absolute trust in "national recognition" and resource advantages of national-level units. Good environmental conditions can enhance user trust and attention, attract users to click and read, and promote content dissemination and sharing. However, maintaining user attention and reading requires not only fixed pushing to cultivate user habits but also rich article content to provide reading value.

(2) Strategy-Oriented Type. Configurations H2 and H5' s peripheral dimensions only involve the techniques dimension, characterized by techniques + content + interaction. The mechanism of strategy-oriented type is attracting reading through push strategies, meeting expectations with high-quality content, and increasing stickiness through active interaction to achieve extensive reading. It emphasizes the auxiliary role of technique strategies in attracting readers throughout the communication process, with publishing time and position being primary considerations. Pushing articles in headline positions during appropriate time periods can maximize article exposure rates and user click-through rates, avoiding articles being ignored when published during busy or inactive user periods. Effective strategies can stimulate readers' curiosity but also raise their expectations; if content quality is low or interactive communication is inactive, maintaining readership stability becomes difficult. Therefore, strategy-oriented type has stricter requirements for content and interaction, and providing practical value content and timely effective interaction are key to increasing reader satisfaction and loyalty.

(3) Comprehensive-Driving Type. Configurations H1 and H4' s peripheral dimensions involve both environment and techniques dimensions, characterized by environment + techniques + content + interaction. Environmental factors provide a good communication foundation for articles, enhancing official account credibility and influence to attract more readers and followers. Technique factors attract readers' interest and attention through selecting appropriate publishing times and positions and using attractive title and presentation techniques, increasing article exposure rates and readability. Content factors are key to meeting reader needs and value demands—interested official account types and article themes, moderate article length, and novel original content can attract readers' attention and increase reading and sharing desire. Timely updates and replies demonstrate official accounts' active participation and attention to readers, increasing reader engagement and loyalty. These elements work synergistically to form a comprehensive driving force, promoting broader recognition and dissemination of articles among readers.

5 Conclusions and Recommendations

Combining ordered Logit regression model and fsQCA method, this study investigates influencing factors and mechanisms of communication effects of scientific popularization journals' WeChat official accounts, yielding the following conclusions. First, supporting unit level, publishing time, position, title techniques, presentation techniques, official account type, article theme, article length, external links, originality, activity level, comment status, and reply status significantly influence the communication effects of scientific popularization journals' WeChat official accounts. Second, the communication effects are influenced by multiple factors comprehensively, with content and interaction as core dimensions and environment and techniques as peripheral dimensions. Third, environment-priority, strategy-oriented, and comprehensive-driving are three typical mechanisms for scientific popularization journals to achieve favorable communication effects. In the process of achieving communication effects, environmental advantages or strategy selection serve as leading factors to attract user reading interest, information content serves as core elements influencing user value judgment, and interaction serves as key factors enhancing user experience.

Based on these conclusions and actual operational conditions, maintaining knowledge leadership and user connections constitutes the core competitiveness for official accounts to obtain long-term attention, improving publishing strategies is key to competing for scarce public attention, and leveraging environmental advantages can gain benefits in popularity and resource support. Therefore, we propose the following recommendations to promote the development of scientific popularization journals' WeChat official accounts.

(1) Leverage Environmental Advantages and Optimize Platform Construction. For national-level supported scientific popularization journal official accounts, environmental advantages mainly lie in public absolute trust in "na-

tional recognition" and resource advantages of national-level units, providing development directions for other scientific popularization journal official accounts. First, focus on reputation building by deepening content creation and reader services to establish brand and credibility; cooperating with field experts to demonstrate professionalism and authority; and strengthening online and offline promotion to expand influence and popularity. Second, make full use of resources. Relying on scientific popularization journals, official accounts not only have stable and high-quality content sources but also rich promotion channels. Official account QR codes can be placed in print journals, official websites, and submission emails for precise promotion, and cooperation with science popularization institutions, technology enterprises, and media can be established to jointly conduct offline science popularization activities. Third, strengthen talent cultivation by providing professional training and organizing internal exchanges to improve editorial teams' professional competence and capabilities, and establishing incentive mechanisms to stimulate team members' creative enthusiasm and self-motivation for progress, thereby improving operational quality.

(2) Establish Marketing Concepts and Improve Publishing Strategies. To compete for scarce audience attention, marketing concepts must be established to cater to public reading habits and improve publishing strategies. On one hand, improve push strategies to achieve rapid traffic attraction. Publish articles during morning hours when comprehension is strong, and set push order according to article importance. Prioritize urgent or professionally valuable articles in headline positions, and batch-publish multiple non-urgent, high-quality articles in headline positions separately. Additionally, use concise, eye-catching titles that highlight core content and value, but avoid exaggerated or misleading wording—although exaggerated titles positively correlate with reading volume, they significantly negatively affect audience sharing willingness [43]. On the other hand, enrich presentation forms to enhance reading experience. Science popularization article distribution should adapt to fragmented, simplified, and visualized reading characteristics, reorganizing various presentation forms including text, images, audio, and video to enhance reader experience through more novel, varied, and vivid expression methods. The barrier between official accounts and video accounts can be broken to compensate for the limitations of graphic expression [44].

(3) Adhere to Knowledge Leadership and Innovate Content Output. Deepening content output is key to obtaining long-term attention for official accounts. First, clarify content positioning to achieve precise pushing. Official accounts need to identify their science popularization type and focus on creating related science popularization knowledge articles. Additionally, through questionnaires, interviews, and backend access data, they should deeply explore audience characteristics and preferences, understanding their areas of interest and knowledge levels to enable precise pushing according to content demands. Second, enrich information volume to meet knowledge demands. When explaining science popularization content in detail, article length can be appropriately extended to provide more knowledge and explanations, but attention should

be paid to changing tone and presentation methods to avoid excessive length, making obscure scientific content accessible and popular. Third, increase originality ratio and innovate content output. Incentivize team members to propose excellent ideas, cooperate with research institutions and universities to conduct scientific research, and invite renowned experts and scholars in the field to write articles, promoting content innovation through unique perspectives, in-depth exploration, and authoritative information. Simultaneously, obtain original label permission to gain platform traffic 倾斜 (preference).

(4) Maintain User Links and Emphasize Interactive Communication. To establish user links and stabilize user development, official accounts must provide good interactive services. On one hand, leverage platform advantages to achieve instant interaction. First, ensuring long-term, regular pushing is necessary to increase presence and cultivate user habits. Second, set topic guidance at article ends and conduct Q&A activities to promote comment section interaction and enhance reader experience. Third, enable private messaging functions to respond to reader questions and feedback more privately and personally, establishing closer relationships. Additionally, establish WeChat communities and conduct live interactions regularly or irregularly to achieve efficient, instant, two-way interactive communication. Furthermore, solicit reader submissions, providing feedback and exposure opportunities to stimulate reader participation enthusiasm and contribution willingness. On the other hand, break geographical limitations and expand offline exchanges. Organize reader meetings, field visits, community cooperation, and other activities to provide users with face-to-face exchange platforms, enhancing user participation and loyalty. Simultaneously, allow audiences to book and follow up on lecture activities through official accounts, increasing reader dependence on official accounts.

The limitations of this paper are: insufficient comprehensive examination of elements such as content readability and information usefulness, with relatively subjective measurement; numerous condition variable combinations, possibly making the obtained configuration types unable to cover most situations. Future research could consider: incorporating more quantitative indicators to enhance objectivity in qualitative variable measurement, adding eye-tracking experiments to improve accuracy; deeply analyzing each influencing factor and underlying driving mechanisms from user motivation, cognition, and capability perspectives; expanding data collection time spans to conduct longitudinal tracking studies on communication effects of scientific popularization journals' WeChat official accounts.

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