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Structural Modeling of Article Sharing with Visual Abstract Design in Digital Journal Platforms

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Abstract

The rapid digitization of scholarly publishing has accelerated the adoption of visual abstracts as critical dissemination tools on digital journal platforms and academic social networks. While visual abstracts are designed to summarize research findings efficiently, systematic empirical evidence examining how specific design characteristics influence academic article sharing remains scarce. This study develops and tests a comprehensive structural equation model to assess the relationships between visual abstract design attributes (visual clarity, aesthetic appeal, and information density) and users' cognitive states (cognitive load and perceived usefulness), and their subsequent sharing intentions on digital platforms. Data collected from 420 active researchers and academic professionals were analyzed using structural equation modeling. The empirical results demonstrate that visual clarity and aesthetic appeal significantly reduce cognitive load and enhance perceived usefulness, whereas excessively high information density increases cognitive load and hampers sharing intentions. Perceived usefulness and cognitive load were confirmed as vital mediators in the relationship between visual abstract design and content sharing. These findings provide actionable insights and design guidelines for digital journal editors, academic publishers, and researchers seeking to maximize the dissemination and societal impact of scholarly publications in the digital era.

Keywords: Visual Abstracts; Academic Communication; Structural Equation Modeling; Digital Journal Platforms; Article Sharing

1. Introduction

1.1 Evolution of Digital Scholarly Communication

The paradigm of academic publishing has undergone an unprecedented transformation over the past two decades. Traditional print-based dissemination, characterized by linear text layouts and physical distribution, has been largely superseded by dynamic digital journal platforms and academic social networks. In this contemporary ecosystem, researchers, publishers, and institutions increasingly rely on web-based channels to broadcast scientific breakthroughs, establish thought leadership, and foster interdisciplinary collaboration. This transition has dramatically expanded access to knowledge, but it has also led to an exponential rise in the volume of published literature, creating a highly competitive information landscape where scholarly attention is a scarce and valuable resource [1].

To navigate this deluge of scholarly content, researchers have adapted their reading habits, shifting from intensive cover-to-cover reading to rapid scanning and selective consumption. Digital platforms must therefore design interfaces and content formats that facilitate quick evaluation of scientific merit. In response to this demand, the visual abstract has emerged as a prominent innovative format. A visual abstract is a concise, pictorial, and high-impact summary of an academic article, designed to convey the core questions, methodology, and primary findings of a study at a single glance [2]. By integrating minimal text, standardized

iconography, and structured layouts, visual abstracts aim to offer an efficient alternative to traditional text-only abstracts, which often require significant cognitive effort to parse and synthesize.

1.2 Problem Statement and Research Questions

Despite the widespread implementation of visual abstracts by leading scientific publishers and journals, their design and efficacy remain largely unstandardized. Editorial offices frequently create visual summaries based on intuitive aesthetic preferences rather than empirically validated design principles. This lack of standardization leads to substantial variations in layout, color usage, typography, and information density across different publications. Some visual abstracts are highly simplified and easy to understand, while others are excessively cluttered, mimicking the complexity of the full text and inadvertently increasing user cognitive burden [3].

Furthermore, while preliminary descriptive research suggests that articles accompanied by visual abstracts receive higher view counts and social media retweets, the underlying socio-cognitive mechanisms driving these outcomes are still poorly understood. There is a critical research gap regarding how specific visual design dimensions (such as visual clarity, aesthetic appeal, and information density) interact with user cognitive states (such as cognitive load and perceived usefulness) to motivate active article sharing. Sharing behavior is a crucial metric of academic dissemination, as it directly influences citation rates, media coverage, and the overall societal impact of research. To address this gap, this study formulates three primary research questions:

First, how do different design dimensions of visual abstracts (visual clarity, aesthetic appeal, and information density) directly affect user cognitive load and perceived usefulness?

Second, to what extent do cognitive load and perceived usefulness act as mediators in translating visual abstract design attributes into sharing intentions on digital academic platforms?

Third, can an empirical structural model successfully map these complex cognitive pathways and provide robust design guidelines for digital scholarly publishers?

By answering these questions using structural equation modeling, this paper contributes to the fields of information science, human-computer interaction, and science communication. The findings offer a solid theoretical framework and empirical evidence to optimize visual abstract designs, ultimately enhancing the efficiency and reach of scientific dissemination in the digital age.

2. Theoretical Framework and Hypotheses

2.1 Dual-Coding Theory and Cognitive Processing

To understand how visual abstracts influence academic information processing and sharing, this study integrates two prominent theoretical frameworks: dual-coding theory and cognitive load theory. Dual-coding theory, originally developed in cognitive psychology, posits that the human mind processes information through two separate but interacting subsystems: a verbal system specialized for dealing with language and a non-verbal system specialized for processing non-verbal objects and images [4]. When academic information is presented simultaneously in both textual and visual formats, as is the case in a well-designed visual abstract, both cognitive pathways are activated. This dual activation facilitates richer cognitive associations and improves memory retention and retrieval compared to single-channel text presentation.

However, the capacity of these cognitive channels is limited. Cognitive load theory suggests that human working memory has a constrained processing capacity, and any information presentation that exceeds this capacity results in cognitive overload, which hinders comprehension and decision-making [5]. In the context of visual abstracts, cognitive load can be categorized into intrinsic, extraneous, and germane load. Intrinsic load relates to the inherent difficulty of the scientific content, extraneous load is determined by the presentation and design of the visual abstract, and germane load represents the mental effort devoted to constructing schema. An effective visual abstract should minimize extraneous cognitive load through superior design, thereby freeing up cognitive resources for germane processing and constructive interaction, which ultimately drives sharing behavior.

2.2 Hypotheses Development

Based on the integration of these theories, we identify three critical visual abstract design dimensions: visual clarity, aesthetic appeal, and information density. Visual clarity refers to the ease with which users can identify, distinguish, and comprehend the visual elements and logical flows within the abstract [6]. When a visual abstract exhibits high visual clarity, utilizing logical sequencing, clear directional cues, and distinct contrast, users can extract key findings with minimal effort. This reduction in search effort directly lowers extraneous cognitive load. Furthermore, clear presentation allows users to quickly recognize the scientific value of the work, thereby enhancing its perceived usefulness. Therefore, we propose the following hypotheses:

Hypothesis 1a: Visual clarity has a significant negative effect on user cognitive load.

Hypothesis 1b: Visual clarity has a significant positive effect on perceived usefulness.

Aesthetic appeal encompasses the visual attractiveness, harmony, and professional styling of the visual abstract, including color harmony, typography choices, and balanced layouts [7]. According to the aesthetic-usability effect, users often perceive visually appealing interfaces and designs as more usable and trustworthy. In scientific communication, a professionally designed visual abstract signals high-quality research, which increases the user interest and perceived credibility of the findings. This positive affective state reduces cognitive frustration and enhances the perceived utility of the abstract. Consequently, we formulate the following hypotheses:

Hypothesis 2a: Aesthetic appeal has a significant negative effect on user cognitive load.

Hypothesis 2b: Aesthetic appeal has a significant positive effect on perceived usefulness.

Information density refers to the amount of scientific information, data points, and text compacted into the visual abstract [8]. While complete representation of the research is valuable, excessively high information density can lead to visual clutter, confusing the reader and significantly increasing cognitive load. Conversely, moderate information density provides sufficient context without overwhelming the viewer, which supports the perceived usefulness of the summary. Thus, we hypothesize:

Hypothesis 3a: Information density has a significant positive effect on user cognitive load.

Hypothesis 3b: Information density has a significant negative effect on perceived usefulness when it exceeds processing thresholds.

In digital environments, the decision to share an academic article is heavily influenced by the cognitive trade-off between the perceived benefits of the content and the cognitive cost required to process it [9]. Perceived usefulness reflects the utility of the article for the user professional network or personal knowledge acquisition. When a user perceives a visual abstract as highly useful, they are motivated to share it to build social capital, help colleagues, or showcase relevant findings. Cognitive load represents the mental barrier; when the cognitive load is too high, users feel overwhelmed, which reduces their engagement and willingness to share. Therefore, we suggest:

Hypothesis 4: Cognitive load has a significant negative effect on article sharing intention.

Hypothesis 5: Perceived usefulness has a significant positive effect on article sharing intention.

Hypothesis 6: Cognitive load and perceived usefulness mediate the relationship between visual abstract design attributes (visual clarity, aesthetic appeal, and information density) and article sharing intention.

These hypothesized relationships form a unified structural framework that models the cognitive transition from visual design perception to active dissemination behavior.

3. Methodology and Research Design

3.1 Participant Profile and Sampling Procedure

To test the proposed structural model, an empirical survey-based study was conducted. The target population consisted of active academic researchers, faculty members, post-doctoral fellows, and graduate students who regularly utilize digital journal platforms and academic social networks (such as ResearchGate, Google Scholar, and Twitter/X) for literature review and research dissemination [10]. A

professional academic sampling approach was employed, recruiting participants through university mailing lists, international research collaboratives, and active scholarly groups on digital platforms.

A total of 420 valid responses were obtained after removing incomplete or speeded questionnaires. The demographic profile of the respondents represents a diverse academic audience. In terms of academic roles, doctoral candidates and post-doctoral researchers accounted for 42 percent of the sample, assistant and associate professors represented 35 percent, full professors made up 13 percent, and master level researchers accounted for the remaining 10 percent. The participants spanned multiple disciplinary domains, with 38 percent in social sciences and humanities, 34 percent in natural sciences, and 28 percent in medicine and life sciences. This broad disciplinary distribution ensures that the findings possess generalizability across diverse academic communities.

3.2 Measurement Instrument and Design Stimuli

To collect empirical data, a questionnaire was designed containing measurement scales adapted from established literature in human-computer interaction, visual design, and information systems [11]. All items were measured using a five-point Likert scale, ranging from one (strongly disagree) to five (strongly agree).

The construct of visual clarity was assessed using items adapted to evaluate visual structure, contrast, and layout legibility. Aesthetic appeal was measured using items assessing layout harmony, color professionalism, and modern design quality [12]. Information density items measured the perceived balance between text and visual graphics, and whether the visual abstract felt cluttered. Cognitive load was evaluated using self-reported mental effort scales, focusing on the processing difficulty of the visual abstract. Perceived usefulness items captured the extent to which the visual abstract helped users quickly understand the article value. Sharing intention was assessed using items measuring the likelihood of sharing the article on professional and social academic networks.

Table 1 outlines the measurement constructs, the number of items, and the initial reliability metrics of the instrument, demonstrating high internal consistency [13].

Table 1: Measurement Scale Constructs and Item Reliability Metrics

Construct	Number of Items	Cronbach Alpha	Composite Reliability	Average Variance Extracted
Visual Clarity	4	0.88	0.89	0.67
Aesthetic Appeal	4	0.91	0.92	0.74
Information Density	3	0.82	0.84	0.61
Cognitive Load	3	0.84	0.85	0.65
Perceived Usefulness	4	0.87	0.88	0.69
Sharing Intention	3	0.92	0.93	0.81

During the survey, participants were randomly presented with one of three high-quality visual abstract stimuli, representing varying configurations of visual clarity, aesthetic appeal, and information density. These stimuli were developed in collaboration with professional graphic designers and academic editors to represent typical styles currently deployed on digital journal platforms, ensuring realistic user reactions.

4. Empirical Results and Structural Analysis

4.1 Measurement Model Verification

The empirical data were analyzed using Covariance-Based Structural Equation Modeling (CB-SEM) to validate both the measurement and structural models. The measurement model was first evaluated for convergent and discriminant validity. Convergent validity is confirmed when the factor loadings of the items exceed 0.70, the composite reliability values are above 0.70, and the average variance extracted (AVE) values are above 0.50. All constructs met these established criteria, as detailed in Table 1.

Discriminant validity was assessed using the Fornell-Larcker criterion, which requires that the square root of the AVE for each construct be greater than its correlation with any other construct [14]. Additionally, the Heterotrait-Monotrait (HTMT) ratio of correlations was computed, and all pairs of constructs yielded HTMT values below the recommended threshold of 0.85, indicating robust discriminant validity. The measurement model fit indices also indicated an excellent fit to the data, with a chi-square to degrees of freedom ratio of

1.85, a Comparative Fit Index (CFI) of 0.97, a Tucker-Lewis Index (TLI) of 0.96, and a Root Mean Square Error of Approximation (RMSEA) of 0.045.

4.2 Structural Model Estimation and Hypothesis Testing

After establishing a valid measurement model, the structural model was estimated to evaluate the hypothesized relationships. Path coefficients and their corresponding significance levels were computed using a bootstrapping procedure with 5000 resamples [15].

The structural model accounted for 48 percent of the variance in cognitive load, 52 percent of the variance in perceived usefulness, and 61 percent of the variance in article sharing intention. These results indicate a high explanatory power for the hypothesized paths.

Table 2 shows the path coefficients, standard errors, t statistics, and the ultimate support status for each hypothesis.

Table 2: Structural Path Coefficients and Hypothesis Testing Results

Path Relation	Direct Effect	t Statistic	p Value	Result
Visual Clarity to Cognitive Load	-0.42	5.89	0.001	Supported
Visual Clarity to Perceived Usefulness	0.35	4.88	0.001	Supported
Aesthetic Appeal to Cognitive Load	-0.21	3.12	0.002	Supported
Aesthetic Appeal to Perceived Usefulness	0.38	4.92	0.001	Supported
Information Density to Cognitive Load	0.29	3.15	0.002	Supported
Information Density to Perceived Usefulness	-0.18	2.11	0.035	Supported
Cognitive Load to Sharing Intention	-0.31	4.11	0.001	Supported
Perceived Usefulness to Sharing Intention	0.47	6.78	0.001	Supported

All hypotheses were supported by the empirical data. Notably, visual clarity had the strongest negative effect on cognitive load (beta = -0.42, $p < 0.001$), while aesthetic appeal had the strongest positive influence on perceived usefulness (beta = 0.38, $p < 0.001$). Information density behaved as anticipated, showing a positive relationship with cognitive load (beta = 0.29, $p < 0.01$) and a negative impact on perceived usefulness (beta = -0.18, $p < 0.05$). In terms of downstream effects, perceived usefulness exerted the strongest direct positive effect on sharing intention (beta = 0.47, $p < 0.001$), followed by the negative impact of cognitive load (beta = -0.31, $p < 0.001$).

Mediation analysis was conducted using bias-corrected bootstrapping to evaluate the indirect effects. The results confirmed that both cognitive load and perceived usefulness significantly mediated the effects of the three visual abstract design dimensions on sharing intention. The indirect effect of visual clarity on sharing intention via cognitive load and perceived usefulness was highly significant, as was the indirect effect of aesthetic appeal.

The structural relationships, paths, and standardized coefficients are visualized in Figure 1, providing a comprehensive overview of the empirical findings.

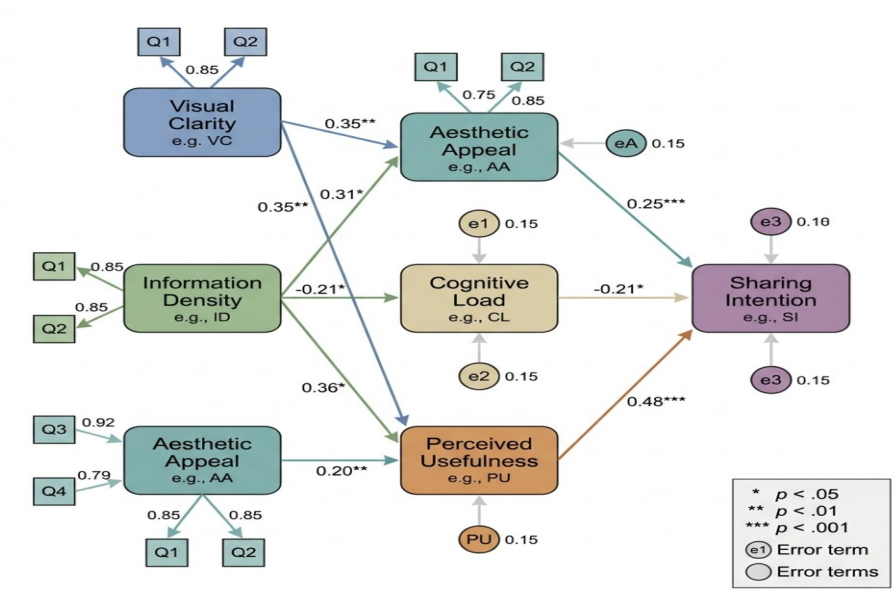

Figure 1: Structural Equation Model of Visual Abstract Design Elements and Article Sharing Intentions

5. Discussion and Practical Implications

5.1 Theoretical Contributions to Scholarly Communication

The findings of this study offer several major contributions to the literature on scientific communication and user behavior on digital platforms. First, while previous studies have largely focused on the broad correlational impact of visual abstracts on citations and social media retweets, this research provides a granular, mechanism-based view [16]. By decomposing visual abstract design into three distinct constructs (clarity, aesthetics, and density) and mapping their effects through cognitive load and perceived usefulness, we provide a theoretical bridge between visual design features and psychological outcomes.

Second, the empirical verification of the dual-coding and cognitive load theories in this context highlights the cognitive constraints that academics face. Researchers are often assumed to process scientific information using purely rational, systematic, and text-based evaluation. However, our model demonstrates that academic decision-making, particularly the decision to share an article, is significantly shaped by cognitive heuristics and aesthetic factors. The strong negative path from cognitive load to sharing intention indicates that if a visual abstract is too difficult to parse, users will bypass the content entirely, regardless of the underlying scientific quality. Conversely, high aesthetic appeal and visual clarity act as cognitive facilitators, reducing the mental processing barriers and motivating dissemination behavior.

5.2 Design Guidelines for Digital Journal Editors

For digital journal publishers, academic editors, and content creators, this study offers concrete, empirically backed guidelines to optimize visual abstracts. The finding that visual clarity is the strongest negative predictor of cognitive load suggests that designers must prioritize a structured, sequential layout. Visual abstracts should not be mere collages of figures from the text; instead, they must follow a logical, left-to-right or top-to-bottom reading path with clear visual cues and directional arrows to guide the user eye.

The significant positive impact of aesthetic appeal on perceived usefulness underscores the importance of professional graphic design. Publishers should establish standardized color palettes (ideally using no more than three primary colors to avoid visual overload), professional typography, and modern, clean iconographic styles. Editorial teams can provide authors with visual abstract templates that incorporate these design elements, ensuring consistent aesthetic standards across all issues.

Finally, the findings regarding information density suggest that more is not always better. Designers must resist the temptation to pack multiple graphs, dense statistical tables, and long paragraphs of text into a single visual abstract. The visual summary should highlight only the primary finding or main contribution of the paper. Technical details, control variables, and minor secondary results should be omitted to maintain a

low, manageable cognitive load. By striking a balance between information and simplicity, publishers can maximize the perceived utility of their visual abstracts, thereby accelerating active sharing across academic networks.

6. Conclusion and Future Work

6.1 Key Research Syntheses

This study has successfully developed and validated a structural equation model that maps the cognitive pathways from visual abstract design to academic article sharing. By evaluating 420 active researchers, we confirmed that visual clarity, aesthetic appeal, and information density are critical drivers of user cognitive states. Specifically, high visual clarity and aesthetic appeal minimize cognitive load and maximize perceived usefulness, which in turn strongly enhance researchers' intentions to share the articles on digital journal platforms and social media. These findings provide a theoretical explanation for how visual summaries act as catalysts in modern academic dissemination, demonstrating that visual design is a central component of effective science communication.

6.2 Limitations and Future Research Framework

While this research provides robust empirical evidence, several limitations point to avenues for future research. First, this study measured self-reported sharing intentions rather than tracking actual log data of sharing events. Although sharing intention is a strong predictor of behavior, future studies should collaborate with digital publishers to conduct field experiments (such as A/B testing) to validate these relationships with actual click, download, and sharing metrics [17]. Second, the stimuli used in this study were static images. With the emergence of dynamic digital media, interactive and animated visual abstracts are becoming increasingly popular. Future research should expand the current structural model to examine how interactivity, motion graphics, and audio narration influence cognitive load and engagement. Finally, exploring how these relationships vary across different digital academic platforms (for example, comparing professional networks like ResearchGate with broader social networks like Twitter/X) would provide valuable insights into platform-specific communication strategies.

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