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An investigation on Graphical Abstracts use in scholarly articles

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ABSTRACT

Recently, Graphical Abstracts (GA) are increasingly being used in scholarly articles in order to enhance browsing and aid in paper selection. This study aims to demonstrate how GAs have been adopted in the social sciences. In the social sciences, GAs appeared for the first time in 2010, and from 2011 to 2015 a 350% increase was observed. Forty-seven percent of journals related to the social sciences have published at least one article with a GA. Among the social science disciplines, social and economic geography has most actively adopted GAs, whereas, in law, GAs are still not used. Authors use GAs to present: 1) an overview of the article, including the research process and key results (sometimes with background), 2) the key results of the study, 3) the research process or methods used, and 4) the background of the study. Authors re-use the visualizations in their manuscripts, integrate or modify the visualizations in their manuscripts, or create a new visualization for the GA. Depending on the content of GAs, different types of visualizations are used; for example, charts are mainly used to represent results and diagrams are used to present research methods or provide an overview of the article. Areas of future research into GAs are suggested.

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1. Introduction

As digital technologies have made visual information easier to generate and disseminate, visual information is becoming a more prevalent means of communication. Visualization is one of the many types of visual information, and visualization technologies have recently received attention from public and professional communities. Several definitions of visualization have been discussed, and the following are commonly included in those definitions: 1) visualization is a graphical representation of data, information, and/or knowledge, 2) the aims of visualization are to effectively convey and communicate information and/or knowledge and to amplify cognition, and 3) visualization shows what could not be presented otherwise. In addition to the values of visualization itself, it has been found that when verbal and visual techniques are combined to convey information, attention, understanding, and recall of the information are enhanced. The effectiveness of combining text and visual information has been investigated experimentally and shown in fields such as education, public health, and marketing.

Journal articles have long integrated visual information, such as tables, charts, graphics, and photos, to effectively present results and to show models/frameworks, examples, and contextual backgrounds within scholarly communications. Recently, Elsevier initiated the "Article of the Future" project,[1] and the Graphical Abstract (GA), which utilizes visual information as an abstract, is a part of the project. The Article of the Future project "aim[s] to revolutionize the traditional format of the academic paper." The project has developed discipline-specific prototypes which enhance navigation and browsing, add content (e.g., interactive tables, figures, and maps, graphical abstracts, etc.), and provide context (e.g., related information, related articles, etc.).

Among these features of the Article of the Future project, the focus of the current study is the Graphical Abstract (GA). The Elsevier website provides a working definition of GA: "[A] Graphical Abstract is a single, concise, pictorial and visual summary of the main findings of the article. [. . .] This could either be the concluding figure from the article or a figure that is specially designed for the purpose, which captures the content of the article for readers at a single glance."[2]; GAs in Elsevier journals do not appear in PDF file or print format, only in online articles and online search result lists. Therefore, as addressed on the Elsevier website, a GA is intended to

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[1] http://www.articleofthefuture.com/.
[2] http://www.elsevier.com/authors/journal-authors/graphical-Abstract.

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enhance browsing and aid in paper selection by allowing a reader to quickly understand the main focus of the paper.[3]

Although the benefits of GAs can be anticipated based on the general benefits of visualization and multimodal communication, there has been a lack of research exploring how GAs are practically utilized in scholarly articles and what their influences are on scholarly communication. In this context, this study attempts to initiate research on GAs and establish a future research agenda. GAs are popularly used in science and engineering journals as a way of representing, for example, molecular geometry, cell structures, mechanical structures, and so on. Although GAs are less popular in the social sciences than in the hard sciences and engineering disciplines, the implications from research in the social sciences have a greater potential to be applied to other knowledge creation and knowledge sharing cases involving humans and society in general. Therefore, this study aimed to understand how GAs are employed in the social sciences. The following research questions are addressed:

RQ1: How frequently are Graphical Abstracts adopted in social science disciplines?

RQ2: What types of Graphical Abstracts are used in social science disciplines?

This study will demonstrate how GAs are adopted in the social sciences and suggest how to enhance effectiveness of Graphical Abstract for scholarly communication.

2. Related studies

2.1. Visualization

As Bresciani stated, "visual representations are used to organize and structure information and ideas in order to convey knowledge to amplify cognition and to enhance communication" (Bertschi et al., 2011, p. 14). It has been demonstrated that visualization is valuable for browsing, exploring, developing insights, and making new discoveries (Fekete, Wijk, Stasko, & North, 2008). Visualization is an interdisciplinary field, and terminologies of data-, information-, and knowledge visualizations have been variously employed, according to the contexts and applications of the visualization. Mayer (2010) attempted to compare these three types of visualizations using the concepts of data, information, and knowledge. Burkhard (2005) compared information visualization and knowledge visualization in terms of ten aspects, goals, benefits, content, recipients, influence, proponents, contribution, root, means, and complementary visualizations.

Some studies have presented taxonomies of visualizations. A periodic table of visualization methods (Lengler & Eppler, 2007) systematically categorized 100 visualization methods into six groups: data visualization (visual representation of quantitative data in schematic form), information visualization (interactive visual representations of data), concept visualization (representation of qualitative concepts), metaphor visualization (utilization of visual metaphors), strategy visualization (systematic use of visual representations for strategies), and compound visualization (combinations of different types of visualization). In addition, each visualization method was thought of in three dimensions: task and interaction (overview, detail and overview, and detail), cognitive processes (convergent thinking and divergent thinking), and represented information (structure and process). Eppler and Burkhard (2005) organized types of knowledge visualizations as structured text and tables (organization of knowledge with grids), heuristic sketches (drawings facilitating knowledge transfer and creation of insight), conceptual diagrams (schematic representation of abstract ideas in standardized formats), visual metaphors (utilization of visual metaphors to enhance knowledge transfer), knowledge maps (graphical representations using cartographic conventions), and interactive visualizations and animations (visualizations which allow users to control and interact with the visualizations).

2.2. Multimodal information

Whereas studies on visualization focus on visual information itself, other research has established theories as to how humans process text-visual information. These theories are based on the assumption that "people learn more deeply from words and pictures than from words alone" (Mayer, 2005, p. 31). Dual coding theory, posited by Paivio (1986), assumes that there are two different cognitive subsystems, one for verbal information and the other for non-verbal information, and that these two subsystems separately process and create representations of the corresponding type of information. Dual coding theory posits that the two subsystems operate independently from one another but frequently work simultaneously, and, therefore, a multimodal stimulus can foster greater recall and understanding than can a unimodal stimulus. Mayer's (2005) cognitive theory of multimedia learning (CTML), which is based on dual coding theory, includes the notion that verbal and visual presentations, which enter the mind through sensory memory, are processed through selection, organization, and integration processes. During the selection process, relevant words and/or images are selected from the presented texts and/or illustrations, and in the organization process, selected words and images form coherent verbal and/or visual representations. The selection and organization processes are conducted in two separate channels. Then, the verbal and visual representations are integrated with prior knowledge retrieved from long-term memory. Selection, organization, and integration processes occur in working memory.

Although these theories support the superiority of multimodal information, it is not the case that multimodality is always beneficial or equally as effective as other means of presentation. There are lines of research which have developed a set of principles for effective visual representation, particularly in learning environments. Mayer (2005) found that human cognitive capacity is easily overloaded by an excess of both essential and extraneous materials, and presented several principles which can reduce extraneous overload; the principles include coherence, signaling, and spatial contiguity. The coherence principle suggests exclusion of extraneous materials. Sung and Mayer (2012)'s study supported the coherence principle by demonstrating that graphics which are directly related to an instructional goal enhance cognitive processing, whereas irrelevant graphics do not enhance learning, although all graphics, even if they are irrelevant, have a positive effect on affective measures. The spatial contiguity principle recommends placing text and visuals that correspond with one another close together. Johnson and Mayer (2010) supported this principle by comparing eye movements of subjects viewing a slide with four different versions of text/image placement. The signaling principle recommends providing cues that will direct attention, and includes how to organize/process presented information. Holsanova, Holmberg, and Holmqvist (2009) found that people process complex materials more easily when guidance is provided through a spatially and conceptually organized layout.

Eitel, Scheiter, Schüler and Nyström (2013) examined the scaffolding effect, which occurs even following a brief exposure to spatial information extracted from an image; the scaffolding effect

[3] "A Graphical Abstract should allow readers to quickly gain an understanding of the main take-home message of the paper and is intended to encourage browsing, promote interdisciplinary scholarship, and help readers identify more quickly which papers are most relevant to their research interests. Authors must provide an image that clearly represents the work described in the paper." (http://www.elsevier.com/authors/journal-authors/graphical-abstract.)

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