

## ADOPTION, CITATION, AND DIFFUSION OF SCIENTIFIC ARTICLES:

### WHAT IS DIFFUSED?<sup>1</sup>

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**Abstract:** It is suggested that the diffusion of scientific articles can be studied in terms of relationships that take place between a class of behaviours associated with the article citation and the social media which stimulate this class verbally. This suggestion assumes that the diffusion does not concern the article, but the relationships between this specific class and their verbal antecedents and consequents in the social media pertinent to those making the citation. The role of interpersonal relationships in controlling the diffusion of scientific articles by rules and information networks is highlighted. It is argued that a framework which conceptualizes the diffusion of scientific papers as processes such as social learning, induction and stimulus control may favour the research of the theme not only by behavioural psychologists and information scientists, but also by researchers and professionals from other areas.

**Keywords:** Citation. Scientific article. Scientific communication. Interpersonal relationships.

When published, the scientific article is eligible for adoption and citation. When cited, the article is diffused. Diffuse is a transitive pronominal verb, but its

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predication does not usually distinguish the peculiarities of the subject. For this syntax, an article would be diffused in the scientific literature the same way as light or radio waves propagate in vacuum. However, scientific articles are not normally loitering in the vacuum. Neither do innovations, technologies, knowledge, politicians' candidacy, child pornography, rap music, religious sect and other things, good or not, tangible or not, inanimate or not, which one also says that they diffuse. There should be another way of saying that such things are diffused.

This is an essay on the diffusion of scientific article, and I want to make clear what I mean by diffusion. To be diffused, the scientific article depends on a journal or other means of information, not necessarily printed (Guedes, 2004). Through printed and electronic media, the article becomes the object of reading. But reading is not a condition required for the diffusion of a scientific article, unfortunately – see the generous inclusion of references that reveals itself free, superfluous, sometimes pretentious signs of erudition (Araújo, 1986) when checked by those consulting them. The mere printed or electronic citation appears to be sufficient, at a certain extent. This is what I want to clarify: citation is behaviour and it can be defined, measured and analysed as such. More: citation offers a behavioural definition criterion for the diffusion of scientific articles, even at the expense of some negligence related to consideration of diffusion by oral means or as to the precise identification of the different uses of the article by citation makers – for example, reading.

## Behaviour and social media

By virtue of the difficulty of observing the reading and other behaviours of the citation maker of a scientific article, the citation may be taken as an indicator of occurrence of a very specific behavioural class which, if reduced to practice, would include probably, in addition to the eventual reading, the following components, among other possibilities: (i) consultation to sources (books, articles, data bases); (ii) consultation to persons (authors, colleagues); (iii) personal communications; (iv) audiences (classes, lectures, meetings, congresses); (v) article handling; (vi) electronic records and notations; (vii) textual transcript; (viii) bibliographical reference transcript. Such components, or responses, are evidently conjectures on possible elements of a specific class, said operant (Catania, 1998). The study of this class seems to be the domain of the information science, but it would be adequate, as I suggest in this essay, if these and other eventual components were the object of a properly behavioural research.

Since the diffusion of a scientific article does not occur as the propagation of magnetic waves, it should be located in social media, where

there is all sorts of verbal influence. I indistinctly refer to printed, electronic, and face media. Books, journals, data bases in their respective citation networks, newspapers, magazines, Internet blogs, email, Twitter, class, lecture, the conversation over coffee, among other candidates, are all verbally influential social media. The diffusion of a scientific article can be understood, thus, in the set of relations that takes place between a class of behaviours associated with the citation of the article and the stimuli of the social media that verbally influence this class. Such conception presumes that diffusion does not concern the article, but the relationships between the class and its verbal antecedents and consequents in social media pertinent to the citation maker. Logically, if any component of the class does not occur, there is no diffusion.

Regardless the fact of the class occurring in its entirety or only partially (for example, only the consultation to a data base), the particular occurrence of a citation is a behavioural indicator that the article's citation maker adopted it in some way, even if the adoption is limited, in a derogatory example, to merely one or more items from the list of references (a case of the spurious citation of a citation, without reading, nowadays popularised by the expression *control-C, control-V*). Similarly, collectivization (increased frequency) of the citation in a given temporal and/or geographical scale is a behavioural indicator that the adoption of the article has been diffused. In this perspective, it is not the article that is diffused, as intended by the light and radio waves metaphors: it is its adoption, as indicated by the counting of the article's citations.

Adoption is, thus, the functional unit of the diffusion.<sup>2</sup> This, in turn, designates processes of behavioural relationships through which individual adoptions were collectivized, i.e., become more frequent. Applied to scientific articles, this conception is based on the conceptual framework offered by Elkins & Simons (2005) for a generic definition of diffusion originally suggested by Strang (1991) and Strang & Soule (1998). According to this framework, the concept of diffusion designates processes, not results.

One may question whether the citation count adequately expresses what is known in academic jargon as impact factor of a scientific article (e.g., Rocha-e-Silva, 2009). The growth of on-line publications has allowed the emergence of a variety of measures of the impact factor. However, the

2 Adoption is an abstract concept that has been defined in many ways, none satisfactory. The research tradition of diffusion of innovations (Rogers, 1995) takes the individual or an organization as the unit of analysis. It is likely that such a characteristic derives from the predominant use of retrospective research methods, as it is the case of surveys and recalls. The use of behavioural indicators, such as citation, allows for the measurement of adoption prospectively. Feeney (2001) used rates of adoption for measuring moment-by-moment the diffusion of an educational innovation in a U.S. university.

impact assessment as function of frequency of citations that the article receives is still a common procedure in the scientific community (Bollen, Van de Sompel, Hagberg & Chute, 2009).

## Rules and networks

Beyond the scope of this text is the conjecture about the variables that determine, or facilitate or hinder the adoption and diffusion of a scientific article. This is a problem analogous to an immeasurable amount of diffusion cases of interest in biological and social disciplines, whose study has been the object of vast research literature (e.g., Bandura, 1986; Rogers, 1995), all of it characteristically weak when it refers to methods of research, as well as the definition of concepts and analysis of contingencies existing in environments in which the adopters behave (Jardim, 2008; Pennypacker, 1986; Stolz, 1981). It is pertinent to point out, however, the role of interpersonal relationships in most of adoption and diffusion behaviours (e.g., Valente, 1995).<sup>3</sup> On the fortunate characterization of Katz (1999), interpersonal relationships operate both as guardians of social norms and as information networks.

Rules are verbal antecedents by which agencies and agents of social control pre-specify the contingencies that operate in the selection of many behaviours (Hayes, 1989).<sup>4</sup> An important function of rules is what is known as cognitive control of human behaviour. The networks, in turn, are what Mitchell (2009) describes as small worlds where individuals, organisations, and cultures connect. In particular, modern information networks have contributed to expand remarkably the connections between individuals and between them and interest groups, particularly in companies, universities and research centers (Srinivasa, 2006). One consequence of this development is the multiplication of opportunities for previous reinforcement of adoptions by peers, a condition that has shown to be determinant for the success of the diffusion of a variety of technological innovations in agriculture, industrial production, medical epidemiology

- 3 The progress and the increasing ease of use of information and communication technology tends to contribute to the antecedents and consequents of adopting a scientific paper to be sought mainly in the written information. However, empirical research of these factors cannot ignore the interpersonal word-of-mouth, always taken as a key-variable for a successful diffusion (Katz & Lazarsfeld, 1956; Stolz, 1981).
- 4 To make the acceptance of an article for publication contingent upon the meeting of the norms of a journal is obviously an efficient selection rule. In another aspect, to make the good evaluation of a graduate program's productivity contingent upon publication of their master's and doctorate's in qualified journals, rather than the production of theses and dissertations, should also be.

and other areas (e.g., Coleman, Katz & Menzel, 1957). There is no reason to suppose that it is different with the scientific article; on the contrary.

Based on what they provide for the identification of relevant variables, rules and information networks are likely to be a promising starting point for the empirical study of relationships between the behavioural class outlined above and social media that influence it. Several of the antecedent and consequent conditions under which someone adopts and diffuses (cites) an article are public and relatively identifiable. In the context of information science, a behaviour analyst can follow the course of diffusion, for example, of an article on community psychology in epidemiology or health promotion literature (i.e., in a different citation network) in terms of the antecedent and consequent stimuli of the citation. In computer science, Shi, Tseng & Adamic (2009) found that diffusion of small impact articles through different citation networks is correlated positively with two aspects of citations: (i) recentness (i.e., the greater temporal proximity of publication date of the article indicated in citation), and (ii) the academic community from which originates the article, as stated in the citation. This correlation, curiously, does not maintain itself in higher impact articles.

Eventually, a behavioural analysis can conceptually fit the diffusion of scientific article in a set of processes already widely researched, like social learning, induction (generalization of responses) and stimulus control (Catania, 1998; Guerin, 1994; Skinner, 1969). This framework, I suppose, would favour the behavioural research of the scientific article in various dimensions (temporal, geographic, socio-cultural) of interest not only of behavioural psychologists and information scientists, but also researchers from other fields, educators, sociologists, publishers, booksellers, disseminators of science, communication and marketing people, and other categories of people whom a behavioural approach may concern.

### **Adoção, citação e difusão do artigo científico: o que é que se difunde?**

**Resumo:** Sugere-se neste texto que a difusão do artigo científico pode ser estudada em termos das relações que se processam entre uma classe comportamental associada à citação do artigo e os meios sociais que estimulam essa classe verbalmente. Tal sugestão presume que a difusão não concerne ao artigo, mas às relações entre a classe específica e os seus antecedentes e consequentes verbais, nos meios sociais pertinentes a quem faz a citação. É realçado o papel das relações interpessoais no controle da difusão de artigos científicos por meio de regras e redes de informação. Argumenta-se que o enquadramento conceitual da difusão do artigo científico nos processos comportamentais de aprendizagem social, indução e controle de estímulos pode favorecer o estudo do tema não só por psicólogos do comportamento e cientistas da informação, mas também por pesquisadores e profissionais de outras áreas.

**Palavras-chave:** Artigo científico. Citações. Comunicação científica. Relações interpessoais.

### **Adoption, diffusion et citation d'article scientifique: ce qui est diffusé?**

**Résumé:** Il est suggéré que la diffusion d'articles scientifiques puisse être étudiée en termes de relations qui ont lieu entre une classe de comportements associés à la citation de l'article et les médias sociaux qui stimulent cette classe verbalement. Cette suggestion suppose que la diffusion ne concerne pas l'article, mais les relations entre la classe spécifique et de leurs antécédents et des conséquents verbales dans les médias sociaux pertinents à ceux qui font la citation. Le rôle des relations interpersonnelles dans le contrôle de la diffusion d'articles scientifiques par les règles et les réseaux d'information est mise en surbrillance. Il est soutenu que un cadre qui conceptualise la diffusion d'articles scientifiques dans les processus comportementaux de l'apprentissage social, l'induction et le contrôle du stimulus peut favoriser la recherche du thème non seulement par les psychologues du comportement et les spécialistes de l'information, mais aussi par les chercheurs et les professionnels d'autres secteurs.

**Mots-clés:** Article scientifique. Citation. Communication scientifique. Relations interpersonnelles.

## Adopção, difusão e citação do artigo científico: ¿qué se difunde?

**Resumen:** Se sugiere que la difusión de artículos científicos puede ser estudiada en términos de las relaciones que tienen lugar entre una clase de conductas asociadas a la citación del artículo y los medios de comunicación social que estimulan esta clase verbalmente. Esa propuesta supone que la difusión no se refiere al artículo, pero a las relaciones entre la clase específica y sus antecedentes y consecuentes verbales en los medios de comunicación social pertinentes a quien hace la citación. Se resalta el papel de las relaciones interpersonales en el control de la difusión de artículos científicos por las normas y redes de información. Se argumenta que un marco que concibe la difusión de artículos científicos como procesos comportamentales de aprendizaje social, inducción y control de estímulos puede favorecer la investigación del tema no sólo por los psicólogos del comportamiento y científicos de la información, sino también por los investigadores y profesionales de otras áreas.

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