The validity of Bradford's Law in academic electronic mailing lists

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Abstract

Purpose – The purpose of this paper was to check the validity of Bradford's Law in the contemporary world of academic electronic mailing lists.

Design/methodology/approach – The present research study applied Bradford's Law to academic electronic mailing lists to determine: whether, on the Internet, mailing lists and the posts sent to them follow the same distribution as scientific journals and the articles published in them with respect to the original form of Bradford's Law; and whether the behaviour of the Bradford distributions differs depending on the type of academic discipline (social studies or sciences) and subject category (documentation and education, medicine and life sciences) to which the list belongs. As a prior step, the utility of mailing lists was analysed during the 10-year period of 2002-2011, together with their expected future in terms of ratifying the applicability of the Law.

Findings – The results showed that, in general, electronic mailing lists are continuing to be used, and that Bradford's Law is indeed satisfied, especially in the science subject categories, coherent with the fact that Bradford's Law in cybermetrics holds only for fairly narrow (closed) and well-defined (homogeneous) environments.

Originality/value – The originality of the present research study was to check the validity of the historic Bradford's Law in the contemporary world of Internet.

Keywords Life sciences, Education, Documentation, Medicine, Bradford's Law, Electronic mailing lists

Paper type Research paper

Introduction

Bradford's Law of scattering, referring to scientific literature, was originally enunciated by Samuel C. Bradford in the following terms:

> If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus, when the numbers of periodicals in the nucleus and succeeding zones will be as $1:n:n^2$. (Bradford, 1934, pp. 85-86)

With this statement of the law, Bradford was expressing the observed highly uneven distribution in journals' output of articles. In particular, most articles are concentrated in just a few journals, and there is a small proportion published in a large number of

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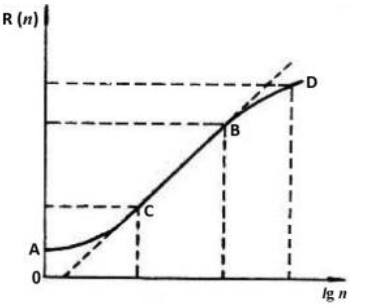
journals (Castillo and Carretón, 2010). This is why most articles on a given topic can be searched for in just a small number of journals (the nucleus or core). After this core, a much greater number of journals will have to be searched to retrieve the same number of articles. This greater number will constitute the first zone, and so on, with the rest of the zones. The number of zones to determine is arbitrary, although Bradford originally defined three (Morato Lara, 1999).

To display Bradford distributions, one uses a semi-logarithmic plot. This will comprise two curved segments – initial (core) and final (Zone 2) – and an intermediate straight-line segment (Zone 1). The number of journals that form the core of the distribution is read off of the *x*-axis, corresponding to the point at which the initial curved segment makes the transition to the straight-line segment (Egghe and Rousseau, 1990; Ferreiro, 1993) (Figure 1).

Despite its acceptance by the international scientific community, Bradford's Law takes no account of certain variables – for example the journals' publication frequency (Urbizagástegui, 1996) and size (Bensman, 2001) – so that the law identifies the journals that are the most productive but not necessarily the most specialized in the field under study. These reasons have led to various interpretations of the theoretical basis of the law. Gorbea-Portal (1996) used the mathematical model of Bradford, identifying the regularity of the concentration and dispersion of knowledge recorded by sources. Oluic-Vukovic (1997) studied the classical bibliometric law and the more general stochastic models. Basu (1998) discussed the theoretical aspects of Bradford's Law and its graphical representation, while Chongde and Zhe (1998) indicated the need for more statistical tests of new models of Bradford's Law to obtain the best model. Hjørland and Nicolaisen (2005) indicated that the meaning of *subject* has never been explicitly addressed in relation to Bradford's Law. They introduced the distinction between lexical scattering, semantic scattering and subject scattering.

In stating the law, Bradford focused exclusively on the documental aspect of scientific journals and the articles they publish. There have been numerous studies that have followed this pattern in applying Bradford's Law to the field of scientific journals (Bigdeli and Gazni, 2012; Kademani *et al.*, 2013; de Arenas *et al.*, 2002; Pereira *et al.*, 2007; Singh *et al.*, 2007) and the development of library collections through citation analysis that identifies the most frequently cited scientific journals and, therefore, those



Source: Pontigo and Quijano (1977)

Figure 1.
Typical Bradford curve

considered most important by professional and research networks (Crawley-Low, 2006; Arango and Alvarado, 2010; Taylor, 2007).

However, there have also been studies using Bradford distributions in other areas unrelated to scientific journals. An example of such an area is that of cybermetrics. This deals with the application of traditional informetric techniques to any kind of information accessible on the Internet, incorporating other new techniques (Bar-Ilan, 2001; Cronin, 2001; Faba-Pérez *et al.*, 2004). The aim has been to examine whether the law can be used in this area, with the advantages that would entail. Bar-Ilan (1997), for example, applied the law to the case of newsgroups on a specific topic. Cui (1999) examined the out-links from websites of major US medical schools to discover the Bradford distribution core set of URLs. Faba-Pérez *et al.* (2003) studied how well the distribution of in-links received by Web spaces fit either a power law (of the Lotka type) or a printed publication bibliometric distribution (of the Bradford type). Navarrete-Cortés *et al.* (2007) applied the law to compile the various electronic resources distributed on the Internet. Sudhier (2010) studied the behaviour of Wiki users on the Internet. Lu *et al.* (2011) analysed the distribution of Web resources in the field of information science.

Following this line of research, the objective of the present research was to apply Bradford's Law to specialist electronic mailing lists to examine two aspects:

(1) whether, on the Internet, mailing lists and the posts sent to them follow the same distribution as scientific journals and the articles published in them with respect to the original form of Bradford's Law; and

(2) whether the behaviour of the Bradford distributions differs depending on the scientific discipline and subject category to which the list belongs.

Given these objectives, the working hypothesis posited was: If Bradford's Law is applicable mainly in narrow, well-defined areas of scientific research (Brookes, 1969), it should also hold when working with academic electronic mailing lists, as they are also closed environments with homogeneous characteristics.

However, before applying the law and examining the advantages that it provides, we looked at the trend in the use of mailing lists over the years 2002-2011. In particular, it was important to check whether it would still be useful to apply the law to the electronic mailing list corpus. If new Internet communication systems (social networks, blogs, etc.) are imposing themselves on earlier systems, such as e-mail, a result could be a gradual decline in the concomitant use of mailing lists.

Materials and methods

The study's focus was on RedIRIS's LISTSERV (www.rediris.es/list/) mailing list server. This is Spain's academic and research network which provides advanced communications services to the nation's scientific and university community. It is funded by the Spanish Government's Ministry of Economy and Competitiveness and managed by the public business entity Red.es (www.rediris.es/rediris/), belonging to the Ministry of Industry, Energy and Tourism. LISTSERV distribution lists are tools that promote coordination and collaboration between groups of researchers with common interests by facilitating information exchange via e-mail. Every list is managed by one or more administrators who have tools at their disposal that enable them to easily adapt the list to their user group's needs. For example, administrators can set different access

policies (public lists, private lists, moderated lists, etc.), create Web files of the messages sent (with a built-in search function), allow messages to be sent through the website or publish internal newsletters.

LISTSERV mailing lists are grouped into 30 subject categories. Four of these were chosen for study. Two represented the social studies academic discipline: documentation (32 lists) and education (61 lists). The other two represented the sciences academic discipline: medicine (81 lists) and life sciences (81 lists). The reason for selecting LISTSERV mailing lists was the official nature of the source. This allowed the researchers to follow its classification, studying the lists in each category without having to make our own judgements about the membership of the category or whether a given list might belong to more than one category.

The period chosen for analysis was the 10 years from 2002 to 2011. Only lists operational or "alive" throughout that period were taken into account. This criterion reduced the initial number of lists in each category. The final numbers of lists were: documentation, 15; education, 22; medicine, 27; and life sciences, 43. We hence worked with a total of 107 lists (Tables I-IV).

First, the authors of this study subscribed to each list (the process is specified at www.rediris.es/list/uso/). Once the subscription had been accepted, each list's archives were analysed. In those archives, the posts to the lists are sorted by month (and some even by week). For each list, therefore, a 10 years × 12 months array was generated, with the content of each element being the corresponding number of posts, determined manually. As a result, the total number of posts recorded during the first quarter of 2013 in these 107 lists was 342,721. It was decided to work with the 2002-2011 decade, and exclude the year 2012 and the first quarter of 2013, to ensure non-incorporation of new posts to the lists during the investigation.

A table was generated for each subject category with its lists ordered by decreasing number of posts in the study period (2002-2011). Their temporal behaviour was studied, and Bradford's Law was applied to each category individually to check whether it satisfied the statement of the law and whether it fitted the law's graphical representation.

Table I.
Documentation category mailing lists active throughout 2002-2011

No.	Mailing list	Description
1	aha	List of the current history association
2	arxiforum	Forum on archives
3	bescolar	Coordination of school libraries
4	bib-med	Documentation in medicine and health sciences
5	cinedoc	Documentation and new technologies in Spanish cinema
6	fidel	Online sources of information and documentation
7	harte-l	Forum for art history
8	isko-es	Knowledge in information and documentation systems
9	issi	Scientometrics, informetrics and cybermetrics
10	iwetel	Forum for library and information professionals
11	medired	Sources of medical information
12	musicdoc	Documentation of music and musicology
13	recida	Network of centres for environmental information and documentation
14	reder	Network of studies and dissemination on the 1939 Republican exile
15	virtuarte	Art world forum

No.	Mailing list	Description
1	aha	List of the current history association
2	adipe-l	Interuniversity association for experimental paedagogy research
3	alfabeto	Research in reading and writing
4	cibersociedad	Newsletter of the cybersociety observatory
5	econeduc	Forum on education economics
6	eduadultos	Forum for adult education
7	edualist	Exchange of educational experiences
8	edumat	Mathematics education forum
9	eduprofe	Topics on teachers
10	edutec-l	Forum on educational technology
11	elearning	eLearning and technologies applied to education
12	equisalud	Social inequalities in health
13	etnoedu	Ethnographic research in education
14	filoninos	Philosophy for children
15	flenet	Français langue étrangère et Internet
16	formaespa	Training teachers of Spanish as a foreign language
17	harte-l	Forum for art history
18	leeme	Music education
19	logopedia	Language disorders, speech and voice
20	ocupacional	Innovation in vocational training
21	psicoeduc	Educational psychology
22	quintiliano	Studies on rhetoric

Table II.
Education category mailing lists active throughout 2002-2011

Results and discussion

First, trends in the use of the mailing lists were studied over the 10-year period (2002-2011). Figure 2 shows that all of the categories except life sciences – whose marked downward trend was to be expected, given the lack of current relevance of lists, such as vacas-l (viz., mad cow disease) – followed an upward trend, with a future prediction of a continuation in growth. This trend was especially strong in medicine.

As three of the four categories analysed showed an increasing use of the lists, with the future expectation being in the same line, and the overall trend over the 10-year period being slightly positive (Figure 3), it was therefore deemed feasible to check whether the statement and graphical representation of Bradford's Law indeed held in the field of electronic mailing lists.

Documentation

With a total of 59,959 posts, and following Bradford's stipulations in the original statement of the law, Table V is divided into three zones of productivity (23,727; 18,221; 18,011 posts), whose mailing lists are in the real ratios of 1:2:12, respectively, with a Bradford constant = 4. The "Total post" column indicates the size of each distribution list. The first core zone consists of only the most productive list: iwetel (Forum for Library and Information Professionals). This is followed by Zone 1 comprising arxiforum (Forum on Archives) and bib-med (Documentation in Medicine and Health Sciences), and Zone 2 which contains the other lists. Application of the $1{:}n{:}n^2$ law would give an estimated distribution of these electronic mailing lists of 1:4:16.

No.	Mailing list	Description
1	3erres	Alternatives to animal testing
2	arritmias	Cardiac arrhythmias course online
3	autoinmunet	Systemic autoimmune diseases
4	bib-med	Documentation in health sciences
5	calidadinv	Quality management in research
6	cardio-l	Ibero-American cardiology forum
7	celaquia	Coeliac disease forum
8	electromedicina	Technology and medical equipment
9	enfaps	Nursing and primary healthcare
10	enteogenos	Multidisciplinary study of entheogens
11	epidemiologia	Research in epidemiology, public health and clinical epidemiology
12	equisalud	Social inequalities in health
13	eusalud-l	Discussion of clinical cases based on biomedical imaging
14	evimed	Evidence-based medicine
15	farmacol	Pharmacology forum
16	fisioterapia	Hispanic physiotherapy
17	hijos-esp	Forum for parents of children with cerebral palsy
18	logopedia	Language disorders, speech and voice
19	medepor	Forum for sports medicine
20	medfam-aps	Forum for family medicine and primary healthcare
21	medired	Medical information sources
22	paleopat	Forum on human palaeopathology
23	pediap	General paediatrics forum
24	pet	Clinical and research applications of PET
25	radiofisica	Radiation physics and radiation protection
26	sordoceguera	Forum on deafblindness
27	toxicol	Multidisciplinary toxicology forum

Table III.
Medicine category mailing lists active throughout 2002-2011

Figure 4 is a plot of the cumulative posts given in the penultimate column of Table V. It shows that the resulting curve presents a rough approximation to a Bradford distribution. Contrary to what would be the case for the perfect law, however, the linear segment not only passes through the points corresponding to Zone 1 but also through many points of Zone 2. Moreover, the core lies below the line.

Education

Table VI presents the data for the 22 lists selected for the education category, again ordered in terms of decreasing productivity of posts. With 57,691 total posts, the real ratios of the three zones into which the table is divided (25,090; 16,685; 15,916 posts) are 1:3:18, respectively, with a Bradford constant = 4.5. The core zone consists of only the by far most productive list: formespa (Training Teachers of Spanish as a Foreign Language). Zone 1 comprises elearning (eLearning and Technologies Applied to Education), logopedia (Language Disorders, Speech and Voice) and filoninos (Philosophy for Children), and Zone 2 comprises the rest. Application of the $1{:}n{:}n^2$ law would give an estimated distribution of these electronic mailing lists of 1:4.5:20.25.

Figure 5 is a plot of the corresponding cumulative posting data. One observes that the curve approximates Bradford's Law, as the three lists conforming Zone 1 are in a

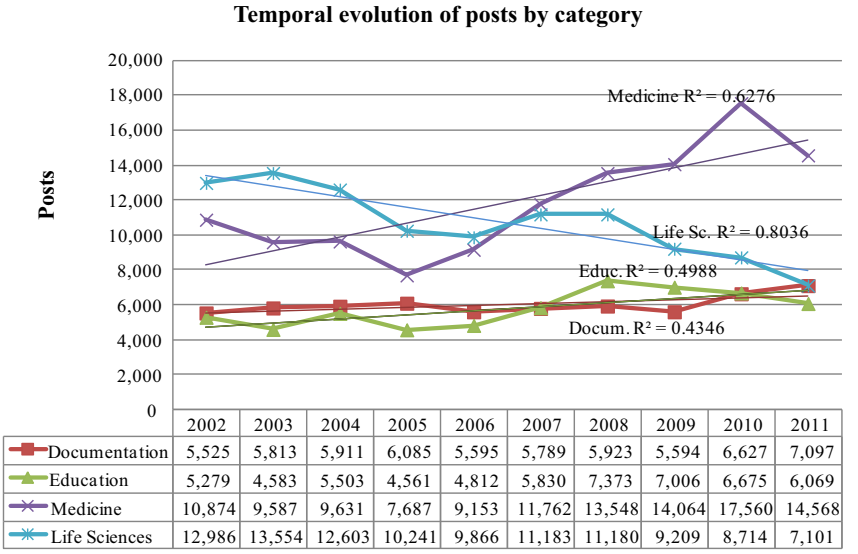
No.	Mailing list	Description
1	3erres	Alternatives to animal testing
2	agua-es	Water resources
3	aha	List of the current history association
4	ahim-l	Ibero-Macaronesian Herbaria
5	aliment	Anthropology of food and health
6	ambiental	Environmental protection and sustainable development policies
7	aquatic-l	Aquaculture forum
8	aracnologia	Arachnology forum
9	bievo	Evolutionary biology and ecology
10	biotec	Biotechnology in agriculture, environment and food
11	calidadinv	Quality management in research
12	cederul	Forum on rural development
13	cerdo-iberico	Iberian swine and their products
14	cytali	Food science and technology
15	electromedicina	Technology and medical equipment
16	enp	Protected natural areas
17	enteogenos	Multidisciplinary study of entheogens
18	entomologia	Entomology forum
19	equisalud	Social inequalities in health
20	etologia	Behaviour: ethology and evolutionary ecology
21	farmacol	Pharmacology forum
22	flora-l	Conservation of the Iberian peninsula's plant biodiversity
23	forestal	World forestry forum
24	fotogrametria	Aerial, terrestrial and near object photogrammetry
25	greg-l	Forum on general relativity and gravitation
26	habitat	Library of cities for a more sustainable future
27	iberpal	Forum for Iberian and Latin American palaeontology
28	invasoras	Invasive species of the Iberian peninsula
29	marinet	Marine environment and research forum
30	mercator	Geomatics: cartography, surveying, photogrammetry, remote sensing, GPS
31	merge	Scientific forum on geological resources of space
32	microali	Food microbiology
33	ovejas-l	Small ruminant livestock farming
34	paleopat	Forum on human palaeopathology
35	radiofisica	Radiation physics and radiation protection
36	recida	Network of centres for environmental information and documentation
37	renanet	Scientific-technical forum on natural resources
38	restauragua	Restoration of inland aquatic ecosystems
39	skolithos	Forum on trace fossils
40	soc-rural	Forum for rural studies and research
41	toxicol	Multidisciplinary toxicology forum
42	vacas-l	Dairy and beef cattle production
43	zonanosaturada	Research and technological development for the study of the Vadose zone

Table IV.
Life sciences category mailing lists active throughout 2002-2011

straight line. Contrary to what would be the case for the perfect law, however, the core lies just below this line.

Medicine

Table VII presents the data for the 27 lists selected for the medicine category, again ordered in terms of decreasing productivity of posts. With 118,434 total posts, the real ratios of the



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Documentation	5,525	5,813	5,911	6,085	5,595	5,789	5,923	5,594	6,627	7,097
Education	5,279	4,583	5,503	4,561	4,812	5,830	7,373	7,006	6,675	6,069
Medicine	10,874	9,587	9,631	7,687	9,153	11,762	13,548	14,064	17,560	14,568
Life Sciences	12,986	13,554	12,603	10,241	9,866	11,183	11,180	9,209	8,714	7,101

Figure 2.
Trends in the use of electronic mailing lists in the 10-year period (2002-2011)

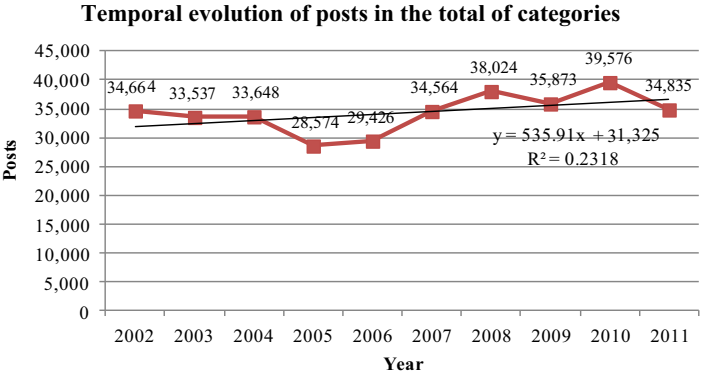


Figure 3.
Trend in the overall use of electronic mailing lists for the four categories

three zones into which the table is divided (36,764; 45,033; 36,637 posts) are 1:3:23, respectively, with a Bradford constant = 5.33. The core zone consists of only medfam-aps (Forum for Family Medicine and Primary Health Care). Zone 1 comprises pediap (General Pædiatrics Forum), celaquia (Cœliac Disease Forum) and arritmias (Cardiac Arrhythmias Course Online), and Zone 2 comprises the rest. Application of the $1{:}n{:}n^2$ law would give an estimated distribution of these electronic mailing lists of 1:5.33:28.44.

Figure 6 is a plot of the corresponding cumulative posting data. One observes that the curve perfectly approximates Bradford's Law, as it consists of an initial and a final curved segment and an intermediate straight line segment.

Life sciences

Table VIII presents the data for the 43 lists selected for the life sciences category, again ordered in terms of decreasing productivity of posts. With 106,637 total posts,

Documentation	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total posts	Cumulative posts	Zones
1													
iwetel	1,825	2,243	2,172	2,765	1,926	2,090	2,066	2,222	3,204	3,214	23,727	23,727	Core
2													
arxiforum	1,005	1,239	1,391	1,269	1,422	1,212	1,319	1,382	1,364	1,546	13,149	36,876	Zone 1
bib-med	829	679	619	466	401	379	393	436	435	435	5,072	41,948	
12													
fidel	445	384	390	344	432	413	421	304	331	424	3,888	45,836	Zone 2
recida	56	72	67	54	187	370	393	421	474	449	2,543	48,379	
bescolar	114	55	127	250	352	394	317	180	199	258	2,246	50,625	
aha	95	144	299	314	227	269	242	190	171	193	2,144	52,769	
reder		227	197	179	158	142	132	65	64	56	1,589	54,358	
harte-l	190	113	119	73	125	101	336	144	123	122	1,446	55,804	
isko-es	152	158	155	120	136	148	117	100	124	169	1,379	57,183	
medired	167	155	144	72	41	24	39	47	25	84	798	57,981	
issi	53	124	93	66	69	83	70	83	72	74	787	58,768	
virtuarte	205	83	41	35	48	26	11	3	19	43	514	59,282	
musicdoc	12	108	70	74	65	54	31	12	22	26	474	59,756	
cinedoc	8	29	27	4	6	84	36	5	0	4	203	59,959	

Table V.
Documentation category's zones of mailing list productivity

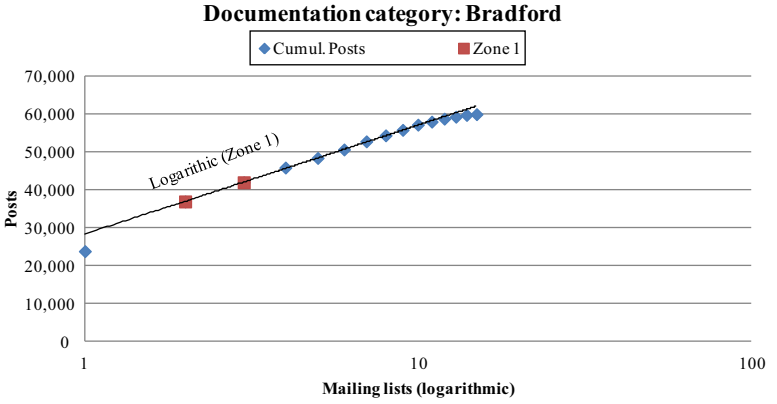


Figure 4.
Semi-log Bradford plot of the electronic mailing list distribution for the documentation category

the real ratios of the three zones into which the table is divided (33,921; 36,722; 35,994 posts) are 2:6:35, respectively, with a Bradford constant = 4.42. The core zone comprises two lists, cytali (Food Science and Technology) and entomologia (Entomology Forum). Zone 1 comprises six lists and Zone 2 the rest. Application of the $1{:}n{:}n^2$ law would give an estimated distribution of these electronic mailing lists of 2:8.83:39.01.

Figure 7 is a plot of the corresponding cumulative posting data. One observes that the curve is an almost perfect approximation to Bradford's Law.

This analysis of the four categories shows that those representing the sciences (medicine and life sciences) fit a Bradford distribution better than those representing the social studies (documentation and education).

Documentation	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total posts	Cumulative posts	Zones
1													
formespa	497	485	742	1,080	2,071	3,299	4,551	4,829	3,945	3,591	25,090	25,090	Core
3													
elearning	318	474	1,328	1,163	630	787	569	581	1,265	1,070	8,185	33,275	Zone 1
logopedia	708	1,022	698	500	500	411	503	448	269	135	5,194	38,469	
filoninos	369	232	209	306	412	304	450	358	224	442	3,306	41,775	
18													
aha	95	144	299	314	227	269	242	190	171	193	2,144	43,919	Zone 2
flenet	213	223	260	192	181	152	167	111	243	126	1,868	45,787	
edulist	559	358	536	171	60	68	37	16	18	9	1,832	47,619	
edutec-l	449	328	201	106	91	54	75	44	70	40	1,458	49,077	
harte-l	190	113	119	73	125	101	336	144	123	122	1,446	50,523	
leeme	394	295	257	111	109	53	76	38	36	29	1,398	51,921	
aidipe-l	136	81	121	125	127	81	146	112	132	201	1,262	53,183	
edumat	293	120	152	86	79	65	42	19	54	22	932	54,115	
eduadultos	236	158	156	122	54	32	29	14	21	14	836	54,951	
psicoeduc	267	199	159	53	26	13	16	6	1	2	742	55,693	
eduprofe	160	96	77	52	39	53	37	19	37	24	594	56,287	
equisalud	86	58	26	29	20	37	45	21	40	31	393	56,680	
ocupacional	171	78	52	14	9	5	3	4	4	0	340	57,020	
alfabeto	55	43	16	33	17	16	28	28	15	10	261	57,281	
econeduc	27	38	20	8	13	12	8	4	2	4	136	57,417	
etnoedu	39	12	20	2	9	14	2	4	3	1	106	57,523	
quintiliano	3	19	47	14	2	0	6	6	2	0	99	57,622	
cibersociedad	14	7	8	7	11	4	5	10	0	3	69	57,691	

Table VI.
Education category's zones of mailing list productivity

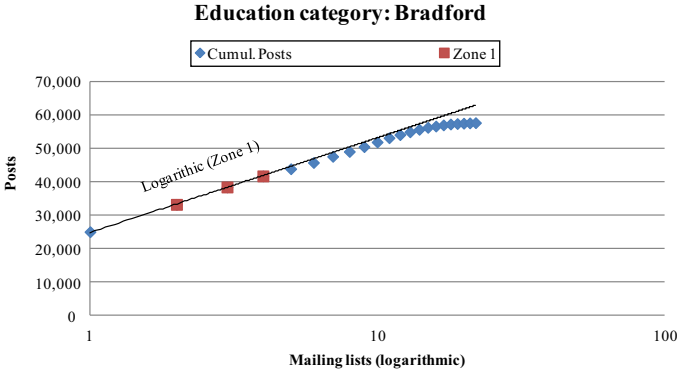


Figure 5.
Semi-log Bradford plot of the electronic mailing list distribution for the education category

These results confirm the theory that Bradford's Law holds in cybermetrics only if one is working with environments that are well-defined (Faba-Pérez *et al.*, 2004). This may be because all of these two categories' lists are specific to the scientific field to which the category refers. The social studies categories, however, include lists that are not specific to the category, reflecting its multidisciplinary nature. However, in this research, the authors worked with only two categories of each discipline, which is a limitation. Therefore, in future research, it would be good to

Documentation	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total posts	Cumulative posts	Zones
1													
medfam-aps	1,407	1,450	1,823	1,720	1,932	3,942	4,868	5,323	7,943	6,356	36,764	36,764	Core
3													
pediap	826	1,122	1,060	734	1,193	1,450	2,251	2,960	2,622	3,207	17,425	54,189	Zone 1
celiaquia	1,768	1,813	2,144	1,579	2,159	2,544	1,033	584	446	552	14,622	68,811	
arritmias	582	476	245	187	304	789	1,611	2,012	4,263	2,517	12,986	81,797	
23													
bib-med	829	679	619	466	401	379	393	436	435	435	5,072	86,869	Zone 2
sordoceguera	792	1,093	1096	744	396	199	312	168	95	125	5,020	91,889	
hijos-esp	859	491	395	393	775	606	702	310	214	46	4,791	96,680	
enteogenos	47	30	18	46	227	442	1,023	1,113	306	256	3,508	100,188	
radiofisica	419	246	344	226	225	184	293	248	96	218	2,499	102,687	
electromedicina	83	250	274	286	191	275	203	94	133	73	1,862	104,549	
toxicol	275	199	212	206	217	126	187	129	115	85	1,751	106,300	
cardio-l	286	347	209	175	124	88	101	128	84	57	1,599	107,899	
3erres	219	172	126	150	158	79	117	126	74	43	1,264	109,163	
fisioterapia	574	128	123	60	36	22	18	74	119	33	1,187	110,350	
pet	357	121	184	157	130	80	63	41	13	2	1,148	111,498	
paleopat	35	54	79	87	98	141	58	64	136	207	959	112,457	
epidemiologia	557	117	19	9	9	6	12	23	158	47	957	113,414	
medired	167	155	144	72	41	24	39	47	25	84	798	114,212	
evimed	130	78	70	54	55	93	48	18	123	85	754	114,966	
medepor	41	55	83	68	94	84	66	57	87	61	696	115,662	
enfaps	160	104	64	49	42	36	36	30	3	3	527	116,189	
autoimmunet	90	64	75	78	82	74	25	21	7	4	520	116,709	
eusalud-l	70	106	100	14	152	13	7	1	1	4	468	117,177	
farmacol	161	105	41	35	29	18	12	13	9	25	448	117,625	
equisalud	86	58	26	29	20	37	45	21	40	31	393	118,018	
logopedia	20	49	51	58	57	22	24	23	9	6	319	118,337	
calidadinv	34	25	7	5	6	9	1	0	4	6	97	118,434	

Table VII.
Medicine category's zones of mailing list productivity

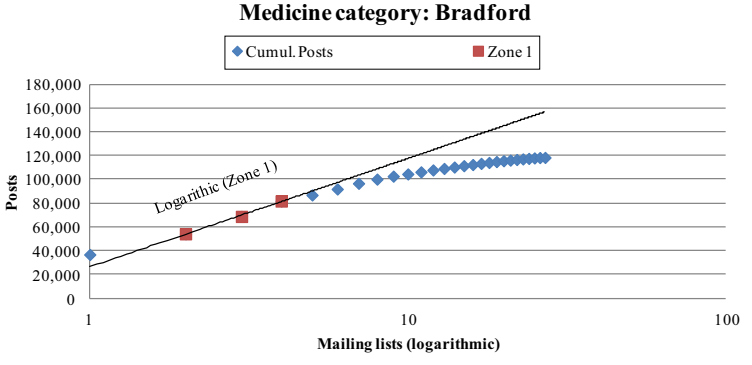


Figure 6.
Semi-log Bradford plot of the electronic mailing list distribution for the medicine category

Documentation	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total posts	Cumulative posts	Zones
2													
cytali	2,190	3,678	2,562	2,136	2,212	2,051	2,139	1,259	1,226	1,086	20,539	20,539	Core
entomologia	2,486	1,744	1,597	877	1,150	1,529	1,331	794	1,052	822	13,382	33,921	
6													
biotec	551	753	1,461	544	618	1,134	1,063	1,161	1,535	669	9,489	43,410	Zone 1
marinet	636	881	1,231	1,157	630	666	538	567	814	832	7,952	51,362	
microali	897	1,056	713	714	787	703	1,031	755	534	587	7,777	59,139	
aracnologia	400	602	502	394	146	843	353	572	760	435	5,007	64,146	
enteogenos	47	30	18	46	227	442	1,023	1,113	306	256	3,508	67,654	
vacas-l	848	584	493	315	215	169	209	72	62	22	2,989	70,643	
35													
recida	56	72	67	54	187	370	393	421	474	449	2,543	73,186	Zone 2
radiofisica	419	246	344	226	225	184	293	248	96	218	2,499	75,685	
mercator	480	328	222	234	184	112	140	255	205	141	2,301	77,986	
aha	95	144	299	314	227	269	242	190	171	193	2,144	80,130	
electromedicina	83	250	274	286	191	255	203	94	133	73	1,842	81,972	
ovejas-l	291	411	284	173	166	198	89	83	97	45	1,837	83,809	
toxicol	275	199	212	206	217	126	187	129	115	85	1,751	85,560	
skolithos	291	277	252	194	164	84	109	89	79	67	1,606	87,166	
enp	141	182	159	116	125	129	111	230	152	144	1,489	88,655	
forestal	234	134	76	165	315	307	116	30	50	32	1,459	90,114	
renanet	67	56	51	221	370	463	170	14	16	20	1,448	91,562	
3erres	219	172	126	150	158	79	117	126	74	43	1,264	92,826	
ambiental	346	185	229	241	187	0	5	3	2	3	1,201	94,027	
agua-es	434	319	166	152	83	1	6	2	10	11	1,184	95,211	
bioevo	50	45	48	126	104	91	402	161	51	60	1,138	96,349	
paleopat	35	54	79	87	98	141	58	64	136	207	959	97,308	
flora-l	24	74	73	73	100	120	123	133	82	83	885	98,193	
iberpal	110	84	118	106	93	82	83	82	61	25	844	99,037	
aquatic-l	97	70	148	255	44	54	72	34	15	4	793	99,830	
restauragua	49	26	32	78	98	120	80	135	71	67	756	100,586	
habitat	77	67	101	84	71	40	90	77	61	82	750	101,336	
ahim-l	59	84	104	62	99	90	103	121	0	0	722	102,058	
greg-l	36	46	71	84	75	86	80	49	25	38	590	102,648	
invasoras	60	45	70	29	42	18	37	3	88	126	518	103,166	
soc-rural	52	40	36	39	56	68	66	54	35	45	491	103,657	
etologia	95	84	75	89	41	22	13	21	11	9	460	104,117	
farmacol	161	105	41	35	29	18	12	13	9	25	448	104,565	
cerdo-iberico	161	70	41	36	15	31	10	8	28	16	416	104,981	
equisalud	86	58	26	29	20	37	45	21	40	31	393	105,374	
fotogrametria	88	97	57	37	28	17	11	9	15	5	364	105,738	
cederul	76	79	63	37	17	2	2	1	1	2	280	106,018	
zonanosaturada	28	57	38	22	24	19	22	11	11	23	255	106,273	
aliment	57	16	32	11	7	2	1	0	2	8	136	106,409	
merge	65	25	5	2	15	2	1	5	5	6	131	106,540	
calidadinv	34	25	7	5	6	9	1	0	4	6	97	106,637	

Table VIII.
Life sciences category's zones of mailing list productivity

expand the subject categories in both disciplines and even add categories of human sciences to study their behaviour as well.

Conclusions

There has been much discussion about the influence that the new communication systems (social networking, instant messaging, blogs, etc.) may have had on the decline in the use of e-mail and, by analogy, on the use of electronic mailing lists. According to the Nielsen Company (www.nielsen.com) data (Márquez Espino, 2010), the time spent on e-mail dropped by 28 per cent in 2010 relative to the previous year. However, the present work has shown that e-mail posts to electronic mailing lists of the documentation, education and medicine categories underwent growth over the 10-year period of 2002-2011 and have a solid future prediction in this line. The life sciences category was an exception to this trend. The indication is, therefore, that the use of e-mail continues to be a widespread form of communication on the Internet.

The results have shown that each of the four categories selected (documentation, education, medicine and life sciences) fits both the verbal statement of the law of scattering of the scientific literature as originally enunciated by Bradford and its graphical representation. For the 10-year period studied, in all cases, the authors found patterns of ratios for the core, Zone 1 and Zone 2 that were similar to the Law's expected $1{:}n{:}n^2$ ratios. Also, all the plots of the posting distributions followed, to a greater or lesser extent, the shape of a Bradford distribution.

In detail, the Bradford's Law plots showed that the fit was better for the science categories than for those of social studies. In particular, the life sciences category and, above all, the medicine category matched especially well the typical Bradford distribution plot. This may be because all of these two categories' lists are specific to the scientific field to which the category refers. They are well-defined and homogeneous areas, characteristics that would make them likely to fit a Bradford distribution better (Brookes, 1969). The social studies categories (documentation and education), however, include lists that are not specific to the category. Examples are aha (List of the Current History Association), which is present in both the documentation and the education categories, or virtuarte (Art World Forum) in the documentation category. Indeed, it is precisely this last category (documentation) which fits the Bradford distribution least well, reflecting its multidisciplinary nature.

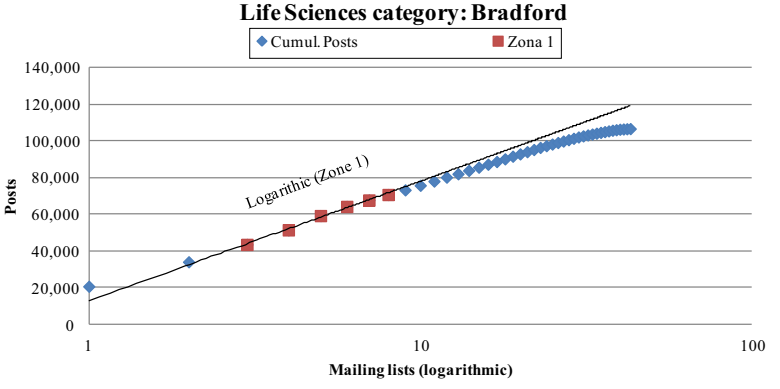


Figure 7.
Semi-log Bradford plot of the electronic mailing list distribution for the life sciences category

The results show that it is possible to apply Bradford's Law in the case of academic electronic mailing lists and, therefore, it is possible to discriminate the core most productive lists in each subject category. The identification of this core allows professionals and researchers to subscribe and participate only in the most important lists of their discipline. This reduces the time to search and query other lists and, therefore, facilitates the productive management of time. Also, the distribution lists are essential to identify professional and research lines of scientific areas, because messages sent to the lists reflect the interests of its participants over time. Therefore, it is recommended that librarians know the core distribution lists in each subject category to take this variable into account when forming the library collection. This variable is the needs of the participants of the lists.

These conclusions support the hypothesis stated towards the end of the introduction. One can say, therefore, that Bradford's Law holds in the case of electronic mailing lists, as these are closed and homogeneous environments, and the more uniform the environment, the more likely it is to hold. Some 10 years ago, Faba-Pérez *et al.* (2004) conducted a cybermetric research study analysing a broad, heterogeneous Web environment. They found exponential distributions that in no way matched Bradford's Law. The present results would seem to lend support to the continuing usefulness of electronic mailing lists and confirms the fact that Bradford's Law holds in cybermetrics only if one is working with environments that are well-defined and not too broad.

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