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CORRELATION BETWEEN GROWTH OF PUBLICATIONS AND CITATIONS : A STUDY BASED ON GROWTH CURVES

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The relative growth rate (RGR) and doubling time (Dt) for publications and citations appeared in Indian library and information Science journals during 1975 to 1985 were determined. The reducing trend of RGR and increasing rate of Dt in both--publications and citations indicates that the growth is neither exponential nor linear. The size of the literature were calculated by applying logistic growth formula. Literature on different subjects follows the similar type of growth trend within equal economic, intellectual and environmental conditions and with the increase of number of publications, the number of citations will also increase.

INTRODUCTION

Growth of publications and citations is a common feature among different branches of knowledge. The changes in the size of literature over a specific period may be termed as growth of literature. Many studies have been made on the growth of literature. Price (1963) [5] for the first time popularised the idea of exponential knowledge growth in scientific literature and derived the rate of growth as 5 percent over the past two centuries, corresponding to a doubling time of 15 years. But this nature of growth was not accepted by the later investigators. Tegue et. al (1981) [6] did a critical analysis of law of exponential growth and put forth that if there are some limitations such as, intellectual, physical or economic on the size of the literature, then logistic growth may be more appropriate. In fact, most of the times, growth of literature is governed by these factors. It was also noticed that in case of first-rate literature, the growth function was linear. Mahapatra [2] measured the relative growth of botanical literature and found modified exponential growth specially Gompertz curve for Indian botanical literature. Few studies conducted on the growth of library and information science literature derived the amount of literature existing at a specific interval of time. The present work differs from the others; here, not only the nature of growth of literature has been derived, but also an attempt is made to show the similarities between the growth of publications and citations.

COLLECTION OF BASIC DATA

Commonly the growth studies are based on secondary sources of information i.e. abstracts. But, in Indian library and information science literature, most of the journals are delayed publications, and therefore, are not covered in the abstracting services in time. Due to this, data have directly been collected from the primary sources i.e. the journals themselves comprising of *Indian Journal of Agricultural Library and Information Science, Annals of Library Science and Documentation, Herald of Library Science, IASLIC Bulletin, ILA Bulletin, Journal of Library and Information Science, Libra, Library Herald and Library Science with a slant to Documentation and Information Studies.*

The first Indian journal on library and information science titled Library Miscellany was published in the year 1912. After 1947, quite a number of journals were added. By 1980s [3], India occupied a remarkable position among the countries producing library and information science journals. But, simultaneously, there was also a high rate of mortality of the journals. Few journals could sustain themselves and few could continue publications almost without a break. The journals that are selected for this analysis were having publications throughout 1975 to 1985 without any break. During the period of study 1456 articles were published in the journals which contained 9182 citations. The individual issues of the journals published

during 1975 to 1985 were scaned and the total number of articles appeared and the total number of citations provided against each article in the journals were recorded year-wise.

TYPE OF GROWTH CURVES

To make analysis of the nature of growth of both articles and citations, three types of growth curves - exponential, linear and logistic were tested. The exponential growth is defined mathematically by an exponential function and represented as, $F(t) = ae^{bt}$ [5]. The *logistic curve* has a lower limit (usually O) and an upper limit or ceiling beyond which the size can not grow and can be represented mathematically as,

$$U_t = \frac{K}{1 + \mu \cdot} \qquad [1]$$

In case of first rate literature, it is reported that the increase is not exponential but the growth function is linear [6]. The linear growth curve is represented mathematically as, $U_e = a + bt$ [1]. Besides these growth curves, Relative Growth Rate (RGR) and Doubling time (Dt) which are related to growth study had been applied in this study.

The RGR is defined as the increase in number of articles/pages per unit of time [2]. The mean relative growth rate of articles over the specific period of interval is calculated mathematically as,

$$\bar{R}\ (P) = \frac{Loge^{2^P} - Loge^{1^P}}{2^P - 1^P}$$

Here $\bar{R}$ (P) = relative growth rate of articles over the specific period of time.

$Loge^{1^P}$ = Log of initial number of articles

$Loge^{2^P}$ = Log of final number of articles

Similarly, the RGR for citations is the increase in number of citations per unit of time. The mean relative growth rate of citations [$\bar{R}$ (C)] over the specific period of interval is calculated mathematically as,

$$\bar{R}\ (C) = \frac{Loge^{2^C} - Loge^{1^C}}{2^C - 1^C}$$

Here $\bar{R}$ (C) = mean relative growth rate of citations over specific period of time

$Loge^{1^C}$ = Log of initial number of citations.

$Loge^{2^C}$ = Log of final number of citations.

Doubling time (Dt) is directly related to relative growth rate (RGR) and is defined as the time required for the articles/citations to become double of the existing amount. It is also determined that if the number of article in a subject doubles during a given period then the difference between the logarithms of numbers at the beginning and at the end of this period must be the logarithm of the number 2 [2]. If Napier Logarithm is used the value of $Loge^2$ is 0.693. Therefore, once the average growth rate is calculated then it becomes a question as to, by what time interval do the Napier Logarithm of numbers increases by 0.693? Thus, the corresponding doubling time (Dt) was calculated as follows:

$$Dt\ (P) = \frac{Loge^2}{\bar{R}(p)} = \frac{0.693}{\bar{R}(p)}$$

$$Dt\ (C) = \frac{Loge^2}{\bar{R}(C)} = \frac{0.693}{\bar{R}(C)}$$

Here, Dt (P) and Dt (C) are the average doubling time of articles and citations respectively.

RESULTS OF THE STUDY

The Relative Growth Rates (RGR) were calculated for both-publications and citations separately. The Doubling Time (Dt) against each year of study was also determined. The values of RGR and Dt for publications are represented in Table 1 and the values of citations are shown in Table 2.

It can be seen in Table1 that the value of average relative growth rate of articles [$\bar{R}$ (P)] decreased gradually from 0.79 to 0.1 in 1983 and again increased to 0.13 in 1985.

Table 1

RGR and Dt for publications in library and information science journals during 1975 to 1985.

Year	No. of articles	Cumulative no.	Log_e^{1P}	Log_e^{2P}	$\bar{R}$ (P)	* Mean $\bar{R}$ (P)	Dt (P)	Mean Dt (P)
1975	99	99	-	4.60	-		-	
1976	121	220	4.60	5.39	0.79		0.88	
1977	123	343	5.39	5.84	0.45		1.54	
1978	148	491	5.84	6.20	0.36	0.40	1.93	2.19
1979	125	616	6.20	6.42	0.22		3.15	
1980	132	748	6.42	6.62	0.2		3.47	
1981	132	880	6.62	6.78	0.16		4.33	
1982	147	1027	6.78	6.93	0.15		4.62	
1983	101	1128	6.93	7.03	0.10	0.13	6.93	5.40
1984	147	1275	7.03	7.15	0.12		5.78	
1985	181	1456	7.15	7.28	0.13		5.33	

*R (P) represents RGR for publications.

Similarly, in case of citations (Table 2) the value of average relative growth rate of citations [$\bar{R}$ (C)] decreased from 0.95 in 1976 to 0.15 in 1981 and increased to 0.16 in 1982 and remained constant in 1983. In 1984, the value of $\bar{R}$ (C) was decreased to 0.15 and remained constant for 1985. The values of doubling time of publications [Dt (P)] increased from 0.88 in 1976 to 6.93 in 1983 and reduced to 5.33 in 1985. In citations the corresponding values of doubling time of citations [Dt (C)] increased from 0.73 in 1976 to 4.62 in 1981 and decreased in 1982 to 4.33. In 1984 and 1985, it remained constant (4.62) which is more than the earlier years. The mean relative growth [$\bar{R}$ (P)] for the first five years (i.e. 1976 to 1980) showed a growth rate of 0.40 whereas for the last five years (i.e. 1981 to 1985) it was reduced to 0.13.

Table 2

RGR and Dt for citations in library and information science journals during 1975 to 1985

Year	No. of citations	Cumulative no.	Log_e^{1C}	Log_e^{2C}	Mean $\bar{R}$ (C)	*$\bar{R}$ (C)	Dt (C)	Mean Dt (C)
1975	437	437	-	6.08	-		-	
1976	693	1130	6.08	7.03	0.95		0.73	
1977	648	1778	7.03	7.48	0.45		1.54	
1978	836	2614	7.48	7.87	0.39	0.46	1.78	1.95
1979	776	3390	7.87	8.13	0.26		2.67	
1980	879	4269	8.13	8.36	0.23		3.01	
1981	691	4960	8.36	8.51	0.15		4.62	
1982	853	5813	8.51	8.67	0.16		4.33	
1983	1006	6819	8.67	8.83	0.16	0.15	4.33	4.50
1984	1105	7924	8.83	8.98	0.15		4.62	
1985	1258	9182	8.98	9.13	0.15		4.62	

R (C) represents RGR for citations.

The corresponding mean doubling time [Dt (P)] for the period increased from 2.19 to 5.40. In case of citations also the mean relative growth rate [$\bar{R}$ (C)] was 0.46 in the first five years (1976 to 1980) and was reduced to 0.15 in the last five years i.e. during 1981 to 1985. The corresponding doubling time [Dt (C)] for 1976 to 1980 was 1.95 and was increased to 4.50 during 1981 to 1985.

The values of RGR and Dt sufficiently indicated that the logistic growth curve would be more appropriate. To find out the specific trend of growth, the logistic growth equation was applied and expected values were plotted on the graph.

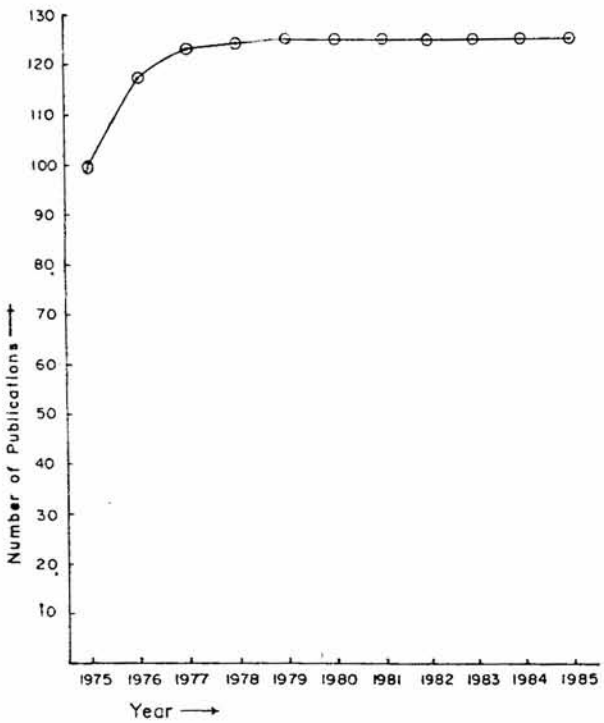

Fig.1 Logistic pattern of growth of publications

It was noticed that the number of publications has reached nearer to the upper limit where the saturation of growth of publications would be gained.

The growth of citations also had a gradual reduction in the RGR and simultaneous increase of Dt.

To get the specific trend of growth of citations, the equation for logistic growth was applied and the expected values were plotted on a graph (Fig. 2). It was also noticed that the nature of growth would likely to follow logistic growth pattern.

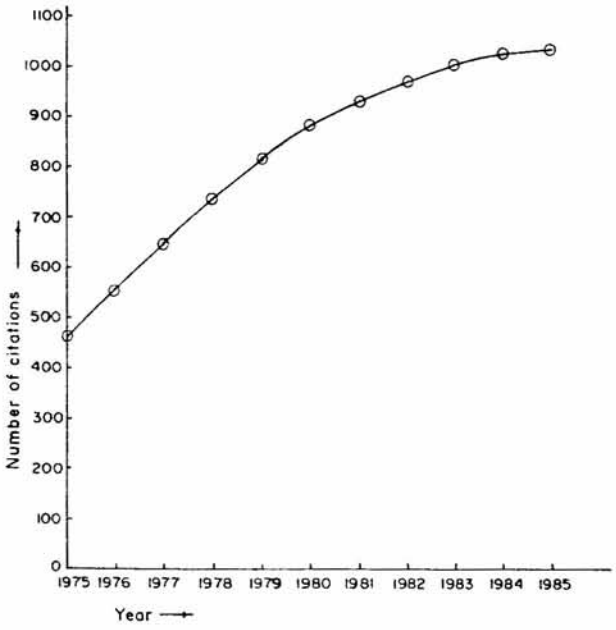

Fig.2 Logistic pattern of growth of citations

CONCLUSION

The equal rate of RGR and Dt for both publications and citations sufficiently indicates that probably with the increase of number of publications, the number of citations will also increase. Therefore, citations may be used as a yardstick to study the nature of growth of literature in a subject. The average RGR value of Indian plant physiology literature during 1980 was 0.12 and corresponding Dt value was about 5/1/2 years [2]. The average RGR value of Indian earth science literature during 1988 was 0.11 with the corresponding Dt of 7 years [4]. The average RGR value of Indian library and information science literature during 1985 was 0.13 with corresponding Dt of about 5 years. This result indicates that within equal economic, intellectual and environmental conditions, literature on different subjects perhaps follows the similar type of growth trends.

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