Evaluating the Productivity of Research Publications in Distance Education : An Application of Anova Model

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Abstract : *The present study investigates growth and complexity of research publications from 1972 to 1996. Through this study the author attempts to evaluate the status of the various geographic regions in promoting distance education activities by means of their publication data. The study found the highest level of publication in the last ten years. Environmental factors influenced the growth of publication. Besides traditional research,the topics such as information technology, on-line delivery, R&D work etc., got priority in publication. The author proposes for collaborative research studies by open/distance education institutions in the country.*

Introduction

Appraisal and assessment of research performance is of fundamental concern to the formulation of research politics of any nation. Though a large number of parameters have been identified for the purpose of evaluation, only the bibliometric indicators have been applied widely among the R&D centers, academic institutions, and government sectors. Evaluation based on the publication outputs is considered as the most reliable criteria, because producing research papers are not a random event, but are the cumulative effect of the socio-economic forces, financial support, manpower resources, sponsoring agencies etc. Thus, the publication profile of a country is used as an indicator to reflect the research priorities of the country, apart from using it as a yardstick to measure the growth, pattern and trend of research areas of that country. The present study attempts to evaluate the status of the various geographic regions in promoting the DE activities by means of their publication data. Though the concept DE is of recent origin, it has aroused greater enthusiasm in large part of the global communities, which is evidenced from the quantum of publications invited by this discipline in the last twenty five years. A quantitative analysis of these publications would exhibit not only the range of research problems being addressed by the individual regions, but also the social relevance of these problems at the local and global context. Moreover, a critical evaluation of the publications would reflect the relative position of the geographical

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regions in their research performance on one hand, and the research areas that have attracted wider attention on the other. The results of such evaluation are of vital importance to the policy makers and the administrators both in assessing the status of the research activities and in formulating the strategic planning and decision making for future activities.

Statement of the Problem

A cursory glance at the bibliographic data on DE in the last 25 years has brought to light the overwhelming response from majority of the countries in producing publication on this subject. Unless some evaluation mechanism is evolved to monitor the research efforts of the past, it would be difficult to lead research on the right direction. This situation calls for a periodical assessment of the publications that would provide (i) the depth and dimension of research that have been conducted, (ii) thrust areas of research, (iii) priorities of research efforts, (iv) research gaps, (v) existing trend in research, and (vi) future requirements. A consolidation of these information would provide ample opportunities for the funding agencies and the R&D units to mobilize their resources in building up research on vital areas. The present study attempts to assess the growth, the pattern of development and the complexity of research in the different thematic groups of DE from 1972 to 1996.

Objectives

The objectives of this study were: (i) to assess the composition, growth and development of research publications in the sub-fields (thematic groups) of DE over the time span of 25 years in the world continents, (ii) to examine the variations in the quantum of publications in different regions and the research fields, (iii) to identify the fields that have brought in variations between the regions, (iv) to find out the regions that have similar research profiles, and (v) to measure the pattern of research performance of the regions and to compute the shifts in the research priorities during the different period of time.

Methodology

The data for the present study were collected for 25 years during 1972-96 by downloading the records related to the various dimensions of DE for the entire regions. The research output records have been classified into sixteen homogeneous subjects. The exponential growth model is applied to capture the changes in the publications during different period of time. The variations in the distribution of publications both within the geographical regions and the thematic groups have been identified by the application of the ANOVA model (Iverson and Norpoth, 1987). The Critical Difference technique is used to compute the mean differences between the continents and the subjects. The Relative Priority Index (Nagpaul and Pant, 1994) is adopted to compare the publication output of different research fields within a continent or that of different continents for a given research field.

Table 1 : Productivity of publications on distance education

S. No.	Thematic Groupings	Continents					Total	Mean S.D.	C.V	%
		Africa	America	Asia	Europe	Oceania				
1.	Planning Policy, course design, etc	68	318	277	647	271	1581	316.2	208.9	66.08
2.	Areas of education	50	241	213	524	196	1224	244.8	172.7	70.55
3.	Community based education	19	93	48	163	66	389	77.8	54.7	70.33
4.	Curriculum Development	11	88	44	122	84	349	69.8	42.9	61.54
5.	Staff Development	2	25	32	46	33	138	27.6	16.2	58.68
6.	Quality of Education	20	92	90	202	149	553	110.6	68.5	70.00
7.	Learner Support	24	226	151	490	194	1085	217.0	170.8	78.73
8.	Impact of DE	3	7	3	5	2	20	4.0	2.0	50.00
9.	Performance Evaluation	22	128	151	178	52	531	106.2	66.5	62.57
10.	Research paradigm	55	68	73	72	42	310	62.0	13.3	21.43
11.	Computer Aided Instruction	4	37	7	78	38	164	32.8	29.9	91.24
12.	On line Delivery Mechanism	28	544	177	624	262	1635	327.0	250.7	76.67
13.	Collaboration & Networking	11	72	25	92	21	221	44.2	35.6	80.52
14.	Virtual Campus	0	10	5	14	3	32	6.4	5.6	87.42
15.	Internet Based Education	1	10	5	1	1	18	3.6	3.9	110.41
16.	Multimedia Based Education	0	2	4	3	0	9	1.8	1.8	99.38
	Total	**31**	**83**	**1961**	**1305**	**3261**	**1414**	**8259**		
	Mean	19.88	122.56	81.56	203.81	88.39	523.1			
	S.D	21.14	145.87	86.42	230.08	984.60	557.4			
	C.V.	106.34	119.02	106.96	112.89	106.91	106.6			

Productivity of Publications on Distance Education

The productivity of publications on the various dimensions of DE during the last 25 years has been analyzed and presented in Table 1. It has revealed both the percentage contribution of the individual geographic regions (continents) to the total productivity and the percentage share of publications received by the individual thematic groups (fields) in DE. The continent-wise analysis of the publications shows that Europe is the largest producer of publications on DE and it accounted for 39.5 per cent in the total productivity. The next largest contribution is made by America and its share amounts to 23.74 per cent. Both Asia and Oceania have contributed almost equally and their share of publications are 15.8 per cent and 17.13 per cent respectively. The contribution of Africa is found to be the least at 3.85 per cent. The variations in the distribution of publications between the continents is quite high and it is confirmed from the values of the co-efficient Variation which represent 106.6 per cent.

Field-wise analysis has shown that only a few fields like the On-line Delivery Mechanisms, Planning Policy, Areas of Education and Learner Support have attracted about 66.9 per cent of the world publications, while the fields like the impact of DE. Virtual Campus, Internet – based Education and Multimedia based Education have received only 0.68 per cent of the total publication productivity. Among the rest of the fields, the highest share of publications are found in Quality Education, Performance Evaluation, Community based Education, and Curriculum Development. The field-wise analysis has shown that the distribution of the publications among the different fields are skewed, but the degree fo skewness varies across fields and it ranges from 21.43 per cent to 110.41 per cent.

Trends in the Distribution of Publication in Different Geographical Regions and Thematic Groups During 1972-1996

In order to identify the changes in the productivity of the publications and to analyze the factors attributed to the changes in their productivity over a period of time, the trend analysis is applied and the results are presented in Tables 2 to 6. It is computed by applying the linear-regression function, and the results are fitted into the equation : $Y = 1 + bt$, where, 'a' is the intercept, 'b' is the slope of the curve at the origin and 't' is the time. The trend analysis has been carried out for two different environments viz: the continents and the thematic groupings. The growth rate of the publication is calculated by applying the exponential growth model: Y 1 + bt, and it is calculated by taking log on both sides. The Growth Rate is estimated by adopting the following procedures : (i) the coefficient of determination is computed by adopting the equation Log Y = 1+bt, where t = 0, 1 ..... t years, (ii) then [(antilog of b) – 1] X 100 iz computed to get the average rate of growth of the variables under consideration.

Publications Trend in the Various Geographic Regions During : 1972 -1996

The trend in the distribution of publications across different geographical regions has been calculated and presented in Table 2 and 3. Though a negative trend is noticed in the initial period, the rest of the periods have witnessed a rising trend of publication. The region-wise analysis have indicated that, the trend values are found to be higher for

Europe, which has increased from 311.7 to 1326.6 during the last 20 years. On the contrary, the trend values are found to be lower for Africa and it has seen a gradual increase from 25.5 to 139.8 publications in the last two decades. The disparities noticed between these two regions can be attributed to the fact that, Europe being the forerunner in the establishment of DE, has widened its research activities and hence it has received a large number of publications, while Africa the latecomer in this venture has yet to build a strong research base and hence it has received only a limited number of publications. America ranks next to Europe in its publication trend, while Asia and Oceania have similar trend of publications right from the initial period. A period-wise analysis has revealed that a break through in the publication trend, is seen in the third period (1982-86), thereafter, the trend in publication has moved at a great speed and reached its peak in the fifth period. The percentage analysis also has shown that significant changes in the publication trend have happened only in the last two periods. It is observed that more than 82 per cent of the total research publications have been published only during the last two periods (1987-96). In the same manner, the individual regions have seen a greater productivity of publications only in the last two periods. For instance 81 per cent of the publications from Africa, 85.2 per cent from America, 91.1 per cent from Asia, 75.8 per cent from Europe and 84.3 per cent from Oceania have been produced only in the last ten years. Comparatively, this period has established a milestone in the publication trend and this may be attributed to two major factors viz: (i) the growing emphasis given

Table 2 : publication trend in different geographical regions during 1972-1996

S. No.	Continents	Period 1		Period 2		Period 3		Period 4		Period 5	
		1972-76		1977-81		1982-86		1987-91		1992-96	
	Actual value	Trend value	Actual value	Trend value	Actual value	Trend value	Actual value	Trend value	Actual value	Trend value	Actual value	Trend
1	Africa	3	-12.6	14	25.5	45	63.6	111	101.7	145	139.8
2.	America	6	-112.2	84	136.1	195	384.4	695	632.7	942	881.1
3	Asia	1	-127	21	66.9	95	260.8	412	454.7	775	648.6
4.	Europe	122	-26.6	254	311.7	408	650	1051	988.3	1415	1326.6
5.	Oceania	6	78.8	46	170	282.6	517	463.3	674	644	
	Total	**137**	**357.8**	**419**	**641.7**	**913**	**1641.2**	**2786**	**2640.7**	**3951**	**3640.2**

Source : Computed

Table 3 : Growth of publications in different geographical regions during 1992-1996

S.No.	Continent	Intercept a_n	Co-efficient b_n	Trend	'F' ratio	R^2
1.	Africa	0.2613	0.4267 (7.098)**	53.22	50.39	0.94
2.	America	0.5686	0.5310 (5.395)**	70.06	29.11	0.91
3.	Asia	1.5880	0.1997 (2.282)**	22.12	7.74	0.66
4.	Europe	1.8309	0.2747 (12.582)*	31.61	158.30	0.98
5.	Oceania	0.4970	0.5152 (6.44)**	67.40	41.48	0.93
6.	Overall	1.8290	0.3743 (11.59)*	45.40	134.39	0.98

Source : Computed.
Note : Figures in Parentheses represent 't' value.
* Significant at 1 per cent level.
** Significant at 5 per cent level

to the globalization of education and the (iii) the widespread application of information technology in DE programmes, which have invited a larger number of deliberations, discussions and publications on DE in the last ten years.

The increasing participation of the continents in the DE programmes has been witnessed from the rate of growth of publications. An analysis of the growth rate of publications of the entire regions shows that the research paper are produced at a rate of 45 per cent per period. Among the continents, America is producing the research papers at a rate of 70.1 per cent followed by Oceania (67.4%), Africa (53.22%), Europe (31.6%) and Asia (22.12%). The differences in the rate of growth among the regions may be due to (i) the socio-economic and political differences between the continents, and (ii) the time of establishment of DE. The above analysis has also highlighted the inverse relation existed between the time of establishment of DE and the growth rate of publications. The regions that have introduced DE at an early period have witnessed a lower growth rate in their production of research papers, while the regions that have taken to DE in the later period have seen a faster growth in their publication activities.

Publication Trend in the Various Thematic Groups During : 1972 -96

The publication turned of the various thematic groups has been attempted and presented in Table 3. Planning has revealed a striking increase from 132.4 to 667.6 papers and thereby registering a 5 fold increase during the last twenty years. Similar trend is noticed in areas of education and learner support where the trend values of the publication have increased from 110 to 611.4 and from 92.3 to 463.4 respectively. Surprisingly, on-line delivery has recorded an eight fold increase by moving from 98 to 782 papers over the period of time. It is inferred that these four groups of subjects have been the main focus of interest in DE programmes since they have attracted considerably a large number of papers in all the periods. The need to keep track of the impact of DE,

Table 4 : Publication trend in different thematic groups during 1972-96

S. No.	Thematic Groupings	Period									
		1972-76		1977-81		1982-86		1987-91		1992-96	
		ACTUAL VALUE	TREND VALUE	ACTUAL VALUE	TREND VALUE	ACTUAL VALUE	TREND VALUE	ACTUAL VALUE	TREND VALUE	ACTUAL VALUE	TREND VALUE
1.	Planning Policy & Course design etc.	21	–46	90	132.4	197	310.8	376	489.2	669	667.6
2.	Areas of Education	15	–23.8	110.0	23	194	243.8	490	377.6	466	511.4
3.	Communication based education	8	–13.2	23	32.1	51	77.4	118	122.7	187	168.0
4.	Curriculum Development	8	–21.8	18	23.8	32	69.4	88	115.0	201	160.6
5.	Staff Development	4	4.8	7	11.4	13	27.6	51	43.8	63	60.0
6.	Quality of Education	7	–35.8	46	37.3	35	110.4	137	183.5	327	256.6
7.	Learner Support	34	–31.4	57	92.3	119	216.0	378	339.7	492	463.4
8.	Impact of DE	1	–2.8	1	1.0	1	4.8	1	8.6	20	12.4
9.	Performance Evaluation	13	–9.6	41	48	65	105.6	175	163.2	234	220.8
10.	Research Paradigm	7	7.4	15	35.6	57	63.8	159	92	71	120.2
11.	Computer Aided Instruction	1	–12	1	10.5	16	33	66	55.5	81	78
12.	On line delivery Mechanism	18	–130	52	98	125	326	502	554	933	782
13.	Collaboration Networking	2	–20.4	15	11.9	10	44.2	46	76.5	148	108.8
14.	Virtual Campus	1	–5.2	1	1.0	1	7.2	1	13.2	32	19.6
15.	Internet Based Education	1	–2.4	1	1.0	1	4.4	1	7.8	18	11.2
16.	Multimedia Based Education	1	–0.6	1	1.0	1	2.6	1	4.2	9	5.8
	Total	**137**	**–357.8**	**419**	**614.7**	**913**	**1641.2**	**2786**	**2640.7**	**3951**	**3640.2**

Source : Computed

Table 5 : Growth of publications in different thematic groups during 1972-96

S.No.	Variables	Intercept a_o	Co-efficient b_o	R^2	G
F1	Planning Policy, Course Design, etc	1.0868* (6.0895)	0.3814* (7.0878)	0.9436* [50.24]	46.43
F2	Areas of Education	0.9282** (4.0859)	0.3942** (5.7551)	.09169* [33.12]	48.32
F3	Community Based education	0.629* (7.4355)	3.448* (13.513)	0.9838* [182.75]	41.17
F4	Curriculum Development	0.2365NS (1.8179)	0.3257* (8.3032)	0.9583* [68.95]	38.50
F5	Staff Development	0.5966** (2.5529)	0.3814* (5.4129)	0.9071** [29.30]	46.43
F6	Quality of Education	1.1834* (11.3574)	0.3144* (10.008)	0.9709* [100.15]	36.94
F7	Learner Support	–6.6NS (0.9070)	3.8NS (1.7321)	0.5NS (0.3)	36.93
F8	Impact of DE	–0.3421*** (2.575)	0.4791* (5.9777)	0.9919* [35.73]	61.44
F9	Performance Evaluation	0.8884* (7.8239)	0.314* (9.1716)	0.9656* [84.12]	36.89
F10	Research Paradigm	0.6544NS (2.0142)	0.3058** (3.1217)	0.7646** [9.74]	35.77
F11	Computer Aided Instruction	–0.7044NS (1.9358)	0.5636** (5.1371)	0.8979** [26.39]	75.70
F12	On line Delivery Mechanism	0.8233* (4.8783)	0.4415* (17.5692)	0.9904* [308.68]	55.50
F13	Collaboration & Networking	–0.0055NS (0.02032)	0.4225** (5.1776)	0.8994** [26.81]	52.58
F14	Virtual Computers	–0.602NS (1.0445)	0.301NS (1.732)	0.50NS [3]	35.12
F15	Internet Based Education	–0.502NS (1.0445)	0.251NS (1.7321)	0.5NS [3]	28.53
F16	Multimedia Based Education	–0.3817 NS (1.0445)	0.1908 NS (1.7321)	0.5 NS [3]	21.05

Source : Computed.

Note : Figures in parentheses represent 'T' value.
Figures in squared brackets represent 'F' value.

* –Significant at 1 percent level.

** – Significant at 5 percent level.

*** – Significant at 10 percent level.

NS –Not Significant. G– Annual growth rate percentage.

to reorient and restructure the DE programmes has inspired publications only in the last period. Similarly, the need to adopt the technological proliferation to the effective delivery (by means of the virtual campus, internet and multimedia of the DE programmes) has stimulated a larger amount of publication only in the fifth and has registered a remarkable trend of publications in the last two decades, and their rate of increase ranges from 7 to 11 folds. This may be due to the fact that there has been a series of discussions going on at the national and international fora addressing the most current and critical issues related to the quality of education, computer-aided instruction, online delivery and the collaboration and networking and this has ultimately boosted up the publication outputs in the fields specified above. On the contrary there are certain fields that have not received wider attention and hence, they have not attracted a greater number of publications. For instance, some of the fields like Research Paradigm and Performance Evaluation have recorded the lowest level of increase compared to the other fields in the thematic groups. The sharp differences in the publication trend between the fields may be attributed to the extent of contribution of those fields in the successful implementation of the DE programmes.

Table 6 : Publication productivity according to continents and subjects : Anova model

Source of Variation	Degrees of Freedom (df)	Sum of Squares (ss)	Mean Sum of Squares (MSS)	'F' ratio
Variation due to continents	15	926868.2	61791.21	8.45*
Variation due to subjects	4	289983.6	72495.89	9.92*
Error	60	438551.6	7309.192	–
Total	79	1655403	–	–

Source : computed.

* – Significant of $F_{15,60}$ and $F_{4,60}$ ratio at 1 per cent level.

** – Significance of F4, 60 ratio at 5 per cent level.

Table 7 : Mean differences in the publication productivity between the geographic regions during 1972-96

	Geographical Regions	Mean	C1	C2	C3	C4	C6
C1	Africa	19.88	0				
C2	America	122.56	213.7	0			
C3	Asia	81.56	128.4	85.3	0		
C4	Europe	203.8	380.8***	169.1	254.3	0	
C5	Oceania	88.38	142.7	71.1	14.19	240.1	

Source: Computed

*** –Mean differences about 300 percentage of CD value.

Table 8 : Mean differences in the publication between thematic groupings during 1972-96

	Thematic Groups	Mean	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	Planning Policy, Course Design, etc	316.2	0															
F2	Areas of Education	244.8	97	0														
F3	Community – Based Education	77.8	325***	228	0													
F4	Curriculum development	69.8	336***	239	11	0												
F5	Staff Development	27.6	394***	296	68	57	0											
F6	Quality of Education	110.6	281	183	45	56	113	0										
F7	Learner Support	217.0	135	38	190	200	258	145	0									
F8	Impact of DE	4.0	426***	329***	101	90	33	146	291	0								
F9	Performance Evaluation	106.2	286	190	38	49	108	5	160	139	0							
F10	Research Paradigm	62.0	346***	250	22	11	46	67	211	79	60	0						
F11	Computer – Aided Instruction	32.8	388****	289	81	50	7	108	251	40	100	40	0					
F12	On-line Delivery Mechanism	327.0	15	112	340***	351***	406***	295	150	441****	312****	361***	401***	0				
F13	Collaboration & Networking	44.2	371***	274	46	35	23	90	236	55	85	258	15	386***	0			
F14	Virtual Compus	6.6	423***	325***	97	86	29	142	2888	3	136	76	35	438***	52	0		
F15	Internet Based Education	3.6	427***	329***	101	90	33	146	291	1	140	79	40	441***	56	4	0	
F16	Multimedia Based Education	1.8	428***	331***	104	93	35	149	293	3	142	82	42	443***	57	7	3	0

Source : Computed

*** –Mean differences above 300 percentage of CD values.

The variations among the fields with respect to their publication productivity is also noticed from the average growth rate (exponential) of publications. It is identified from Table 5 that the rate of growth of publication is found to be higher at 75.7 per cent for Computer-aided Instruction and it is lower at 21.05 per cent for Multimedia based Education. The coefficient values are found to be statistically significant at 1 per cent level in seven groups of subjects. Among the rest of the fields, the quality of education, has shown the highest growth rate of 61.44 per cent per period.

Publication Trend During 1972-1996: An Overview

An overall analysis of the publication trend has brought to light a synoptic view of the changes occurred in the publication scenario of the subject DE in the last 25 years. It is interesting to note that the initial period (1972-76) has seen a negative trend in the total publication productivity, and this has marked the 'budding' stage of the discipline DE and hence the number of publications has been found to be very low and scattered. On the contrary, the subsequent periods have witnessed a tremendous increase in publication on DE, in accordance with its growing popularity at the international scenario. The second period (1977-1981) has seen a spurt in the publication productivity which is noted from the three fold increase in the number of papers produced (137 to 419) during this period. In the same manner the productivity of research papers on DE has been a spectacular increase from 913 to 2787 by registering more than three fold increase in the fourth period (1982-96). As against this third (1982-86) and fifth periods (1992-96) have seen a gradually increase. In the third period the publication has doubled from 19 to 913, and in the fifth period it has registered an 1.4 fold increase (2786 to 3951). Though the rate of increased is different between the periods, a steady upward trend is discernible in all the periods and this is confirmed from the coefficient values.

Variations in the Publication Productivity Between Continents and Thematic Groups

To examine the variations in the publication performance among the continents and the thematic groups, the analysis of variance two way classification is used. The assumption behind the 'analysis of variance' technique is that the treatment (thematic groups) and the environmental (geographic regions) effects are additive and that environmental effects are independent in probability sense, have equal variance and are normally distributed. In other words, while examining the empirical data, it is worthwhile to watch for the skewed distribution, unequal variance and other abnormalities to make the appropriate corrections or transformations. Hence, the Bartletts' test (χ^2 test) is applied to find out the homogeneity of the explanatory variables. Here, the variations in the publication productivity between the continents and the thematic groups have been tested by adopting the χ^2 test. It is seen that the calculated values of χ^2 is 58.25 with 4 d.f at 1 per cent level which is greater than the tabulated values (15.966) for the productivity of publication between the continents. Hence, the assumption of unequal distribution of publications among the different continents is accepted. Similarly, the calculated

value of χ^2 is 152.47 with 15 d.f at 1 per cent level which is greater than the tabulated value (30.58) for productivity of publications between the thematic groups. Hence, the null hypothesis of homogeneity of variance of publication data among the different thematic groups is accepted. Once the explanatory variable are found to be homogeneous, the ANOVA model is used.

The general additive model used for analysing the variations in the distribution of publications (thematic groups) between the continents is, $X_{ij} = \mu_i + \alpha_i + \beta_j + \varepsilon_{ij}$.

X_{ij} denotes the distribution of publication of the 7th field in the ith continent, where,

j = 1, 2,3 ... 16 (fields)

i = 1, 2, 3, ... 5 (continents).

μ_i explains the general effect of the publication productivity

α_i explains the additional effect on the publication due to 'i' the continent (ith category of the row variable)

β_j is the additional effect on the publications due to 'j' the field (jth category of the column variable)

ε_{ij} explain the effect fo the residual variables.

And, the general additive model used for estimating the regional variations in the publication productivity between the thematic groups is $X_{ij} = \mu_i + \alpha_i + \beta_j + \varepsilon_{ij}$. In this model,

X_{ij} denotes the distribution of publication productivity of the 'j' continent in the ith field, where

j = 1, 2,3 ... 5 (continents)

i = 1, 2, 3, ... 16 (fields).

μ_i explains the general effect of the publication productivity.

α_i denotes the additional effect on the publications due to ith field (ith category of the row variables)

β_j explain the additional effect on the publications due to the jth continent (jth category fo the column variable)

ε_{ij} explains the effect of the residual variables

The ANOVA-Two way Model is adopted to test the following hypotheses:

(i) There is significant difference between the geographic regions (continents) in the distribution of publication among the thematic groups (fields)

ii) There is significant difference between the thematic groups (fields) in the distribution of publications among the geographic regions (continents).

The results depicting the variations in the publications productivity between the continents and the thematic groups are presented in Table 6. It is inferred from the results

that the calculated value of $F_{(15,60)}$-ratio is 8.45 in the publication productivity between geographic regions and it is greater than the Table value (3.05) at 1 per cent level of significance. It is also observed that the calculated $F_{(4,60)}$ value is found to be 9.92 in the distribution of publications between the thematic groupings and it is also greater than the table value (5.69) at 5 per cent level of significance. Hence the first and the second hypotheses which have assumed significant variations between the geographic regions (continents) and between the thematic groups (fields) are proved. But this analysis has not explained the extent and level of variations existing between the variables and hence the Critical Difference is attempted.

Mean Difference (M_i) in the Distribution of Publications Between Continents and Thematic Groups

Further, to identify the magnitudes of the differences in publication productivity between the variables under considerations (continents and fields), the Critical Difference Technique of the following form is used.

$$CD = \sqrt{2/n\ (\mu SE)\ F.(n-k)} \qquad \text{at } 5\%,.\ 1\%$$

The differences between the sample means are calculated by taking into account different pairs of the variables (continent and thematic groupings) and compare them with the CD values as shown below:

(i) For distribution of publications between the Continents

$$CD = \sqrt{2/16 * 7305 * 2.53} \qquad \text{at } 5\%,. = 48.06$$

(ii) For distribution of publications between the thematic groupings

$$CD = \sqrt{2/5 * 7305 * 1.84} \qquad \text{at } 5\%,. \text{ level} = 73.32$$

The above CD values are then compared with the mean differences (μ_i) in the distribution of publications between the continents and between the thematic groupings. The mean effect values are converted to percentages ($\mu_i/C^* 100$) and presented in Tables 7 and 8.

A comparison of the CD values among the pairs of continents shows that the variabilities are found to be wider between the pairs C1 and C2, C1 and C4, and C4 and C5 and it is particularly narrow among the pairs C1 and C3, C1 and C5 and C2 and C4. The rest of the pairs viz. C2 and C3, C2 and C5, C3 and C5 are found to be homogenous and they exhibited a little variation.

It implies that Africa differs significantly (>300%) with America and Europe, but its differences are marginal (>200%) with Asia and Oceania. In the same manner Oceania and Asia differ significantly (>300%) with Europe in their distribution of publication. On the contrary the differences between America and Europe are only marginal (>200%). Thus, this analysis has brought to light the relative position of each one of the continents in the world map of publication on DE.

Table 9 : Areas of relative priority

S. No	Priority Levels	Period–1 Y 72-76					Period–2 Y 82-86					Period–3 Y 92-96				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1.	Trust P1>175	Fe,F10	F4,F6 F12			F1,F6	F10	F11			F4, F5	F8	F15	F9, F16		
2.	High Priority 145<PI<175					F2	F5		F1,F4 F9		F13	F3 F10, F13, F15	F8, F13	F5		F11
3.	Marginal Priority 115<PI<145							F3 F4 F6, F9 F12, F13		F2,F3 F7, F11	F1, F6 F12	F1,F2, F9	F10, F12,F14	F10, F15	F14	F6,F7 F10
4.	Average 85<PI<115		F1		F1,F2 F3,F4 F5,F7 F9,12, F13			F2, F7 F10	F10 F12	F1,F5 F9, F13	F7	F4, F11	F2,F3 F4,F5 F7,F9 F11,F16	F1,F2 F3,F6 F7	F1,F2 F4,F6 F3,F6 F12,F13, F16	F1,F2 F7,F11, F12
5.	Low Priority 55 < PI < 85		F7		F6, F10	F7	F1,F2 F3,F4		F2,F5 F6,F7	F6, F12	F2, F9 F10	F6,F7 F12	F1,F6	F4,F8 F12,F13, F14	F3,F5,F8	F8,F9
6.	Very Low Pirority 25 < PI < 55						F9, F12	F1	F3	F4, F10	F3	F5		F11	F9, F10	F13, F14, F15
7.	Neglect < 25	F1,F2 F4-F9 F11-16	F2,F3 F5, F8-11, F13-16	F1-16	F8,F11, F14,F15 F16	F3,F4 F5 F8-16	F5,F7 F8,F11 F13-16	F5, F8 F14, F15, F16	F8,F11, F13, F14 F15, F16	F8, F14 F15 F16	F8, F11, F14, F15, F16	F14, F16			F15	F16

A - Africa
B - Americca
C - Asia
D - Europe
E - Oceania

F1-Planning Policy, course Design, etc
F2-Areas of Education
F3-Community - Based Education
F4-Curriculum Development
F5-Staff Development
F6-quality of Education
F7-Learner Support
F8-Impact of DE
F9-Performance Evaluation
F10-Research Paradigm
F11-Computer Aided Instruction
F12-On-line Delivery Mechanism
F13-Collaboration & Networking
F14-Virtual Campus
F15-Internet Based Education
F16-Multimedia Based Education

Priorities of Research in Distance Education

The profiles of research priorities of the continents are presented in Table 9 for three time periods 1972-76, 1977-82 and 1992-96. It brings to light not only the research priorities of each continents for different subfields in a given time span, but also exhibits the changes in their priorities over the entire period of time taken for analysis. The priority index (PI) is used to measure the differences in the priority accorded to different sub-fields. It is computed by using the formula $(PI)_{ij} = (n_{ij}/n_{io}) \times 100$ when n_{ij} is the number of publications by country i in sub-field j, n_{jo} is the number of publications by the country i in all sub-fields, n_{jo} is the number of publications by the country i in all sub-fields, n_{oj}, is the number of publication s by all countries in sub-field j, n_{oo} is the total number of publication by all countries in all sub-fields. This formula includes two different parameters viz: (i) ratio of contribution of the individual fields to the total country's productivity, and (ii) the ratio of contribution of the individual fields to the global productivity on a given subject. The PI values are used to 'benchmark' the research priorities of the sample countries on a seven point scale. It is interesting to note from Table 9 (i) the similarities and dissimilarities among the continents with respects to their research priorities and also (ii) the changes in their priorities at different point of time. During the initial period, the African countries have given the top priority to the areas of Community-based Education and Research Paradigm on DE, while the American countries have concentrated on the areas such as Curriculum Development, Quality of Education, and On-line Delivery Mechanisms. There seems to be a large difference in the research profile of these two continents at this phase. Europe has treated all the subjects with equal priority and it has not attached undue weightage to any individual fields. Contrary to this, the Oceanic countries have assigned greater importance to a few fields like Planning Policy. Area of Education and Quality of Education. Both Oceania and America seemed to have considered Quality of Education as the most significant area of research during the first phase.

The second period has seen a striking difference in the research profiles of the continents. Africa has extended its research priorities in the second phase by including the field Quality of Education also to the existing areas of preferences. The changes in the research interests are found to be conspicuous in the American countries. For instance, those are as that have occupied the first position (thrust) in the previous period are now shifted to the third (marginal) position. Similarly, those areas that have been in the neglected areas of research, viz. Performance Evaluation, and Collaboration and Networking have been raised to the marginal level of priority in the second phase. These areas have witnessed a great shift from the seventh place to the third place in the priority list. In the same manner, the field Computer-aided. Instruction has been lifted from the seventh place (neglected area) to the prime place of research (thrust) in the second phase. Asia has accelerated its research on DE only in the second phase and its interests are centered around the areas related to the Planning Policy, Curriculum Development, and Performance Evaluation. It is to be noted that the first three continents do not seemed to have developed their research pro-

files on the homogeneous pattern and their research efforts are diffused. Like America, the Europe also has encouraged research on the field Computer-aided Instruction in the second phase. Quite contrary to the research interests in the first period, Oceania has developed its interests around Curriculum Development, Staff Development and Collaborative Learning. Like Asia, Oceania also has stimulated research in the area of Curriculum Development during the second period. Barring a few exceptions, each continent seems to have built up its own line of priorities and there is no clear cut pattern existing among the continents.

The third period has witnessed remarkable changes in the thrust area of research. Africa has given great importance to Impact of DE , Collaboration and Networking and Internet based Education in the last phase. These areas have been shifted from the 7th place to the first place during this period. Some of the other fields have also been moved to the third (marginal) place of importance in the last period from the fifth position (low priority) in the second phase. Similar changes are seen in America also. The field F15, as been shifted to the thrust area (first position) from the area of neglect (seventh position) and the field F13 has been moved from marginal priority to the higher priority (third to second) in the third phase. The subjects F10 and F14 also have witnessed such changes. They have been moved to the third position now, from 4th and 7th positions respectively in the last phase. Both Africa and America have shown greater concern for the field F15 during the last period. Asia has shifted F5 to second place of priority from its fifth place in the earlier period. It has also lifted F5 and F9 to the first level of priority from their second and seventh positions in the former period. Oceania has shifted subject F11 from its seventh position to the third position during this period. Europe has distributed its research efforts more or less evenly among all the field, while the rest of the continents have changed their research priorities at every point of time. It can be easily seen from Table 9 that the distribution of PI is skewed, but the degree of skewness varies across continents.

Conclusion

The above analysis has brought to light the dynamic changes in the publication practices of the subject DE ien the last 25 years. The highest level of publication (above 80 per cent) is noticed only in the last ten years and the impact of the environmental factors on the outrageous growth of publication cannot be overlooked. Apart from the traditional research centering around topics on the planning policy, curriculum development, areas of education, there is a fervent enthusiasm for taking up research on topics related to exploitation of information technology for effective retrieval of the DE. Infact, the subject 'online delivery' mechanisms has invited the highest number of publications than the other subjects. The chronological review of the publication has indicated that the 80's has marked the beginning of the new era of research on DE. The remarkable growth in the publication during the 90's is the outcome of the progressive R&D activities which are necessitated by the fast changing trends in the mode of education, the revolution in the information technology, the governmental policies towards 'right to education', and the growing demand for skilled and trained manpower. A pe-

riodical assessment of the changing trends in the thematic groups would be a great source of information for the R&D centres and the finding agencies to identify the thrust and the obsolete areas of importance at different point of time. This would provide a guideline to formulate their research agendas on the right direction and to frame their funding strategies in a scientific manner. The evaluation of the research profile of the continents would assist the institutions involved in DE to identify the regions that have similar research interest and help them plan for collaborative research.

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