Research article Available online www.ijsrr.org ISSN: 2279–0543

International Journal of Scientific Research and Reviews

Development of Education in Madhya Pradesh: A Principal Component Analysis

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ABSTRACT

Education forms an important instrument of achieving sustainable development. The present paper is an attempt to study the development of education in Madhya Pradesh for the year 2015-16. The study is based on secondary data. Seven indicators of education development were selected for every district and the Principle Component Analysis technique was used to construct the Educational Development Index. The results point that district Gwalior with the Index value of 0.68725 has the highest rank and district Burhanpur with the Index value of 0.21054 has the lowest rank among 50 districts of Madhya Pradesh. The composite Education Development Index of the state is 0.41522. It was observed from the study that none of the districts were educationally highly developed, only 12 percent districts were educationally developed, 86 percent districts were educationally underdeveloped and 2 percent districts were educationally highly underdeveloped.

KEYWORDS: Education, Madhya Pradesh, Principle Component Analysis, Education Development Index

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INTRODUCTION

Education is the most crucial social infrastructure which helps a country in achieving rapid economic development. Education is no longer a sheer social service; it is in fact a long term national asset aimed at escalating human resources. Apart from providing competent people, it exposes the people to new ideas and creates right approach and atmosphere which are a pre requisite for economic development (Myrdal 1968)[1]. Most underdeveloped countries believe that it is the rapid quantitative expansion of educational opportunities is the basic key to national development (Todaro 1989)[2]. According to (Dewey 1944)[3] **"**Education is the process of facilitating learning or the acquisition of knowledge, skills, values, beliefs and habits. Educational methods include storytelling, discussion, teaching, training and directed research. Education frequently takes place under the guidance of educators, but learners may also educate themselves**".**

As far as literacy rate in India is considered, it stands at 74.04 percent in 2011[4]. India's literacy rate at the time of independence was a mere 14 percent, over the years literacy rate has been increasing but with varied rates in different states with some states like Kerala and Mizoram well above national average and Bihar with a dismal rate of 63.8 percent. There is also a concern for female literacy rate (65.46 percent) which is much below the male literacy rate (82.14 percent). Therefore there is a need to improve the overall literacy rate as improved literacy rate has an impact on increasing a country's economic growth rate and decreasing population growth rate. Also as India has a very young population, literacy will play a very important role in turning the young population into potential human capital. Like in most other states across India, Madhya Pradesh also follows the 10+2+3 tier of whole education. The school education system in Madhya Pradesh consists of Primary from classes I - V, Middle from classes VI - VIII, Secondary covering the classes IX & X and Higher Secondary covering the classes X and XI means that there is 5+3+2+2 system of education in Madhya Pradesh. The total literacy in Madhya pradesh[5] was 63.7 in 2001 which increased to 70.6 in 2011 with a growth rate of 10.83 percent. The male literacy was 76.1 in 2001 which increased to 80.5 in 2011 with a growth rate of 5.78 percent. The female literacy was 50.3 in 2001 which increased to 60.0 in 2011 with a growth rate of 19.28 percent.

RESEARCH METHODS

The study is based on secondary data. The data has been collected from District information System for Education - a data base of National University for Educational Planning and Administration, New Delhi for the year 2015-16, Census documents 2011 and Digest of statistics, Govt. of Madhya Pradesh 2015-16. Seven indicators of education development have been selected for every district and the Principle Component Analysis technique is used to construct an

Educational Development Index to study the educational development in the state of Madhya Pradesh.

RESULTS AND DISCUSSION

Madhya Pradesh literally means Central Province and is located in the geographic heart of India, between latitude 21.2° north 26.87° north and longitude 74°59' east 82°06' east. The state is bordered on the west by Gujarat, on the northwest by Rajasthan on the northeast by Uttar Pradesh, on the east by Chhattisgarh, and on the south by Maharashtra. Madhya Pradesh is administratively divided into 10 divisions namely Bhopal, Chambal, Gwalior, Indore, Jabalpur, Narmadapuram, Rewa, Sagar, Shahdol and Ujjain divisions and these divisions are further divided into 52 districts.

Madhya Pradesh has a total area 308252 km^2. This gives the state the 2^{nd} rank among 29 states of the union of India. According to census 2011 the total population of Madhya Pradesh is 72597565 which rank the state at 5^{th}. Out of total population 34612920 are males and 34984645 are females. Growth rate of population during the decade from 2001 to 2011 was 20.3%. Density of population in Madhya Pradesh is 236 persons per km^2. Sex ratio is 930 according to census 2011.

For the present analysis, following seven types of indicators have been used to construct an Education Development Index for the 50 districts of Madhya Pradesh as the data for two districts was not available:

1. No. of Primary Schools per 10,000 Population; denoted as S1
2. No. of Higher Secondary Schools per 10,000 Population; denoted as S2
3. No. of Primary Schools per 100 square Km; denoted as S3
4. No. of Higher Secondary Schools per 100 square Km; denoted as S4
5. Gross Enrolment Ratio at Primary Level; denoted as S5
6. Pupil Teacher Ratio at Primary Level; denoted as S6
7. Literacy Rate in Percentage; denoted as S7.

Table: 1. Education Development Indicators in Madhya Pradesh in 2015-16

DISTRICT	S1	S2	S3	S4	S5	S6	S7
ALIRAJPUR	27.09	1.2	62	2.76	114.9	35	36.1
ANUPPUR	16.21	2.5	32.4	5.01	102.2	25	67.88
ASHOKNAGAR	13.53	1.17	24.4	2.11	118.2	36	66.42
BALAGHAT	12.32	2.05	22.7	3.79	103.7	22	77.09
BARWANI	17.72	1.34	45.2	3.42	93.6	34	49.08
BETUL	13.54	2.12	21.2	3.33	104.2	23	68.9
BHIND	10.61	2.1	40.5	8.05	119.3	29	75.96
BHOPAL	4.86	2.52	41.5	21.57	131.5	25	80.37
BURHANPUR	7.51	1.77	16.6	3.91	100.1	35	44.36

CHHATARPUR	11.91	1.76	24.1	3.59	134.8	37	63.74
CHHINDWARA	13.42	2.23	23.4	3.95	104.4	24	71.16
DAMOH	12.46	1.49	21.57	2.58	114.1	30	69.73
DATIA	11.7	2.09	31.7	5.68	123.1	29	72.63
DEWAS	11.03	2.13	24.5	4.74	104.9	24	69.35
DHAR	15.59	1.79	41.8	4.8	107.1	29	59
DINDORI	21.19	1.96	19.9	1.8	113.1	28	63.9
GUNA	13.71	1.47	26.6	2.86	132	32	63.23
GWALIOR	7.93	2.72	46.2	12.12	175	24	76.65
HARDA	10.56	2.24	18.05	3.83	115.7	30	72.5
HOSHANGABAD	10.12	2.58	18.7	4.78	112.2	23	75.29
INDORE	4.08	2.44	34.2	20.54	128.2	26	80.87
JABALPUR	7.42	2.01	35	9.51	103	25	81.07
JHABUA	19.76	1.41	56.2	4.02	129.7	44	43.3
KATNI	10.94	1.64	28.5	4.28	106.6	28	71.98
KHANDWA	9.77	1.46	17.4	2.61	107.1	34	66.39
KHARGONE	15.17	1.67	35.4	3.9	106.1	29	62.7
MANDLA	20.43	2.01	37.1	3.65	106.4	25	66.87
MANDSAUR	10.42	1.82	25.2	3.8	106.9	22	71.88
MORENA	11.46	1.78	45.1	7.3	131.9	37	71.03
NARSIMHAPUR	11.84	2.13	25.2	4.53	104.1	22	75.69
NEEMUCH	11.96	2.14	23.2	4.15	100.1	18	70.8
PANNA	16.74	1.56	23.8	2.22	122.7	28	64.79
RAISEN	14.2	2.12	22.3	3.34	100	22	72.98
RAJGARH	13.43	1.73	33.7	4.37	109	258	61.21
RATLAM	12.15	1.67	36.3	5.01	107.1	27	66.78
REWA	16.18	1.71	60.5	6.43	121	29	71.62
SAGAR	9.86	1.73	25.8	4.02	110.6	32	76.46
SATNA	12.76	1.99	37.9	5.91	115.4	28	72.28
SEHORE	11.45	2.92	22.8	5.82	107	25	70.06
SEONI	16.41	1.76	25.8	2.77	100.8	19	72.12
SHAHDOL	15.87	1.83	27.2	3.14	107	28	66.67
SHAJAPUR	6.7	1.97	16.3	4.9	106.1	23	69.69
SHEOPUR	13.57	1.36	14.1	1.42	126.2	38	57.43
SHIVPURI	13.69	1.55	23.4	2.67	125.4	34	62.55
SIDHI	15.6	1.81	36.2	4.2	116	34	64.43
SINGRAULI	13.29	1.46	27.5	3.03	119.6	55	60.41
TIKAMGARH	12.6	1.38	36.07	3.96	129.9	39	61.43
UJJAIN	8.34	2.04	27.2	6.68	113.7	25	72.34
UMARIA	12.81	1.97	20.2	3.11	107.4	36	65.89
VIDISHA	13.62	1.93	26.95	3.82	111.2	29	70.53

Source: Calculated from the data from DISE of NUEPA, New Delhi. Census documents 2011.

From the above indicators some are positive in nature and some are negative in nature. Apart from pupil teacher ratio which is a negative indicator, all other indicators are positive. Therefore the data needs to be normalized before applying the statistical tools to give the correct results. The following formula was used to convert the data into normalized form:

$$NV_{id} = 1 - \left[\frac{\text{BEST } S_i - \text{OBSERVED } S_{id}}{\text{BEST } S_i - \text{WORST } S_i}\right]$$

Where NV_{id} is the normalized value of the indicator of the particular district,

Best S_i is the best value of the indicator,

Observed S_{id} is the observed value the indicator of that district,

Worst S_i is the worst value of the indicator.

First the best and worst values in an indicator are identified. The best and the worst values will depend upon the nature of the particular indicator. In case of a positive indicator, the highest value will be considered as the best value and the lowest, will be treated as the worst value. If the indicator is negative in nature, then the lowest value will be considered as the best value and the highest value will be treated as the lowest value. The normalized values are given below.

Table: 2. Normalized Value of the Education Development Indicators of MP

DISTRICT	NORMALIZED VALUE S1	NORMALIZED VALUE S2	NORMALIZED VALUE S3	NORMALIZED VALUE S4	NORMALIZED VALUE S5	NORMALIZED VALUE S6	NORMALIZED VALUE S7
ALIRAJPUR	1.0000	0.0171	1.0000	0.0665	0.2617	0.9292	0.0000
ANUPPUR	0.5271	0.7600	0.3820	0.1782	0.1057	0.9708	0.7067
ASHOKNAGAR	0.4106	0.0000	0.2150	0.0342	0.3022	0.9250	0.6742
BALAGHAT	0.3581	0.5029	0.1795	0.1176	0.1241	0.9833	0.9115
BARWANI	0.5927	0.0971	0.6493	0.0993	0.0000	0.9333	0.2886
BETUL	0.4111	0.5429	0.1482	0.0948	0.1302	0.9792	0.7294
BHIND	0.2837	0.5314	0.5511	0.3290	0.3157	0.9542	0.8864
BHOPAL	0.0338	0.7714	0.5720	1.0000	0.4656	0.9708	0.9844
BURHANPUR	0.1490	0.3429	0.0522	0.1236	0.0799	0.9292	0.1837
CHHATARPUR	0.3402	0.3371	0.2088	0.1077	0.5061	0.9208	0.6146
CHHINDWARA	0.4059	0.6057	0.1942	0.1256	0.1327	0.9750	0.7796
DAMOH	0.3641	0.1829	0.1559	0.0576	0.2518	0.9500	0.7478
DATIA	0.3311	0.5257	0.3674	0.2114	0.3624	0.9542	0.8123
DEWAS	0.3020	0.5486	0.2171	0.1648	0.1388	0.9750	0.7394
DHAR	0.5002	0.3543	0.5783	0.1677	0.1658	0.9542	0.5092
DINDORI	0.7435	0.4514	0.1211	0.0189	0.2396	0.9583	0.6182
GUNA	0.4185	0.1714	0.2610	0.0715	0.4717	0.9417	0.6033
GWALIOR	0.1673	0.8857	0.6701	0.5310	1.0000	0.9750	0.9017
HARDA	0.2816	0.6114	0.0825	0.1196	0.2715	0.9500	0.8094
HOSHANGABAD	0.2624	0.8057	0.0960	0.1667	0.2285	0.9792	0.8715
INDORE	0.0000	0.7257	0.4196	0.9489	0.4251	0.9667	0.9956
JABALPUR	0.1451	0.4800	0.4363	0.4015	0.1155	0.9708	1.0000
JHABUA	0.6814	0.1371	0.8789	0.1290	0.4435	0.8917	0.1601
KATNI	0.2981	0.2686	0.3006	0.1419	0.1597	0.9583	0.7979
KHANDWA	0.2472	0.1657	0.0689	0.0591	0.1658	0.9333	0.6736
KHARGONE	0.4819	0.2857	0.4447	0.1231	0.1536	0.9542	0.5915
MANDLA	0.7105	0.4800	0.4802	0.1107	0.1572	0.9708	0.6842
MANDSAUR	0.2755	0.3714	0.2317	0.1181	0.1634	0.9833	0.7956

MORENA	0.3207	0.3486	0.6472	0.2918	0.4705	0.9208	0.7767
NARSIMHAPUR	0.3372	0.5486	0.2317	0.1543	0.1290	0.9833	0.8804
NEEMUCH	0.3424	0.5543	0.1900	0.1355	0.0799	1.0000	0.7716
PANNA	0.5501	0.2229	0.2025	0.0397	0.3575	0.9583	0.6380
RAISEN	0.4398	0.5429	0.1712	0.0953	0.0786	0.9833	0.8201
RAJGARH	0.4063	0.3200	0.4092	0.1464	0.1892	0.0000	0.5584
RATLAM	0.3507	0.2857	0.4635	0.1782	0.1658	0.9625	0.6822
REWA	0.5258	0.3086	0.9687	0.2486	0.3366	0.9542	0.7899
SAGAR	0.2511	0.3200	0.2443	0.1290	0.2088	0.9417	0.8975
SATNA	0.3772	0.4686	0.4969	0.2228	0.2678	0.9583	0.8045
SEHORE	0.3202	1.0000	0.1816	0.2184	0.1646	0.9708	0.7552
SEONI	0.5358	0.3371	0.2443	0.0670	0.0885	0.9958	0.8010
SHAHDOL	0.5123	0.3771	0.2735	0.0854	0.1646	0.9583	0.6798
SHAJAPUR	0.1138	0.4571	0.0459	0.1727	0.1536	0.9792	0.7469
SHEOPUR	0.4124	0.1086	0.0000	0.0000	0.4005	0.9167	0.4743
SHIVPURI	0.4176	0.2171	0.1942	0.0620	0.3907	0.9333	0.5882
SIDHI	0.5006	0.3657	0.4614	0.1380	0.2752	0.9333	0.6300
SINGRAULI	0.4002	0.1657	0.2797	0.0799	0.3194	0.8458	0.5406
TIKAMGARH	0.3702	0.1200	0.4587	0.1261	0.4459	0.9125	0.5633
UJJAIN	0.1851	0.4971	0.2735	0.2610	0.2469	0.9708	0.8059
UMARIA	0.3794	0.4571	0.1273	0.0839	0.1695	0.9250	0.6624
VIDISHA	0.4146	0.4343	0.2683	0.1191	0.2162	0.9542	0.7656

Source: Calculated from table 1

After computation of normalized values, I calculate the Weights of every indicator by using Factor Loading and Eigen Values from Principal Component Analysis (PCA).

Table: 3. Total Variance Explained

Total Variance Explained									
	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.751	39.298	39.298	2.751	39.298	39.298	2.683	38.333	38.333
2	1.618	23.113	62.411	1.618	23.113	62.411	1.685	24.078	62.411
3	.979	13.980	76.392						
4	.730	10.433	86.824						
5	.463	6.619	93.443						
6	.342	4.887	98.330						
7	.117	1.670	100.000						
Extraction Method: Principal Component Analysis.									

Here it is worth to mention that only those components are extracted whose total initial Eigen value is above 1. It can be observed from table 3 and table 4 that 2 components have been extracted because only 2 components have the total initial Eigen value above 1 (2.751 and 1.618).

Table: 3. Component Matrix

Component Matrix[a]		
	Component	
	1	2
No. of Primary Schools per 10000 Population	-.820	.152
No. of Secondary Schools per 10000 Population	.786	-.093
No. of Primary Schools per 100 Sq. Km	-.175	.867
No. of Secondary Schools per 100 Sq. Km	.767	.507
Gross Enrolment Ratio at Primary Level	.269	.704
Pupil Teacher Ratio at Primary Level	.250	-.186
Literacy Rate in Percentage	.840	-.218
Extraction Method: Principal Component Analysis. a. 2 components extracted.		

Table: 4. Rotated Component Matrix

Rotated Component Matrix[a]		
	Component	
	1	2
No. of Primary Schools per 10000 Population	-.833	-.053
No. of Secondary Schools per 10000 Population	.785	.102
No. of Primary Schools per 100 Sq. Km	-.381	.798
No. of Secondary Schools per 100 Sq. Km	.620	.679
Gross Enrolment Ratio at Primary Level	.089	.749
Pupil Teacher Ratio at Primary Level	.288	-.120
Literacy Rate in Percentage	.868	-.006
Extraction Method: Principal Component Analysis. a- Rotation Method: Varimax with Kaiser Normalization.		

Weights for indicators were calculated by the following formula:

$$Wi = \sum_{n=1}^{n} (|Cn| \times EVn)_n$$

Where,

W*i* is the weight of the particular indicator

C*n* is the nth component of that indicator

EV*n* is the nth Eigen value of that indicator.

Table: 6. Weights of the Education Indicators in MP

Rotated Component Matrix			Initial Eigen values		
	Component		1	2	
	1	2	2.751	1.618	WEIGHTS
No. of Primary Schools per 10000 Population	-.833	-.053	2.29025	0.08616	2.37642
No. of Secondary Schools per 10000 Population	.785	.102	2.15975	0.16508	2.32484
No. of Primary Schools per 100 Sq. Km	-.381	.798	1.04912	1.29048	2.33960
No. of Secondary Schools per 100 Sq. Km	.620	.679	1.70586	1.09870	2.804562
Gross Enrolment Ratio at Primary Level	.089	.749	0.24368	1.21138	1.45506
Pupil Teacher Ratio at Primary Level	.288	-.120	0.79117	0.19338	0.98455
Literacy Rate in Percentage	.868	-.006	2.38730	0.00954	2.39685
TOTAL WEIGHTS					14.6819

Source: Calculated from the tables 3 and 5

By using the above formula the weights were calculated for each indicator as can be seen in the table 6. The third column of the table shows the weights of every indicator and also total weight of indicators was calculated and depicted.

The Education Development Index of each district of Madhya Pradesh was determined with the help of Normalized values and Weights of each indicator by using the following formula:

$$EDI_d = \frac{\sum_{i=1}^{n}[NVi \times Wi]}{\sum_{i=1}^{n} Wi}$$

Where,

EDI_d is the Education Development Index of each district

NVi is the Normalized value of the i^{th} indicator

Wi is the Weight of i^{th} indicator.

Table: 7. Education Development Index of Madhya Pradesh in 2015-16

DISTRICT	EDUCATION DEVELOPMENT INDEX	RANK
ALIRAJPUR	0.42487	**17**
ANUPPUR	0.49152	**7**
ASHOKNAGAR	0.30932	**47**
BALAGHAT	0.41571	**21**
BARWANI	0.34345	**41**
BETUL	0.39187	**32**
BHIND	0.52073	**5**
BHOPAL	0.68176	**2**
BURHANPUR	0.21054	**50**
CHHATARPUR	0.37454	**36**
CHHINDWARA	0.42234	**20**
DAMOH	0.33449	**43**
DATIA	0.46829	**12**
DEWAS	0.40167	**26**
DHAR	0.42481	**18**
DINDORI	0.40365	**24**
GUNA	0.35851	**39**
GWALIOR	0.68725	**1**
HARDA	0.40114	**27**
HOSHANGABAD	0.44779	**13**
INDORE	0.63252	**3**
JABALPUR	0.48552	**9**
JHABUA	0.42660	**16**
KATNI	0.37614	**34**
KHANDWA	0.27750	**48**
KHARGONE	0.39338	**31**
MANDLA	0.48106	**10**
MANDSAUR	0.37492	**35**
MORENA	0.50116	**6**
NARSIMHAPUR	0.43030	**15**
NEEMUCH	0.40029	**28**
PANNA	0.36803	**38**
RAISEN	0.41024	**23**

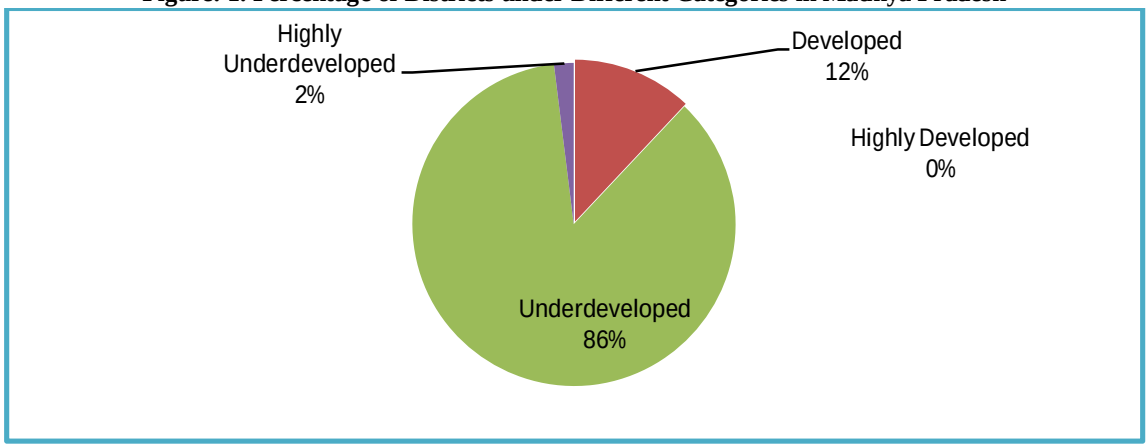
RAJGARH	0.31951	**46**
RATLAM	0.40225	**25**
REWA	0.56212	**4**
SAGAR	0.38525	**33**
SATNA	0.47914	**11**
SEHORE	0.48553	**8**
SEONI	0.39814	**29**
SHAHDOL	0.39408	**30**
SHAJAPUR	0.33394	**44**
SHEOPUR	0.26254	**49**
SHIVPURI	0.34209	**42**
SIDHI	0.43152	**14**
SINGRAULI	0.32749	**45**
TIKAMGARH	0.37343	**37**
UJJAIN	0.42326	**19**
UMARIA	0.35709	**40**
VIDISHA	0.41178	**22**
COMPOSITE EDUCATION DEVELOPMENT INDEX	**0.41522**	

By using the above formula the Education Development Index for each district was computed in table 7. The table points that the composite Education Development Index of the state is 0.41522. The table 7 also depicts that the highest index value of the district indicates the top position for the education development. Gwalior district is on the top position with 0.68725 values. The reason behind this is that, in Gwalior, availability of primary schools as well as secondary schools per 100 sq. km has been good among the districts of the state. Its gross enrolment ratio was highest in the study year. Its pupil teacher ratio was also good among the districts in the state. Its literacy was one of the best with 76.65 percent which increased the Index value of the district, followed by Bhopal (0.68176) and Indore with the value 0.63252. On the lower side, Burhanpur district (0.21054) has the lowest Index value and stood at last position followed by Sheopur (0.26254) and Khandwa (0.27750).

On the basis of the values of the indices, the districts have been classified into following four categories on one point scale:

S. No.	Category	Range	No. of Districts	Percentage
1	Highly Developed	0.75 – 1.00	0	0
2	Developed	0.50 – 0.74	6	12
3	Underdeveloped	0.25 – 0.49	43	86
4	Highly Underdeveloped	0.00 – 0.24	1	2

Figure: 1. Percentage of Districts under Different Categories in Madhya Pradesh



I have classified all the districts of Madhya Pradesh into four categories; highly developed, developed, underdeveloped and highly underdeveloped. Districts with index values in the range 0.750 to 1.00 are classified as 'highly developed', the districts with index values in the range 0.500 to 0.749 are classified as 'developed', districts with index values in the range 0.250 to 0.499 are classified as 'underdeveloped' and districts with index values between 0.000 to 0.249 as 'highly underdeveloped'. It is of great concern that none of the districts are coming under 'highly developed' category. Out of 50 districts studied, only 6 districts are coming under 'developed' category and 43 districts are coming under 'underdeveloped' category. While as 1 district has come under 'highly underdeveloped' category. If we notice at the percentage of districts under different categories, only 12 percent districts are developed, 85 percent districts are underdeveloped and 2 percent districts are highly underdeveloped in Madhya Pradesh.

CONCLUSION

The study is in line with the Education Development Index of NUEPA, New Delhi. There is a vast and uneven development of social infrastructure like education in the state of Madhya Pradesh. There has been high degree of disparity across districts as reflected in the values of education development index and its indicators. With huge inequalities within the state imply that there is a need to redesign the public policies that directly affect the development of education. It may be stated that whatever be the policies adopted for improving education sector in the state, emphasis should be given to enhance skills based on education because it is conducive to accelerate the rate of economic growth.

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