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RESEARCH ARTICLE

SOME MEASURES OF INTERMEDIATE BETWEEN-GROUP INEQUALITY: INDIAN EVIDENCE

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ABSTRACT

Inequality measures can be classified into two broad categories, such as leftist inequality measures and rightist inequality measures. The rightist view states that equal proportional changes in all incomes leave inequality unchanged, and the leftist view of inequality states that equal absolute changes in all incomes leave inequality unchanged. These are two extreme value judgments. An intermediate position can also be taken into account which would yield an 'intermediate' inequality measure. In this study we develop two multidimensional between-group intermediate inequality measures based on the centrist approach to inequality which is just the middle of two extremes. We apply these measures on Indian data to assess the inequality among the social groups in the distributions of household monthly per capita consumer expenditure and educational achievement across rural and urban areas in fourteen major states.

INTRODUCTION

Inequality is usually assessed interpersonally or between-group only in one dimensional space, i.e., in the distribution of income (Kolm 1976a and 1976b; Atkinson 1970; Sen, 1973; Cowell 1980; Shorrocks 1980, 1984; Ebert, 1988a and 1988b). However, a considerable number of scholars and researchers have argued in favour of using educational achievement and status of health along with income in the context of inequality measurement, since only income is not adequate for explaining well-being. According Kolm (1977), only income inequality may give a misleading picture of the extent of inequality within a given population or between different groups of individuals. He has done a pioneering work on the formal analysis of multidimensional interpersonal inequality and its foundational issues. He developed the dominance criteria by multidimensional generalization of the Pigou-Dalton transfer principle. The multidimensional inequality measures satisfying the dominance criteria enable us to compare the degrees of multidimensional inequality between two or more distributions[1].

The first valuable work on multidimensional inequality was conducted by Maasoumi (1986), where the study developed a multidimensional measure of inequality by using an aggregation function that converts the multidimensional distribution into a distribution of utilities. Later on, Tsui (1995) generalized the univariate Atkinson-Kolm-Sen approach, which is based a social welfare function, and developed some multidimensional interpersonal inequality measures. Inequality indices can be classified into two broad classes developed on the basis of two fundamental value judgments associated with the measurement of inequality, these are rightist approach and other is leftist approach to inequality measures. The rightist view of relative inequality states that equal proportional changes in all incomes leave inequality unchanged, and the leftist view of absolute inequality states that equal absolute changes in all incomes leave inequality unchanged. A major number of unidimensional inequality and multidimensional inequality indices are based on the rightist value judgment (Atkinson 1970; Sen, 1973; Ebert, 1988a and 1988b).

The number of studies based on the leftist value judgment is very sparse (Kolm, 1976a and Blackorby and Donaldson, 1980). The inequality measures developed on the basis of the rightist value judgment are known as relative inequality measures and the inequality measures developed from the leftist value judgment are known as the absolute inequality measures.

[1]The dominance criteria are discussed in Ray Chaudhury (2011), which includes the dominance criterion based on 'correlation increasing majorization' given by Tsui (1999) and List (1999). The last majorization criterion can take care of the systematic cross-correlation between inequalities in different dimensions. The measures of multidimensional inequality which satisfy this majorization criterion can take into account both degrees of inequality in different dimensions and systematic cross-correlation between inequalities in different dimensions.

Therefore, the relative inequality measures are the ones which satisfy the 'scale invariance' property, the absolute measures satisfy the 'translation invariance' property as described in the literature on inequality measures (Kolm 1976a and 1976b). If these two value positions indicate two extreme value judgements, an intermediate position can also be considered, which would yield an 'intermediate' inequality measure (Kolm, 1976a and 1976b). The major objective of this study is to develop two intermediate multidimensional between-group inequality indices by incorporating the centrist value judgment in the analysis[2]. We apply these intermediate inequality measures to assess between-group inequality across four social groups of Indian society, such as Higher Castes, Other Backward Castes, Scheduled Castes, and Scheduled Tribes, in the distributions of monthly consumer expenditure and educational status across rural and urban areas in fourteen major states of India[3]. The remainder of this paper is structured as follows. The second section describes different approaches associated with inequality measure. Section three describes different types of intermediate Unidimensional interpersonal inequality indices. Section four explains the multidimensional intermediate between-group inequality measures developed from the AKS measure and GGI measure. The fifth section describes the empirical illustration of the multidimensional intermediate between-group inequality measures.

Approaches to the measures of interpersonal and between-group inequality: Based upon the earlier discussion it is clear that there are two broad approaches in the measurement of inequality. One approach based measures are called relative inequality measures and other approach based measures are called absolute inequality measures. The inequality measures included in the first category satisfy the scale invariance property, i.e., the value of inequality assessed by the measure will be unchanged if all incomes will be changed by equal proportion. This condition can be written in the following way:

$$I^n(\lambda.Y) = I^n(Y); \quad \text{for } n \geq 2, Y \in D^n, \text{and } \lambda \in R_+ \qquad (1)$$

Where Y is income, n is the number of individuals or groups defined by some way of classification of population, and λ represents a particular proportion. The inequality measures included in the second category satisfy the translation variance property, i.e., the value of inequality assessed by the measure will be unchanged if all incomes will be changed by equal size or amount.

This condition can be written in the following way:

$$I^n(Y + \delta.1^n) = I^n(Y); \quad \text{for } n \geq 2, Y \in D^n, \text{and } \lambda \in R_+ \qquad (2)$$

Where Y is income, n is the number of individuals or groups defined by some way of classification of population, and λ represents a particular size or amount of the rise in income. Kolm (1997a & 1976b) has designated the relative inequality indices as rightist measures of inequality and absolute index of inequality index as leftist measures of inequality as equal proportional rise in income raises the absolute difference between the incomes and the actual inequality condition will be aggravated and equal absolute rise may reduce the percentage difference between the income levels of a distribution.

According to his view, if all observations increase by equal proportion (say, λ), the dispersion of the distribution will increase. On the contrary, when all observations increase by equal absolute amount, the lowest income will rise by the largest percentage or rate and the highest income will rise by the lowest percentage, i.e., dispersion of the distribution declines. Based on this view, Bossert and Pfingsten (1996) used the compromise property: (i) $I(x) < I(\lambda x)$, and (ii) $I(x) > I(x + \delta)$. This compromise condition is less conservative compared to the conditions applied in the case of relative measures of inequality. In case of relative inequality measures the condition is: $I(\lambda x) = I(x)$; where $n \geq 2$ and $x \in D^n$ and $\lambda \in R$ (R is the set of all real numbers). Likewise, for the absolute inequality measures: $I(x + \delta) = I(x)$; where $n \geq 2$and $x \in D^n$ and $\delta \in R$ ($\mathbb{R}$ is the set of all real numbers). On the basis of this view regarding the relative and absolute measures of inequality, Kolm (1997a & 1976b) proposed a less conservative approach to inequality and termed this new approach as 'intermediate approach' to inequality. The inequality measures which are based on the intermediate approach to inequality satisfy the aforementioned compromise condition. Different scholars have proposed different forms of the intermediate inequality measures and the fundamental similarity among all these measures is that they all satisfy the compromise condition[4].

Different intermediate measures of interpersonal inequality: Bossert and Pfingsten (1996; henceforth BP) have suggested a single parameter class of inequality measure, called μ-inequality concept. An index of intermediate inequality based on this μ-inequality concept satisfies the following condition: $I^n(x + \tau(\mu x + (1-\mu)1^n) = I^n(x)$; where n is the number of persons in the economy for vertical inequality measure and $n \geq 2$ and $(x + \tau(\mu x + (1-\mu)1^n) \in D^n$; where D^n is the set of all n-dimensional vectors with only non-negative components. BP have developed an index satisfying the intermediate attitude to inequality, which is based on the μ-inequality concept.The μ-inequality case is the intermediate case of the extreme two cases relative and absolute measures of inequality. For $\mu = 1$ the intermediate view becomes the relative view and for $\mu = 0$ the intermediate view becomes absolute view. If μ lies with 0 and 1 then the attitude to inequality becomes intermediate. However, with the rise in total income or attribute the value of the index approaches to the rightist or relative view of the

[2] One measure of intermediate multidimensional intermediate between-group inequality is defined from the group analogue of AKS measure and other is developed from the group analogue Generalized Gini (GGI) as described in Ray Chaudhury (2011). The first measure satisfies all axiomatic properties except the *correlation increasing majorization* criterion, but the second measure satisfies all axiomatic principle along with the *correlation increasing majorization criterion*.

[3] We assess between-group inequality in the distribution of consumer expenditure and years of education in Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

[4] Different intermediate measures are explained in the Appendix III.

Table 1. Average 'mpce' of the social groups in India and in its fourteen major states (in Rupees)

States	Rural (A)					Urban (B)				
	Others	OBC	SC	ST	Total	Others	OBC	SC	ST	Total
Andhra Pradesh	993.83	792.24	706.67	741.8	868.37	1491.63	1188.16	1254.98	1128.05	1340.48
Assam	1144.55	660.03	721.04	594.09	805.22	1380.44	1100.61	885.21	1126.02	1216.32
Bihar	749.56	627.06	518.32	400.52	610.24	1436.68	859.29	643.79	312.99	1037.6
Gujarat	880.2	750.72	740.14	528.27	817.7	1587.11	987.46	1016.38	901.6	1305.36
Karnataka	882.26	790.92	512.79	628.9	810.5	1641.93	1410.83	1020.82	968.09	1451.21
Kerala	1086.07	940.08	664.13	695.41	991.58	1415.32	949.71	781.32	789.99	1139.93
Madhya Pradesh	654.62	532.95	468.34	279.48	605.97	1265.47	813.69	713.46	657.84	1024.22
Maharashtra	708.53	716.07	610.93	454.02	806.73	1179.95	1033.83	873.31	1023.99	1137.52
Orissa	655.62	499.72	385.49	335.85	595.66	1623.27	1056.11	723.63	585.34	971.45
Punjab	1200.68	1002.16	794.54	866.17	1020.79	1409.76	1114.69	1086.55	1128.99	1284.14
Rajasthan	762.56	703.53	556.81	552.32	711.71	1515.45	914.73	748.26	966.08	1169.8
Tamil Nadu	975.79	833.69	653.8	490.16	814.6	1577.72	1155.42	899.84	573.56	1164.7
Uttar Pradesh	895.04	715.71	486.64	442.96	662.23	1498.33	966.9	843.89	1149.47	938.1
West Bengal	895.57	804.75	586.7	464.38	753.36	1470.61	1174.34	837.2	1200.9	1314.18
All India	869.99	774.88	581.18	450.16	771.85	1475.81	1096.21	925.44	1014.75	1235.94

Source: 66th Round of employment and Unemployment Survey (NSSO; 2009-10).

Table 2. Average years of schooling of the social groups in India and its fourteen major states

States	Rural (A)					Urban (B)				
	Others	OBC	SC	ST	Total	Others	OBC	SC	ST	Total
Andhra Pradesh	5.68	3.93	3.89	3.02	4.84	8.12	6.52	6.57	6.75	7.41
Assam	7.9	6.27	5.87	5.32	6.23	9.09	9.44	8.45	7.73	9.31
Bihar	5.87	3.33	2.47	1.32	3.87	8.79	6.65	4.57	8.12	7.75
Gujarat	5.72	4.59	4.8	3.37	5.08	9.66	6.65	6.95	6.74	8.36
Karnataka	6.05	5.27	3.8	4.22	5.15	9.66	7.91	6.49	6.37	8.28
Kerala	8.71	7.97	6.6	6.06	8.22	10.28	8.93	8.52	8.51	9.45
Madhya Pradesh	5.51	3.98	3.43	2.59	4.23	9.43	6.46	5.22	4.91	8.47
Maharashtra	5.92	5.71	5.24	4.56	5.85	8.76	8.45	6.89	6.29	8.4
Orissa	5.88	5.01	3.98	3.11	5.14	9.83	7.99	5.2	6.24	8.69
Punjab	5.78	5.48	4.42	4.14	5.17	10.08	7.83	7.52	6.86	8.9
Rajasthan	4.83	4.03	3.25	2.94	4.11	8.85	6.02	4.96	5.25	7.81
Tamil Nadu	6.43	6.02	5.05	4.62	4.98	9.6	7.91	6.49	5.31	8.68
Uttar Pradesh	5.96	4.07	3.47	2.73	4.69	8.82	6.62	5.11	8.7	8.22
West Bengal	6.38	5.59	4.01	2.49	4.9	9.73	8.04	6.45	6.77	9
All India	6.06	4.61	3.66	3.6	5.05	9.25	7.49	6.37	6.83	8.72

Source: 66th Round of employment and Unemployment Survey (NSSO; 2009-10).

Table 3. Multidimensional inequality among the social groups in rural areas

States	Rural		Urban	
	I_C^{AKS} $r_j(\forall j) = 0.5$ (2)	I_C^{GGI} $r_j(\forall j) = 0.5$ (3)	I_C^{AKS} $r_j(\forall j) = 0.5$ (4)	I_C^{GGI} $r_j(\forall j) = 0.5$ (5)
Andhra Pradesh	0.062 (6)	0.072(8)	0.063 (10)	0.08 (11)
Assam	0.075(5)	0.064 (9)	0.101(5)	0.068(14)
Bihar	0.133 (1)	0.179(1)	0.151 (2)	0.191(2)
Gujarat	0.037(12)	0.056(10)	0.053 (11)	0.074(12)
Karnataka	0.053 (9)	0.08(6)	0.067(9)	0.084 (9)
Kerala	0.041(11)	0.041(12)	0.041(14)	0.069(13)
Madhya Pradesh	0.091 (4)	0.137(3)	0.162 (1)	0.197(1)
Maharashtra	0.043(10)	0.04 (13)	0.069 (8)	0.082(10)
Orissa	0.119 (2)	0.145(2)	0.136(4)	0.149 (4)
Punjab	0.032(13)	0.037(14)	0.072 (7)	0.095 (7)
Rajasthan	0.059 (7)	0.105(4)	0.09(6)	0.128 (5)
Tamil Nadu	0.022(14)	0.055 (11)	0.051 (12)	0.11 (6)
Uttar Pradesh	0.097(3)	0.102(5)	0.149 (3)	0.152(3)
West Bengal	0.056(8)	0.079(7)	0.044(13)	0.087(8)
All India	0.092	0.091	0.112	0.163

Source: 66th Round of employment and Unemployment Survey (NSSO; 2009-10). Note: We take $\alpha_j = 100$ for monthly per capita consumption expenditure and $\alpha_i = 1$ for years of schooling.

inequality. Pfingsten and Seidle (1997) have pointed out these limitations of the BP index and proposed a wide class of intermediate inequality invariant measure, where the inequality invariant ray does not merge with the relative inequality invariant ray. The P-S inequality measure is called α-ray invariant inequality measure. In general α-ray invariance requires an inequality measure not to change provided any income change is distributed according to the value judgment presented by the relative pattern α. For an example, if for only two person economy the incomes of these two persons are X_1 and X_2. The values of these incomes are 200 and 600. Then α −ray invariant inequality measure states that the values of incomes will be 230 and 670, if income will rise by 100 units and $\alpha = (0.3, 07)$. Del Rio and Ruiz Castillo (1999; henceforth DRRC) have introduced another measure of intermediate inequality on the basis of invariance condition.

This DRRC class of intermediate inequality measure is a subset of the P-S intermediate measure. DRRC inequality

concept is called (v, π) inequality; where v is the reference of the initial distribution and π is related with the distribution of additional income, where $\pi \in (0, 1)$. Therefore, according to DRRC, if π100% of additional income will be allocated to individuals according to initial income shares and $(1 - \pi)$100% in equal absolute amounts, then the intermediate attitude of inequality will be satisfied.

Group analogue of multidimensional intermediate inequality measures: Following the multidimensional relative between-groups inequality indices in Ray Chaudhury (2011) and the literature on the intermediate approach to the measures of inequality we develop two intermediate measures of multidimensional between-group inequality in this study. The intermediate multidimensional between-group inequality measures developed in this study satisfy the compromise condition stated earlier section. The intermediate measures are developed by adding a constant 'α' with each observation of the attributes taken into account by following Aczel (1966).
If there are K well-define groups and M attributes, then the form of the first category of multidimensional intermediate between-group inequality measure is having the following form:

$$I_C^{AKS} = 1 - \left(\sum_{i=1}^{K} \lambda_i \left(\prod_{j=1}^{M} \left(\frac{\mu_{ij} + \alpha_j}{\mu_j + \alpha_j} \right)^{r_j} \right) \right)^{\frac{1}{\sum r_j}}$$

Based on the same number of well-defined groups and same number of attributes the form of the second measure of multidimensional between-group inequality measure is having the following form:

$$I_C^{GGI} = 1 - \left(\frac{1}{M} \right) \sum_{i=1}^{K} \lambda_i \left(\sum_{j=1}^{M} \left(\frac{\mu_{ij} + \alpha_j}{\mu_j + \alpha_j} \right)^{r_j} \right) + \left(\frac{1}{MK(K-1)} \right) \sum_{\substack{i=1 \\ i>j}}^{K} \sum_{l=1}^{K} \left(\left| \sum_{j=1}^{M} \left(\frac{\mu_{ij} + \alpha_j}{\mu_j + \alpha_j} \right)^{r_j} - \sum_{j=1}^{M} \left(\frac{\mu_{lj} + \alpha_j}{\mu_j + \alpha_j} \right)^{r_j} \right| . \lambda_i . \lambda_l \right)$$

Where λ_i and λ_l are the population shares of the i-th and l-th groups. The value of α_j shouldn't be very large, as the larger value of α reduces the importance of the observations. Therefore, α_j should be chosen carefully according to the observations of the attribute/s. These measures are less conservative and satisfy the *normalization*, *within-group anonymity* (index (3) satisfies the *between-group anonymity*, but index (4) does not satisfy this property), *total population size invariance* and *group replication invariance* principles[5]. These measures do not satisfy the *population composition invariance* principle as these are population weighted form of the group specific aggregate achievements across the dimensions. Like the multidimensional relative inequality measure, (3) satisfies only *uniform majorization* criterion, though (4) satisfies *uniform majorization* and *correlation increasing majorization criteria*.

Empirical illustration: We use the dataset provided by the 66th Round of employment and Unemployment Survey conducted by National Sample Survey Office (NSSO; 2009-10). The data were collected on the basis of multi-stage stratified random sampling method, which covers around 1,00,000 households and 5,00,000 individuals in rural and urban areas of India. This survey dataset provides information on household consumer expenditure, employment or occupational status, and educational achievements in terms of some categories of education and so forth. The categories of education are illiterate, illiterate but no formal schooling, formal schooling but below primary level of education, primary completed, middle level of education completed, secondary level of education completed, higher secondary level of education completed, and graduate and above. We convert these categories of education into years of schooling and use the dataset after this conversion[6]. The datasets provided by NSSO also provide some demographic details, such as sex, caste, religion, family background, and so on. The sample includes individuals belonging to different religious groups, and we take only those individuals who report themselves as Hindu as our objective is to evaluate the inequalities among the social groups in multidimensional space. Dropping all religious groups except Hindus, dataset contains only around 4,00,000 individual respondents. Finally we include the individuals age 25 years and above in the sample in our analysis, as the individuals included in this age groups have already completed their education. Accordingly the sample size reduces to 2,30,000.

Indian Hindu population can be classified into four social groups by caste, such as Higher castes (HCs), Other Backward Castes (OBCs), Scheduled Castes (SCs), and Scheduled Tribes (STs). We compute multidimensional intermediate between-group inequality in the distribution of household monthly per capita consumer expenditure and educational achievement by using the indices (3) and (4).Table 1 and 2 report the average household monthly consumer expenditure and years of schooling of four social groups across rural and urban areas in fourteen major state of India. The comparing the reported values of monthly household per capita consumer expenditure and years of schooling across the social groups we can explain the between-group inequality in the distribution of consumer expenditure and in education. However, it is very hard to explain these inequalities. For this reasons we use the summary measure of between-group inequality. The reported values of and in Table 3 for rural areas reveal that between-group inequality in monthly per capita consumer expenditure, and education is the highest in Bihar which is one of the BIMARU states. Tamil Nadu occupies the better position compared to other thirteen major states in terms of between group inequality in the earlier mentioned two dimensions of well-being. It can be observed from the reported figures in Table 3 that the multi-dimensional intermediate between-group inequality in urban Madhya Pradesh is the highest, which is also one of the BIMARU states of India, and urban areas of Kerala occupies the better position compared to all other major states taken into account in terms of multidimensional between-group inequality across the social groups. The states are ranked according to the computed values of and in rural and urban areas. While we use the measure instead of then in the rural areas some states move up in the league table and similar fact can be observed in the case of urban areas. However, the ranking differential between and is not significant (Spearman's rank correlation coefficient being 0.991, significant at 1 percent level) for rural areas, and also for the urban areas (Spearman's rank correlation coefficient being 0.983, significant at 1 percent level). This implies that the use instead of does not provide any significantly different picture on multidimensional inequality among the social groups across the major states of India.

[5] All the axiomatic properties or dominance criteria and majorization criteria are are explained in Ray Chaudhury (2011).

[6] The method of conversion is given in Table (A1) in Appendix II.

However, the ranking of the states change significantly while we move from rural to urban areas of India. The computed value of the Spearman's rank correlation coefficient between the ranks of the states by in rural and urban areas is having the value 0.709 (significant at 5 percent level), and the computed value of the Spearman's rank correlation coefficient between the ranks of the states by in rural and urban areas is having the value 0.687 (Significant at 5 percent level). Therefore, even if the ranking differential between the rural and urban areas is not significant but the level of significance of the Spearman's rank correlation coefficient rises from 1 percent level to 5 percent level, which implies that the strength of association between the ranks of the states across rural and urban areas is relatively low. One important thing can be noticed that the values of multidimensional between-group intermediate inequality in urban areas is greater than in the rural areas for almost all states irrespective the measure we use in the analysis.

Conclusion

In this study we have developed two multidimensional intermediate between-group inequality measures based on the two multidimensional relative between-group inequality measures derived in Ray Chaudhury (2011). The measure developed in this study satisfies the centrist attitude towards inequality. We apply these newly defined measures on Indian data and assessed inequality across four social groups across rural and urban areas of fourteen major states. An important finding in the empirical section of this study is that in India there is a striking contrast in the between-group inequalities in the multidimensional distribution of 'mpce' and 'years of schooling' between rich and poor state-regions classified by the average 'mpce'. In the relatively richer states the computed values of multidimensional between-group inequality assessed by some standard measures of inequality are less than the multidimensional between-group inequalities in the poorer states. This raises the important question, at least in the context of India, if inequality between groups comes down with economic prosperity.

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Appendix I

Group analogue of multidimensional Atkinson-Kolm-Sen measure

The group analogue of Atkinson-Kolm-Sen measure of multidimensional inequality is having the following form as described in Ray Chaudhury (2011):

$$I^{AKS} = 1 - \left(\sum_{i=1}^{K} \lambda_i \left(\prod_{j=1}^{M} \left(\frac{\mu_{ij}}{\mu_j}\right)^{r_j}\right)\right)^{\frac{1}{\sum r_j}} \qquad (1A)$$

Group analogue of multidimensional Generalized Gini Index(GGI)

The group analog**u**e of the multidimensional Generalized Gini Index (List, 1999) is having the following form as derived in Ray Chaudhury (2011):

$$I^{GGI} = 1 - \eta + \theta \qquad (2)$$

Where $\eta = \left(\frac{1}{M}\right) \sum_{i=1}^{K} \lambda_i . \left(\sum_{j=1}^{M} \left(\frac{\mu_{ij}}{\mu_j}\right)^{r_j}\right)$ and

$$\theta = \left(\frac{1}{MK(K-1)}\right) \sum_{\substack{i=1 \\ i>j}}^{K} \sum_{l=1}^{K} \left| \left(\sum_{j=1}^{M} \left(\frac{\mu_{ij}}{\mu_j}\right)^{r_j}\right) - \left(\sum_{j=1}^{M} \left(\frac{\mu_{ij}}{\mu_j}\right)^{r_j}\right) \right| . \lambda_i . \lambda_l$$

Appendix II

Table A1. Transformation of education codes into years of education

Educational attainment code	Imputed years of education
Not literate	0
Literate through attending NFEC/AEC, TLC or others	1
Literate, but below primary	3
Primary	5
Middle	8
Secondary	10
Higher secondary	12
Diploma and other equivalent degrees	14
Graduation	15
Post-graduation and others	17

Note: NFEC = Non Formal Education Centre, TLC = Total Literacy Campaign, AEC = Alternative Education Centre

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