ESTIMATING LITERACY RATE: A Study Relating Literacy Rate with Combined Gross Elementary and Secondary Schools Enrollment Rate

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I. INTRODUCTION

Literacy rate is one of the core indicators used to measure social development. As the gauge of the extent to which populations possess the rudimentary skills of reading and writing, it is usually taken, along with other indicators, to reflect the quality of human resource and even the quality of life of a society. Moreover, planners and policy makers need estimates of literacy rate to evaluate past performance and to formulate more responsive education policies. To underscore its importance, literacy rate has annual targets in the *Five-Year Philippine Development Plan, 1978-1982.* In the Macro Component of the Economic and Social Impact Analysis/Women-in-Development (ESIA/WID) Project, literacy rate is the key indicator of the education sector framework.

Literacy data, however, are relatively scarce because of the costs involved in their collection and processing. In the Philippines, literacy counts are conducted in the census of the population that is undertaken roughly every ten years; past censuses were in 1903, 1918, 1939, 1948, 1960, 1970, and most recently, 1980 (Table 1).

This paper addresses the problem of generating annual literacy rate estimates to fill the gap between planning considerations and the scantiness of statistics on literacy.

II. ANALYSIS OF LITERACY RATE

Literacy data in the Philippines have been gathered in censuses of the population since 1903 (Table 1). The collection procedure is as follows: the respondent, a responsible member of the household, is

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TABLE 1
LITERACY RATE OF THE POPULATION 10 YEARS OLD AND OVER: 1903, 1918, 1939, 1948, 1960 AND 1970

Year	*Literacy Rate (in Percent)*	*Total Population (10 and over)*	*Literates*
1903	20.16	4,973,526	1,002,588
1918	49.19	6,381,261	3,138,634
1939	48.81	10,888,898	5,315,510
1948	61.30	12,984,079	7,950,644
1960	72.05	18,145,872	13,073,743
1970	83.37	25,195.125	21,004,399

Source of basic data: National Census and Statistics Office, *Philippine Yearbook 1978.*

asked what the highest grade completed by each household member is and whether or not he (she) attended school in the preceding school year. For each member ten years old and over,[1] the respondent is then asked if he (she) is literate or able to read and write. However, all persons who have completed grade 4 are automatically considered literate.

This method of gathering literacy data without verification tests has been criticized, particularly by Keane (1970, p. 91). Given that the Philippines is noted for the high social regard accorded to education and, by extension, to literacy, data on literacy and educational attainment could have an upward bias. Keane cites studies undertaken by the Bureau of Public Schools in the early sixties which revealed that Grade 4 pupils had a literacy rate of only 53 percent for languages used at home and only 35 percent and 28 percent for Pilipino and English, respectively, which are the two languages learned in school.

This argument notwithstanding, it can still be surmised that, with the extensiveness of the formal school system in the Philippines, most people acquire literacy skills from the schools. In fact, based on the operational definition in the Census, literacy is a function of school enrollment or attendance.

1. The minimum age for the literacy question was lowered to six in the 1970 Census of Population and Housing.

This hypothesis (that enrollment determines the number of literates) is supported by a report done by McGranahan and others for UNRISD in which a cross-sectional correlation matrix was drawn up for 73 indicators based on data from 115 countries to determine their correspondence with socioeconomic development (McGranahan et al. 1972, p. 55). The correlation coefficient between literacy rate and combined primary and secondary enrollment rate was 0.948.

Moreover, an analysis of the 1960 and 1970 data of literacy rate for the Philippines, by selected minimum ages (10 years old and over, 15 years old and over, and 25 years old and over), shows that literacy rate decreases as the selected minimum age of its target population increases (see Table 2). Thus, in 1960, the literacy rate for both sexes is 72.1 percent for the population 10 years old and over, 71.9 percent for those 15 years old and over, and 64.5 percent for those 25 years old and over.

These numbers are indicative, perhaps, of the fact that relatively more schooling opportunities are available to children today as compared to their peers in earlier generations. Furthermore, the implication is that, despite the steeply pyramidal population structure of the Philippines, the formal school system is achieving its basic objective which is to inculcate literacy skills in students.

However, the 1960 and 1970 data also suggest that the scope of the nonformal education system still leaves many things to be desired. There is probably a lack of institutional outreach programs for people who dropped out of or were not able to attend school, so that the population 25 years and over exhibits a level of literacy rate substantially below that of population groups with lower minimum ages. This implies that the formal school system is still the institution with education primacy.

Perhaps because of this finding, among other reasons, the National Manpower and Youth Council (NMYC) was established in the early seventies to take charge of the nonformal education sector. The effectiveness of NMYC programs should become evident in the literacy performance of the older population groups in the 1980 Census and subsequent censuses.

III. HYPOTHESIS

Based on the above, two hypotheses can be submitted:

(a) Literacy rate and the combined gross elementary and second-

TABLE 2
LITERACY RATE OF THE POPULATION BY SELECTED MINIMUM AGES, BY SEX
1960 AND 1970

Year	*BOTH SEXES*			*MALE*			*FEMALE*		
	10 Years Old and Over	*15 Years Old and Over*	*25 Years Old and Over*	*10 Years Old and Over*	*15 Years Old and Over*	*25 Years Old and Over*	*10 Years Old and Over*	*15 Years Old and Over*	*33 Years Old and Over*
1960	72.1	71.9	64.5	73.6	74.2	68.8	70.6	69.5	60.6
1970	83.4	82.6	77.7	84.6	84.3	80.5	82.2	80.9	74.3

Source of basic data: National Census and Statistics Office, *Census of Population and Housing*, 1960, 1970.

ary schools enrollment rate are longitudinally correlated in the Philippine experience; and

(b) Given this relationship, the combined gross elementary and secondary schools enrollment rate may be used to estimate literacy rate.

IV. CONCEPTS

Literacy rate is defined, usually for census purposes, as the percentage of the population which can, with understanding, both read and write a simple message about everyday life. Thus, a person who can read but not write or vice versa is not considered literate. The standard formula of literacy rate may be stated as:[2]

$$R_i = \frac{L_i}{P_i} \times 100$$

where R_i = literacy rate of age group i (usually ten years old and over)
L_i = number of literates of age group i
P_i = population of age group i

Enrollment is defined in the *Glossary of Education Terms* as the total number of pupils or students who have registered as of September 1 in a given school year.[3] The formula for combined gross elementary and secondary schools enrollment rate may be given as:

$$G = \frac{E + S}{\sum_{i=7}^{16} P_i} \times 100$$

where G = gross enrollment rate
E = elementary school enrollment
S = secondary school enrollment
P_i = population of age group i (where i = 7 to 16 years)

2. For purposes of this paper, the minimum age used is ten years old.

3. *Glossary of Education Terms*, Technical Working Group on Education and Manpower Statistics, 1982. Mimeographed.

Being a "gross" measure, the enrollment rate may include overaged and underaged students in the numerator, although its denominator covers the population of a specific age group.

V. METHODOLOGY

The following were done to test the hypotheses.

1. Collection of enrollment statistics

Several sources of data on elementary and secondary enrollment were identified: the 1979 and 1980 editions of the *MEC Statistical Bulletin* and the *Philippine Enrollment Projection Program (PEPP)*, both of the Ministry of Education and Culture Office of the Planning Service (MEC, OPS); and the 1979, 1980, and 1981 editions of the *Philippine Statistical Yearbook* of the National Economic and Development Authority (NEDA) (refer to Table 3). From SY 1949-50 to SY 1966-67, data were taken from the *1979 Philippine Statistical Yearbook*. In the next segment of the time series, between SY 1967-68 and SY 1971-72, the statistics of the *1979 MEC Statistical Bulletin* were used. Enrollment figures between SY 1972-73 and SY 1978-79 were lifted from the PEPP tables. For SY 1979-80, the enrollment level reported by the *1980 MEC Statistical Bulletin* was used.

2. Collection and adjustment of population data for enrollment rate[4]

The population aged 7 to 16 years constitutes the denominator for combined gross elementary and secondary schools enrollment rate. Population estimates for this age group, however, are not readily available from the National Census and Statistics Office (NCSO), which is the official source of population data.

The usual procedure for deriving the estimates of the 7-16 population is to break down population figures that are reported in five-year age groups into single ages. This is done by using a set of coefficients called the Sprague Multiplier, "a 6 term fifth difference osculatory formula" (Shryock et al. 1971) that maintains given population totals while arriving at single age values. Single age estimates of from 7 to 16 years can then be summed to obtain the enrollment rate denominator.

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4. Thanks are due to Ms. Lydia Baal of the NCSO who provided the procedure for the adjustment process.

TABLE 3
COMBINED ELEMENTARY AND SECONDARY SCHOOLS' ENROLMENT BY SOURCE: SY1949-50 TO SY1979-80

School Year	*Combined Elementary and Secondary Schools Enrollment*				
	I	*II*	*III*	*IV/V*	*VI*
49-50	4,260,815[a]	–	–	–	–
50-51	4,367,971[a]	–	–	–	–
51-52	4,509,659[a]	–	–	–	–
52-53	4,141,774[a]	–	–	–	–
53-54	4,050,827	–	4,050,827	–	–
54-55	4,004,285	–	–	–	–
55-56	4,042,824	–	–	–	–
56-57	4,221,687	–	–	–	–
57-58	4,289,853	–	–	–	–
58-59	4,558,208	–	4,558,208	–	–
59-60	4,762,287	–	–	–	–
60-61	4,808,045	–	–	–	–
61-62	5,100,627	–	–	–	–
62-63	5,584,394	–	–	–	–
63-64	6,109,332	–	6,109,332	–	–
64-65	6,539,460	6,539,460	–	–	–
65-66	6,909,985	6,909,985	–	–	–
66-67	7,398,208	7,398,208	–	–	–
67-68	7,745,848*	7,705,848*	–	7,773,157	–
68-69	8,115,086	8,115,086	8,206,197	8,206,197	–
69-70	8,351,842	8,351,842	8,446,857	8,446,857	–
70-71	8,589,536	8,589,536	8,688,364	8,688,364	–
71-72	8,727,432	8,727,432	8,802,654	8,802,654	–
72-73	8,950,105[b]	8,937,820	8,897,721	8,888,724	8,888,739
73-74	9,306,948[b]	9,210,693	9,167,087	9,167,087	9,189,453
74-75	9,585,987[b]	9,591,737	9,541,425	9,541,425	9,526,251
75-76	9,900,699[b]	9,944,094	9,888,986	9,888,986	9,922,900
76-77	–	–	10,316,677	10,316,677	10,195,005
77-78	–	–	10,558,101	10,558,101	10,561,579
78-79	–	–	10,999,078	10,997,223[c]	10,999,078
79-80	–	–	10,994,229	10,994,229[d]	10,999,078

– Not available
a Only UP is included in State Colleges and Universities.
b Enrollment figures for UP, State Colleges and Universities are projected.

The distribution of the population by five-year age groups is therefore crucial in obtaining the estimates of the population base of enrollment rate. Data, however, are available only in census years (1939, 1948, 1960, 1970, 1975, and 1980). For intercensal years, only total population estimates, as of July, are prepared by the NCSO. In order to derive annual five-year age group estimates, the growth rates of estimates of each five-year age group between two consecutive censuses were computed (and assumed constant throughout the intercensal period), using the formula:

EQ 1:
$$r_i = \left[\left(\frac{P_{li}}{P_{oi}} \right)^{1/t} - 1 \right] \times 100\%$$

where r_i = annual growth rate of five-year age group i
P_{oi} = population of five-year age group i at base period 0 (or the earlier censal year)
P_{li} = population of five-year age group i after a period of time from base period 0 (i.e. the later censal year)
t = time elapsed (in years) between P_{li} and P_{oi}

The set of growth rates obtained in the above equation were then used to derive the "preliminary" July estimate of each age group, as t was incremented for each iteration to the time elapsed from 0, i.e.

EQ 2: $$P_{ji} = P_{oi} \times (r_i + 1)^t$$

where P_{ji} = the population of age group i at year j
P_{oi} = population of five-year age group i at base period 0
r_i = annual growth rate of five-year age group i
t = time elapsed (in years) between P_{ji} and P_{oi}
j = an intercensal year between 0 and 1 of *EQ*1.

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c Projected.
d Actual. Source: 1980 MEC Statistical Bulletin.
* The difference between the figures is due to a discrepancy in the reported enrollment of the Bureau of Public Schools: 6,176,737 in the 1979 Statistical Yearbook and 6,136,737 in the 1980 Statistical Yearbook.

Sources of data:
I. NEDA, 1979 Philippine Statistical Yearbook
II. NEDA, 1980 Philippine Statistical Yearbook
III. NEDA, 1981 Philippine Statistical Yearbook
IV. SY1967-68 to SY1978-79: MEC, 1979 Statistical Bulletin. SY1979-80: MEC, 1980 Statistica Bulletin.
V. MEC, Philippine Enrollment Projection Program (PEPP).

These age group estimates were then summed up for each year ($\sum_{i=1}^{n} P_i$ for every j). Subsequently, percentage shares ($P_i/\Sigma P_j$) of the various age groups were computed. Completing this step, the percentages were multiplied by their corresponding estimates of total population which are separately prepared by the NCSO. The resulting figures were regarded as the "final" five-year age group estimates, the sum total of which was equal to the annual total population estimates of the NCSO.

3. Computation of combined gross elementary and secondary schools enrollment rate

Combined gross elementary and secondary schools enrollment rates were computed by taking the sum of elementary and secondary enrollments and dividing it by the population estimate for that school year (Table 4).

4. Estimation of the literacy rate

While annual estimates of enrollment rate are readily available, literacy rates are generated only in census years. The logistic curve equation that was developed to set annual Plan targets for literacy rate was used to produce annual estimates from 1939 to 2000 (see Table 5).

The procedure for deriving the parameter values of the logistic curve model for literacy rate is as follows: Given the equation

$$L_t = \frac{K}{1 + e^{(a + bt)}}$$

where L_t = literacy rate at time t
K = the asymptote (in this case, $K = 100$)
a, b = L intercept and slope, respectively
t = elapsed time in years

The usual manner of deriving a and b (and sometimes K) is to take three values of L_t which are equidistant or in which the number of years between consecutive L_t values are equal, e.g. L_2, L_1, and L_0.

To get a, let $t = 0$ so that

$$L_0 = \frac{K}{1 + e^a}$$

TABLE 4

COMBINED GROSS ELEMENTARY AND SECONDARY SCHOOLS ENROLLMENT RATE, SY1953-54 TO SY1977-78 AND LITERACY RATE, 1956 TO 1980

School Year	*Combined Gross Elementary and Secondary Schools Enrollment Rate*	*Year*	*Literacy Rate*
1953-54	68.39	1956	69.71
1954-55	65.71	1957	70.80
1955-56	64.48	1958	71.86
1956-57	65.45	1959	72.90
1957-58	64.64	1960	73.91
1958-59	66.76	1961	74.90
1959-60	67.80	1962	75.86
1960-61	66.35	1963	76.80
1961-62	67.94	1964	77.71
1962-63	71.81	1965	78.60
1963-64	75.92	1966	79.46
1964-65	78.36	1967	80.29
1965-66	79.94	1968	81.10
1966-67	82.62	1969	81.88
1967-68	83.80	1970	82.64
1968-69	85.41	1971	83.37
1969-70	85.01	1972	84.08
1970-71	84.47	1973	84.76
1971-72	83.60	1974	85.42
1972-73	82.47	1975	86.05
1973-74	83.29	1976	86.66
1974-75	84.36	1977	87.25
1975-76	86.04	1978	87.82
1976-77	87.25	1979	88.36
1977-78	89.31	1980	88.89
1978-79	91.99	1981	89.39
1979-80	91.03	1982	89.87

TABLE 5
LITERACY RATE, 1939-1980
(Estimated by logistic curve), $L_t = \frac{100}{1 + e^{0.0486 - 0.0519t}}$

Year	*t*	*Literacy Rate*	*Year*	*t*	*Literacy Rate*	*Plan Targets*
1939	0	48.79	1970	31	82.64	
1940	1	50.08	1971	32	83.37	
1941	2	51.38	1972	33	84.08	
1942	3	52.67	1973	34	84.76	
1943	4	53.97	1974	35	85.42	
1944	5	55.25	1975	36	86.05	86.1
1945	6	56.53	1976	37	86.66	86.7
1946	7	57.80	1977	38	87.25	87.3
1947	8	59.06	1978	39	87.82	87.8
1948	9	60.31	1979	40	88.36	88.4
1949	10	61.55	1980	41	88.89	88.9
1950	11	62.77	1981	42	89.39	89.5
1951	12	63.97	1982	43	89.87	
1952	13	65.16	1983	44	90.33	
1953	14	66.33	1984	45	90.79	
1954	15	67.48	1985	46	91.20	
1955	16	68.61	1986	47	91.61	
1956	17	69.71	1987	48	92.00	92.1
1957	18	70.80	1988	49	92.37	
1958	19	71.86	1989	50	92.73	
1959	20	72.90	1990	51	93.07	93.1
1960	21	73.91	1991	52	93.40	
1961	22	74.90	1992	53	93.71	
1962	23	75.86	1993	54	94.01	
1963	24	76.80	1994	55	94.30	
1964	25	77.71	1995	56	94.57	
1965	26	78.60	1996	57	94.83	
1966	27	79.46	1997	58	95.08	
1967	28	80.29	1998	59	95.32	
1968	29	81.10	1999	60	95.54	
1969	30	81.88	2000	61	95.76	95.8

$$\text{Thus, } a = ln \left(\frac{K}{L_0} - 1 \right)$$

To derive the value for b_1, a technique is used in which the differences between the reciprocals of consecutive L values are equated.

$$\text{Let } \frac{1}{L_2} - \frac{1}{L_1} = \frac{1}{L_1} - \frac{1}{L_0} \text{ so that}$$

$$1 = \frac{\frac{1}{L_2} - \frac{1}{L_1}}{\frac{1}{L_1} - \frac{1}{L_0}} \quad \text{or} \quad \frac{\frac{e^{a+2b}}{K} - \frac{e^{a+b}}{K}}{\frac{e^{a+b}}{K} - \frac{e^{a}}{K}}$$

This should result in $b = ln\ (1/L_2 - 1/L_1)/(1/L_1 - 1/L_0)$. (See Yamane 1967.)

However, the available input data for L in this case are not equidistant; literacy rates were generated for the following census years: 1939, 1948, 1960, and 1970. Therefore, another technique has to be used in which the equation is transformed into a linear equation.

$$\text{Thus: } L_t = \frac{K}{1 + e^{a+bt}}$$

$$\frac{K}{L_t} = 1 + e^{a+bt}$$

$$\frac{K}{L_t} - 1 = e^{a+bt}$$

$$ln \left(\frac{K}{L_t} - 1 \right) = a + bt$$

$$\text{Let } L_t' = ln \left(\frac{K}{L_t} - 1 \right)$$

$$\text{so that } L_t' = a + bt$$

In this form, the least squares method can be applied to get a and b values, regardless of the distance among L values.

$$\text{Thus: } b = \frac{n \Sigma\ tL_t' - \Sigma t \Sigma L_t'}{n \Sigma\ t^2 - (\Sigma t)^2}$$

and

$$a = \bar{L}_t' - b\bar{t}$$

Using the figures of literacy rate in Table 1 (1939: $t = 0$), the logistic curve equation is derived as:

$$L_t = \frac{100}{1 + e^{0.0486 - 0.0519t}}$$

5. Correlation

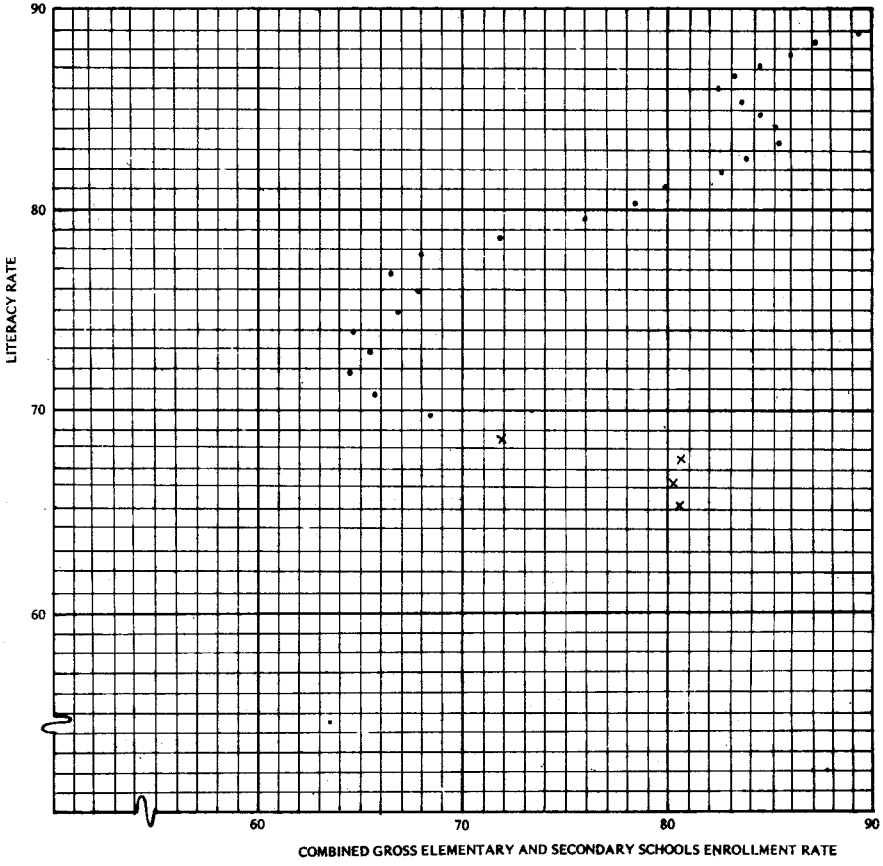
The values of literacy rate and the combined gross elementary and secondary schools enrollment rate were plotted in a scatter diagram with enrollment rate at the X axis and literacy rate at the Y axis (see Chart 1). To accommodate the two-year delay in the publication of enrollment statistics, an equivalent lag was introduced in the model. For instance, literacy rate for 1978 was aligned with the enrollment rate of SY 1975-76.

An initial glance at the chart shows that the trend appears to zigzag. Since literacy rate is derived by logistic curve, its path inexorably rises. Enrollment data, on the other hand, are derived from administrative reporting forms of the Ministry of Education and Culture, so that its level is subject to the vacillations of economic and demographic elements.

These considerations allow misgivings that the relation between the two variables may be spurious after all. However, deeper examination of the trend indicates that, if one dropped the first four observations, there would be a definite rising curve in the ordered pairs of literacy rate and gross enrollment rate. Moreover, the first four observations, which are equivalent to SY 1949-50 to SY 1952-53 of the enrollment rate series, may be caused by disruptions in the normal relationship between the relevant age group and the enrollment population. It may be speculated that the years immediately succeeding World War II saw extremely high enrollment rates because of delayed and overaged students who were unable to attend school in the war years. This would explain the high enrollment levels relative to low literacy rates in the years mentioned. The tapering off of enrollment rate at the start of the enrollment rate series would be reflective of the gradual stabilization in enrollment rates as the delayed enrollees were graduated from the school system by means of accelerated programs.[5]

5. Another reason for dropping off the first four school years from the ob-

CHART 1
SCATTER DIAGRAM OF COMBINED GROSS ELEMENTARY AND SECONDARY SCHOOLS ENROLLMENT RATE AND LITERACY RATE



After deliberating these issues, it was decided to compute for a linear correlation coefficient. The coefficient of determination was also calculated, and the *t*-test was used to test the significance of the relationship. The results of the computations, including the values of the linear equation, are given in the next section.

VI. PRESENTATION OF FINDINGS

The relationship being tested here between literacy rate and combined gross elementary and secondary schools enrollment rate had 25 observations. The coefficient of correlation for the linear model is computed at 0.9391 and its corresponding coefficient of determination, which is the degree of variation exhibited by literacy rate that can be explained by or attributed to changes in the enrollment rate, is 0.8819. The computed t at 13.1059 is found to be significant at $\alpha = 0.001$ ($t = 3.792$).

The equation of the model may be expressed as:

$$L_t = 31.8291 + 0.6327\, X_{t-2}$$

where L_t = literacy rate at time t

X_{t-2} = combined gross elementary and secondary schools enrollment rate at time $t - 2$.

VII. LIMITATIONS

The limitations of the study are mainly concerned with the quality and scarcity of the data inputs. The gap in the availability of literacy data led to the use of the logistic curve equation to generate the needed annual figures. In effect, the present model is rooted in statistics derived from a model which it actually seeks to improve.

It is also unfortunate that the absence of a published figure for literacy rate (based on the 1980 Census of Population and Housing) and the lack of agreement in its definition[6] preclude a way in which the methodology submitted here may be verified.

Enrollment data for the same school years, on the other hand, had different reported figures, although all publications cite the

servations of the correlation is that enrollment levels do not include those of state colleges and universities aside from UP. (Refer to the footnote in Table 3.)

6. The MEC publishes literacy data based on school attendance or non-attendance.

Ministry of Education and Culture as their primary source of data. This problem resulted in several shifts in the growth of the enrollment series.

Since a model is only as good as its data inputs, the poor quality of the data has serious implications on the accuracy of the model itself relative to the reality it attempts to describe.

VIII. CONCLUSION

Based on its results, this study may be deemed to have validated the hypothesized relationship. Its theoretical significance is in replicating, in a sense, the relationship reported by McGranahan in his study. The difference, however, lies in the fact that while the correlation matrix done in the earlier study used inter-country data for a single point in time, the present research shows that the relationship between enrollment and literacy rates still holds using time series data for a single country.

Another value of the study is that, with the estimating equation, it is now possible to estimate the level of literacy rate, given the value of combined gross elementary and secondary schools enrollment rate. The policy implication of this is that the equation may be used to derive estimates of the budgetary allocations for enrollment that would cause a unit increase in literacy rate.

In conclusion, it needs to be stressed that the study is merely an initial attempt to construct a simple model which would estimate the level of output from input or intermediate variables that are tractable to manipulation by policymakers. More intensive and sophisticated studies are called for to discover the interrelationships among an array of variables together with the direction and magnitude of their causality, so that understanding of the social aspects of development will be enhanced.

IX. RECOMMENDATION

As part of the process to improve the estimation of literacy rate, it is recommended that another model be developed which is closer to the operational reality in collecting literacy data. In the section on Analysis of Literacy Rate, it was stated that Grade 4 was considered the cut-off point beyond which students were automatically recorded as literate. From this fact, the following model may be conceived:

$$L_t = \alpha L_{t-1} + \beta E_t$$

where L = number of literates
E = number of Grade 4 enrollees
α = survival rate of the literate population (10 years old and over)
β = survival rate of the 10-year-old population

In this model, the number of literate persons is considered as the sum of the stock of surviving literates in the previous year, e.g., a census year, and the number of Grade 4 pupils in the current year who survive.

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