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STATISTICAL ANALYSIS OF DEMOGRAPHIC AND EDUCATION DATA FOR PROJECTING SCHOOL ENROLMENT IN INDIA

Document prepared for the national training seminar on methods for projecting school enrolment in India

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PREFACE

Projection of the future number of pupils enrolled constitute the starting point of quantitative educational planning, as they provide the basis for estimating the future needs of teachers, classrooms and other facilities. While in developing countries the need for such projections is well recognized, the national services responsible for their preparation do often not have sufficient personnel qualified in the statistical methods required. This is particularly true for methods which take adequately into account population variables and which are adapted to the education and population data available in these countries.

The Unesco Office of Statistics, Paris, has since 1972 been engaged in preparing education projections with special reference to developing countries. In the course of this work, the need for specialized training in simple statistical methods for quantitative analysis of the relationship between population growth and education requirements became evident. To meet this need the Office has, with the financial support of the UNFPA (United Nations Fund for Population Activities) undertaken to arrange national training seminars on methods for projecting school enrolment in developing countries. The project includes four seminars per year during the three year period 1977-1979. Its main objective is to develop a greater awareness in developing countries of the need to take adequately into account population variables when preparing educational plans. This will be achieved by promoting the use of statistical methods adapted to the education/population problems encountered and the statistical data available in the countries participating in the project. Each seminar will last for about 10 working days and is designed for around 30 participants, drawn to the extent possible from services responsible for educational statistics and educational planning at the regional and province level.

India is one of the four countries participating in the second year of this project. The seminar in India will be held in New Delhi in the period 20 November - 1 December, 1978. The purpose of the present document is to serve as a support for the teaching at this seminar. Although self-contained, this document should be read with this in mind since several topics which have only been touched upon here will be dealt with in further detail during the sessions.

The seminar has been arranged jointly by the Unesco Office of Statistics and the National Staff College for Educational Planners and Administrators New Delhi, in co-operation with the Union Ministry of Education and Social Welfare, Government of India. We should like to express our deep gratitude to the national authorities for their help in supplying the statistical information required for preparing this document.

Paris, September 1978

UNESCO OFFICE OF STATISTICS

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PART I : POPULATION AND EDUCATION IN INDIA

SECTION 1 : POPULATION: BASIC CONCEPTS OF DEMOGRAPHY

I.1.1 The subject-matter of demography

Demography is the scientific study of certain characteristics of human populations, particularly with respect to their magnitude, their change over time, and their structures according to sex, age, occupation, geographical location and other characteristics. Virtually all quantitative analyses in educational planning depend upon population information in one form or another. For this reason all educational planners need an understanding of the basic concepts of demography - including an appreciation of their limitations. We shall therefore review some of these concepts in this section. However, as the main objective of this seminar is to provide training in education projection methods, this review will be partial and the readers are referred to specialized literature on demography for further study of this topic.

Human populations undergo continuous change. The changes in the set of individuals which make up the population may be divided into three, usually termed by demographers the "vital" processes :

a) births
b) deaths
c) migration.

Before we examine how these vital processes may be measured, let us look at a fundamental statistic: the size of the population.

I.1.2 The size of the population

The main sources of information on population size - that is the state of a population at a given time - are from censuses and registration systems. Censuses involve the complete enumeration of all the inhabitants of a defined geographical area. In developed countries these have had a long and valuable history. In the United Kingdom, for example, censuses of the population have been taken every tenth year since 1801. They are, however, expensive to carry out and demand large numbers of trained personnel for their satisfactory completion. Consequently, a number of developing countries have yet to implement scientific population censuses. This is not the case in India where a number of population censuses have been carried out.

Table 1 shows the absolute size of the Indian population in decennial Censuses 1901-1971, and the average annual rates of population growth between the Censuses (1). The table shows that over the seventy years 1901-1971 the population grew by 309.8 million. This represents a total percentage growth of 129.9%, at an average annual rate of 1.2%.

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(1) The concept of the average annual growth rate is defined in I.1.3 below.

Figure 1. Growth of Population in India 1901-1971 (millions)

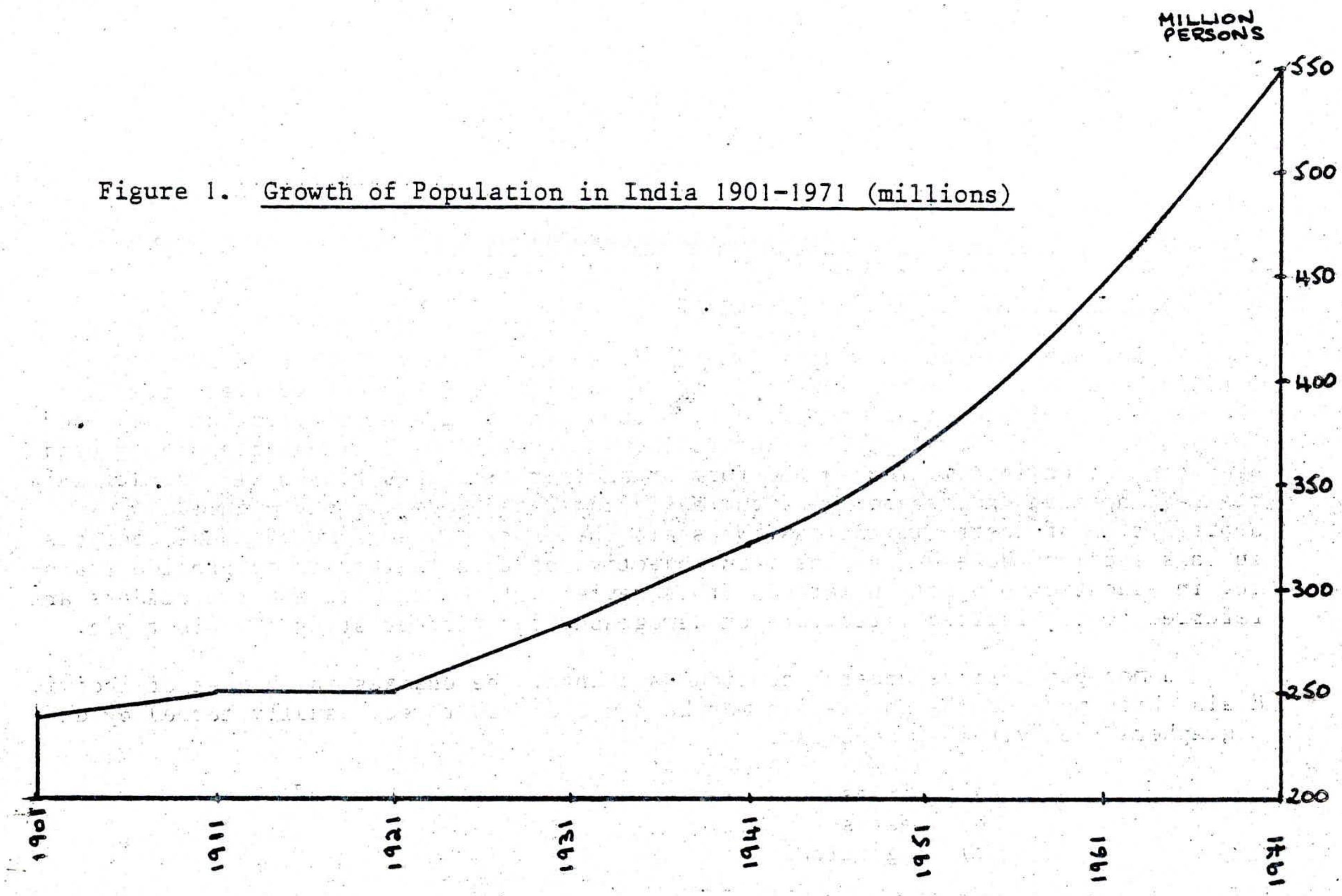

Table 1. Population Size and Average Annual Rate of Growth in India, Decennial Censuses 1901-1971.

Census date	Population (millions)	Average Annual Rate of Growth Between Censuses (%)
1901	238.4	0.56
1911	252.1	-0.03
1921	251.3	1.05
1931	279.0	1.34
1941	318.7	1.26
1951	361.1	1.98
1961	439.2	2.24
1971	548.2	

Source : Statistical Abstract, India 1975, Central Statistical Organization, Ministry of Planning, Table 5.

It may be noted that the highest inter-censal average annual growth rate of 2.24% occured during the most recent inter-censal period, 1961-1971. This high rate however declined over the period 1971-1976. The Expert Committee on population projections estimated that the 1976 population totalled 610.1 million (1). Over the 5

(1) Statistical Pocket Book, India, 1977, Central Statistical Organization, Ministry of Planning, p. 6; and Demographic Yearbook, 1976. United Nations, New York, 1977; Table 3.

year period 1971-1976 this represented an average annual growth rate of 2.16%. A further projection for 1981 (1) has suggested that total population will be 672 million. This would represent a slight decline in the average annual growth rate to 2.1% over the total ten year period 1971-1981.

Projections of the Indian population were assessed by the United Nations in 1973 and are presented in Table 2. Three alternative sets of assumptions regarding trends in the vital processes are made (See Section I.1.8 of this paper). It should be noted that even the low variant of the United Nations projections gives figures higher than the recent estimates and projections made by the Indian national authorities and cited above.

Table 2. United Nations Population Projections for India, 1970-1985 (millions)

Year	Low variant (a)	Medium variant (b)	High variant (c)
1970	543.1	543.1	543.1
1975	610.4	613.2	613.9
1980	683.6	694.3	697.6
1985	757.4	782.9	795.3
Annual average growth rate 1970-1985 (%)	2.24	2.47	2.54

Source: World Population Projects as Assessed in 1973, Population Studies No. 60, United Nations, New York, 1977, Tables 28, 30 and 31.

The average annual growth rate over the period 1970-1985 implied by the low variant population projections is 2.24%, exactly the inter-censal rate actually recorded between 1961 and 1971. However, taking 5-year periods separately, the United Nations low variant implies a decline in the growth rate from 2.34% (1970-75) to 2.05% (1980-85). The reader should note that these projections were prepared in 1973 and that they are currently being revised by the United Nations.

Although the size of the population indicates to the educational planner general orders of magnitude, by itself it represents information of only limited value. This is because populations of similar size may differ greatly as to their past and future dynamic behaviour (change over time) and in their structure (distribution by age, sex or other characteristics). In the remainder of Section 1 we shall be mainly concerned with the dynamic behaviour of population. In Section 2 we consider some of the structural implications.

(1) Country Report, India, Fourth Regional Conference of Ministers of Education and those Responsible for Economic Planning in Asia and Oceania, Colombo 1978, Chapter 1. Report prepared by the Ministry of Education and Social Welfare.

I.1.3 The rate of population growth in India

As has already been implied in the above discussion, the average annual rate of growth is an important basic tool in demography. It should not be confused with the total percentage growth of population over a period of time. To clarify the distinction between these two concepts, let us consider the official projection of total population from 548.2 million in 1971 to 672 million in 1981. This represents a projected increase of 22.6% over the 10 year period. It is not an average annual rate of growth. In fact, the average annual rate of growth which corresponds to a total percentage growth of 22.6% over a 10 year period is 2.1%. Let us now see how each of these figures has been calculated.

The total percentage growth of 22.6% over the period 1971-1981 has been calculated by the following formula :

(1) percentage growth over the period $= 100 \left[\frac{P_n}{P_o} - 1 \right]$

where P_o = Population in the initial year "o"

P_n = Population in the final year "n".

Hence, % growth over the period 1971-1981 =

$$100 \left[\frac{672}{548.2} - 1 \right] \% = 22.6\%.$$

The average annual rate of growth is calculated by formula 2 shown below. This is in fact the standard formula for reckoning compound growth, where annual percentage increases are reckoned on the base not only on the original figure in Year 1 but also on compounded successive annual increments. It contrasts with the simple rate of growth formula which adds a constant amount each year to the original. The difference between a compound rate of growth and a simple rate of growth can readily be illustrated by considering how a sum of 1000 rupees would grow in the face of 10% rates of interest.

Year	SIMPLE INTEREST		COMPOUND INTEREST	
	Accrued Capital Sum	Annual Interest (10% of original capital)	Accrued Capital Sum	Annual Interest (10% of accrued capital)
Year 1	1000	100	1000	100
Year 2	1100	100	1100	110
Year 3	1200	100	1210	121
Year 4	1300	100	1331	133.1
Year 5	1400	100	1464.1	146.41

Population growth is of the compound variety and it is quite easy to see therefore that one cannot simply divide the total percentage increase above (22.6%) by the number of years (10) to arrive at the average annual rate of increase. Instead the formula one uses to arrive at average annual rate of increase is :

(2) $P_n = P_o \cdot (1 + r)^n$

"r" being the rate we want to calculate.

To calculate r from this formula we have to take logarithms and re-express the formula as :

$$\log P_n = \log P_o + n \left[\log (1 + r)\right]$$

This can in turn be rearranged as

$$\log P_n - \log P_o = n \left[\log (1 + r)\right], \text{ or } \log (1 + r) = \frac{\log P_n - \log P_o}{n}$$

In the example under discussion,

$P_n = 672$

$P_o = 548.2$

$n = 10.$

Thus :

$$\log (1 + r) = \frac{8.8274 - 8.7389}{10}$$

$$(1 + r) = 1.021$$

$$n = 0.021$$

$$= 2.1\%$$

EXERCISE I

Columns (a), (b) and (c) of Table 2 give the United Nations low, medium and high variant projections respectively of the population of India from 1970-1985. Using these figures, calculate for each variant :

i) the total percentage growth over the period 1970-1980.
ii) the average annual rate of growth from 1970-1980.

Formula (1) and (2) should be used for calculations.

The rate of growth of the total population describes population change, but does not explain it. For an understanding of the underlying factors giving rise to this change, the vital processes must be analysed: births, deaths and migration.

I.1.4 Births

Crude birth rate

The crude birth rate of an area is defined as the number of live briths occuring in that area in a given time period, usually a year, divided by the population of the area as estimated at the middle of the particular time period. The rate is most often expressed in terms of "per 1000 of population".

$$(3) \quad \text{Crude birth rate} = \frac{\text{Number of live births in a year}}{\text{Mid-year total population}} \times 1000$$

The crude birth rate in India in 1975 was 35.2 per thousand (1).

The crude birth rate is an elementary statistic which requires only global information for its calculation. It is not calculated with any reference to the structure of the population according to age or sex, even though it is the proportion of women of child-bearing age in the population that largely determines present and future population changes. Therefore a more refined measure of "fertility" is desirable.

Fertility rates

Fertility measures the rate at which a population augments itself by births relating births to the number of females "at risk", that is, of child-bearing age. Two fertility rates may be distinguished here, the general fertility rate and the age-sepcific fertility rate.

(4) the general fertility rate =

$$\frac{\text{Number of live births in a year}}{\text{Mid-year population of women of child-bearing age}} \times 1000$$

The general fertility rate in India over the period 1961-1971 was 193 (2). Often "child-bearing age" is taken to be 15-49 years. It is called a "general" rate because it attributes all births to all women within these age-limits. Clearly however fertility is not constant over all years of child-bearing potential. A more disaggregated measure of fertility is the age-specific fertility rate.

(5) the age-specific fertility rate =

$$\frac{\text{Number of live births born to women in a specified age-group in a year}}{\text{Mid-year population of women in the specified age-group}} \times 1000$$

In calculating the age-specific fertility rate, potential mothers may be grouped by single year of age or by age-groups of, e.g., 5 years. It need hardly be added that the age of women is not the only factor affecting fertility. Fertility depends on numerous other influences - social and cultural as well as physical - including the availability and use of techniques of birth control, age at marriage, duration of marriage, average time between births, and so on. It is important to note that fertility rate calculations are based on the number of births occuring in a single year. Obviously these rates may change quite considerably over time. A dynamic analysis of population change must take account of both these changes and the second vital process we have specified: deaths.

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(1) Dates supplied by national authorities from Sample Registration Scheme, Registrar General.

(2) Ibid.

I.1.5 Deaths

The crude death rate of an area is defined analogously to the crude birth rate. It is the number of deaths occurring in that area in a given time period, usually a year, divided by the population of the area as estimated at the middle of the time period :

$$(6)\quad \text{crude death rate} = \frac{\text{Number of deaths in a year}}{\text{Mid-year total population}} \times 1000$$

The crude annual death rate in India in 1975 was 15.9 per thousand (1). Over the period 1961-1971 the rate was estimated to be 18.9 per thousand.

Deaths result, of course from a multitude of causes (some of which can, and some of which cannot, in principle be influenced by public policies). The different age-groups in the population experience different rates of mortality from specified causes. For this reason, the crude death rate is only a relatively clumsy tool for the social planner. To further investigate the mortality experienced by a population, deaths rates according to age may (data permitting) be usefully calculated.

The age-specific death rate is defined as follows :

$$(7)\quad \text{age specific death rate} = \frac{\text{Number of deaths in a year in a specified age-group}}{\text{Mid-year population in the specified age-group}} \times 1000$$

One commonly-calculated age-specific death rate is the infant mortality rate

$$(8)\quad \text{Infant mortality rate} = \frac{\text{Number of deaths below age 1 in a year}}{\text{Number of live births in the year}} \times 1000$$

Because of the susceptibility of small babies to infection and their vulnerability to accidents this rate is generally much higher than other age-specific death rates (until a great age is reached). It and the other age-specific rates up to the year of entry into the school system, are of obvious importance to the educational planner in projecting future school intake. According to national estimates the infant mortality rate in India was 122 per thousand live births in 1971 (2).

Another basic demographic relation which may now be introduced is the crude rate of natural increase. This measures the change in population size, due to births and deaths, as a percentage of total population. (Note that it takes no account of net migration: the difference between emigration and immigration). It is defined as follows :

$$(9)\quad \text{Crude rate of natural increase} = \frac{\text{Number of births in a year minus number of deaths in a year}}{\text{Mid-year population in the year}} \times 1000$$

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(1) Data supplied by national authorities from Sample Registration Scheme, Registrar General. For 1971 the rate was estimated to be 14.9 per thousand.

(2) Data supplied by national authorities. This figure for 1971 is also given in the Demographic Yearbook 1976, (op. cit.), Table 4, though a few states were not included.

Table 3 presents data for India (1961-1971) and selected world regions (1965-1976). It can be seen that the crude birth and death rates in India were significantly higher than the world averages for the period 1965-1976. India's rate of natural increase at 23 per 1000 population was somewhat above the world figure of 19 per thousand, and very close to that of Asia as a whole (in which India is included). It should be noted that the rates of natural increase (i.e., the differences between crude birth and death rates) do not always exactly correspond to the figures for the annual rate of population growth in the first column of the table. Discrepancies may of course be due to error and differing methods of estimation, but the third vital process, migration, if significant will cause a divergence between the two rates.

Table 3. Annual growth of population, crude birth and death rates and rate of natural increase - India and selected regions, 1965-1976

	Annual rate of population growth % 1965 - 1976	Crude birth rate (per 1000) 1965-1976	Crude death rate (per 1000) 1965-1976	Rate of natural increase (per 1000) 1965 - 1976
India (1)	2.2	41.9	18.9	23
Africa	2.7	46	20	26
Asia (2)	2.2	36	14	22
Europe	0.6	16	10	6
Latin America	2.7	38	10	28
North America	1.0	17	9	8
U.S.S.R.	1.0	18	8	10
World	1.9	32	13	19

Source : Data for regions derived from Demographic Yearbook, 1976, op. cit., Table 1.

Notes : (1) Data for India supplied by national authorities and refer to the period 1961-1971.
(2) Including India.

A feature of Table 3 in general is the marked difference between the crude rates of natural increase experienced in the industrialized regions of Europe, North America and the USSR and those ruling in the less developed regions of Africa, Latin America and Asia (including India). The most recent estimate of the crude birth rate supplied by Indian national authorities indicates a figure of 35.2 live births per thousand population in 1975. This is well over twice the rate of 14.7 (1) experienced in the United States in 1976, for example, though well below the rate of 49.5 (1) estimated in Bangladesh over the period 1970-75.

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(1) Source : Demographic Yearbook 1976, op. cit., Table 4.

India's crude death rate is high by world standards and significantly higher than that for Asia as a whole. The annual rate of population growth, at 2.2% was 0.3 percentage points above the world average, and very considerably above the European rate of 0.6%. If the rate of 2.2% experienced over the decade 1961-1971 (1) were to continue, one can calculate (using formula (2) above) that the Indian population would double in 31.9 years. By way of contrast, Europe's population would take 115.9 years to double.

EXERCISE II

On the basis of the data given in the first column of Table 3, use formula (2) to calculate the number of years it will take for the populations of the countries and regions listed in this table to double.

Table 4 presents data illustrating the wide variance between countries in infant mortality and fertility rates and life expectancy at birth (a concept explained in I.1.6. below). It can be seen that infant mortality and fertility rates show a strong positive association (i.e. the higher the infant mortality, the higher the fertility rate tends to be). Life expenctancy at birth tends to be relatively high in countries in which infant mortality rates are low. The table reveals the relatively low expectancy of life at birth for both sexes in India. For example, at birth an Indian female can expect over 30 years less life than her counterpart born in the United States.

(1) According to data published in Statistical Pocket Book, India 1977, the rate over the later period 1966-1976 was 2.15%, i.e. marginally lower.

Table 4. Fertility rates, infant mortality rates, and life expectancy at birth : India and selected countries, 1970 - 1975

	Fertility rate (per 1000) (1) (a)	Infant mortality rate (per 1000) (b)	Life expectancy at birth (years) Male (c)	Female (d)
India	136.7 (2)	122 (3)	47.1 (4)	45.6 (4)
Argentina	94.2 (5)	59.0 (6)	65.2	71.4
Congo	178.5 (7)	180.0 (7)	41.9	45.1
Finland	47.6 (8)	10.2 (9)	66.6 (5)	74.9 (5)
Indonesia	175.7	125.0 (10)	47.5 (11)	47.5 (11)
U.S.A.	60.4 (9)	16.7 (9)	68.2 (9)	75.9 (9)
U.S.S.R.	55.5 (8)	27.7 (9)	64.0 (12)	74.0 (12)

Source : India, column (a) Demographic Yearbook, 1976, Table 4; column (b) Sample Registration Scheme, Registrar General; columns (c) and (d) Statistical Abstract 1975, Table 9.
All other countries, Demographic Yearbook, 1976, op. cit., Table 4.

Notes : (1) For India and USSR, per 1000 females aged 10-49 at year mid-point. For all other countries, per 1000 females aged 15-49 at year mid-point.
(2) 1958-59. Estimate for rural India, based on results of National Sample Survey
(3) 1971
(4) Based on 1% sample, 1971
(5) 1972; (6) 1970; (7) 1960-61; (8) 1973; (9) 1974;
(10) 1962; (11) 1960; (12) 1971-72.

I.1.6 Life tables

The life table is an analytical tool of great importance in demographic analysis. It presents the life-history of a hypothetical cohort of individuals from birth (though it could commence at any age) to their eventual death.

A cohort is a set of individuals possessing some common characteristic. In this case, the characteristic is a common year of birth. In later sections of this paper, we shall consider cohorts of individuals flowing through the educational system; and in that analysis, cohorts may be distinguished by their age or by their common school grade in the initial year of the flow analysis.

A cohort of individuals born in a particular year is gradually diminished, year by year, by death, until all members have died. A life table may be a historical life table, based on the observation through time of the mortality experienced by a real cohort of individuals. Such tables are however of relatively little value compared with life tables constructed by applying current mortality rates by age to a theoretical cohort of, say, 1000 persons. The construction of such tables requires a considerable amount of information, and they are not available for all countries. However, if such tables can be drawn up, valuable indices may be estimated from them. These include :

a) probabilities of death and survival for individuals at particular ages or periods.

b) life expectancies at particular ages: the average number of years that persons at particular ages can be expected to live, i.e. will live on average if current mortality rates continue into the future.

Life expectancy at birth is a widely-used indicator in comparative studies. Low life expectancy at birth is usually associated with high infant and childhood mortality rates. Even where a country's life expectancy at birth is low by internataional standards, it is often the case that life expectancy at age 10 is significantly higher and indeed comparable with countries at relatively advanced levels of socio-economic development. This is because of the very high rates of infant and early childhood mortality. Once an individual has survived this particularly risky period of his life, he may expect to survive for a number of years comparable with his surviving contemporaries in other countries having much lower rates of childhood mortality.

I.1.7 Migration

The third major component explaining population change together with births and deaths is, of course, migration. Clearly in analysing past population change, and in projecting future change, rates of emigration and immigration may play an important role. For detailed manpower and educational planning, age-specific rates of migration would obviously be desirable and it would also be useful to know the education level of both immigrants and emigrants. Statistical information on the number, age and educational level of both immigrants and emigrants can rarely be obtained even in highly developed industrial countries having relatively comprehensive systems of data collection. Such details were unfortunately not available in the preparation of this study.

However, population migration within a country ("internal migration") may be of considerable importance for economic and social planning. In particular the phenomenon of population movement from rural to urban areas has, historically, been invariably associated with economic development. The process is currently being observed in India and may be expected to continue in the long term. The development will have potentially important consequences for educational planning, particularly through its effects on enrolment rates and other rates such as those of intake and drop out, to be discussed later in this paper. A research study (1) in investigating rural-urban migration in Greater Bombay and its implications for educational planning found that the more educated and the more skilled in rural areas tended to migrate to urban areas. This inevitably tends to depress rural areas and creates a problem similar to that of the "brain drain". The study also found that rural migrants endeavoured to improve their educational qualifications after migrating to urban areas. A further finding with important implications for population growth and educational planning was that rural migrants had a lower fertility than non-migrants, but a higher fertility than urban non-migrants. Thus - in the short-term at least - rural-urban migration tends to increase overall urban fertility.

A considerably amount of sophisticated theoretical work has developed on internal migration in recent years (2). Unfortunately this cannot be surveyed in the con-

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(1) "Educational Implications of Rural-Urban Migration in India", S.N. Agarwala, in Population Dynamics and Educational Development, UNESCO, Bangkok, 1974.

(2) See, for example, Methods of Measuring Internal Migration, Population Studies No. 47, United Nations, 1970, and Methods of Projections for Urban and Rural Population, Population Studies No. 55, United Nations, 1974.

text of this paper. Clearly the overriding need however is for improved statistical data on the characteristics of internal migrants, particularly concerning their fertility and educational levels.

In India in 1974, the urban population was estimated to be 20.6% of the total, having grown from 19.2% in 1967 (1).

I.1.8 Population projections

Population projections are based on specific assumptions about future changes in the many influences on births, deaths and migration summarised under the three "vital processes" discussed above. Estimates of the size of future changes in these influences inevitably rest on evidence derived from analysis of past and current trends. These assumptions about future change are then applied to the present population structure. Population projections thus show the prospects for the future size and structure of the population, given the present size and structure and current trends.

Obviously, any set of assumptions covering a lengthy period into the future is liable, in the event, to be demonstrated as "false". Changes in technology, social behaviour and values will all have their interdependent influences. Population projections do not therefore - indeed cannot - reflect the impact upon population changes of radical new developments or influences in society. They have the objective of making explicit how the present population will develop over time, assuming the continuation of observed trends in the present structure.

The orthodox method of population projection is to postulate various patterns of change in the components of population growth. That is to say, assumptions are made about future rates of fertility, mortality and migration. Commencing with the current age and sex distribution of the population, future population estimates are made by applying, where available, age and sex-specific fertility, mortality and migration rates to each population sub-group. New assumptions about rates may be introduced at any stage of the projection period. In general, a number of plausible assumptions about rates will be made, in order to present a set of alternative projections. Such alternative projections permit sensitivity analyses to be made. The projected population may be more or less "sensitive" to variation in the assumptions about particular vital rates. To the extent that the projection varies little with (i.e. is less sensitive to) changes in a particular assumed rate, less attention need be given to the "correctness" of that assumption. Where, however a projection is very sensitive to a particular assumed rate, the assumption requires closer scouting, and, if possible, the development of a better information base on which to ground it.

Table 2 presented three different United Nations population projections for India over the period 1970-1985. In their construction, it was assumed that the

(1) Demographic Yearbook 1976, op. cit., Table 6.

gross reproduction rate (1) would decline over the period 1970-2000 from an initial level of 2.8 by 30%, 40% or 50% in the low, medium and high variants respectively. With respect to the assumptions about mortality, life expectancies at birth for both sexes were assumed to be 48.4 for the low variant and 49.5 for both the medium and high variants. Because of the lack of reliable migration statistics, this component of population change was not taken into account in preparing the projections for India.

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(1) The gross reproduction rate is a special case of the total fertility rate. Whereas the total fertility rate measures the total number of children a cohort of women will have, the gross reproduction rate measures the number of daughters it will have if the cohort experiences a given set of age-specific fertility rates throughout its reproduction ages. This rate is referred to as the gross reproduction rate since no allowance is made for mortality over this period. The net reproduction rate is adjusted to take into account mortality of women over their reproductive years.

SECTION 2 : DEMOGRAPHY AND EDUCATIONAL PLANNING

I.2.1 Introduction

This second section of Part I should be read as an introduction to the concepts underlying the education flow model presented in Part II. In it we examine the structure of the population with particular references to its distribution by geographical location, age and sex.

The geographical distribution of the population is of particular importance in planning the location of schools. It also has important implications for the relative opportunity of access to education experienced by the inhabitants of different areas, district or states. The age-structure of the population should be analysed in order to calculate measures of the participation of the population in education, and of the "burden" imposed on the working population by the total costs of education. Distribution of population by sex usually exhibits a situation of rough equality of numbers of males and females in a given area, and only merits special attention where there is considerable numerical imbalance between the sexes and significantly different educational treatment is provided for females from that for males.

I.2.2 Quality of demographic data

The efficient administration of an educational system depends to a considerable extent on the availability of appropriate statistics, such as those which have been discussed in Section 1. In India as in most developing countries, certain key data are not fully available. But almost as important as the question of availability is that of quality. Amongst the characteristics of high quality statistics are completeness of reporting on the phenomenon being described; clear definition of categories which must be collectively comprehensive, but individually mutually exclusive; computational accuracy; consistency between tabular presentations; clear presentation of the results, with adequate explanation of the assumptions and procedures used. Several factors may tend to work against the availability of high quality statistics (1).

One factor may be that only a limited financial provision may be made for statistical work in the public sector. Secondly, there is often an acute shortage of qualified statisticians at all levels. Despite these two factors, there is frequently a rapidly growing demand for statistical information for planning and other purposes. This causes statisticians, inevitably, occasionally to compromise on quality in order to facilitate speedy analysis. Further compounding the problems of quality may be poor communications and the low educational level of some of those from whom the information must initially be obtained. For all these reasons, progress in quality improvement may often be slow. Thus the emphasis must be on statistical material that is simple and good, rather than on more complicated (however seemingly desirable), information.

Many developing countries cannot hope to match, within a short space of time, the costly and complex data-gathering and analysis systems which exist in developed countries. Regular censuses and sample surveys are the essential tools for a satisfactory data framework. But these can only be developed slowly with the gradual

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(1) The need for high quality statistics in India is discussed in Reading Material, Second Training Programme for State Education Planning Officers, New Delhi 1978.

(and costly) building of the necessary administrative machinery and personnel - and indeed changed attitudes of the general public towards the provision of data. At an early stage of this process, efficient systems of birth, death, marriage and divorce registration should ideally be implemented.

The educational planner, however, is obliged to work with the data at his disposal, whilst simultaneously developing better information for the future. Given that data are often of a questionable quality, the statistician and planner must accept and make explicit allowance for, margins of error in estimations of present circumstances and projections of the future. He or she must be aware of the methods employed in the collection of statistics, and must have a thorough understanding of the techniques used in their analysis. With these caveats in mind, we now turn to the presentation of data on the geographical distribution of the population and its relevance for educational planning.

I.2.3. The geographical distribution of the population

The population density of an area is an initial, crude indicator of some of the potential problems facing the educational planner. It is defined as :

$$(10) \quad \frac{\text{Mid-year population living in a defined area}}{\text{Surface area}}$$

We have seen (Table 1) that the total population of India according to the Census in 1971 was 548.2 million. Taking the area of the country as 3.29 million square kilometres (km^2) (1), the estimated population density in 1971 was :

$$\frac{548.2}{3.29} = 166.6 \text{ inhabitants per } km^2.$$

By 1977 the density of population per km^2 was estimated to be 188 (2). Table 5 shows 1976 population densities for countries comprising Middle South Asia, including India, and the World. It can be seen that India had a density well above the regional average of 127. The world population density, at 30 persons per km^2, was less than one sixth that of India. The density of population in Bangladesh is noteworthy as being greatly in excess of India and indeed one of the highest in the world.

Table 6 shows, for the years 1971 and 1977, populations of States and Union Territories, population densities and (for 1971 only) the percentages living in urban areas (3). It can be seen that State and Union Territory population densities

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(1) Statistical Abstract 1975, op. cit., p. 1.
(2) Selected Educational Statistics 1976-77, Statistics and Information Division, Ministry of Education and Welfare, New Delhi, 1977, p. 5.
(3) Urban areas are defined as follows :
 (a) All places with a municipality, corporation or cantonment or notified town area.
 (b) All other places which satisfy the following criteria:
  (i) a minimum population of 5,000.
  (ii) at least 75 percent of male working population is non-agricultural.
  (iii) a density of population of at least 400 per sq. km.

Table 5. Population densities of selected countries in Asia, 1976

Country or region	Population per km^2
Afghanistan	30
Bangladesh	496 (1)
India	185 (2)
Iran	21
Maldives	409
Nepal	91
Pakistan	90
Sri Lanka	218
Middle South Asia	127
World	30

Source : Demographic Yearbook 1976, op. cit., Table 3.

Note : (1) 1974
(2) Population estimated 610.1 million.

varied very considerably. For example in 1977 the density in Chandigarh was 3780 persons per km^2, itself a considerable increase from the 1971 (Census) figure of 2572 per km^2. By contrast in Arunachal Pradesh the density in 1977 was a mere 7 persons per km^2. Another aspect of this contrast is indicated by the fact that Chandigarh's population in 1971 was 90.5% urban, the figure for Arunachal Pradesh being only 3.7%.

The unevenness of the dispersion of population may be seen by the fact that, in 1977 over 50% of the total population lived in only the five most populous states (Uttar Pradesh, Bihar, Maharashtra, West Bengal, Madhya Pradesh) which comprise less than 40% of the land area. Another indicator of the uneven spread across States and Union Territories is that in 1971 the most populous 15 out of the 31 States and Union Territories comprised over 96% of the total population.

Considerable variation may also be seen in the urban population percentages. Apart from the heavily urbanized Chandigarh, Delhi and Pondicherry, the proportion of the population defined in the 1971 Census as urban ranged from a high of 30.3% in Tamil Nadu to as low as 7.0% and 3.7% in Himachal Pradesh and Arunachal Pradesh respectively. The State of Andhra Pradesh, which ranked fifth in population size in 1971, with 19.3% urban came nearest to the national urban population percentage of 19.9%.

In order that the statistics of population density should be of use to the educational planner, the data should ideally refer to the smallest relevant planning areas. Distinct data can only give a very rough indication of the kind of school location problems that the planners at distinct level face. It must be borne in mind that a distinct average of say 200 persons per square kilometre may be compounded of areas with over 5000 persons per square kilometre on the one hand and only 20 per square kilometre on the other.

Table 6. Population density in India by State and Union Territory, 1971 and 1977, and percentage urban population in 1971

States and Union Territories	Land area (thousand km²)	1971 Population (Thousands)	1971 Density (per km²)	1977 Population (Thousands)	1977 Density (per km²)	1977 % Urban
Andhra Pradesh	276.8	43,502	157	48,148	174	19.3
Assam	78.5	14,625	186	17,585	222	8.9
Bihar	173.9	56,353	324	63,052	362	10.0
Gujarat	196.0	26,697	136	30,256	154	28.1
Haryana	44.2	10,036	227	11,484	261	17.7
Himachal Pradesh	55.7	3,460	62	3,893	69	7.0
Jammu & Kashmir	222.2	4,616	21	5,372	24	18.6
Karnataka	191.8	29,299	153	32,719	170	24.3
Kerala	38.8	21,347	550	23,869	612	16.2
Madhya Pradesh	442.8	41,654	94	48,546	110	16.0
Maharashtra	307.8	50,412	164	56,809	184	31.2
Manipur	22.4	1,072	48	1,288	58	13.2
Meghalaya	22.5	1,011	45	1,181	51	14.5
Nagaland	16.5	516	31	625	37	10.0
Orissa	155.8	21,944	141	24,691	158	8.4
Punjab	50.4	13,551	269	15,119	302	23.7
Rajasthan	342.2	25,765	75	29,979	88	17.6
Sikkim	7.3	209	29	235	34	9.4
Tamil Nadu	130.1	41,199	317	44,689	344	30.3
Tripura	10.5	1,556	148	1,858	176	10.4
Uttar Pradesh	294.4	88,341	300	97,997	333	14.0
West Bengal	87.9	44,312	504	50,634	575	24.7
A & N Islands	8.3	115	14	159	19	22.8
Arunachal Pradesh	83.6	467	6	557	7	3.7
Chandigarh	0.1	257	2572	378	3780	90.5
Dadra & Nagar Haveli	0.5	74	151	84	168	(1)
Delhi	1.5	4,065	2738	5,197	3465	89.7
Goa, Daman & Diu	3.8	857	226	1,025	270	26.4
Lakshadweep	0.03	31	994	37	1233	(1)
Mizoram	21.1	332	16	(2)	(2)	(1)
Pondicherry	0.5	471	983	552	1104	45.5
India	3,288.0	548,160	167	618,016	188	19.9

Sources : Land area and 1971 data, Statistical Abstract 1975, op. cit., Tables 1 and 2, 1977 data, Selected Educational Statistics 1976-77, op. cit., Table 2.

Notes : (1) not available
(2) included in Assam.

The local planning authorities will need considerably more detail than is provided by either the State or district averages when considering the location of new schools. Ideally one needs to know population densities and probable enrolment ratios in the planned catchment area of any new educational institution. In densely populated areas like Delhi there may be problems in finding school sites, but the education planner has no fear that schools may not reach the optimum size for lack of pupils. In rural areas, on the other hand, the viability of planned new schools is a real issue (1).

One may use as a guiding principle in school location the objective that where possible pupils should be able to reach the school on foot (2). Whilst the strength and stamina of children will of course vary with age, it is reasonable to assume that the maximum capability would be in the region of about 5 kilometres (3 miles) walking distance between school and home as a maximum. This indicates that the maximum catchment area of a school should be 78.55 square kilometres (3). Using this information together with data on the Indian population structure, one can draw up a table to show the number of children likely to be seeking school places in different circumstances as regards population density and enrolment ratios. Let us illustrate this for India with data from grades VI - VIII of the secondary level, bearing in mind that in 1971 the 11-13 age-group (i.e. middle school-aged children) accounted for 7.4% of the Indian population (4).

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(1) Those readers with a particular interest in questions of population distribution in relation to school location are advised to consult the recent series of studies on this subject by the International Institute for Educational Planning, Paris. For example see J. Hallak, Planning the Location of Schools, UNESCO, Paris 1977.

(2) "The Constitution itself directs that the State must provide free and compulsory education up to the age of 14 .... Educational facilities were sought to be within walking distance of the children throughout the country .... 72% of the rural population is served by the middle sections located either in the habitation of residents or within the walking distance of 3 kms." Country Report, India, op. cit., p. 22.

(3) The formula for calculating the area of a circle is :

area of circle = πr^2 where r = radius of circle
π = 3.142

In our case we have defined the radius as 5 km, the maximum distance we expect the child to walk to school. So the area of the (circular) catchment area would be π x 25 sq. km = 78.55 sq. km.

(4) Selected Educational Statistics 1976-77, op. cit., p. 1

Table 7. Viable schools in relation to population density and enrolment ratios at Middle School level (grades VI - VIII) in India

1	2	3	4								
Population per sq. km.	Population in 5 km radius area (Col 1 x78.55)	Of which 11-13(7.4% of Col 2)	Enrolments, given different enrolment ratios (% of Col. 3)								
			20%	30%	40%	50%	60%	70%	80%	90%	100%
25	1,964	145	29	44	58	73	88	102	116	131	145
50	3,928	291	58	87	116	146	175	204	233	262	291
75	5,891	436	87	131	174	218	262	305	349	392	436
100	7,855	581	116	174	232	291	349	407	465	523	581
125	9,819	727	145	218	291	364	436	509	582	654	727
150	11,783	872	174	262	349	436	523	610	698	785	872
175	13,746	1017	203	305	407	509	610	712	814	915	1017
200	15,710	1163	233	349	465	582	698	814	930	1047	1163
250	19,638	1453	291	436	581	727	872	1017	1162	1307	1453
500	39,275	2906	581	872	1162	1453	1744	2034	2325	2615	2906
1000	78,550	5813	1163	1744	2325	2907	3488	4069	4650	5232	5813

Table 7 provides an indication to the educational planner of the potential for forming schools of viable size in areas of varying population densities and enrolment ratios. In India in 1976 the average middle school enrolment was 181 pupils (1).

If one were to take, say, 150 as being a minimum target for a middle school (six classes, two at each grade, minimum class size 25), one can see from the table the minimum requirement in terms of enrolment ratios and population density to provide this number of children. The heavy line in the table demarcates situations in which the minimum is attainable from those where it is not. As we shall see in Table 14 below, actual enrolment ratios vary considerably among the States and Union Territories from 12.5% in Arunachal Pradesh to 88.4% in Kerala. Higher enrolment ratios are associated with the more densely populated States. It is of course not surprising that enrolment ratios should be higher in well-populated areas: the level of income is generally higher in such areas, more of the available employment opportunities require educated workers, and because of greater population density, schools tend to be closer to people's homes than the 5 km assumed in this table.

(1) Figure calculated by dividing the total of middle schools (94214) into the total middle school enrolment (17,007,599) in 1976. Source : Tables IV and V, Selected Educational Statistics, 1976-1977, op. cit.

The table shows us that where population is 25 or less per square kilometre (which was the case in 3 States and Union Territories in 1977, and would have also been the case in many more Districts, and locations within Districts) even a 100% enrolment ratio does not produce a viable school if the catchment area is only 78.55 km^2. In these areas the only options would seem to be to accept smaller schools, or to enlarge the catchment area by ~~use~~ of daily transport for children to school, or provision of residential facilities in term-time.

I.2.4 The distribution of the population by sex and age

A study of the distribution of the population by age and sex is very important both to the demographer and to the educational planner. From the point of view of demographic analysis it summarises the history of a nation's population and also governs to a large extent its future growth. For the educational planner it makes possible calculation of the size of the school-age groups in the population (and therefore of enrolment ratios), and indicates the degree of strain on the working population involved in providing schooling for the young; these two aspects are discussed in parts I.2.5 and I.2.6 respectively of this Section.

The division of population by age and sex may be graphically represented by a widely-used descriptive device known as the "population pyramid". Illustrations of population pyramids are shown in Figure 2 for France (2a) and India (2b). The method used in constructing these pyramids will be explained at the seminar.(1)

The way in which the pyramid reveals the past history of a population is well illustrated by the case of France in Figure 2a. This indicates the distribution of France's population in 1967 by year of birth and sex. The main factors having caused the particular configuration of this pyramid are explained in the Figure. Most striking among them are the effects, particularly on the surviving population, of losses in two World Wars; the deficit of births during the war years because of the absence from home of men on active service; and (not specifically noted) the decline of the birth rate in the 1930's at a time of economic depression. If a new pyramid had been drawn for France in 1977, we would see a marked decline in births since 1966 reflecting social and economic trends prevalent in Europe and the wider availability and use of methods (including new ones) of preventing births.

However, much the most important piece of information revealed by France's pyramid is the gradient (angle of steepness) of the sides of the pyramid. In France's case the gradient is steep suggesting that the annual increment of births has been small or in some years even negative over a long period. This rather steep-sided pyramid up to the age of about 70 and rapid tapering only after that age may be taken as broadly representative of the general shape of population pyramids in developed countries. These contrast with typical pyramids for the developing countries with relatively high rates of fertility and mortality, like India (Figure 2b). Typically, since pyramids are broad at the bottom and narrow at the top. In addition, the gradient of the pyramid for developing countries tends to be shallower at the base, and steeper at the top, than for developed countries. This shape results from annual population growth rates over quite a long period of 2-3%, whereas the corresponding figure in Europe is, and has been, much lower.

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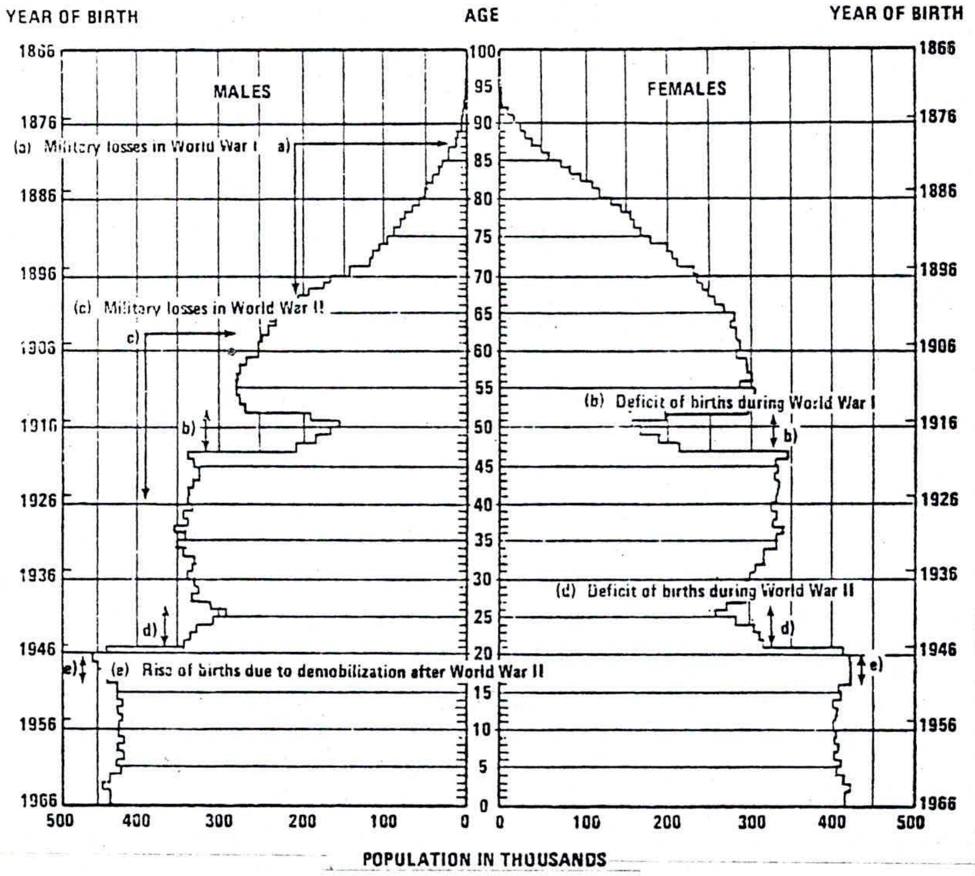
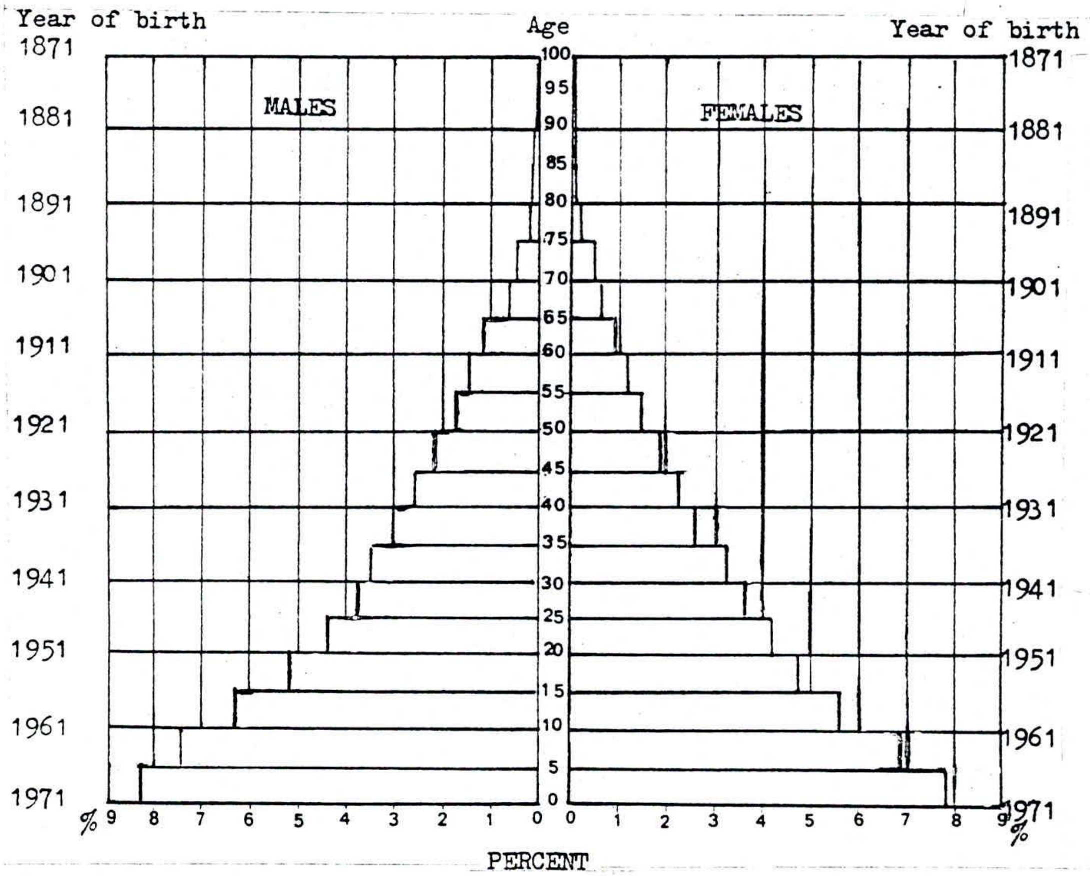
(1) In constructing the pyramid for India, the data for the age-group 70 years and above were distributed on five year age-groups.

Figure 2. Population Pyramids for France and India.

(a) France, by age and sex, January 1, 1967



(b) India by age and sex, 1971



It was also claimed above that the age and sex structure of the population governs the future growth of population as a whole. This is true in the sense that birth rates ultimately depend on the proportion of women who are or will be of child-bearing age. One can see at a glance from Figure 2 that the proportion of the female population past child bearing age is far higher in France than in India. Moreover, within the group of women of child-bearing age of say 15-49, a higher proportion is at the more fertile ages (15-29) in India (55%) than in France (about 45%), and this feature will persist.

So far as the sex structure of the population is concerned, Table 8 shows a preponderance of males in the the early years which gradually develops until it reaches a ratio of 108 males to every 100 females in the 10-14 age group. The ratio then declines because of relatively higher male mortality rates until it reaches its lowest value of 103 in the 25-29 age group. It then steadily rises again to reach the figure of 118 in the 45-54 age group. In the highest age groups it again declines to a figure of 106 in the 70 and over group. Thus in all age groups in Indian society in 1971 there was a preponderance (often a marked excess) of males to females. In this respect India differs from many developing and most industrialized nations. As in India, most countries have a preponderance of males in the early years, but relatively high male mortality rates then produce a marked excess of women in the elderly population. Life expectancy of women (as we saw in Table 4) at birth is, in many countries, greater than that of men. This is not the case in India. Indeed it is not until the age of 40 that the further expectation of life of women becomes as great as that of men (24.7 years). By the age of 60 in India in 1971 women could expect a further 13.4 years of life, as against the male expectation of 13.0 years (1).

Table 8. Population of India by age and sex as a percentage of total population 1971

Age-group	Percentage of total population			Ratio[x] of males to females %
	Total	Males	Females	
0-4	16.2	8.3	7.9	104
5-9	14.1	7.3	6.8	107
10-14	11.9	6.2	5.7	108
15-19	9.8	5.1	4.8	107
20-24	8.4	4.3	4.1	104
25-29	7.4	3.8	3.7	103
30-34	6.6	3.4	3.2	105
35-39	5.7	3.0	2.7	109
40-44	4.9	2.6	2.3	115
45-49	4.1	2.2	1.9	118
50-54	3.3	1.8	1.5	118
55-59	2.6	1.4	1.2	115
60-64	2.0	1.1	0.9	112
65-69	1.4	0.7	0.6	111
70 and over	1.8	0.9	0.9	106
Total	100.2[xx]	52.0	48.2	108

[x] Calculated on the actual numbers.
[xx] Total does not equal 100.0 due to rounding errors.

Source : Data supplied by national authorities

(1) See Statistics Abstract 1975, Table 9.

I.2.5 Population of school age

The distribution of the population according to age and sex permits the measurement of the relative size of the school age population. This is a basic statistic in any educational planning process.

The actually enrolled population depends on a number of (interdependent) factors. Clearly the ultimate constraint is the population of school age. In many developed countries this constraint is operative; primary level enrolment approaches 100% of the relevant age group. In some developing nations a much lower percentage may attend primary school. Within this constraint an influence on the enrolled population is the demand for education, as expressed in the first instance by pupils and their parents. The extent to which this "social" demand is met may sometimes be measured by the proportion of individual demands for enrolment which can be matched by the supply of school-places. This can never be a wholly satisfactory measure of social demand. Expressed demand will, inevitably, depend to some degree on the known supply of places. Further, social demand is expressed by the public authorities, responding to their perceptions of the demand of society.

The demand for education may be seen as both a "derived" demand and a direct demand. It is a derived demand in that it stems from a higher level demand for those things which education itself provides, such as higher incomes and social mobility. It is a direct demand in so far as education is wanted for its own sake. Governments have difficult choices to make concerning how far they wish, and are able within resource contraints, to satisfy these different elements. They will ultimately choose according to the relative priorities they attach to their major political objectives: for example immediate satisfaction of expressed popular desires, or following their own strategy of long-term economic and social development, or the pursuit of their conception of the just society. Frequently these objectives conflict. For example, a greater degree of equality of educational opportunity between geographical areas, social classes or the sexes may be costly to achieve and might involve delaying the attainment of other social and economic objectives.

I.2.6 The burden imposed by the school population

The dependency rate and the ratio of the school population to the economically active population are two indicators of the "burden" imposed on society by the education system.

$$(11) \qquad \text{Dependency rate} = \frac{\text{Population aged under 15 + population aged over 64}}{\text{Population aged 15-64}} \times 100$$

From the data on which Table 8 was based, i.e. the 1971 Census, we can calculate that the dependency rate in India in that year was 82.7%. This indicates that for every 100 of the population between 15 and 64 there were almost 83 dependents of ages below 15 and over 64.

The economically active and inactive populations are not easy to measure satisfactorily. Not all countries adopt the United Nations proposed broad definition which would describe the active population as all those of either sex who make their labour available for the production of goods and services.

The activity rate may be defined as follows :

$$(12) \quad \text{Activity rate} = \frac{\text{active population}}{\text{Total population}} \times 100$$

Activity rates may be calculated on an age-specific basis and separately for males and females. There is room for vigorous debate on the correct age to use, on what constitutes "economic activity" and on the definition of unemployed. Estimates published by the International Labour Office (1) show an activity rate in 1970 for the Indian population as a whole of 40.2%. For males of all ages the rate in the same year was estimated to be 52.3%, for females, 27.1%. Among the 25-44 age groups the proportion was 96.4% for males, and 48.8% for females.

One measure of the "burden" on the population of working age of providing education to the population of school-age children is obtained by calculating the ratio between these two populations. Actually in many countries this would only be a measure of the potential burden since not all their school-age children are in fact enrolled in school. A measure of the actual burden is provided by the ratio between the actual enrolment and the population of working age. Table 9 shows estimates of these two ratios for 1975 for India and for various other Asian countries as well as averages for selected regions and continents. The third column shows the age-specific enrolment ratio (see II.1.2c for an explanation of this concept) for the age group 6-11 years.

Table 9. Ratios between the population of school-and working-age, and age-specific enrolment ratios for the age-group 6-11 years, selected countries and regions, 1975

Countries and regions	Population 6-11 years / Population 15-64	Enrolment in primary education / Population 15-64 years	Age-specific Enrolment ratio age-group 6-11 years (%)
Industrialized countries	0.15	0.184	94
Developing countries	0.31	0.229	62
Africa	0.30	0.208	51
Latin America	0.30	0.326	78
South Asia	0.30	0.210	61
India	0.29	0.192	61
Burma	0.28	0.210	63
Bangladesh	0.34	0.217	51
Indonesia	0.31	9.249	62
Malaysia	0.32	0.293	93
Pakistan	0.34	0.151	42
Thailand	0.33	0.310	78

Source : India : Enrolment data supplied by national authorities. United Nations population data were used.

Other countries : UN Population Division for population data and Unesco Office of Statistics for enrolment data.

(1) Labour Force Estimates and Projections, 1950-2000, International Labour Office, Second Edition, Geneva, 1977. See in particular Volume 1, Asia, Table 2.

In examining the first column of Table 9 we note first of all the considerable difference between developing and industrialized countries as regards the relative size of their school-age populations. Measured in this way, the burden of the population of working-age in developing countries of enrolling all their children of primary school age (here the age-group 6-11 years) was, in 1975, double that of the industrialized nations. This is a pure effect of the young age-structure of the developing countries' populations.

The second column of Table 9 shows, for 1975, the actual burden on the population of working age of providing primary education. We note that while for each 1000 persons age 15-64 years there were 184 primary school pupils in the industrialized countries, the corresponding figure for the developing countries was 229. Thus in spite of the latter countries' generally lower enrolment ratios - see the third column of the table - the burden on their working population, measured in this way, was higher than in the industrialized countries. The reason is the developing countries "young" age-structure.

It should be noted that the primary school burden on the Indian population of working age, as measured in the second column at 0.192, was below that for developing countries as a whole but slightly greater than the figure for industrialized countries. It is however important to realize in this connection that the figures given in column 2 are affected by the duration of primary education. The duration is five grades for India, Burma, Bangladesh and Pakistan, six grades for Indonesia and Malaysia and seven grades for Thailand.

I.2.7 Distribution of the labour force by economic sector

One of the main concerns in educational planning is that students should acquire the capacities that will enable them to earn their living. It is also important to secure mutual adjustment between the education system and work opportunities that will ensure that the demand for skills and the supply of them is in good balance. For these reasons the educational planner will be interested in the distribution of job opportunities by economic sector, and in the way in which the employment structure is evolving. Economists and statisticians group economic activity into three main sectors: "primary", "secondary" and "tertiary". The primary sector represents those basic economic activities concerned with natural resources, such as agriculture, mining, fisheries, etc. The secondary sector comprises productive industries, such as manufacturing, construction and the like. Finally, the "tertiary" sector involves services by individuals or organisations (indeed it is often termed the "service" sector). As a generalisation, less developed countries are characterised by relatively large primary sectors and small service sectors. The process of development sees a gradual decrease in the proportionate size of the primary sector with corresponding increases in the secondary and tertiary sectors, reflecting the movement of the labour force from agriculture to manufacturing and the increased demand and supply of service activities. Long-term educational plans must take such broad trends into account, by preparing workers who will be adaptable in the face of a changing economic structure.

Table 10 compares the structure of the labour force of India (1971) with that of the United Kingdom (1971). These countries are not necessarily typical of developing and industrialized countries - indeed the low proportion of primary production in the United Kingdom is rather extreme, even for industrialized countries. Nevertheless the comparison is instructive. We may note that primary production accounted for 72.5% of the labour force in India, but only 4.1% in the United Kingdom (which, however, imports a good deal of its food). Industrial production accounts for only 11% of the labour force in India, but over 40% in the UK, while the percentages for the service sector are 15.7% and 49.4 respectively. It should also be noted that the proportion

Table 10. Distribution of economically active population by branch of economic activity and status in India and the United Kingdom

Sector of Economy	INDIA					UNITED KINGDOM				
	Self Employed (a)	Employed (b)	Family Workers (c)	Other & Status Unknown (d)	Total (e)	Self Employed (a)	Employed (b)	Family Workers (c)	Other & Status Unknown (d)	Total (e)
	Percentage of grand total					Percentage of grand total				
Primary										
Agriculture, fishing, hunting, etc.	0.8	1.2	0.4	69.7	72.0	1.1	1.5	–	–	2.5
Mining, quarrying	0.1	0.4	0.0	–	0.5	0.0	1.6	–	–	1.6
Secondary										
Manufacturing	3.1	4.4	1.9	–	9.5	0.5	32.0	–	–	32.5
Construction	0.5	0.7	0.0	–	1.2	1.3	5.4	–	–	6.7
Elec., gas, water	0.0	0.3	–	–	0.3	–	1.4	–	–	1.4
Tertiary										
Transport Storage, communication	0.5	1.9	0.0	–	2.4	0.3	6.0	–	–	6.3
Commerce (2)	3.2	1.3	0.4	–	4.9	2.4	12.4	–	–	14.8
Services (3)	1.6	6.6	0.2	–	8.4	1.8	26.5	–	–	28.3
Activities not adequately described	0.5	0.2	0.0	–	0.7	0.0	0.7	–	–	0.7
Seeking work (4)	–	–	–	–	–	–	–	–	5.1	5.1
Total (5)	10.3	17.0	2.9	69.7	99.9	7.4	87.5	–	5.1	99.9

Sources: All estimates for India based on 1% tabulation of Census returns. Sikkim excluded. Yearbook of Labour Statistics 1977, International Labour Office, Geneva 1977, Table 2A, p. 100

Notes : (1) "Others and status unknown" relates to cultivators and agricultural labourers.
(2) In U.K. this includes Wholesale and Retail trade, Restaurants and hotels
(3) In U.K. this includes both "financing, insurance, real estate and business services" as well as community, social and personal services".
(4) U.K. Figure is for the unemployed. Figures for India exclude persons seeking work for the first time unemployed.
(5) Due to rounding errors, the sum of the figures in each column does not necessarily add up to the total and the sum of the totals does not add up to 100.0.

in wage or salary employment (column b) is over five times as great in the UK as in India. Finally, we note that the three categories self-employed, family workers, and cultivators and agricultural labourers accounted for 82.9% of the economically active labour force in India as compared to 7.4% in the U.K.

I.2.8 Stock of education in the population

The educational attainment of the population as a whole changes only slowly, since people generally have their schooling at the start of their lives and do not significantly add to it thereafter through any formal courses. Although the idea of continuing education is gaining ground in a number of countries including India, (1) it still remains true that in most countries the vast majority of people do not return to the classroom once they have left it in their youth. For this reason one should be cautious about assigning to education any dramatically large impact in the short-term on a country's economic and social life. These effects are more gradual and are felt over decades rather than in a few years. It may be conversely true that we can expect only limited versatility and responsiveness to change in populations with a restricted educational background.

In a number of countries, information has been collected (usually through the Census) regarding the educational attainment of the population. Information of this nature may be particularly indicative for the manpower planner, especially if it is available for individual occupations. It is then possible to identify groups of workers who are deficient in general education or particular skills with a view to providing upgrading programmes for them. The same kind of approach may be employed in relation to literacy among the population as a whole. Table 11 shows literacy rates in India for both males and females derived from the three Censuses of 1951, 1961 and 1971.

Table 11. Percentage of males and females literate in India, 1951-1971

Year	Percentage literate		
	Males	Females	Total
1951	24.9	7.9	16.6
1961	34.4	12.9	24.0
1971	39.5	18.5	29.4

Source : Education in India since Independence, A Statistical Review, Ministry of Education and Social Welfare, New Delhi, 1972, Table 21.

(1) A number of important developments have taken place in the field of adult education since 1971. The farmers' functional literacy (FFL) programme, begun in 1967, has continued to expand and a new non formal education programme focussing on the 15-25 year age-groups was formally launched in 1975, part of a significant programme of adult education having a target of making 100 million people literate within 5 years of launching the National Adult Education Programme. Special emphasis will be placed "on education of women and those belonging to weaker sections of society". See Country Report, India, op. cit., pp. 14-15.

I.2.9 Concluding remarks on Part I

We have now completed our survey of the main demographic data which are commonly used by educational planners. Births, deaths, migration and the distribution of the population by sex and age help to analyse and project the size of the school population. The geographical distribution of population helps particularly in planning the location of schools, and more generally in planning the distribution of educational resources in order to achieve the various objectives of social policy. The availability of resources must rest, ultimately, on the economic potential of the country. We have examined a number of purely demographic measures of the burden of the educational system on the population. Finally, preparation of demographic data showing the secotral distribution of the labour force is an iuitial stage in the process of planning educational systems to meet the requirements of economic development.

PART II : SCHOOL-AGE POPULATION AND SCHOOL ENROLMENT RATIOS IN INDIA

SECTION 1 : ENROLMENT RATIOS

II.1.1 Introduction

Enrolment ratios are the most commonly used indicators for assessing a country's coverage of enrolment at a particular level of education, or of a particular age-group.

There are several different types of enrolment ratios. Unfortunately, users do not always state clearly which ratio has been employed and how it has been calculated, even though the magnitude of such ratios may vary considerably according to the type of ratio employed. It is very important when using a particular ratio to bear in mind its precise definition, particularly in making inter-temporal or international comparisons. Section 1 of this Part therefore introduces and defines the main types of enrolment ratios used in educational planning.

In this Section of the paper we shall refer wherever possible to Indian data. Basic data on enrolment are contained in Table 12 and on population in Table 13.

Table 12. Enrolment by level of education, 1960-1976, millions, India

Level of Education	1960		1965		1973		1976	
	Enrolment MF	%F	Enrolment MF	%F	Enrolment MF	%F	Enrolment MF	%F
Elementary (Grades I-V)	34.9	32.7	49.2	35.9	63.2	37.9	67.5	38.2
Lower secondary (Grades VI-VIII)	6.7	24.3	10.3	26.7	14.7	30.4	17.0	31.9
Higher secondary (Grades IX-X)	3.0	18.5	5.2	22.7	7.5	27.7	8.8	28.3
Total	44.6	30.5	64.7	33.4	85.4	35.7	93.3	36.1

Sources : 1960 and 1965, Selected Educational and Related Statistics at a Glance (Plan and Non-Plan), Education Division, Planning Commission, Government of India, 1969, Table XVI.
1973, Educational Statistics at a Glance 1973, Department of Education, Government of India, 1974, Table 5, 1976, Selected Educational Statistics 1976-1977, op. cit., Table V.

Table 13. Population of India by sex and school-age group, 1976 (projected) (in 000's)

Age-group	Male	Female	Total
6-10	42,471	40,316	82,787
11-13	23,365	21,638	45,003
14-17	27,838	25,621	53,459
18-24	39,423	36,989	76,412

Source : Data supplied by national authorities.

II.1.2 Definition of enrolment ratios

Three types of enrolment ratios may be distinguished (1). These are :

a) Overall enrolment ratio
b) Level enrolment ratio
c) Age-specific enrolment ratio

a) The overall (or crude, or general) enrolment ratio

(13) $$\text{Overall enrolment ratio} = \frac{E^t}{P^t} \times 100$$

where E^t = total enrolment at all levels of education in year t

P^t = total population of school age in year t (generally refers to all three levels of education).

This is the least refined of the various enrolment ratios. It is not adequate for detailed study of enrolment development. Comparisons using this ratio between countries or States within a country, or over time within countries have important weaknesses. They give no information on the age of pupils. They do not distinguish the levels at which they are enrolled. They do not indicate the length of the various educational stages in the country concerned, which may or may not total the same number of years as the age span in the denominator.

b) The level enrolment ratio is perhaps the most commonly used measure of enrolment. It may also be called the level-specific enrolment ratio, and is often referred to as the enrolment ratio for primary, secondary or higher education. We should distinguish between:

i) the gross level enrolment ratio
ii) the net level enrolment ratio.

(1) For a more detailed discussion of the use of enrolment ratios, see B. Fredriksen: "Employing enrolment ratios and intake rates for developing countries : Problems and shortcomings", in Population and School Enrolment, CSR-E-9, Unesco Office of Statistics, Paris, 1975, pp. 64-81.

The gross level enrolment ratio relates total enrolment, regardless of the age of those enrolled, to the population which according to official national regulations should be enrolled at this level. Thus:

$$\text{(14)} \quad \text{gross level enrolment ratio} = \frac{E_h^t}{P_a^t} \times 100$$

where : E_h^t = enrolment at school level "h" (primary or secondary or higher, as specified) in year "t"

P_a^t = population in that age-group "a" which officially corresponds to level "h", in year "t".

The net level enrolment ratio on the other hand includes in the numerator (enrolment - "E") only those enrolled pupils of the "correct" age. Thus the same age-group is included in both the numerator and denominator. For this reason, the net level enrolment ratio is sometimes termed the age-level specific enrolment ratio.

$$\text{(15)} \quad \text{net level enrolment ratio} = \frac{E_{h,a}^t}{P_a^t} \times 100$$

where : $E_{h,a}^t$ = enrolment in age-group "a" at level "h", in year "t".

Table 14 shows gross level enrolment ratios for elementary and secondary education by sex in 1976 for the States and Union Territories of India. It will be seen that at the primary level several enrolment ratios for boys - and a few for girls - are considerably in excess of 100%. In fact, in Manipur the ratio for boys was as high as 175.4. Even at the middle schools at the secondary level the ratio exceeded 100% in one case, in Lakshadweep, at 104.0. Such high enrolment ratios indicate that there are more children at each level than in the population groups (6-10, 11-13, 14-16) which officially correspond to these respective levels. Assuming that the enrolment and population figures used in the calculations are correct, this means that children outside the 6-10 age range are in elementary school. This may be either because some entered late (or early, in the case of 5 year-old pupils) or because their progress through school was delayed by repeating. Even though all but one of the secondary ratios are below 100%, there may equally well be over-age enrolment and repeating at this level too. In fact, as we shall see in Exercise III, by no means all the children in Indian secondary schools are in the age range 11-16.

Nevertheless, enrolment ratios well in excess of 100% at any level may indicate errors in the population and/or enrolment data used (e.g. over-reporting of enrolment). Possible sources of such errors will be discussed at the seminar. Ratios exceeding 100% may also indicate that the enrolment and population data do not refer to the same date, or that the age-group used in the denominator does not correspond to the duration of the level in question. Finally, we note the considerable differences in enrolment ratios at all levels between states and between boys and girls within each state. These differences will be further discussed at the seminar.

Table 14. Gross level enrolment ratios for elementary and secondary education, States and Union Territories, by sex, India 1976

States and Union Territories	Grades I-V			Grades VI-VIII			Grades IX-XI		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Andhra Pradesh	88.4	54.3	70.9	34.2	16.3	25.3	14.1	6.2	10.3
Assam	76.6	53.9	65.4	43.0	26.8	35.0	31.8	16.1	24.1
Bihar	83.1	33.8	59.1	37.0	11.1	24.5	23.7	3.6	14.1
Gujarat	111.9	75.9	94.4	53.0	30.4	42.0	27.3	14.8	21.3
Haryana	92.0	47.7	71.7	56.7	20.9	40.0	19.1	6.9	13.5
Himachal Pradesh	113.5	78.6	96.4	73.8	30.2	52.4	40.2	12.9	26.7
Jammu & Kashmir	78.0	41.5	60.4	55.8	23.3	40.1	31.4	12.2	22.2
Karnataka	86.6	69.3	78.2	53.7	32.4	43.1	35.0	17.8	26.4
Kerala	111.0	100.8	105.9	92.9	83.7	88.4	37.5	25.5	35.9
Madhya Pradesh	81.9	41.2	62.2	37.0	13.6	25.7	18.8	6.7	13.0
Maharashtra	112.4	83.2	98.0	55.8	30.6	43.3	34.4	15.7	25.3
Manipur	175.4	129.8	152.7	71.9	37.0	54.2	30.9	17.1	23.9
Meghalaya	122.6	112.4	117.5	42.0	27.4	34.6	33.1	21.4	27.2
Nagaland	148.5	117.7	133.5	80.3	64.9	72.8	37.1	22.1	30.1
Orissa	98.1	58.7	78.8	31.3	12.8	22.2	21.9	6.1	14.2
Punjab	113.0	100.2	107.1	59.7	40.7	50.9	31.0	19.5	25.7
Rajasthan	86.8	31.9	60.4	39.1	11.0	21.5	25.1	5.1	14.2
Sikkim	131.3	70.8	101.4	23.9	11.4	17.6	8.1	3.6	5.8
Tamil Nadu	110.5	92.2	101.5	59.6	35.9	47.9	36.6	18.2	27.4
Tripura	93.6	67.1	80.4	42.4	26.6	34.2	20.1	13.4	16.8
Uttar Pradesh	111.6	70.3	91.8	51.7	15.8	34.9	37.0	9.0	24.4
West Bengal	104.3	62.8	83.7	44.1	21.7	32.9	22.2	11.7	17.2
A & N Islands	122.9	100.5	111.8	71.7	49.1	60.4	31.1	21.9	26.0
Arunachal Pradesh	86.8	38.5	63.3	18.8	6.0	12.5	5.9	1.4	3.8
Chandigarh	71.4	66.5	69.1	57.9	53.4	55.8	29.4	30.5	29.9
Dadra & Nagar Haveli	99.2	52.3	75.7	28.0	11.9	19.8	12.9	6.6	9.7
Delhi	117.8	105.1	111.6	98.7	76.7	88.3	72.9	59.8	66.7
Goa, Daman & Diu	122.4	102.3	112.5	73.5	51.2	62.3	36.0	26.1	31.1
Lakshadweep	148.5	116.9	132.7	104.0	56.1	80.5	31.0	16.3	24.2
Mizoram	-	-	-	-	-	-	-	-	-
Pondicherry	161.2	126.9	98.6	78.7	47.5	63.2	46.7	23.3	35.1
India	97.5	63.5	80.9	48.7	24.5	37.0	28.8	12.3	20.9

Source : Selected Educational Statistics 1976-1977, op. cit., Table VI.

Table 15. Gross enrolment ratios for higher education for selected countries latest year available (both sexes)*

India	(1974)	4.5
Philippines	(1975)	18.9
Burma	(1975)	2.1
Indonesia	(1975)	2.4
Malaysia	(1974)	3.2
Singapore	(1975)	9.2
Thailand	(1975)	3.5
Japan	(1974)	24.7
USA	(1975)	57.6
U.K.	(1974)	16.7

* Obtained by dividing the enrolment by the population aged 20-24 years.

Source : UNESCO Office of Statistics.

Table 15 gives gross level enrolment ratios for higher education in India and certain other selected countries. Such a table should be interpreted with great caution. There are many pitfalls in international comparisons of this sort, as we have already observed. To take an example, most British children have completed 13 or 14 years of education (5-18) before they enter higher education, whereas for example in the Philippines the fourteenth grade is the final year of college education. Moreover in Britain most higher education courses are three years only; this depresses the enrolment ratio which (as in the above table) is derived from using five age-groups as the denominator.

We shall be calculating the net level enrolment ratios for girls in elementary and secondary education in India in Exercise III. The net level enrolment ratio has 100 as its possible maximum. Very often however it will be below 100 in developing countries where a fixed entry age to each school level may not be imposed. This means that consecutive levels of education may overlap in terms of the ages of the pupils. In India for example there are some children of 11 or more in elementary school and some children of 9 and 10 in secondary school. This means that the net level enrolment ratio cannot reach 100 in either case.

If we want to deal with the problem just mentioned and calculate how many children of a certain age are enrolled in the education system at whatever level then we must use a different kind of enrolment ratio, the age-specific enrolment ratio.

c) The age-specific enrolment ratio relates the enrolment of a given age or age-group in a given year to the population of that age in that year.

(16) $$\text{Age specific enrolment ratio} = \frac{E^t_a}{P^t_a} \times 100.$$

Note that in this formula

$E^t_a = E^t_{P,a} + E^t_{S,a} + E^t_{H,a}$, where P, S and H refer to primary, secondary and higher levels respectively.

EXERCISE III

The following information is available for 1970 on enrolment by single year of age in elementary and secondary general education for girls in India. Population data for girls, as estimated by United Nations, is given alongside.

Age	Enrolment			Population
	Elementary Education Grades I-V	Secondary General Education		
		Lower stage Grades VI - VIII	Upper stage Grades IX - XII	
Under 5	72 977			
5	2 197 066			7 912 130
6	3 972 805			7 679 176
7	4 069 248			7 444 127
8	3 653 253			7 207 750
9	3 011 239	102 289[1)]	105[1)]	6 970 814
10	2 056 352	424 412	1 046	6 735 713
11	1 216 490	744 664	11 152	6 504 853
12	625 552	876 327	55 303	6 270 829
13	268 881	732 375	178 056	6 031 141
14	107 888	509 386	350 096	5 791 456
15	54 469[2)]	289 250	427 496	5 558 787
16		134 405	336 433	5 330 346
17		49 909	203 991	5 124 674
18		17 361	87 672	4 951 282
19		6 616	35 944	4 801 904
20		2 479[3)]	20 783[3)]	4 658 170
Total all ages	21 306 220	3 889 473	1 708 077	

1) Figure refers to pupils aged 9 and below
2) Figure refers to pupils aged 15 and above
3) Figure refers to pupils aged 20 and above.

On the basis of the above information calculate :

a) the net and gross enrolment ratios for elementary education for girls in 1970.

b) the net and gross enrolment ratios for lower and upper stage (separately) of secondary general education for girls in 1970.

c) the age specific enrolment ratios for the three age-groups 6-10, 11-13 and 14-17 years for girls in 1970.

SECTION 2 : THE EDUCATIONAL FLOW MODEL AND ITS USE IN PROJECTING FUTURE ENROLMENT IN PRIMARY EDUCATION

II.2.1 Introduction

There is a variety of mathematical models which has been used throughout the world in educational planning. This paper is restricted to a discussion of educational flow models, which are models specifying the flow of pupils into, through and out of the educational system. The fundamental objective of such models is to provide an explicit, logical and integrated framework in which to fit available data describing the flow of pupils through the system. Having developed such a framework, it may be used to project - that is, to demonstrate the implications for enrolment at future dates of explicit assumptions about the continuation of past and current trends and relationships.

The major purpose of this section is to introduce and explain the technique of the educational flow model. The model will be applied at a relatively high level of aggregation, as most of the examples included below will refer to India as a whole. A full analysis by state cannot be attempted in a paper of this length. The data needed for such a detailed analysis were in any case not available to the author at the time this paper was prepared. However, during the practical work sessions at the seminar, participants will be analyzing wastage and preparing enrolment projections for four selected states. The problems involved in preparing projections at the state and district level will moreover be discussed at length at the seminar.

It is worth stressing here that the discussion is restricted to the introduction of the basic flow model as applied at the elementary level. The particular issues raised by planning at the second and third levels of education will not be treated here. The principle of the use of the method is however the same at these levels as for elementary education. The particular data problems experienced at the second and third levels (e.g. transfer between different types of education and different fields of study) will be discussed at the seminar.

We shall refer to the flow model discussed in most of this section as the Grade Transition Model. This is the most commonly used model for enrolment projections. In order to employ this model we need data on enrolment by grade for at least two successive years as well as data on repeaters for the last of these two years. If we want to study changes over time in the transition rates (i.e. the promotion, repetition and dropout rates, see below for definition), we need, of course, data for more years. Projections of such rates will be discussed briefly in Section II.2.13 of this paper and will be dealt with in more detail at the seminar.

In cases where the data available are limited to cover enrolment by grade only, i.e. no data on repeaters are available, the Grade Transition Model cannot be applied and we have to use a more simple method. The most common model among these simplified methods is the Retention Model, also referred to as the Grade Ratio Model. This model will be presented briefly in Section II.2.15 and the differences between this model and the Grade Transition Model will be discussed further at the seminar.

II.2.2 Characteristics of educational flow models

Certain characteristics of educational flow models should be clarified at the very outset of the discussion.

Their use does not imply or necessitate any particular approach to educational planning, or any particular set of fundamental objectives which educational systems may be supposed to pursue. Whether schools are intended to satisfy the social demand for education; or to meet the manpower "requirements" of economic development plans; or to maximise the rate of return to the investments made by individuals and society in the educational system; or to satisfy all three or indeed other objectives, an educational flow model is quite neutral. It is essentially a technical, mathematical tool of analysis which can, if its limitations are properly understood; be valuably applied to planning educational systems with any mixture of objectives.

The flow models most commonly used do not seek to explore or explain the behavioural relationships which determine in part the parametres playing such an important role in the model. (1) For example, current repetition rates and prediction of their future magnitudes are important parametres in the flow models. Repetition rates themselves however depend on several factors such as, for example, the existing regulations on the level of educational performance expected of a pupils if he is to be promoted at the end of a school year to the next grade. Similarly, dropout rates are important parametres in determining the future development of enrolments. In secondary and higher education particularly, dropout rates may in part reflect individuals' perceptions of their short-term and longer-term employment and earnings prospects, and so in principle may be influenced by social policies on work and pay for school leavers. Dropout rates will also reflect factors on the education supply side; for if the national educational structure is not complete in some areas - and thus, for example, some elementary schools do not contain all grades - pupils may be forced to leave school against their own wishes.

II.2.3 Distinction between enrolment projections, forecasts and targets.

A projection (as has already been made explicit above in the discussion of population projections), is a conditional statement about the future. It is the elaboration of the effects in the future of making sets of assumptions about trends in the parametres characterising the educational system. Thus a projection does not necessarily offer the most probable (in some person's judgement) outcome. Rather, its main function is to demonstrate to the decision-maker the results which follow from changing some of the parametres (or from leaving them unchanged). Depending on the desirability to the decision maker of the projected outcomes, he may intervene with policy changes to affect the underlying trends.

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(1) Flow models including behavioural relationships have however been developed, particularly for individual institutions of higher education, see, for example: Mathematical Models for the Educational Sector: A Survey, OECD, Paris 1973.

A forecast, by contrast, attempts to give the most likely outcome of future school enrolment. It will be obtained by combining with projections further data concerning future policies, plans or expectations, or "best guesses" about future developments in values of the parametres such as the intake, promotion, repetition and dropout rates. Thus an element of judgement, lacking in projection, enters into forecasting.

Targets sometimes form the basis for the estimation of future required enrolments. For example, a target such as "x% of the 6-10 year-old population should be enrolled in primary education by 1982", could be specified. The job of the educational planner would then be, using techniques including the flow model, to make explicit the implications of meeting such a target for the required intake, promotion and other rates, as well as the number of teachers, new school buildings, etc. Target-setting thus goes beyond the work of projection, with its emphasis on technical relationships between the various parametres, and beyond the probable outcomes of the forecaster; it introduces the idea of desirable outcomes.

Thus whether the objective of a particular exercise is to make projections, forecasts or analyse the requirements implied by the adoption of targets, the educational flow model may be utilised.

II.2.4 The advantages of mathematical models

Mathematical models, as opposed to less formal modes of reasoning such as the purely verbal, have certain distinct advantages.

a) Specification and quantification of relationships

The planner is obliged to specify the relationships seen as relevant, i.e. to state explicitly which factors relate to which. Secondly he must attempt to quantify the parametres of the model using the available data. This quantification can make explicit both the internal relationships within the educational system and the relationships between education and other sub-systems such as manpower and population.

b) Research and data requirements

are frequently clarified by the construction of a mathematical model. Data collection and research are resource-consuming. Models can help in the assessment of priorities for expenditure in these areas.

c) Logical consistency

between separate analyses within the educational systems is ensured by the explicit specification and estimation of relationships which often involve large and complex quantities of information.

d) Rapid calculation of the future implications

of alternative educational policies is facilitated by the use of such models, particularly if computerised, i.e. models permit simulation analyses.

e) Intranational and international comparative analyses may be made more readily through the models' specification and quantification of key relationships. Such comparisons may help in forming future educational strategies based on other countries' experiences.

II.2.5 The flow of students through an educational cycle

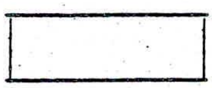
We may now introduce the basic education flow model in the context of the elementary level in India. The model will be applied at the highly aggregated, national, level, but the reader will be given exercises using data for four States.

In describing the flow of students through an educational cycle (1), certain key statistics must be calculated. Looking at the system on the national level (2), at the end of each school year students may :

a) be promoted to the next higher grade
b) have to repeat the same grade during the following year
c) have dropped out, either because they have left the school system, or migrated to another school system, or died.

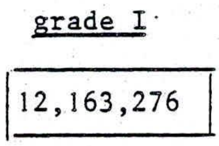
It is the analysis of these flows of students over time between and within grades which forms the core of the basic educational flow model.

In order to illustrate the fundamental concepts involved, let us examine the flows of students at the elementary level in India between 1969 and 1970. These flows may be represented graphically. The enrolment in a specific grade in a specified year may be written inside a rectangle, thus :

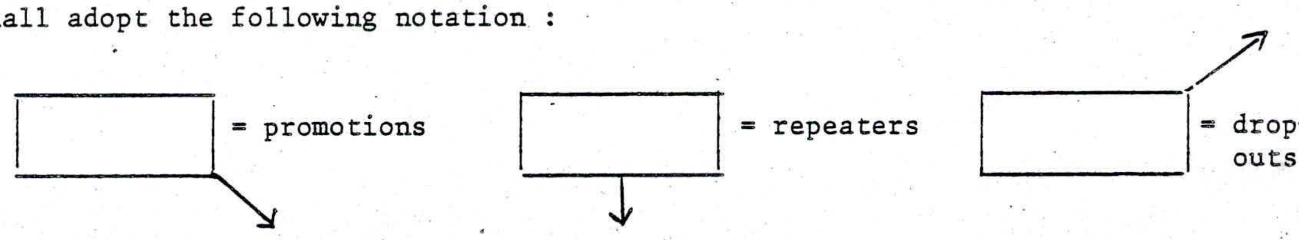


As an example, for boyes in India in grade I at the elementary level in 1969/70, we have :

Figure 3

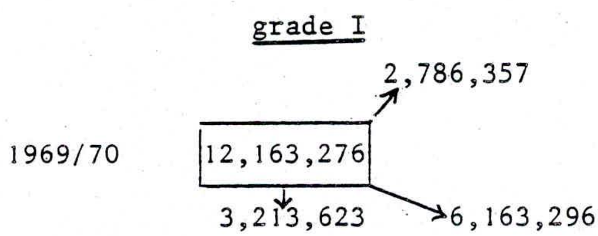


We shall adopt the following notation :



Thus for the pupils enrolled in grade I, in 1969/70, we may write :

Figure 4



(1) In this paper, grades I-V at the elementary level.
(2) If one is looking at a sub-system (e.g. a State or District, a single school, private schools only, a particular type of secondary school, etc.) one must also take account of two-way transfers between the sub-system under review and other sub-systems within the total system.

i.e. of the 12,163,276 pupils enrolled in grade I in 1969/70, 6,163,296 were promoted to grade II; 3,213,623 repeated grade I; and 2,786,357 dropped out before the beginning of the 1970/71 school year.

It should be noted immediately that the total enrolment of 12,163,276 will include individuals in the process of repeating grade I, that is, who were in grade I in the previous year, 1968/69. Therefore, the total, 12,163,276, cannot be taken as the measure of new entrants into the primary system. Nevertheless, the estimation of new admissions is essential for the purposes of future projections. This problem will be discussed at greater length in II.2.12 below.

In order to take account of the difference between those students repeating the first year and those who are the new entrants, two main approaches are available. The first is an individual-based information system, in which each student is carefully followed throughout his career. This method has been adopted in certain developed countries. It requires, however, an expensive system of data collection and analysis. The second method is to consider all the pupils enrolled in a given grade in a given year as a particular cohort, and that all pupils belonging to this cohort have the same behaviour as regards promotion, repetition and dropout, regardless of their previous school history. The methods discussed below are based on this latter assumption, the implications of which will be discussed in more detail during the seminar.

We may now ask: how has it been possible, from the educational statistics collected in India, to work out how many pupils from among those enrolled in a given grade in a given year will in the following year be promoted to the next grade, or will repeat the same grade, or will have dropped out ?

Until recently data were collected on enrolment and repeaters by grade (1). Such data are shown in Table 16 for grades I-V of elementary education. The first row of the table gives the enrolment by grade in 1969/70 while the next two rows show the enrolment and repeaters by grade in 1970/71. From these data we can calculate

(1) Some countries collect data on enrolment and dropout by grade, but not on repeaters. For the purpose of constructing the model of student flows used in this section it is unfortunately true that the dropout data on their own are the least useful of the three types of data (i.e. data on promotion, repetition and dropout). This has nothing to do with the reliability of the information; though as a matter of fact dropout data collected alone (i.e. not derived from repetition and promotion data) have an inherent tendency to be somewhat inaccurate because their compilation involve tracing students who have be definition left school, and it is difficult to be sure that they have not enrolled in another school elsewhere in the system. Promotion and repetition data which record movement by students still in the system are obviously easier to collect and more reliable. In addition to this problem of reliability comes however that one cannot derive promotion or repetition data from knowledge of enrolment and dropout, since a student enrolled in year t may, in year t + 1 (if he has not dropped out), be either promoted or may repeat; and we have no means of knowing which has happened, if we have only enrolment and dropout data. Un year t+1, however, the enrolment must consist of pupils who have either been promoted or who are repeating (if one assumes that there is no direct entry to the higher grades from outside the system). This means, then, that if one has either the repetition or the promotion rate, the other of these two may be derived. Then, if one has both these rates for two successive years, one can also derive dropout rates. For this reason, if one can choose to have data available for just one of the three rates, one would opt for the repetition or promotion rates (including for grade I, into which there is no promotion, the intake rate). Either of these, combined with enrolment by grade, can be used to calculate the other two rates and to construct the complete flow model.

Table 16. Enrolment and repeaters by grade in elementary education. Boys. India

Year	Grade I	Grade II	Grade III	Grade IV	Grade V	Total
1969/70 Enrolment	12,163,276	7,442,004	6,024,765	4,989,961	4,149,091	34,769,097
1970/71 Enrolment	12,514,280	7,667,279	6,182,085	5,104,905	4,270,672	35,739,221
of which repeaters from 1969/70	3,213,623	1,503,983	1,117,447	853,843	642,559	7,331,455

Source : Data supplied by national authorities.

that if grade II repeaters accounted for 1,503,983 of the 1970/71 enrolment of 7,667,279, then the remaining 6,163,296 were newly promoted to the grade from grade I in the previous year. Thus if 6,163,296 were promoted out of grade I in 1969/70, and 3,213,623 are known to have repeated, it follows that 2,786,357 were dropouts (i.e. 12,163,276 enrolments minus 3,213,623 repeaters minus 6,163,296 promoted) from grade I in 1969/70. Thus by knowing the enrolment by grade for two successive years and the repeaters for the last of these two years, we are able to derive the number of pupils who are promoted and who drop out as well. This is possible under the following two assumptions :

(i) that there are no new entrants (from outside the system) to grades other than grade I;

(ii) that transfers between sub-systems can be ignored, so that no account need be taken of transfers between different educational streams, movement from one province or school to another, from private to public schools or vice versa.

These assumptions will be discussed in greater detail at the seminar.

Rates of promotion, repetition and dropout may be calculated in the following way :

The promotion rate

(17) the promotion rate (p_i^t) =

$$\frac{\text{number of students promoted to grade i+1 in year t+1}}{\text{number of students in grade i in year t}}$$

or in symbols :

$$p_i^t = \frac{P_{i+1}^{t+1}}{E_i^t}$$

Using as an example the data for boys in India presented in Figure 4 above, it may be seen that :

$$p_1^{1969} = \frac{P_2^{1970}}{E_1^{1969}} = \frac{6,163,296}{12,163,276} = 0.507$$

Using as an example the data for boys in India presented in Figure 4 above, it may be seen that :

$$p_1^{1969} = \frac{P_2^{1970}}{E_1^{1969}} = \frac{6,163,296}{12,163,276} = 0.507$$

The repetition rate

(18) the repetition rate (r_i^t) =

$$\frac{\text{number of students repeating grade i in year t+1}}{\text{number of students in grade i in year t}}$$

or in symbols :

$$r_i^t = \frac{R_i^{t+1}}{E_i^t}$$

Again using the data for boys in India in Figure 4 above,

$$r_1^{1969} = \frac{R_1^{1970}}{E_1^{1969}} = \frac{3,213,623}{12,163,276} = 0.264$$

The rate of dropout

(19) the rate of dropout (d_i^t)

$$\frac{\text{number of students dropping out from grade i in year t}}{\text{number of students in grade i in year t}}$$

or in symbols :

$$d_i^t : \frac{E_i^t - (R_i^{t+1} + P_{i+1}^{t+1})}{E_i^t}$$

Using the information from Figure 4 above for boys in India,

$$d_1^{1969} = \frac{E_1^{1969} - (R_1^{1970} + P_2^{1970})}{E_1^{1969}} = \frac{12,163,276 - (3,213,623 + 6,163,296)}{12,163,276} = 0.229$$

It can be seen that the rate of dropout is the complement of the sum of the rates of promotion and repetition :

$$p_1^t + r_1^t + d_1^t = 0.507 + 0.264 + 0.229 = 1$$

As already observed, once any two of the rates have been calculated, the third is determined. It is also true, as we noted previously, that if just the repeater rate or the promotion (including intake) rate is known for consecutive grades, one can calculate <u>both</u> the other two rates since, under our assumptions :

$E_{i+1}^{t+1} = P_{i+1}^{t+1} + R_{i+1}^{t+1}$, i.e. enrolment in any grade is made up of just two groups of students, those promoted from the previous grade, and those who are repeating.

Directly resulting from their definitions the rates may be interpreted as relative frequencies. That is, they represent the probabilities for any individual, taken at random from a cohort, of his promotion, repetition or dropout.

This information may be used in two related, but different ways :

a) to reconstruct the school history of a given cohort. This is discussed under point II.2.6 below;

b) under certain assumptions concerning the future development of these rates, to project the future development of enrolment by grade. This is discussed in points II.2.8 - II.2.13 below.

EXERCISE IV

For this and the following exercises, the participants will be split into four groups. On the basis of the data given in the tables below on enrolment by grade and sex in elementary education in four selected states, each group will calculate promotion, repetition and dropout rates by grade and sex for the school-year 1975-76 for each of the four states. These rates will be used in subsequent exercises for analysing wastage and for projecting enrolment by grade and sex in elementary education.

Jammu and Kashmir

Sex		Grade I	Grade II	Grade III	Grade IV	Grade V
Boys	Enrolment 1975/76	80,276	61,175	49,120	41,296	39,249
	Enrolment 1976/77	83,565	61,671	50,809	42,704	39,955
	Repeaters 1976/77	8,461	5,065	6,267	5,629	5,573
Girls	Enrolment 1975/76	45,281	29,241	23,322	20,741	18,241
	Enrolment 1976/77	46,912	31,997	24,417	21,182	19,895
	Repeaters 1976/77	3,817	1,933	3,720	1,670	1,776

Maharashtra

Sex		Grade I	Grade II	Grade III	Grade IV	Grade V
Boys	Enrolment 1975/76	1,264,024	883,006	728,401	602,772	528,122
	Enrolment 1976/77	1,349,833	900,562	758,421	613,693	546,086
	Repeaters 1976/77	290,700	158,900	123,800	96,400	73,900
Girls	Enrolment 1975/76	1,004,979	634,426	491,372	382,577	312,853
	Enrolment 1976/77	1,090,229	662,823	520,650	396,771	329,296
	Repeaters 1976/77	251,000	126,900	88,500	65,000	40,700

Rajasthan

Sex		Grade I	Grade II	Grade III	Grade IV	Grade V
Boys	Enrolment 1975/76	571,771	487,065	289,340	237,081	201,108
	Enrolment 1976/77	552,280	470,461	314,033	242,760	213,706
	Repeaters* 1976/77	91,495	56,455	37,684	23,523	17,631
Girls	Enrolment 1975/76	190,210	168,677	85,629	67,528	56,676
	Enrolment 1976/77	189,109	167,701	90,669	68,561	58,651
	Repeaters* 1976/77	25,019	18,581	8,186	5,691	4,035

Tamil Nadu

Sex		Grade I	Grade II	Grade III	Grade IV	Grade V
Boys	Enrolment 1975/76	775,721	699,954	630,024	548,373	468,308
	Enrolment 1976/77	866,844	690,776	622,821	551,100	470,940
	Repeaters* 1976/77	107,922	81,442	75,424	63,707	57,502
Girls	Enrolment 1975/76	647,814	568,978	487,636	406,858	329,497
	Enrolment 1976/77	751,041	568,190	488,859	409,708	332,000
	Repeaters* 1976/77	86,971	66,592	59,739	45,560	36,985

* *Data on repeaters were not available for Rajasthan and Tamil Nadu. The figures shown here were estimated on the basis of the repetition rates for the school-year 1969/70 provided by the Ministry of Education and Social Welfare.*

II.2.6 Reconstruction of the school history of a given cohort

Replacing the absolute numbers shown in Figure 4 by the corresponding promotion repetition and dropout rates, we may write for grade I :

Figure 5

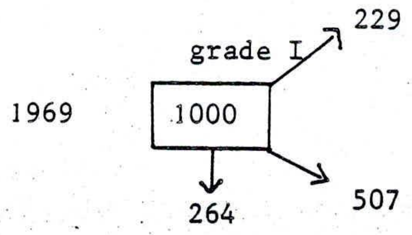


Table 17 presents the rates of promotion, repetition and dropout for boys in India for 1969/70 in grades I-V.

Table 17. Rates of promotion, repetition and dropout for boys in elementary education in India by grade in 1969/70.

	Grade I	Grade II	Grade III	Grade IV	Grade V
Promotion rate	.507	.681	.706	.727	.845*
Repetition rate	.264	.202	.185	.171	.155
Dropout rate	.229	.117	.109	.102	

* As no data were available on examination results, this rate includes all pupils not repeating grade V, including those who drop out.

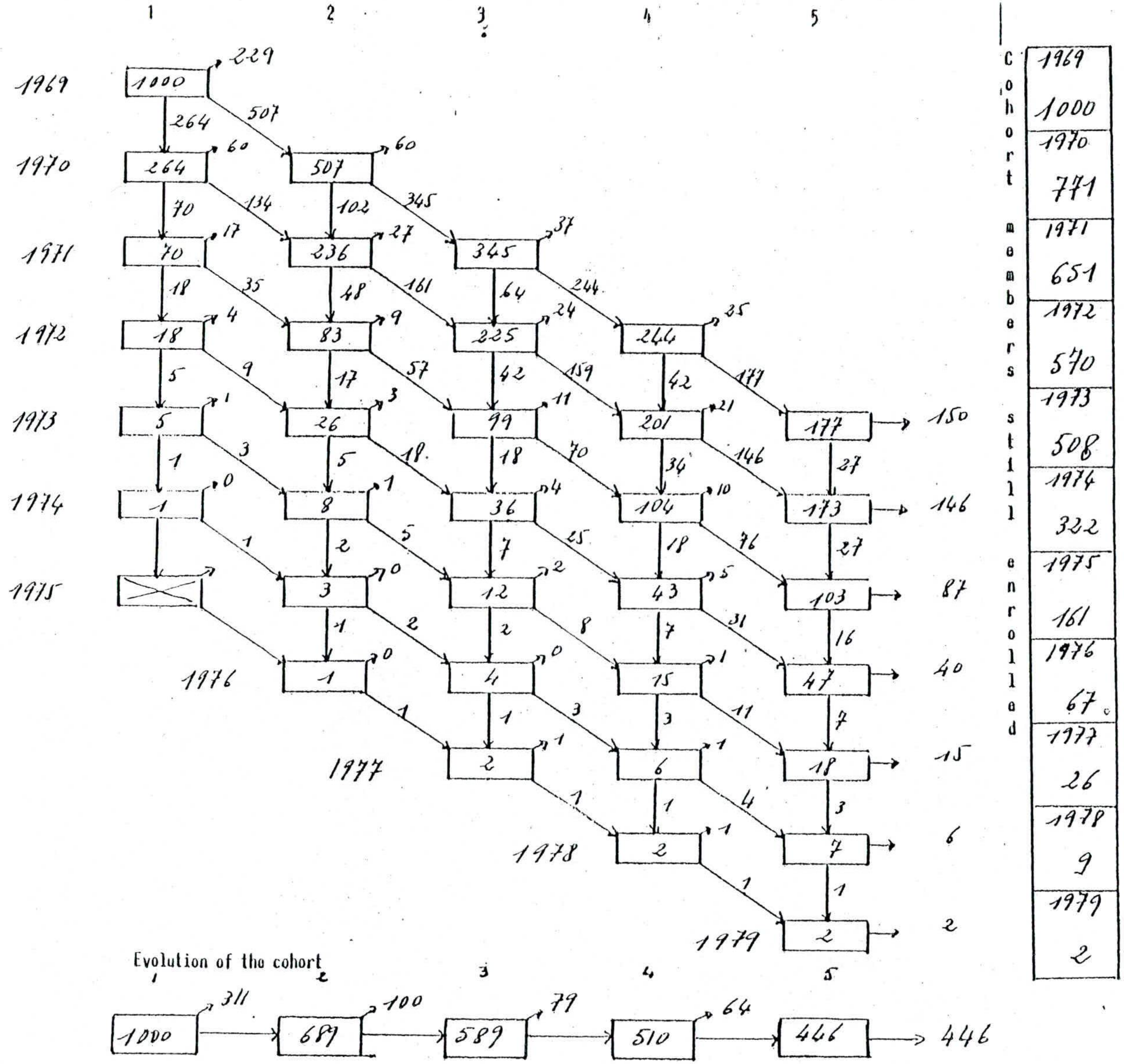
Source : Data supplied by national authorities.

A flow-diagram illustrating the hypothetical flows of a cohort of male students in primary education in India, commencing in 1969/70 may now be drawn up (Figure 6).

Purely as an illustrative exercise in demonstrating the evolution of the cohort in Figure 6, we assume that the flow rates remain constant over the whole period. Thus we have assumed, for example, that the repetition rate in grade III remains constant throughout the period at 0.185. In practice of course flow rates do change over time and should, ideally, be estimated in order to reconstruct a cohort. As we shall see in our discussion of projections, knowledge of trends in past rates can help in projecting the development of future rates.

The procedure followed in constructing Figure 6 is easily understood and will be further explained during the seminar. Of the 1000 pupils enrolled in grade I in 1969/70, 264 would repeat this grade in 1970/71, 507 would be promoted to grade II while 229 would drop out. These figures are obtained by applying the promotion, repetition and dropout rates of Table 17. They are entered in the diagram against their respective arrows. By applying the promotion, repetition and dropout rates of grade II we find further that of the 507 enrolled in this grade in 1970/71 (i.e. the pupils promoted from grade I in 1969/70), 507 x 0.681 = 345 would be promoted to grade III in 1971/72 while 507 x 0.202 = 102 would repeat grade II in this latter year. In order to obtain the figure 236 in the rectangular box (a figure showing how many of the original 1000 pupils would in 1971/72 be in grade II after having repeated once) we must add to these 102 those pupils who are promoted to grade II after having once repeated grade I, i.e. 264 x 0.507 = 134.

Figure 6 : Hypothetical flow of the 1969/70 cohort of boys through elementary education in India



Grades	Pupil-years
1	1358
2	864
3	723
4	615
5	527
Total	4 087
Out-put (N°of pupils)	446
Years input per completing pupil	9.16
Input/output	1.83

All the other figures in the flow diagram may be obtained in the same way, employing for each year and grade the promotion, repetition and dropout rates given in Table 17. The assumptions on which this reconstruction is based may be summarized as follows :

a) Rates of repetition, promotion and dropout remain constant over the entire period, and are those observed in 1969/70.

b) A pupil may repeat six times at most during elementary education. This is of course a theoretical maximum and very few pupils would indeed actually repeat that many times.

c) There are no new entrants into the system after the first year. For the sake of analytical clarity, we calculate only the flows of a hypothetical cohort or 1000 new entrants in 1969/70.

d) In any particular grade, the identical rates of repetition, promotion and dropout are assumed to apply to both those who have reached the grade directly and those who have been delayed by one or more repetitions.

These four assumptions will be discussed further during the seminar.

It should be noted that data were not available on the number of pupils who actually graduated successfully from elementary education in 1969/70. For this example we have therefore assumed that there is no dropout from grade V. Under this assumption we see that out of the original 1000 students, 446 will eventually successfully complete grades I-V. Of these 446 students, 150 are estimated to graduate without repetition from the primary level in 1973/74; 146 in 1974/75 after repeating once; 87 in 1975/76 after repeating twice; 40 in 1976/77, and so on. 554 of the original 1000 drop out from grades I-IV. The rows of rectangles at the foot of the flow diagram show that out of the 1000 pupils, 311 drop out from grade I, 689 eventually complete the first grade and enter the second, 100 drop out from the second grade, and so on. Finally, the column on the right hand side of the flow diagram shows how many students of the original cohort are still enrolled, year by year. The figure in a particular box is found by adding up the enrolment in each grade that year. Thus, the number 651 for 1971/72 equals 70 + 236 + 345.

EXERCISE V

Using the results obtained from completion of Exercise IV, participants, working in four groups, will reconstruct the school history of the cohorts for boys and girls for the four States commencing grade I in 1975/76. Section II.2.6, Table 17 and Figure 6 show how this is done. It should be assumed that the flow rates calculated in Exercise IV will remain constant over the entire period of the evolution of the cohort.

II.2.7 Efficiency in education

"Efficiency" is a concept which has been developed and refined particularly by economists. It refers to the relationship between the inputs into a system (be the system, e.g., agriculture, manufacturing or education), and the outputs from that system (be they wheat, vehicles or educated individuals). An activity is said to be "efficient" if maximum output is being obtained from given inputs, or if a given output is being obtained with the minimum possible inputs. Inputs and outputs have somehow to be valued so that they may be aggregated; and usually prices are used to perform this valuing function. The problems of measuring efficiency in education, however, are considerable. They stem from difficulties in measuring educational output. How educational output is to be measured depends, of course, on the nature of the objectives of the educational system. Depending on the analytical and philosophical viewpoint adopted, the objectives may differ considerably.

From Figure 6 we see that 446 out of 1000 pupils are calculated as eventually completing the primary cycle. This would be the output from this cohort if we consider that all pupils who drop out should be counted as "wastage". This is a relatively restricted definition of output since some of the dropouts no doubt have acquired some of the skills which the system set out to teach them. In a more complete definition of output the educational attainment of these dropouts should, therefore, be taken into account (1).

Educational inputs comprise the buildings, teachers, text-books, etc., which may all be aggregated financially in terms of expenditures per student-year. However, an input indicator appropriate for the measure of output in terms of successful completers is the number of pupil-years used by the cohort. In a system consisting of five grades, a minimum of five pupil-years would be required for a pupils to complete successfully the cycle. However, perfect efficiency is almost never achieved in the real world. Pupils repeat grades, so increasing the number of student years (inputs). Students drop out before completing the cycle, thus diminishing output. The table in the right hand corner of Figure 6 shows the number of pupil-years used by this cohort. We see that the pupils spent a total of 1358 pupil-years in grade I, i.e. 1000 in the year 1969/70 by the pupils entering in this year, 264 in 1970/71 by pupils repeating for the first time, 70 in 1971/72 by pupils repeating for the second time, and so on. Considering all five grades, the total number of pupil-years spent by this cohort is 4087. This represents the total "input". The "output", i.e., successful completers of the five-year cycle, as we have seen was 446. The average number of pupil-years per successful completer was therefore :

$$\frac{4087}{446} = 9.16$$

(1) On the issues surrounding the definition and measurement of educational wastage in an Indian context, see C.L. Sapra, Educational Wastage and Stagnation in India, National Council of Educational Research and Training, New Delhi 1967, and C.L. Sapra, Measurement of Educational Wastage, National Council of Educational Research and Training, New Delhi 1972.

If there had been no repetition or dropouts, the 446 pupils would have needed only 446 x 5 = 2230 pupil-years to complete the five-year elementary cycle. By dividing the number of years actually spent by this optimal number we obtain an indicator of efficiency generally referred to as the input-output ratio, which in this case is :

$$\frac{4087}{2230} = 1.83$$

In a perfectly efficient situation, this ratio would equal 1.00.

It should be noted that this definition of efficiency is a relatively narrow, technical one (1). It is not an economic definition of efficiency in the sense that it ignores both the financial costs of inputs and the monetary value of the output. Nevertheless it is a useful indicator for comparative analysis of the effects of repetition and dropout, particularly within a country at a particular point in time, when prices of inputs and the values of outputs may be expected to be relatively homogeneous across the country.

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We have above briefly illustrated how we, if data on repetition and enrolment by grade are available, may reconstruct the school history of a given cohort. The assumptions involved in this method has been outlined briefly and will be discussed at the seminar.

In the case where data on repetition are not available, a method referred to as the apparent cohort method is often used to estimate the dropout between grades. This method requires data on enrolment by grade for successive years. The method consists of comparing the enrolment in grade I of a cycle a particular year with the enrolment in successive grades during successive years, assuming that the decrease from each grade to the next equals dropout. If there is no repetition, this method would give the same estimates for dropout as the reconstructed cohort method. The apparent cohort method may still give reasonable results if the repetition rates are relatively small and do not vary much in magnitude between grades. However, if repetition rates are large and vary in magnitude between grades, the results given by the two methods may be very different. Moreover, the apparent cohort method can at best give only an approximate estimate of dropout and in no case can it give information on the effect of repetition on the internal efficiency of a cycle or level of education.

The difference between the assumptions behind the above two methods will be further discussed at the seminar and the differences in the results obtained from each of them will be illustrated on the basis of data for India.

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(1) Apart from anything else the definition does presuppose that all pupils are capable of "successfully completing the course". If this were not the case, it might be argued that the efficiency of the system was in fact increased by pupils leaving early. Given the wide range of human capabilities it seems questionable whether a single measure of "success" can be divised in terms of performance level reached: one should also take account of pupil capability and the level of pupil attainment on entry to the course. For these reasons, in addition to those mentioned in the text, the input-output ratio should be regarded as a potentially fruitful way of thinking about efficiency, rather than as the only definitive measure of it.

EXERCISE VI

Using the hypothetical cohorts constructed in the preceding exercise, complete the table in the top right hand corner, and calculate the input-output ratio. Prepare a brief statement containing your assessment of whether the system shown in Figure 6 is more or less efficient than the system represented by the flow diagram for the cohort which you prepared in Exercise V. Analyze which factors have caused the observed difference in efficiency between the two cohorts.

II.2.8 The role of education projections in educational planning

We have now examined the major tools and techniques used in describing and analysing student flows. The same tools and techniques enable the planner to project school enrolments in the future. Enrolment projections are at he heart of almost all aspects of educational planning. An example of their application will be seen in Part III of this paper examining future teacher requirements.

In its simplest sense, the term "projection" would be used only for exercises of the extrapolation into the future of past trends. Thus enrolment projections would inform us about how many pupils would be enrolled at some future time, assuming no changes in the educational system, with past trends continuing unchanged in the future. The objective of such projections would be to give the planner a basic frame of reference for the future. Against this frame the planner could judge the validity of the assumptions behind the model, or the effects of changes in the parametres such as repetition, promotion and dropout rates. Thus, to emphasize what has already been said, a projection of this type is not a forecast (except in the unusual circumstances that the changes expected to occur in the structure of the system or its parametres exactly replicate past changes).

In practice projections as actually made by educational planners are developed both through the extrapolation of certain unchanged trends, and by assuming particular changes in one or more of the others. This compromise allows the planner explicitly to take into account changes in educational policy during the period.

Hence enrolment projections are best understood as conditional forecasts of new entrants, total enrolments, and of leavers, as well as of the future structure of the educational system.

II.2.9 Factors influencing the student flow

Four independent factors influence the flow of students through an educational cycle (1) :

a) the population of admission age
b) the admission rate to the first grade
c) the rates of repetition at different grades
d) the rates of promotion at different grades.

These four factors determine the inflow of students into the cycle, the manner in which they proceed through the cycle up to the planning horizon, and the numbers of successful completers of the cycle in successive years.

In projecting enrolments, a simple extrapolation of enrolment trends would not be enough. The student-flow model, by way of contrast, has as its great advantage that it clearly demonstrates the role played by policy variables in the enrolment projections. For planners should regard rates of admission, dropout and repetition as policy variables. They are capable of regulation in the pursuit of a country's welfare objectives. They are not exogenous, uncontrollable factors in the light of which other adjustments have to be made. Even the population of admission age is potentially influenced by available policy measures, such as family planning or reduction in childhood mortality rates through better health care. The great potential for reduction of these rates will have profound long-run implications for the whole educational system's development.

II.2.10 . Preparing an enrolment projection

In order to project a cohort of students from a base year until some future date, a minimum set of data must be available. In the context of the four factors (a)-(d) listed in II.2.9 above, this data-set will be :

a) a projection over the plan-period of the age-group corresponding to the admission age
b) a projection of the number of new entrants to grade I of primary education
c) an estimation of the repetition rates, grade by grade, over the period
d) a similar estimation of the promotion (and hence, as a residual, the dropout) rates.

We shall below illustrate how we may use the Grade Transition Model to project enrolment by grade in Elementary education in India. As the latest data on repetition available for India at the time this paper was prepared was for 1969/70, we shall

(1) Note that a fifth factor, the rate of dropout, is not independent of the rates of repetition and promotion : the three rates must sum to unity. Note also that the factors are here specified as being independent in relation to the flow of students through an educational cycle. It is well-known that where promotion from one cycle to another is in some sense selective, such an administrative restriction of the promotion rate may well result in a higher rate of repetition in the grades preceding the selective hurdle, in which case the rates might not be independent of each other.

prepare a projection for the five year period 1970-1975. The results will then be compared to the actual development of enrolment during this period. The purpose of this exercise is hence not to provide a projection for the future, but to illustrate how the method may be used. At the same time, since actual enrolment data are available for the period 1970-1975, we may "check" how well the model works. The reader should note carefully the several assumptions upon which this explanatory projection exercise is based, the object of which, it should again be stressed, is to give an illustration of the methodological approaches and problems rather than to make a projection for actual use in India. Alternative ways of solving the problems encountered will be discussed during the seminar. The example below will be limited to cover boys only. As the transition rates generally are different for boys and girls, it is important to prepare projections separately for the two sexes. This will be done in the practical exercises.

II.2.11 Projection of the age-group of admission age

Part I of this paper introduced the concepts underlying the projection of population groups by age and sex. Clearly the essential factors influencing the projection of the age-group of school admission age are fertility and childhood mortality rates up to the admission age. The age of admission is generally six years in India, although it is five in some states. Table 18 shows the United Nations' estimates for the number of boys aged 6 years in India during the period 1970-1975. We have used these estimates for this example since data were not available to the author year by year, from national sources. Such data as were available suggested that the UN estimates for this period are rather close to the national ones. For example, national data estimated the number of boys aged 6 years in 1974 to be 8,567,000 as compared to 8,733,715 for the UN estimates, i.e. a difference of 1.9%.

Table 18. Estimates of the number of boys aged 6 years old in India 1970-1975.

Year	Number of boys (in 000's)
1970	8219
1971	8404
1972	8463
1973	8590
1974	8734
1975	8900

Source : United Nations Population Division.

II.2.12 Methods of projecting new entrants

It is of curcial importance to determine as accurately as possible the new admissions to grade I, as this will influence the enrolment in all subsequent grades in the following years. Normally countries do not directly collect data on the number of new entrants, and these data are derived by subtracting the number of repeaters in grade I a given year from the enrolment in this grade the same year. Thus, in countries where repetition is permitted, data on new entrants to grade I can only be derived if data on repeaters are collected. Again we see the crucial importance for educational projections and planning of collecting these types of statistics.

There are many possible methods for projecting new entrants and the one to be chosen for a particular case depends mainly upon the data available for the country in question, the age-distribution of the new entrants (i.e. do some of them come from other ages than the legal admission age?) and the proportion of the admission age-group entering school.

In a country where all new entrants start school at the same age, the number of new entrants to the educational system in a given year depends upon the number of children of admission age and upon the proportion of this age-group which enters school (the intake rate). Assuming that all children start school at the age of 6, the number of new entrants in year t may be expressed as :

(20) Number of new entrants $N_6^t = e_6^t \; P_6^t$

where N_6^t = number of new entrants aged 6 years in year t;

e_6^t = proportion of 6 year olds entering grade I of primary education in year t;

P_6^t = population aged 6 years old in year t.

The new entrants should, if possible, be calculated separately by sex. The pattern of admission is generally quite different for boys and for girls, particularly in developing countries. This is also the case in India.

In developed countries where practically all children enter school at the official age, the estimation of the future new entrants is mainly a question of estimating the future population of admission age (1). For developing countries the situation is quite different. A large proportion of those children eligible for primary education generally is not enrolled and late entrants, i.e. entrants older than the official age of admission, are common. For countries having a rather low proportion of the children of admission age entering school, it may be sufficient to project directly the number of new entrants without relating it to the size of the population of admission age. However, in general it is desirable to use a model which takes explicitly into account the development of the admission age-group. This is particularly so for countries approaching universal intake to primary education and where the number of new entrants consequently will depend closely on the development of the population of admission age. This is the case now for boys in India. A method taking explicitly into account the development of the population of admission age should therefore be used.

The simplest method to use in projecting intake, and one which is particularly suitable where data on the age of new entrants is not available, is to base it on the apparent intake rate

(21) apparent intake rate : $\dfrac{\text{total number of new entrants of whatever age}}{\text{population of legal admission age in year t}}$

or in symbols (if the official entry age was 6): $N^t = e^t \; P_6^t$

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(1) In developed countries with a substantial private sector of education, estimation has of course to be made of the proportionate breakdown of total enrolment by public and private sectors. For purposes of public education programming, the main concern of the forecasters is with public sector enrolment.

One of the weaknesses of basing the projection of new entrants on formula (21) is that the apparent intake rate may exceed 1; i.e. the number of new entrants may exceed the population aged 6 years. If for example all the six year olds entered school in year t, and ther were in addition children admitted who were older than 6, the apparent intake rate (for which the denominator is the population aged 6 - see formula (21) -) would clearly exceed untiy. This could still be the case of course if less than 100% of 6 year olds (say only 80 or 90%) were entering grade I in year t, but if at the same time substantial numbers of 5 year olds, 7 year olds etc., were admitted. However, as we whall discuss more fully below, the apparent intake rate can only exceed unity during a relatively short period.

Table 19. Estimated apparent intake rates* for boys in India. 1960-1970

Year	Rate	Year	Rate
1960	1.127	1966	1.206
1961	1.247	1967	1.194
1962	1.235	1968	1.158
1963	1.217	1969	1.136
1964	1.244	1970	1.132
1965	1.219		

* Obtained by dividing the estimated number of new entrants a given year by the 6 year old population the same year. Data on repetition were not available for the period 1960-1963 and the new entrants for these four years were estimated by assuming that the percentage that repeaters represented of total grade I enrolment was the same as in 1964.

Source : Enrolment and repetition data supplied by national authorities in response to Unesco questionnaires. United Nations population estimates were used.

Table 19 gives estimates of the apparent intake rate for boys in India during the period 1960-1970. The table shows that the number of boys entering grade I of elementary education was larger than the number of boys aged 6 years throughout this period. Thus the new entrants exceeded the number of boys of admission age by as much as 20% or more during the period 1961-1966. This is caused by the entry of children younger or older than six years. However, as a child can only be a new entrant once, it is obvious that the apparent intake rate cannot exceed unity by as much as 20% for a long period. The decline during the period 1966-1970 is, therefore, logical. One may even wonder whether the fact that the intake rate remained so high during a ten year period does not indicate errors in the data. In general, possible errors may be of three types :

(i) over-reporting of enrolment in grade I
(ii) under-reporting of repetition in grade I (i.e. children who repeat are not recorded as repeaters and will hence be counted as new entrants.
(iii) under-reporting of the population aged 6 years.

Of these three possible sources of error one would not expect serious errors in the population data in a country such as India with a long tradition of taking population censuses. Errors of types (i) and (ii) may, however, occur. In this connection it is interesting to quote from the Interim Report of the Working Group on Universalisation of Elementary Education which, in discussing various problems involved in attaining universal enrolment at this level, states (1) :

> "It must also be remembered that the existing data on enrolment suffer from over-reporting; a certain proportion of the total enrolment is bogus in the sense that it includes children whose names are shown on the registers as enrolled but who, in fact, do not attend schools so that the daily average attendance is often too small in relation to the overall enrolment. There is evidence to show that this over-reporting is large (it varies from eight to forty-seven per cent) and that it is larger in those States which are backward in elementary education. This increases the magnitude of the task even further".

On the assumption that the population data are reliable, one may examine the magnitude of the two other sources of errors if data are available on new entrants by single years of age for successive years. On the basis of such statistics one may follow the entry of each cohort over time to check that no more than 100% of any particular cohort is reported to enter school. Over-reporting of enrolment or under-reporting of repetition could both lead to results of that type.

Unfortunately, very few countries collect statistics on the age of the new entrants. Such information is not collected in India either. However, data are available on the age-distribution of grade I enrolment, including the repeaters. If we hence could subtract the repeaters, we would obtain an estimate of the number of new entrants by single years of age. The problem is that we only know the total number of repeaters in grade I, and not their distribution by age. If we are willing to assume that the repetition rate is the same for all ages in grade I and equals the average for this grade, we may derive the age-distribution of the new entrants in the following way :

(i) All grade I pupils aged five years in school-year t are taken to be new entrants.
(ii) For other ages, entrants aged a in school-year t are derived as pupils aged a minus the estimated number of repeaters aged a in that school-year.
(iii) The estimated number of repeaters aged a in school-year t is derived as grade I pupils aged a-1 years in school-year t-1, times the overall repetition rate for grade I in school-year t-1, i.e. r^{t-1}.

These assumptions can also be expressed as follows :

(22)
$$N_5^t + E_{I,5}^t \quad \text{(for lowest age)}$$
$$N_a^t = E_{I,a}^t - r_I^{t-1} E_{I,a-1}^{t-1} \quad \text{(for other ages)},$$

where $E_{I,a}^t$ is the enrolment of a year-olds in grade I in year t.

(1) Interim Report from the Working Group on Universalisation of Elementary Education, Ministry of Education and Social Welfare, Government of India, New Delhi (undated), p. 5.

The least realistic of the above assumptions is using the same repetition rate, regardless of the age of the pupils. It is however unlikely that this will seriously affect the estimation of the age-distribution of the new entrants for our purpose. This method will be further discussed at the seminar.

On the basis of the data available on the age-distribution of grade I enrolment in India for the period 1960-1970 (age-data were not available for later years) and the repetition rate in this grade during the same period, we have used the two equations given by (22) to estimate the age-distribution of new entrants in India during the period 1961-1970. The results are given in Table 20. The table shows, for example, that 41.7% of the boys aged five years in 1970 entered school that year, 39.1% of the boys aged six years, and so on.

Table 20. Estimated intake rates by single years of age for boys. India, 1961-1970[x]

Age	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
5 and below[xx]	.310	.306	.332	.396	.383	.395	.386	.382	.404	.417
6	.440	.424	.429	.450	.432	.436	.428	.413	.412	.391
7	.311	.293	.284	.265	.257	.227	.230	.220	.195	.191
8	.132	.134	.106	.091	.100	.096	.108	.100	.088	.091
9	.061	.056	.045	.035	.036	.033	.045	.032	.027	.028
10	.032	.024	.016	.012	.014	.016	.012	.010	.010	.011
11	.010	.008	.003	.003	.004	.011	.005	.004	.003	.004
12 and above[xx]	.008	.007	.005	.004	.005	.005	.002	.003	.003	.003

[x] For method of estimation, see explanation in the text.

[xx] Intake rates for 5 years and below and 12 years and above were calculated using population for 5 year olds and 12 year olds respectively.

Source : Enrolment data supplied by national authorities in response to Unesco questionnaires. United Nations' population estimates were used.

One interesting aspect of this table in relation to the above discussion is that we may use it to follow the entry of each cohort to grade I, year by year. In this way we may, for example, calculate which part of a given cohort has already entered school a given year and, consequently, which part remains to enter in the future. To illustrate this, let us study the cohort of boys aged five years in 1961. We see that a proportion of 0.310 of this cohort entered school in that year, 0.424 entered school in 1962 at the age of six, 0.284 in 1963 at the age of seven, and so on. If we add up all the entry from this cohort we have :

Entry from 1961 cohort =

$$0.310 + 0.424 + 0.284 + 0.091 + 0.036 + 0.016 + 0.005 + 0.003 = \underline{1.169}$$

As the logical maximum for this sum is 1.000, this suggests that there is a over-reporting of new entrants for this cohort of about 17% (1). This is of course

(1) If some children belonging to this cohort did not actually register as new entrants, the over-reporting is, of course, even larger.

under the hypothesis that the assumptions we have made in estimating the age-distribution of the new entrants are reasonably correct. Note however, that our assumptions only effect the age-distribution of the new entrants and not their total numbers. Thus even if our estimated distribution of the entrants between different cohort is incorrect, there nevertheless are inconsistencies in the data on entrants. As explained above, this may be due to over-reporting of enrolment in grade I and/or under-reporting of repetition, assuming that the population data are reasonably correct.

If we add up the intake rates for the 1962, 1963 and 1964 cohorts we obtain 1.152, 1.196 and 1.209 respectively. Thus, for these three cohorts, the reported numbers of new entrants exceeded the number of boys in each cohort by 15.2, 19.6 and 20.9 per cent, respectively. We note that the entry from the 1967 cohort exceeded the size of this cohort by some 8.5% already in 1970, i.e. before there had been any entrants aged 9 years from this cohort. We note further that 98.5% of the 1968 cohort had already been reported to have entered school in 1970, which would imply that there would be a maximum of 1.5% left of this cohort to enter school at the age of eight in 1971. Thus, if the data are correct, we would expect a drastic drop in the intake rate for eight year olds in 1971. Unfortunately, this could not be verified as data on the age-distribution of grade I enrolment were not available for years after 1970.

As the foregoing discussion has made clear, in a situation like that of India where new entrants come from several age groups, one needs to have at one's disposal data on new intake by single years of age, since the number of new entrants is represented by the formula :

(23) $$\text{number of new entrants } N^t = e_5^t P_5^t + e_6^t P_6^t + \ldots . e_{5+n}^t P_{5+n}^t = \sum_{i=5}^{i=n} e_i^t P_i^t ,$$

where :

N^t = total number of new entrants in year t

P_a^t = population aged a years in year t

e_a^t = proportion of population aged a years in year t entering school that year.

$5 + n$ = highest age from which new entrants are drawn.

If we do have data on new entrants by single years of age, this enables us to verify whether all children from a single cohort have entered school, and thus to estimate the size of the pool of potential late entrants from successive cohorts. For if we consider the intake rate for a single cohort in successive years, it is obvious that the following constraint must hold good :

(24) $$e_5^t + e_6^{t+1} + e_7^{t+2} + e_8^{t+3} + \ldots . e_{5+n}^{t+n} = 1\text{, or is less than 1.}$$

In the circumstance that age distribution of new entrants is available, two possible methods of projection of new intake suggest themselves. The first one would consist of extrapolating the past trends in each of the intake rates by single years of age included in formula (23), verifying afterwards that the constraint given by (24) is fulfilled for each year. The second method would consist of defining a new set of proportions based on the remaining part of each age-group that has not so far entered school, and then projecting these new proportions. Both of these methods will be further discussed at the seminar.

As actual data on new entrants by age are not available for India and since the intake rates shown in Tables 19 and 20 suggest errors of some sort in the data, we shall for this exercise resort to the simple method of projecting new entrants given by formula (21). We have thus estimated the following regression equation, applying the least squares method to observations of the apparent intake rates for 1960-1970 given in Table 19:

$$(25) \qquad e^t = 1.23202 - 0.00667t$$

where t refers to a specific year with t = 1 for 1960. This method is explained in Annex I and participants will during the seminar carry out Exercise VII to familiarize themselves further with this technique.

As already explained in the introduction to this section, the projections of enrolment by grade to be presented in this paper will refer to the period 1970-1975. as we want to compare the results obtained from the Grade Transition Model with the actual development of enrolment by grade during this period. Projections of new entrants for this period are obtained by introducing t = 12 for 1971, t = 13 for 1972, etc., in equation (25). The results are given in Table 21.

Table 21. Projected apparent intake rates for boys in India. 1971-1975.

Year	1971	1972	1973	1974	1975
Apparent intake rate	1.152	1.145	1.139	1.132	1.125

The assumption implied in this projection will be discussed in detail during the seminar.

Multiplying the intake rates given in Table 21 by the number of boys aged six years given in Table 18 gives projections for the number of new entrants to grade I of elementary education for the period 1971-1975. The results are shown in Figure 7.

EXERCISE VII

Based on the estimates of apparent intake rates for boys and girls given in Table A below for each of the four states, the participants will project the development of these rates until 1981. Possible methods for such projections will be discussed at the seminar, particularly in the cases where linear regression is not applicable. Afterwards, the participants will apply the projected rates to the population projections given in Tabe B to derive projections of new entrants.

Table A. Estimates of apparent intake rates by sex and state, 1965-1976[x]

Year	Jammu and Kashmir		Maharashtra		Rajasthan		Tamil Nadu	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1965	0.984	0.357	1.101	0.861	1.176	0.435	1.215	0.931
1966	1.029	0.448	1.126	0.879	1.153	0.429	1.219	0.944
1967	1.086	0.509	1.122	0.870	1.131	0.403	1.293	1.076
1968	1.132	0.553	1.146	0.892	0.980	0.317	1.150	0.970
1969	1.152	0.578	1.129	0.874	0.969	0.325	1.155	0.961
1970	1.084	0.581	1.133	0.866	0.967	0.329	1.165	0.988
1971	1.038	0.585	1.182	0.909	0.864	0.319	1.218	1.013
1972	0.986	0.593	1.211	0.942	1.013	0.350	1.277	1.048
1973	0.925	0.574	1.245	0.976	0.917	0.328	1.260	0.992
1974	0.925	0.577	1.296	1.027	1.030	0.364	1.210	1.043
1975	0.920	0.561	1.298	1.033	1.024	0.389	1.149	1.020
1976	0.940	0.570	1.391	1.125	0.978	0.383	1.256	1.179

x These rates were derived by dividing the number of new entrants each year by the population aged six years. New entrants were estimated by assuming that the repetition rate in grade I observed in 1969 for Rajastan and Tamil Nadu and in 1975 for Jammu and Kashmir, and Maharashtra remained stable throughout the period 1965-1976.

Source : Enrolment, repetition and population data supplied by national authorities.

Table B. Projected population aged 6 years, by sex and state 1977-1981.(in 000's)

Year	Jammu and Kashmir		Maharashtra		Rajasthan		Tamil Nadu	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1977	81	77	759	743	476	432	589	550
1978	83	79	765	730	481	436	574	538
1979	84	80	757	722	487	441	559	526
1980	86	82	748	713	493	446	544	514
1981	87	83	739	704	499	450	529	502

Source : Projections supplied by national authorities.

II.2.13 Projection of transition rates

Central to the projection exercise is: how will the transition rates (i.e. the promotion, repetition and dropout rates) for grades I-V develop throughout the projection period? Obviously, in real life situations, most transition rates tend to change. This may be due to policy measures, such as introduction of measures designed to reduce repetition and dropout, introduction of new laws or enforcement of existing ones concerning compulsory school attendance, and so on. It may also be caused by increased public funds to the educational sector, or by changes in demand for education due, for example, to improved living standards and increased employment opportunities for educated manpower.

Table 22 shows the development of the promotion, repetition and dropout rates, by grade, for boys in India during the period 1963-1969, which were the years for which this type of information was available to the author of this paper. We note that, apart from 1963, the rates remained relatively stable throughout this period. For most rates there is no clear trend and only relatively small fluctuations took place. We shall not, therefore, in our projection example, attempt to extrapolate these rates but shall assume that the 1969 rates will remain stable during the projection period.

However, very often the changes in the transition rates are so substantial that they have to be taken into account when preparing enrolment projections. Unfortunately, this is often difficult, in particular if the transition rates fluctuate considerably over time. We shall at the seminar discuss various techniques for making such projections.

Table 22. Promotion, repetition and dropout rates by grade in elementary education for boys in India 1963-1969

	Grade	1963	1964	1965	1966	1967	1968	1969
Promotion rate	I	.556	.488	.482	.484	.481	.495	.507
	II	.665	.695	.682	.690	.675	.689	.681
	III	.697	.726	.717	.716	.705	.718	.706
	IV	.764	.741	.739	.739	.728	.743	.727
	V*							
Repetition rate	I	.256	.254	.267	.249	.253	.251	.264
	II	.113	.198	.205	.197	.198	.197	.202
	III	.229	.171	.178	.170	.177	.174	.185
	IV	.217	.152	.156	.156	.164	.159	.171
	V	.136	.143	.141	.134	.142	.136	.155
Dropout rate	I	.188	.258	.251	.267	.265	.254	.229
	II	.222	.108	.112	.113	.127	.114	.117
	III	.073	.103	.106	.114	.119	.108	.109
	IV	.190	.106	.105	.104	.108	.099	.102
	V*							

* As no data were available on graduation from grade V, promotion and dropout rates could not be calculated for this grade.

Source : The rates were calculated on the basis of data on enrolment and repetition by grade supplied by the national authorities in response to Unesco questionnaires.

II.2.14 Projection of enrolment in elementary education

Combining the projections of new entrants, as discussed in II.2.12, with the assumptions made in II.2.13 about the promotion and repetition rates, we are now in a position to project the enrolment by grade in elementary education for the period 1971-1975, using the 1970 enrolments as a base. The results are shown in Figure 7. We may now compare these results with the actual development of enrolment during this period, as shown by national statistics. To save space we shall limit this comparison to the last year of the period, i.e. 1975.

The projected and observed enrolments of boys by grade for this year were as follows :

	Projected*	Observed*	Projected / Observed
Grade I	13 546	13 275	1.020
Grade II	8 481	8 960	0.947
Grade III	6 994	7 419	0.943
Grade IV	5 858	5 925	0.989
Grade V	4 906	5 071	0.967
Total I-V	39 785	40 650	0.979

* Figures are in thousands.

We note that the projected enrolment exceeded the actual figure in grade I while the oposite was the case for all other grades. The total projected enrolment of boys in elementary education was about 2% lower than the observed one, a relatively small difference. Possible reasons for the differences between the two sets of figures will be discussed at the seminar.

EXERCISE VIII

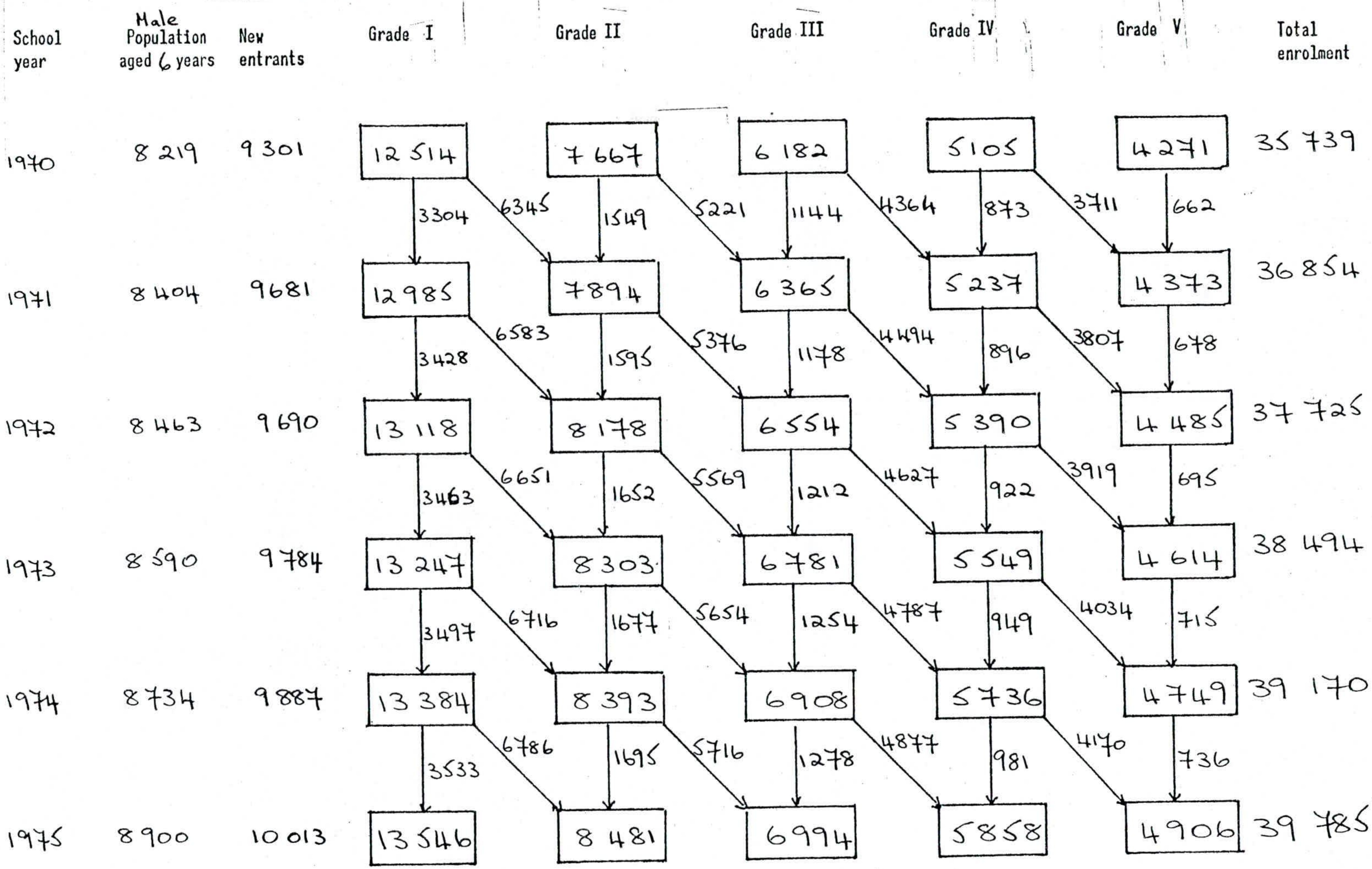
Based on the data on promotion, repetition and dropout rates calculated in Exercise IV and the projections of new entrants prepared in Exercise VII, participants will during the seminar make projections of enrolment by grade and sex in elementary education for the period 1977-1981 for each of the four states.

II.2.15 The Retention Model or Grade Ratio Model

We have so far in this paper illustrated how a model based on data on enrolment and repeaters by grade may be used for analysing wastage and for projecting enrolment by grade in elementary education in India. During this discussion we have several times pointed out the importance of having data on repetition.

However, not all countries collect such information. Some countries only gather data on enrolment by grade. This has also been the case in India in recent years. The most commonly used projection model in these cases is the Retention Model or

FIGURE 7 PROJECTED NUMBER OF BOYS IN ELEMENTARY EDUCATION IN INDIA 1971-1975
(all figures in thousands)



Grade Ratio Model, which may be expressed as follows :(1)

$$(26)\quad E_1^{t+1} = r_1^t E_1^t + N_1^{t+1}$$

$$(27)\quad E_{g+1}^{t+1} = k_g^t\, E_g^t \qquad (g = 2,3,4)$$

All symbols are the same as earlier in this section, except k_g^t,which is the grade ratio for grade g in year t. It gives enrolment in grade g+1 in year t+1 as a proportion of enrolment in the grade below in the preceding year.

Equation (26) gives enrolment in the first grade of the cycle in the same manner as in the Grade Transition Model. This procedure requires data on repetition in grade I. As lack of data on repeaters by grade is often the main reason for using this simplified model, such data may not be available for grade I either. This may make it necessary to resort to more approximate methods for projecting enrolment in the first grade of the cycle. One way would be to project directly grade I enrolment based on past trends, not distinguishing between new entrants and repeaters. This would naturally be a less satisfactory approach, particularly in the long run, since the future development of the new entrants should be related to the development of the population of admission age. It is therefore often preferable to use whatever information is available to estimate the repeaters in grade I and hence use equation (26). If possible, sample surveys should be undertaken in order to arrive at estimates of grade I repetition. New entrants may then be projected employing one of the methods discussed in Section II.2.12.

The enrolments in each grade higher than grade I are expressed as a coefficient (the grade ratio) multiplied by the enrolment in the grade below in the previous year. Much of the weakness of using this model is related to the interpretation and projection of the future development of these ratios. To facilitate the discussion of this aspect, it is useful to derive the relationship between the grade ratio for a given grade and year and the promotion and repetition rates (used in the Grade Transition Model) for the same year. This can be done by comparing the formulas for enrolment in a given grade obtained by the two different models. Enrolment in grade g+1 in year t+1 in the Grade Transition Model may be expressed as :

$$(28)\quad E_{g+1}^{t+1} = p_g^t E_g^t + r_{g+1}^t\, E_{g+1}^t.$$

Setting the two expressions (27) and (28) equal to each other, we obtain :

$$k_g^t E_g^t = p_g^t E_g^t + r_{g+1}^t\, E_{g+1}^t.$$

(1) This discussion is based on: B. Fredriksen: "The use of flow models for estimating the future school enrolment in developing countries", in Methods of Projecting School Enrolment in Developing Countries, Unesco Office of Statistics Paris, 1976, pp. 46-47.

Dividing by E_g^t on both sides of this equation gives :

$$(29) \quad k_g^t = p_g^t + r_{g+1}^t \frac{E_{g+1}^t}{E_g^t}$$

Equation (29) shows that if the repetition rate is zero, the ratio between the enrolment in two successive grades in two successive years will equal the corresponding promotion rate. In this case, the projection of the grade ratio for future years is facilitated since we know that its maximum value is 1, provided the repetition rate remains equal to zero also in the future. If, however, as is the case in India, the repetition rates are far from negligible, the grade ratio may be considerably larger than the corresponding promotion rate, and it may exceed unity.

Equation (29) furthermore shows that the effect of the repetition rate upon the grade ratio depends upon E_{g+1}^t/E_g^t , i.e. the ratio between enrolments in grades g+1 and g in year t. If this ratio is large, it pulls in the direction of a high grade ratio. The ratio E_{g+1}^t/E_g^t may even exceed unity, since it happens quite frequently in developing countries that the enrolment in a given grade of primary education in a given year exceeds the enrolment in the grade below in the same year. This is, of course, possible since the two enrolments originate from different cohorts having experienced a different school history in terms of intake, promotion and repetition rates. It would imply that $E_{g+1}^t > E_g^t$ in equation (29) and that the repetition rate r_{g+1}^t would be multiplied by a factor larger than unity, which would thus make the difference between k_g^t and p_g^t larger than r_{g+1}^t.

It should be noted that the Grade Ratio Model is not suited for analyzing implications of changes in educational policy, since the most important parameters depending upon educational policy (promotion, repetition and drop-out rates) are not included explicitly in the model. This is a serious weakness.

The difference between the two models will be further discussed at the seminar, particularly as regards the differences in the results obtained when the two models are used for analyzing educational wastage.

II.2.16 Sensitivity analysis

It is of great importance to the education planner that he should know how a separate change in any of the factors such as intake, promotion and repetition rates will affect future enrolment and output. When the effects of separate influences are known, the planner may attempt to manipulate them in order to achieve the objectives of educational policy.

Thus enrolment projections should always present several alternative possible futures, each based on a particular set of assumptions. There is of course an infinite set of different combinations of varying assumptions. The particular sets chosen will be those which, in the planner's judgement, seem most realistic and useful in the light of all available information. A comprehensive analysis of enrolment in elementary education, for example, would further investigate at least the following :

a) the effects of differing projections of population.

b) the effects of utilising age-specific intake rates rather than the apparent intake rate

c) the effects of differing assumptions about the future development of intake, promotion and repetition rates. In this connection the importance of collecting annual data on repetition, by grade, cannot be overstressed.

d) more disaggregated analysis, by regional, provincial or even smaller administrative areas, and, very important, by sex.

II.2.17 Concluding remarks on Part II

The object of this section has been to introduce the reader to the basic educational flow model. It is worth repeating here that it is essentially a tool of analysis of the educational system. It is a powerful tool in that it enables the planner to isolate the separate effects of the different policy variables at his command on enrolment, output and efficiency.

Two further points should be emphasized. The quality of a projection depends ultimately on the quality of the data upon which it is based. The projections developed above depended on data which in several cases were not ideal. An advantage of the flow-model however is that it points to the priorities in future improvements in data collection and analysis.

Finally, more sophisticated mathematical and statistical techniques for the development of flow models exist. They cannot, however, be included in an introductory paper such as this. In any case, the effective use of more advanced models cannot be expected in the absence of better data. An efficient, national system of educational and demographic data collection and analysis is, therefore, of highest priority.

PART III : THE CALCULATION OF TEACHER REQUIREMENTS

SECTION 1 : CHARACTERISTICS OF THE TEACHING STOCK

III.1.1 Introduction

In order to assess the future needs of teaching manpower, a preliminary analysis of the current teaching force (size, composition and distribution) and the way in which teachers are deployed should be made. This is because in the short and medium terms the bulk of future teacher supply will consist of teachers continuing in service from the present, or base, year. The number of additional teachers required will thus consist of the difference between the total future size of the teaching force, on the one hand and the numbers of present teachers continuing in service on the other. The importance of knowing the composition of the stock of teachers consists both in the fact that this may be deemed unsatisfactory in some respects (balance in respect of sex, subject specialisation, qualification, nationality, etc.), so that future policies on teacher supply should be directed to righting the situation; and also in the fact that teachers with different characteristics may have varying propensities to continue in service, so that in projecting future teacher supply allowance should be made for differential wastage rates. The actual deployment of teachers is directly related to estimates of future need since shortages of teachers may be reduced or intensified by changing the way in which teachers are used in schools. This last point relates directly to the question of pupil-teacher ratios which we shall examine in the next Section.

Once future teacher stocks have been projected according to explicit assumptions, the planner may compare these stocks with estimated teacher requirements for the education of the future projected students. A variety of possible policies may be adopted to ensure that the required teachers will in fact be available when needed. Among such policies, perhaps the most obvious and important are those concerned with programmes for training new teachers. But the teacher demand-supply balance can also be affected in a number of other ways, through policies on reducing teacher wastage, resorting to alternative supplies of teachers, altering class sizes or teaching loads in the schools, and so on.

The characteristics of the stock of teachers in terms of age, sex, qualification, locality, years of service and other variables are often available, even where data more explicitly concerned with flows of teachers are not. Ideally, in order to obtain an understanding of the dynamics of the situation (that is, how the stock alters through time), statistics should be continuously collected concerning movements of teaching personnel. Such movements would include both those internal to the stock (promotions, changes of institution, etc.), and external (concerning entry into, and exit from, the teaching stock). Estimates of future stocks could then be made by adding and subtracting future flows from the evolving stock.

III.1.2 Size and distribution of the teaching stock in India

Unfortunately in the preparation of this paper the data available on the Indian teaching force was somewhat deficient both as regards its recency and its degree of detail. For this reason the analyses possible in this paper must be rather limited in nature. If more up-to-date or more detailed information is available at the seminar, it will form an additional basis for discussion in this area.

Table 23 shows the development of the stock of teachers by level of education over the period 1960-1975.

Table 23. Number of teachers by type of institution, India, 1960-1975

Year	Primary (000's)	Secondary (000's)	Higher (000's)
1960	742	642	62
1965	944	1007	128
1970	1060	1267	190
1975	1243	1496	236

Source : Country Report, India, op. cit., p. 6

Over the period as a whole, the number of teachers at the primary level grew by 501,000, a total percentage increase of 67.5%. The total percentage increase at the secondary level was 133%, and at the higher level, 281%. The corresponding average annual rates of growth of the teaching stock at the primary, secondary and higher levels were 3.5%, 5.8% and 9.3% respectively. It can be seen that the absolute increase in the stock of teachers was greatest at the secondary level. At the primary level both the greatest total percentage increase (27.2%) and average annual rate of increase (4.9%) occurred between 1960 and 1965.

Table 24 shows, for 1976, teachers, by sex, in primary/junior basic and middle/senior basic schools in India distributed by State and Union Territories. The table shows the percentage of trained teachers in each State and Union Territory at both levels. It can be seen that this percentage varies very markedly. For example, 100% of teachers at the primary/junior basic level in Chandigarh, Delhi, Tamil Nadu and Himachal Pradesh were trained; whereas in Nagaland only 2.7% were trained. For India, 85.5% of teachers at the elementary level were trained. In middle/senior basic schools, the very slightly higher percentage of 86.1% were trained. Women comprised 23.2% of the total (trained and untrained) stock at the primary/junior basic level. At the middle/senior basic level women made up the somewhat greater proportion of 28.3%. Such percentages varied very considerably across the States and Union Territories, however. For example, in Kerala, women comprised 51.9% of all teachers at the elementary level, whereas in Orissa they formed only 7.1% of that State's total. Similar variations may be seen at the secondary level.

The geographical distribution of teachers, according to State and Union Territory in Table 24, is basic information necessary for investigating whether national imbalances are reflected at the State level. Very often, of course, national level sufficiency conceals local shortage. A great deal more detailed local information would be necessary than can be analysed in this document for a proper discussion of geographical teaching imbalances and inequalities. A central issue is that even where there is no numerical deficit at the State level, it may well be that the qualitative composition of the teaching force in some remote areas is much inferior to the national average, and that this situation merits intervention by the authorities. As a matter of fact such data have to be interpreted with great care. It is not always clear for example whether a small stock of teachers in a particular region is the cause of low enrolment, or the result of it. Do the authorities respond to a demand for schooling by providing schooling, or is the provision of schooling the "prime mover" and the level of enrolment simply the reflection of a prior administrative decision? One might think that this could be checked by examining the pupil-

Table 24. Teachers in primary/junior basic and middle/senior basic school, total, percentage females and percentage trained, by State and Union Territory 1976.

State and Union Territory	Teachers in Primary/Junior Basic Schools			Teachers in Middle/Senior Basic Schools		
	Total	% female	% trained	Total	% female	% trained
Andhra Pradesh	79,417	24.9	98.5	32,854	27.4	95.1
Assam	44,512	20.0	61.5	19,369	13.0	30.8
Bihar	106,800	13.3	98.1	65,469	13.8	93.3
Gujarat (1)	111,500	36.0	94.0	...	...	...
Haryana	16,921	30.9	99.9	8,181	30.6	99.6
Himachal Pradesh	8,125	26.1	100.0	8,020	23.2	99.6
Jammu & Kashmir	8,498	37.8	72.0	10,672	29.1	76.0
Karnataka	32,771	16.5	87.6	68,007	27.6	90.6
Kerala	54,000	51.9	97.0	49,000	51.0	96.0
Madhya Pradesh	107,208	16.6	76.0	50,301	18.7	78.0
Maharashtra	73,182	24.5	84.2	146,976	32.1	90.0
Manipur	10,074	8.8	49.1	2,722	8.0	29.0
Meghalaya	4,323	28.2	43.0	1,739	30.5	22.0
Nagaland	3,866	24.6	2.7	1,661	10.6	3.4
Orissa	72,165	7.1	75.0	21,877	5.5	46.4
Punjab	30,344	45.4	99.9	19,131	46.0	99.9
Rajasthan	42,396	19.0	82.2	44,549	18.8	91.1
Sikkim	730	17.0	60.0	453	34.9	40.0
Tamil Nadu	111,033	37.0	100.0	67,846	46.7	100.0
Tripura	3,915	27.2	71.3	2,663	22.6	69.6
Uttar Pradesh	250,963	17.0	98.0	70,028	21.0	85.0
West Bengal	143,979	16.0	52.1	14,925	23.0	29.7
A & N Islands	602	35.2	90.5	526	36.1	82.9
Arunachal Pradesh (2)	874	8.6	...	431	10.9	...
Chandigarh	366	91.8	100.0	274	93.1	100.0
Dadra & Nagar Haveli	313	39.6	99.0	-	-	-
Delhi	15,273	47.0	100.0	4,575	51.3	100.0
Goa, Daman & Diu	2,620	48.6	81.0	1,058	42.0	82.6
Lakshadweep	108	30.6	84.2	79	38.0	88.6
Mizoram	1,933	31.0	58.0	1,175	19.0	29.0
Pondicherry	1,054	30.8	93.9	1,102	37.0	93.5
INDIA	1,339,865	23.2	85.5	715,663	28.3	86.1

Notes : (1) Data for middle/senior basic schools are included with primary/junior basic schools.
(2) Percentage trained not available.

Source : Selected Educational Statistics 1976-1977, op. cit., Table VII.

teacher ratio to discover whether schools and classes are full.

Table 25, shows pupil-teacher ratios by State and Union Territory in 1974 for the primary/junior basic, middle/senior basic and high/higher secondary levels. For India as a whole the ratios were 38, 31 and 26 pupils per teacher respectively. At the primary/junior basic level it can be seen that the ratio ranged from 18 in the Andaman and Nicobar Islands to 55 in Dadra and Nagar Haveli. Out of the 31 States and Union Territories 9 had ratios of 40 or above, while 8 had ratios of 30 or below. Considerable variation may also be seen at the middle/senior basic and high/higher secondary levels. For example, in Sikkim the ratio at the high/higher secondary level was 3, whilst in both Manipur and Uttar Pradesh it was 47. One has to bear in mind however, that pupil-teacher ratios are often associated with population densities.

Table 25. Pupil-teacher ratios by State and Union Territory, India 1974

State and Union Territories	Pupil-teacher ratio		
	Primary/Junior basic	Middle/Senior basic	High/Higher secondary
Andhra Pradesh	40	29	20
Assam	39	23	18
Bihar	34	31	29
Gujarat	31	38	27
Haryana	39	33	32
Himachal Pradesh	29	22	26
Jammu & Kashmir	22	18	19
Karnataka	42	42	25
Kerala	38	35	32
Madhya Pradesh	39	23	20
Maharashtra	35	32	27
Manipur	25	27	47
Meghalaya	46	17	27
Nagaland	23	16	16
Orissa	34	23	13
Punjab	40	31	30
Rajasthan (1)	32	24	9
Sikkim	21	9	3
Tamil Nadu	35	33	24
Tripura	40	27	18
Uttar Pradesh	45	22	47
West Bengal	36	29	27
A & N Islands	18	21	19
Arunachal Pradesh	41	14	15
Chandigarh	31	25	25
Dadra & Nagar Haveli	55	8	15
Delhi	33	27	23
Goa, Daman & Diu	33	26	26
Lakshadweep	24	16	35
Mizoram	40	19	17
Pondicherry	30	37	25
India	38	31	26

Note : (1) 1973

Source : Educational Statistics at a Glance 1974-75, op. cit., Table 8.

It does not necessarily follow that regions with 40 or more pupils per class are being treated less favourably than those with 30 or less. In fact one often finds what one might call "compensating mechanisms" at work, with the urban areas on average being able to attract better qualified teachers but having larger class sizes, and the outlying areas having poorer teachers but smaller classes. Unfortunately no breakdown of the state teaching stocks by qualification level was available during the preparation of this paper, but if other countries' experience applies also to India, then we may infer that one will find the less well-qualified and experienced teachers to be concentrated in outlying areas.

A very important characteristic of the teaching stock is its age structure. The significance of this lies in so far as depletion of the stock through death, retirement (and even resignation) is highly dependent on it. The future planning of teacher supply must take these causes of loss of teachers into account. The retirement rate has obvious implications for the level of future pension payments. Table 26 shows the percentage distribution of teachers by age and sex at the elementary level in three selected States in 1970. For each of these three States the most striking feature is the relative youthfulness of the teaching stock. In all three States the 5-year age group having the largest share of teachers was the 25-29 group, having 24.8%, 29.4% and 21.5% in Maharashtra, Rajasthan and Tamil Nadu respectively. In Rajasthan, 86.2% of teachers were under 40 years of age; in Maharashtra and Tamil Nadu the corresponding percentages were 78.4% and 75.9%. In Maharashtra, Rajasthan and Tamil Nadu the percentages of teachers aged 50 and over were only 5.6%, 2.3% and 6.4% respectively.

The youthful structure of the stock is of course primarily explained both by the general age structure of the Indian population and by the recent expansion of the educational system, with many young, newly qualified teachers entering the teaching force. In countries with a longer history of relatively well-developed educational systems the age structure of the teaching stock is considerably different. Older teachers form a much higher proportion. The significance for the situation in India lies in the calculation of flows out of the stock through death, retirement or leaving the teaching profession. Deaths and retirement, in such a young force, will be relatively insignificant in India for a number of years to come. It further has implications for costs as pension payments also will be relatively low in the near future since such a large part of the teachers are young.

With respect to the female teaching stock in the three States illustrated, a feature of note is that the distribution of females tends to be relatively even younger than that of males in Maharashtra and Tamil Nadu, where 81.8% and 76.2% respectively of female teachers were aged less than 40. In Rajasthan 77.8% of female teachers were under 40, a lower percentage than that of males.

Table 26. Percentage of primary level teaching stock by age and sex for selected states, 1970

State	Age Group																					
	Below 20		20-24		25-29		30-34		35-39		40-44		45-49		50-54		55-59		60 and over		Total All Ages	
	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F	Total	F
Maharashtra	2.0	2.6	15.5	20.0	24.8	25.9	21.0	20.6	15.1	12.7	10.0	8.7	5.9	5.4	4.0	3.1	1.6	1.0	0.0	0.1	99.9	100.1
Rajasthan	3.2	2.4	15.4	18.3	29.4	19.9	26.5	21.3	11.7	15.9	7.1	12.0	4.4	7.9	1.9	2.2	0.3	0.1	0.1	0.0	100.0	100.0
Tamil Nadu	1.5	1.9	16.6	18.0	21.5	21.4	20.1	19.8	16.2	15.1	10.5	10.7	7.3	7.0	4.5	4.0	1.9	2.0	-	-	100.1	99.9

Note: percentages may not sum to 100.0 due to rounding errors.

Source : Data supplied by national authorities.

SECTION 2 : PROJECTION OF TEACHER REQUIREMENTS

III.2.1 Introduction

After having projected the number of pupils enrolled in future years, the next step is generally to project the resources required to sustain this enrolment. For primary education, the teacher is by far the most important such resource, accounting generally for 80-90% of the total recurrent expenditures at this level of education.

Several methods may be used for deriving projections of teacher requirements, depending mainly upon the data available. The simplest, and maybe most employed method in developing countries, is based upon assumptions or targets for the future pupil/teacher ratio. We shall discuss this technique briefly below and illustrate it further during the seminar. A more sophisticated method consists of studying the factors determining this ratio, i.e. class size, teaching load and average number of hours instruction received by the pupils. Section III.2.3 below presents this method which will be illustrated further by examples during the seminar.

Having projected the number of teachers required to sustain a given number of pupils, the next step is to determine the output needed from teacher training institutions to meet this requirement. This is the subject of Section III.2.4.

III.2.2 Method based on the number of pupils and the pupil-teacher ratio

If the only available data refer to the projected enrolment and the future pupil-teacher ratio (which may simply be a policy target), then the number of teachers required is obtained by the following simple formula :

(30) $$\text{Teachers required (T)} = \frac{P}{R}$$

where T = number of full-time equivalent teachers required (1)
P = total projected number of pupils
R = pupil-teacher ratio, i.e., the average number of pupils per teacher.

It should be emphasized however that the introduction of new teaching approaches may, in the future, make calculations of the need for teachers based on this method less appropriate. This is because the concept of a "correct" pupil-teacher ratio loses much of its meaning when the pupil-teacher ratio ceases to be synonymous with class size. Modern education systems allow much greater freedom to vary the size of the teaching group to meet the particular needs of different pupils, or curricular subjects, or teaching methods. Moreover a low pupil-teacher ratio may simply reflect limited class-contact hours for teachers, rather than smaller teaching groups. Given these considerations, there is an increasing realisation on the part of educational administrators that on its own the level of the pupil-teacher ratio may not indicate very much about the quality of instruction in the schools and forms a rather weak basis for estimating future teacher needs.

(1) Not all teachers are necessarily full-time. It is useful therefore to establish as a unit of measurement of teaching input the "full-time equivalent teacher". Two half-time teachers (having equal qualifications) may thus be aggregated as one full-time equivalent teacher.

EXERCISE IX

Based upon the enrolment projections to be made during the exercises included in Part II, the participants will during the seminar make projections of teacher requirements under different hypotheses for the development of the pupil/teacher ratio.

III.2.3 Method based on the number of pupils per class and hours taught by teachers

The data necessary for this method are the following :

a) students enrolled by grade
b) the average number of students per instructional group over the weekly timetable (with due weighting for the time spent in groups of different sizes)
c) the average number of hours per student in contact with teachers, weekly
d) the average number of weekly hours per teacher in contact with instructional groups.

Under c) and d) above one may of course substitute "timetable periods" per week where teacher loads are expressed in this form rather than in hours.

It should be noted that where a system has different curricular branches or streams, or where different grades of teachers have varying teaching loads, it may be necessary to take weighted averages if the aggregate system is under review. Alternatively it will be necessary to prepare separate disaggregated estimates for each sub-system or sub-group of students and teachers, and total the figures at the end of the exercise.

In order to make the initial calculation of full-time equivalent teachers, the following formula may be utilized :

$$(31) \quad \text{Teachers required } (T) = \frac{H \times P}{G \times L}$$

where T = number of full-time equivalent teachers required
P = total projected number of students
H = average number of weekly hours per student in contact with teachers,
G = average number of students per instructional group.
L = average number of weekly hours per full-time teacher (teaching load).

It can be seen that the number of teachers required is directly proportional to the number of pupils and the average weekly hours per student. The requirement is inversely proportional to the number of pupils per class and the weekly hours taught on average by teachers. Thus the educational planner, by making various assumptions about future values of the four variables on the right hand side of formula (31), may obtain a set of alternative projections of future teacher requirements.

EXERCISE X

If, at the time of the seminar, data for India can be obtained on H, G and L, this method will be demonstrated here.

III.2.4 Projecting the demand for new teachers

The question now arises : How should demand for new teachers be calculated? The following steps may be taken to calculate the required output of new teachers from teacher training institutions :

1) future required stocks of teachers should be calculated according to the methods outlined in III.2.2 or III.2.3.
2) Using the data concerning the present teacher stock, the number of present teachers who will remain in their jobs in the future may be projected. In order to do this, estimates must be made of the number (or proportion) of teachers who will leave the profession permanently or temporarily through

- death
- retirement
- replacement of unqualified by qualified teachers
- resignation, movement to other occupations, etc.
- temporary secondments, study leave, in-service courses, etc.
- transfer to administrative work or to other levels of education, or other sub-systems (e.g. private schools)
- other causes.

Ideally a data system would be developed that enabled one to keep track of losses due to each of these causes of outflow and also identified return flows and types of inflow other than new recruits from teacher education and training (e.g. returning qualified teachers from approved absence, re-entry from other occupations, transfers from other levels or types of education, recruitment from abroad etc.). Most systems however do not record flows in this detail and so annual loss has to be calculated on a net basis, at the aggregate level. In other words, instead of recording separately each type of outflow and inflow, and calculating from these gross inflow and gross outflow figure, one takes a crude measure of the net loss, which is the excess of all types of outflow over all types of inflow (excepting new entrants from teacher training). One can express this as an apparent teacher wastage rate which may be derived as follows :

(32) apparent teacher wastage rate (W^t) $= \left[1 - \left(\frac{S^{t+1} - N^{t+1}}{S^t} \right) \right] \times 100$

where S^t = stock of teachers in year t

S^{t+1} = stock of teachers in year t+1

N^{t+1} = newly trained teachers entering service in year t+1

W^t = apparent wastage rate applying to teachers in year t.

It is obvious that teachers in the year t have either remained in service in year t+1 or have "wasted", so that in fact we can also derive the apparent teacher retention rate directly from formula (32).

$$\text{(33)} \quad \text{apparent teacher rentention rate (R)} = \frac{S^{t+1} - N^{t+1}}{S^{t}} \times 100$$

Unfortunately data illustrating the situation in India were not available to the author at the time of writing.

3) Supply of new entrants required can be derived by deducting projected retention of existing teachers from anticipated demand. These "entry to teaching" figures can then be converted into "college output" figures.

4) Finally the necessary intake into teacher training institutions may be estimated in order to produce the required output, by taking into account such factors as the dropout rates of teachers undergoing training and the length of teacher training courses.

The above steps are a simplification of an actual policy-analysis which would (data permitting) have to be considerably more sophisticated. A number of practical complications would present themselves, including at least the following :

a) the steps outlined do not consider the distribution of teachers by subject area, a factor particularly significant in secondary education. The above method aims at an aggregate balance of the supply of and demand for teachers, but can be consistent with marked imbalances within particular subjects. Only refined and disaggregated projection methods (making greater data demands), can offer a solution to this;

b) the outlined steps also fail to analyse the distribution of teachers by geographical locality. In view of the regional inequalities in, e.g. pupil-teacher ratios within India, disaggregated analyses at the State, District or more local level, may be necessary;

c) no distinction was made between the sexes. This may, however be important, particularly if a policy target is to increase female enrolment ratios and this necessitates a greater supply of female teachers.

III.2.5 Concluding remarks on Part III

A full analysis of teacher requirements requires a sophisticated and up-to-date data-system. One of the advantages of the simple analytical models presented in Part III has been to suggest which data should be a priority in future improvements in data collection and analysis.

In India future teacher requirements depend, of course, primarily on how student enrolment develops. There is, as has been shown in Part I and II, a very considerable potential future increase in elementary enrolment ratios. Teacher supply should be geared to anticipated demand; it is costly both in terms of scarce financial resources and in terms of human disorientation if teachers are trained who cannot subsequently be employed in teaching.

Regional inequalities are a difficult policy issue in many countries, not only in the less-developed. Unless teaching labour is directed to those areas which are relatively unpopular within the profession, incentive-systems of various types, including salary differentials or improved promotion prospects, may have to be introduced.

In conclusion, two main issues deserve re-emphasis. New approaches to teaching methods, new curricula, and other reforms in the general educational system must all fundamentally affect the future requrements for teachers. Crude models cannot readily take such developments into account.

Secondly, any fully acceptable analysis for policy purposes must include the costs of training and employing teachers. The opportunity costs of training a teacher to a high level of qualification are very considerable. This must raise issues such as whether teachers need have such lengthy periods of training as they do; whether the desire for lower pupil-teacher ratios can be justified by scientifically-proven research; and whether teachers do any tasks which could equally well be performed by less highly paid, lesser-trained personnel. The cost of employing the teachers that have been trained has also to be taken into account. We shall return to these issues in Part IV where we consider the costs and financing of education.

PART IV : EXPENDITURE ON EDUCATION IN INDIA

SECTION 1 : THE ASSESSMENT OF NATIONAL EDUCATIONAL EXPENDITURE

IV.1.1 Introduction

Educational planners must be closely concerned with the financing of education, and the size and distribution of educational expenditure. It is finance which mobilises the real resources needed to carry out educational plans, and so the budgetary process is inextricably bound up with plan formulation and implementation. Moreover since resources are scarce there is competition for resources both between education and other sectors of expenditure like health or industrial investment ; and also within education itself between different levels of the system, different purposes of spending like teacher training or curriculum development, different regions and so on. This lays on the educational administrator and planner the duty to try and ensure that expenditure patterns represent the best way of meeting national objectives. A further reason for very close concern with educational finance is that the incidence of educational costs and benefits is a highly important political question. Who pays for education, and who receives the benefits in terms of school attendance and opportunities for higher subsequent incomes ? Since appointment to jobs in most societies is becoming increasingly dependent on educational qualifications, the distribution of educational costs and benefits is becoming an ever more important determinant of the distribution of influence and wealth in society at large.

In this Part of the paper we shall first consider the overall dimensions of educational spending in India (Section 1) ; we then go on to consider the distribution of educational expenditure (Section 2) ; and finally review some concepts in costing (Section 3).

IV.1.2 Definitional problems

In assessing the total national outlays on education, an initial problem which arises is to define educational expenditure. The choices one makes are not so important. But it is desirable that definitions of what is included in national educational expenditure are clear, particularly when one country is compared with another, or when one period of time is being compared with another.

One must first arrive at a definition of the scope of education for the purposes of such analysis. Will it include just formal schooling or does it extend to all kinds of structured learning wherever it takes place ? Should vocational training organised by employers be included for example ? What about adult literacy classes or the work of agricultural extension officers ? How much of the activity of cultural agencies - museums, libraries, etc... - is to be regarded as education ? What about research ? It is clear that we have here some fundamental choices in either defining our concerns narrowly, in terms just of schools and colleges, or more broadly to embrace additionally a wide range of training, cultural, research and information activities.

A second set of problems concerns definition of what expenditures even within 'education' are truly 'educational'. In order to support school atendance the authorities may have to be involved in the provision of non-educational services, which might otherwise fall to the expense of households. For example, pupils may be fed in schools or colleges. They may be housed in boarding hostels. They may be transported free or at subsidised rates, and perhaps given free medical care and attention. Poor students may be given free clothing, or uniform allowances. For comparative purposes it is important to know whether such items are classified under education or under other expenditure headings. And if universities, for example are undertaking research, it is necessary to know whether research costs are included in the education budget or not.

Thirdly there are problems arising from accounting practice. Are teachers' pensions to be counted as expenditure on education ? Is allowance for imputed rent made in respect of educational buildings or, once built, are they regarded as free apart from the expense of maintaining them ? What is the practice on depreciation of educational equipment ?

IV.1.3 Sources of educational finance

As a preliminary to any assessment of total national educational effort in financial terms, it is helpful to consider how education is paid for, because this will give guidance in tracking down the different elements in educational expenditure that make up the total national outlay on education.

Basically those who provide educational services draw resources from five main sources :

i) The public authorities
ii) Religious and other charitable bodies
iii) The clients of the education system (pupils and parents)
iv) Income generated by education institutions themselves
v) Subsidisation by institutions' other activities.

From such a listing it becomes immediately clear to us that unless all educational effort is channelled through the government budget, an analysis of Government outlays alone will not reveal the full extent of national resources devoted to education. This is the case in India where there is a significant expenditure on education fees (see Table 27 below).

Let us briefly review in turn the sources of finance we have listed.

The public authorities draw their resources mainly from taxation, borrowing from the public (issue of bonds and loans, operation of savings schemes, etc...) and from foreign aid. Education is normally financed from general revenue, but some countries meet part of their expenditure by raising specific earmarked educational taxes. Foreign aid may come either in the form of general support for Government programmes, or may be tied to particular projects. In the latter case it may not necessarily pass through the Department of Education's budget, and may have to be taken separate account of when attempts are made to aggregate expenditure on a nation's education.

Religious and other charitable bodies may either run schools themselves, or they may give grants to support schools or to enable individual students to attend them. If such private donations are made to public schools or to students to attend public schools, it is possible that they will be entered in Government accounts at national level. But more often these bodies are organising or supporting private educational efforts outside the Government sector. The resources involved may be substantial.

The clients of the education system may help to support it through payment of tuition or other fees. There are arguments both for and against financing education by directly charging the pupil or his family, which are however beyond the scope of this paper. The choice a country makes will largely reflect the history of the evolution of its education system, and its social and political philosophy. It is worth noting that the financing of schools should be distinguished from their management ; in some countries one finds private fee-paying in publicly run schools, and in some there is government financial support for schools under private management. It should be noted that if fee payments are made to a public school and retained by it to meet its operating expenditure, these sums will be additional to sums budgeted by Government.

Income generated by educational institutions themselves would include all kinds of self-help activities on the part of schools and colleges. This income might arise from selling of farm or craft products, cultural performances to raise money, contributions in labour or in cash for the construction of buildings or purchase of equipment. Alternatively education institutions may own property or other financial assets which yield income. Again, the analyst of educational expenditures needs to be reminded of these resources, the spending of which represents part of the total national educational effort, but which do not as a rule pass through the government budget.

Subsidisation by institutions' other activities would apply particularly in the case of economic enterprises which run vocational training programmes. Expenditure on training provided through Government departments may be identifiable in the Government budget ; but training by para-statal organisations or by private industry may be equally, or more important in developing vocational skills.

IV.1.4 Education expenditure in relation to economic aggregates

Having examined some of the problems of definition and identification that arise with regard to educational expenditure, we will now consider the two most common measures that are made of a country's level of effort in the education field. These are :

i) Proportion of the Gross National Product (GNP) devoted to education.
ii) Proportion of public expenditure devoted to education.

In calculating the proportion of GNP devoted to education one must be able to assess the value of private educational effort as well as public, since GNP represents the value of all the goods and services a country produces in both its public and private sectors. Table 27 shows the percentage expenditure on recognised educational institutions in India according to source of funds over the period 1960-1970. It can be seen that fees played a significant role in total expenditures. Fees as a source increased from 17.1% in 1960 to 18.8% in 1965, but then underwent a marked proportional decline to 13.1% in 1970. Also the importance of local body funds declined, particularly between 1965 and 1970. The table shows that the decrease in the importance of these two sources was compensated by a sharp increase in the importance of government funds, from 68.1% in 1965 to 76.1% in 1970.

In attempting to assess the total national effort devoted to education, it has not been possible in preparation of this document to assess fully the total private expenditure on education although, as we have seen this is not insignificant. Nevertheless the great majority of total expenditure on education in India is clearly channelled through the public sector. Indeed the proportion of government funds to total expenditure on education has continued to increase since 1970. In 1975 the

Table 27. Percentage expenditure on recognised educational institutions by source, India 1960-70

Year	Government funds	Local body funds	Fees	Endowments and other sources	Total
1960	68.0	6.5	17.1	8.4	100.0
1965	68.1	6.2	18.8	6.9	100.0
1970	76.1	3.5	13.1	7.3	100.0

Source : Statistical Abstract 1975, op. cit., Table 221.

percentage had risen to 78.5% (1).

Table 28 shows public expenditures on education, both current and capital, and the proportion of their total in GNP over the period 1965-1975. The figures were obtained from different sources and should be interpreted with caution, particularly those referring to GNP. The figure for capital expenditure in 1975 also appears to be very low. With this warning in mind we note that India's public expenditures on education throughout this period represented around 2.5 to 3.0% of the Union's gross national product. We also note that in 1975, public expenditure on education amounted to about 10.9% of the total government expenditures.

It is not in principle difficult to calculate the proportion of public expenditure devoted to education. Whereas private educational expenditures almost always have to be estimated, information on actual public expenditures can be extracted from the public accounts. However in practice a considerable choice exists in the manner in which detailed breakdowns may be presented. Above all, a clear definition of terms is essential in discussion of the proportion of national expenditure devoted to education. We must distinguish clearly between at least two major alternative definitions (and others beyond these are possible) :

i) ratio of total public expenditure by education departments on education and training to the total revenue budget for all States and Union Territories (see the figure of 10.9% given in Table 28.

ii) ratio of all education and all training by all national authorities (i.e. not necessarily commonly recognised as "educational" authorities) to the national budget. This involves a wider definition of 'education', and the training expenditures of a wide variety of other Government Departments and agencies would have to be included. In the preparation of this paper no estimates of this expenditure were available.

IV.1.5 Recent trends in expenditures by type of education

We have thus far examined the size of public educational expenditure, its development in recent years and the main sources of expenditure. Table 29 now illustrates the use to which these funds have been put over the period 1960-1970, according to

(1) See : Country Report, India, op. cit., p. 7.

Table 28. Public current and capital expenditure on education, India 1965, 1970 and 1975

Year	Current expenditure		Capital expenditure		Total	Total as % of all public expenditures	Total as % of GNP
	Amount (000 rupees)	% of total	Amount (000 rupees)	% of total	(000 rupees)		
1965	5,465,000	89.5	639,000	10.5	6,104,000	n.a.	2.6
1970	10,579,660	94.6	603,200	5.4	11,182,860	n.a.	2.8
1975	18,091,100	99.3	131,500	0.7	18,222,600	10.9	2.5

Note : n.a. = not available

Source : 1965 and 1970 : Statistical Yearbook 1976, UNESCO, Paris 1977, Table 6.1
1975 : National Accounts Statistics, Central Statistical Organisation, Ministry of Planning.

type of institution. It should be noted that "direct" expenditure refers to expenditure directly attributable to the maintenance of particular institutions, such as salaries and recurring expenditure. Indirect expenditure represents the amount incurred on direction, inspection, buildings, furniture, scholarships and other miscellaneous items. A point of note is that over the period the importance of indirect expenditure fell markedly from 26.1% to 14.1%. Within the more important category of direct expenditure, that on schools, the most important component, rose from 52.5% in 1960 to 60.6% in 1970. Over the period Universities also received an increased share of direct expenditure, but vocational, technical and special schools, as well as research institutions, suffered a decline in their shares.

Table 29. Percentage expenditure on recognised educational institutions by types of education, 1960-1970, India

Year	Direct Expenditure (%)						Indirect Expenditure (%)	Total (3)
	Universities	Boards of Education	Research Institutions	Colleges (1)	Schools (2)	Vocational technical & special schools		
1960	4.2	0.8	0.7	11.2	52.5	4.4	26.1	99.9
1965	6.0	0.8	0.3	14.1	56.7	1.8	20.3	100.0
1970 (4)	6.8	0.9	0.2	16.2	60.6	1.1	14.1	99.9

Notes : (1) Colleges for general, professional and special education.
(2) High, middle, primary and pre-primary schools.
(3) Totals do not always equal 100.0 due to rounding errors.
(4) Provisional figures

Source: Statistical Abstract 1975, op. cit., Table 222.

SECTION 2 : COMPOSITION AND DISTRIBUTION OF EDUCATIONAL EXPENDITURE

IV.2.1 Alternative ways of disaggregating expenditure

The educational administrator or planner is interested not only in the total size of national educational expenditure, but also in its composition and distribution. There are at least four different types of expenditure breakdown that will be of interest for financial analysis of educational expenditure :

i) By spending agency and administrative programme
ii) By type of expenditure
iii) By level and specialisation of school
iv) By geographical area of the country.

In addition to these main categories, it is also possible that the policy makers in some countries will also need data on expenditure for certain population groups (e.g. the handicapped, religious or ethnic minorities, different income groups, separate data on rural and urban populations etc...), as part of a concern for fair distribution of educational benefits. In this paper we concentrate just on the four main categories.

Naturally analysis under our four categories will be more meaningful if cross-tabulations are possible (spending agency and area, level and type etc...) or if trend analysis is feasible through having data under one heading for several successive years.

IV.2.2 Analysis by spending agency and administrative programme

This type of analysis is most common since it reflects the way in which funds are actually made available through different agencies and programmes. It thus corresponds with the classification used in budgetary appropriations and so has direct administrative uses. We have already seen a simplified presentation in Table 27 of educational expenditure in India by type of agency (national government, local government, private sector). Data was not available during the preparation of this paper, however, to analyse the flows of funds through administrative programmes.

IV.2.3 Analysis by type of expenditure

A broad distinction is normally made in accounting between capital items and current items of expenditure. As a general rule of thumb one can say that capital items are those which have a long life and yield services to the consumer over a period of years, whilst current items are those which are consumed in one year or less. All personal services are regarded as current items, and materials such as paper and chalk etc..., would also be current items. Buildings and heavy equipment with a life of several years would be capital items. More difficult to classify are items like textbooks or footballs which may last more than one year, but nevertheless wear out quite quickly.

Capital expenditure may conveniently be broken down into :

- Acquisition of land and development of sites.
- Construction of buildings for teaching, administrative, recreational and sometimes residential purposes.
- Laying on of services (water, electricity, etc...) to such sites and buildings.

- Purchase and installation of fixed installations and permanent equipment including vehicles.
- Other miscellaneous items.

Current expenditures include :

- Emoluments of various kinds (salaries, allowances, insurance and superannuation payments, etc...).
- Travel and transport of personnel, and subsistence allowances.
- Goods and materials used in the teaching process, or by the administration.
- Purchase of services - water, electricity or gas, sewerage, telephones, postal services, etc...
- Repair and maintenance of buildings.
- Rents.
- Depreciation allowance on capital.
- Interest charges.
- Transfer payments such as scholarships, grants, etc...
- Other miscellaneous items.

Though data were not available to the author for a full analysis of expenditure by type, one point worth noting at this stage is that in India, as indeed in all educational systems, personal emoluments form a very high proportion of total current expenditures. The effect of this is that the total budget for education is highly sensitive to salary changes for teachers. If personal emoluments take too high a proportion of total expenditure the situation may result that teachers are poorly supported with equipment and teaching materials so that learning may suffer. There is very little scope in such a situation for adjusting to straitened economic circumstances, since any substantial economies in educational expenditure would have to be on teachers' pay and allowances, an extremely difficult area in which to make cuts.

IV.2.4 Analysis by level and specialisation

Analysis by level and specialisation is particularly important when drawing up plans for the future development of education, and assessing the resources that will be needed. Tertiary education tends to be more expensive per student than secondary, which in turn is more costly than primary. Similarly, applied and scientific subjects involving practical work are more expensive than ordinary classroom subjects. The reasons for this gradation of unit costs are not difficult to identify.

In general terms the higher levels of education are more expensive per student than the lower levels because :

- teachers are better qualified and more highly paid.
- in many countries teachers are in direct contact with students for fewer hours per week; in other words there are more teachers per class.
- class sizes may themselves be smaller.
- higher institutions have more clerical, administrative and support staff.
- in many countries higher institutions have an element of residential attendance by students, since the institutions are fewer and further from students' homes.
- the standard of accommondation is higher both in terms of quantity, reflecting the fact that older pupils require more physical space, and in quality.
- the higher up the education pyramid one goes, the greater the element of practical work or vocational specialisation ; this tends to be more expensive.

Applied subjects are generally more expensive than general classroom subjects because :

- teaching groups tend to be smaller either because of supervision requirements (teachers can only demonstrate practical skills or supervise handling of dangerous or expensive substances or tools if groups are small) or because specialist options are not fully subscribed.
- teachers may be (but are not in practice always) more highly paid, reflecting the fact that they could alternatively sell their skills to industry and commerce.
- buildings and equipment costs are higher - more space needed per pupil and more expensive equipment and tools.
- a good deal of consumable materials is used up in practical work.

These universal tendencies are evident also in India as Table 30 showing unit costs makes clear. There was a considerable increase in unit costs as one moves up from the elementary level. For example, in colleges for professional education in agriculture, unit costs were 4393.4 rupees in 1975. This was over forty five times the cost per pupil at the elementary level.

Table 30. Unit costs in public educational institutions, India 1975

Institution	Average cost per pupil (rupees)
Primary Schools	96.5
Middle Schools	144.2
High/Higher Secondary Schools	257.8
Schools for Vocational and Professional education.	703.0
Colleges for general education (post-graduate Degree and under graduate standard)	572.5
Colleges for Professional education	
(a) Agriculture	4393.4
(b) Engineering, Technology and Architecture.	1842.7
(c) Teachers Training	1103.2
Universities/Teaching Departments	4123.0

Source : Data supplied by national authorities.

In many countries this steep gradation of costs has caused severe financial problems for Governments because, with the development of education, ever larger proportions of the total student enrolment are located at the more expensive secondary and higher education levels. As a result, the rate of enrolment expansion has in some countries had to be cut back, or the share of the national budget devoted to education would have risen to uncomfortably high levels.

IV.2.5 Analysis by geographical area

In the development of national cohesion, Governments are naturally concerned to ensure that all parts of the country claim their fair share of national resources. It is particularly important to demonstrate to the population that educational services are equitably distributed, and this necessitates undertaking analyses of outlays per pupil at the different levels in each State. For a number of historical reasons there may be an inheritance of inequality between States, with those States having the earliest start in educational development tending to attract the most highly qualified, and therefore the most highly paid, teachers. Education in urban areas also tends to be somewhat more expensive, as physical facilities must be of a higher standard of construction ; and certain urban services laid on to schools must be paid for. To some extent however, the possibility of larger class size in the cities represents an offsetting factor, which will tend to reduce recurrent cost per pupil there.

Table 31 gives some indications of the variation in budgeted educational expenditure (expenditure of educational departments only) by State and Union Territory in India in the school-year 1976-1977. The second column shows the budgeted expenditure on education per capita (in rupees). A very considerable dispersion may be seen, ranging from a high of 187.4 in Lakshadweep to a low of 17.7 in Bihar. For India as a whole, the average per capita expenditure was 30.1 rupees. This figure was exceeded in 21 States and Union Territories. There is a clear tendency for States with large absolute budgets nevertheless to have low per capita educational expenditure.

The third column shows total budgeted expenditure on education as a percentage of the total State and Union Territory budgets. Again, a very considerable range is evident, from a low of 8.2% in Arunachal Pradesh to a very much greater 39.4% in Delhi. For India as a whole the percentage in the school year 1976-77 was 22.7%.

Table 31. Budgeted expenditure on Education (1) by State and Union Territory, per capita and percentage of total budget, school year 1976-77.

States and Union Territories	Total budgeted expenditure (thousand Rs)	Budgeted expenditure on education per capita (Rs)	Total budgeted expenditure on education as % of total budget
Andhra Pradesh	1 373 596	28.9	22.3
Assam	454 860	26.4	24.0
Bihar	1 086 142	17.7	25.7
Gujarat	1 136 453	37.8	25.9
Haryana	357 082	32.2	17.6
Himachal Pradesh	239 828	66.3	25.3
Jammu & Kashmir	208 075	40.9	12.9
Karnataka	1 103 800	34.3	22.1
Kerala	1 442 145	60.8	37.1
Madhya Pradesh	1 016 970	21.7	20.6
Maharashtra	2 050 259	36.7	19.5
Manipur	67 673	57.2	17.2
Meghalaya	51 899	47.7	15.2
Nagaland	55 489	100.3	12.5
Orissa	587 516	24.3	19.0
Punjab	669 984	45.3	23.7
Rajasthan	831 810	28.9	22.7
Sikkim	12 387	58.4	9.2
Tamil Nadu	1 257 597	27.9	21.4
Tripura	94 561	54.9	22.3
Uttar Pradesh	2 149 501	22.4	23.8
West Bengal	1 275 417	25.7	22.3
A & N Islands	18 717	146.2	8.8
Arunachal Pradesh	23 630	48.0	8.2
Chandigarh	44 833	158.4	26.9
Dadra & Nagar Haveli	4 438	54.1	23.5
Delhi	444 173	88.4	39.4
Goa, Daman & Diu	73 336	77.4	24.0
Lakshadweep	6 746	187.4	21.2
Mizoram	36 227	-	10.6
Pondicherry	37 350	71.7	20.4
INDIA	18 212 494	30.1	22.7

Note : (1) Expenditure relates to Education Departments only.

Source : Selected Educational Statistics 1976-77, op. cit., Table VIII

SECTION 3 : THE ANALYSIS OF EDUCATIONAL COSTS

IV.3.1 Introduction

The objective of educational cost analysis is to contribute to greater efficiency in the allocation of educational resources. This means either to maximise educational output resulting from given inputs ; or, alternatively, to minimise the required inputs for a given output. This paper has already discussed the central difficulty facing efficiency analysis in education : the definition and measurement of output. One must accept that although attempts to define outputs more clearly must and will continue, it is doubtful whether a completely quantified description of all the outputs of an education system will ever be attainable. What is more immediately practicable however is to seek ways of reducing the costs of producing each unit of output in the case of outputs which are most easily measurable - for example months of student attendance in school (since the experience of school may be regarded as an output of the system as well as an input towards higher intellectual achievement), number of course graduates, numbers of students reaching a prescribed level of competence. The search for cost savings has immediate practical utility in all education systems.

IV.3.2 Opportunity cost

The notion of "opportunity cost" is a fundamental one in economic analysis. The opportunity cost of a service, or of any factor of production (in this context, of any input into the educational productive process), is its value in its best alternative use. Where goods and services are produced and exchanged in competitive markets, their prices will reflect their opportunity costs. If, for example, a service were priced below its value in its best alternative use, it would be bid away from its current activity into that in which it was more valuable. Competing bidders for the service would ensure that its price to its present user would rise until it was equal to its price in alternative uses.

However, of course, in no country are educational goods and services wholely provided under freely competitive market conditions. Indeed a market in education may be explicitly banned by legislation, or if not, prices (fees) may be closely controlled. The efficiency analyst, in these circumstances, cannot rely on observed market prices for the appropriate estimation of costs. He will need to make estimates of the real opportunity costs involved, e.g. in employing teachers. These estimates are known, in the technical economic literature, as 'shadow' prices. Methods of calculating shadow prices cannot appropriately be discussed here. But the central question is simple : what is the value of a resource (an input) in its best alternative use ? For this is the only proper measure of its true cost. It may be, for example, that a government may employ, as a teacher, an individual who would otherwise be unemployed. In such a case, in stark contrast with the financial cost to government the opportunity cost to the economy would be zero ; no output would be foregone elsewhere through his public employment. The appropriate cost to use in a real resource analysis (as opposed to a financial, accounting analysis) would be zero.

Thus sometimes the financial costs of employing inputs (e.g. teachers) may differ sharply from their opportunity costs to the economy or to the individual. The difference between expenditures and real costs becomes clearest when we consider what is perhaps the major input to education systems, which is student time. If a student were not at school, what would he be doing ? If the answer is that he would be engaged in productive activity, then the value of the output lost through his school attendance is part of the total opportunity costs of education. It is, of course, a part which never appears in the financial accounts. But it is a real part nevertheless.

This underlines the important point that when we speak of 'cost' we ought also to specify 'cost to whom'. The student's time does not enter into the Department of Education budget, unless the student has to be paid an allowance to attend ; consequently the student's time is 'free' to the Department of Education. But it is not free to the student and his family, if that time could otherwise be used to boost the individual's or the family's income : this is one reason why poor families cannot release their children from the farm or shop or from childminding to attend school. Nor is it 'free' to the economy if production is lost. (The same point can of course be made about 'free' education which may be cost-free in a financial sense to individuals, but certainly not to Government or the national economy as a whole).

Education budgets nearly always conceal the real cost of using education buildings. If buildings are rented the 'cost' appears in the budget. If the buildings are owned by Government, the cost is ignored, even though the buildings might be let out for rent (which is thus foregone) or the capital locked up in schools might have been invested in a profitmaking business.

IV.3.3 Costing educational plans

The estimation of the costs of educational plans is a large topic which cannot be fully discussed here. Only a few of the central issues can be mentioned.

Generally, such estimations start from a calculation of unit costs. Costs - both recurrent and capital - may be analysed from past data on the basis of cost per pupil, per teacher, per school, etc... This should be done separately for each level in view of the wide differences in cost between levels. In estimating costs per pupil, care must be taken to ensure that :

a) all the costs incurred in educating a particular group have been reckoned, and account has been taken of the politically important question of which groups such costs fall upon ;

b) if only the financial costs are considered, their relationship with respect to opportunity costs is clearly understood by the decision-makers ;

c) a clear distinction is made between average costs and marginal costs.

The distinction between average and marginal costs is of fundamental importance in decision-making. The marginal cost of educating an extra individual may differ very considerably from the average cost per pupil incurred in educating the group he joins. In efficient decision-making, it is of course the comparison of the extra, or marginal, costs (inputs) with the marginal benefits (outputs) of the programme that should form the basis of the choices made.

Having calculated past unit costs, the planner must make explicit assumptions about their future development. As the salaries of teachers generally play such a major role in total recurrent costs their likely future trend will obviously be of paramount importance to the planner. He will bear in mind that it is not only educational expansion or revisions of salary scales that may tend to inflate the teacher salary element in costs. If there are teacher upgrading programmes or policies to replace inadequate teachers, this may increase the average teacher salary. Similarly if the average age of teachers is slowly rising then more teachers will be higher up their scales (a phenomenon sometimes known as 'incremental creep'). Again, if there is any tendency to shorten teacher hours (without shortening the length of the school day, week or year) or to reduce class sizes, this will raise average teacher cost per pupil. Of all the different causes of a higher teacher salary bill the most important in the majority of countries - rising student numbers apart - is the fact that newly-recruited teachers are better qualified than their predecessors and so are entitled to higher pay. A sort of 'qualification inflation' is at work.

Close analysis of future enrolments (i.e. future number of units) and future unit costs should be carried out in such a way as to distinguish the different elements causing future rises in the educational budget. The planner will quickly realise that some of these increases (e.g. annual increments for teachers) cannot be avoided, while in other areas - such as the level of scholarships, or rate of expansion of universities - there may be room for the policy maker to choose. The margin of choice is nearly always less than the size of the education budget might seem to indicate, for the first call on resources will always be the millions of pupils already in the system whose progression to the next grade or course must be allowed for, and the tens of thousands of teachers already employed. But it is only a careful cost analysis, aimed at identifying cost trends and the scope for economies, that will reveal opportunities for policy changes to improve and extend the system.

Once future levels of enrolment and future costs per student have been calculated, it is relatively simple to make cost projections for the major parts of the education budget. Some items such as curriculum development or the educational broadcasting service cannot easily be estimated on any unit cost basis and will have to be separately estimated. In just the same way parts of the capital budget may be calculated on a unit basis if standardised buildings are used, or if a standard provision (so many square metres, or so many rupees, per pupil) is made ; while other buildings may have to be individually costed.

IV.3.4 Concluding remarks on Part IV

The object of Part IV has been to analyse educational expenditures in India and to draw attention to certain issues. The importance of specifying and defining terms was stressed, and a number of different ways of analysing educational expenditures were examined. The important distinction between financial expenditures and real costs was made. Finally some of the processes and issues involved in calculating the costs of future educational development plans were briefly surveyed.

ANNEX 1 : Technical note : curve fitting and the method of least squares

Frequently a relationship may exist between two variables, and this may be most clearly seen when the data are plotted on a rectangular coordinate system. The resulting set of points is called a scatter diagram. We shall below illustrate how to prepare such a diagram and further how to fit a curve to the points in the simple case where they appear to follow a straight line. In order to relate the example to enrolment projections, we shall illustrate how the apparent intake rate for grade I of elementary education in India might be projected from the data contained in Table 19, page 54 of the main text.

In order to do this, let us denote by "e" the variable "apparent intake rate" ; and by "t" the variable "time", which takes on the value 1 for the first year (1960), 2 for the second, and so on. The data are as follows :

Year	t	Apparent intake rate
1960	$t = 1$	$e_1 = 1.127$
1961	$t = 2$	$e_2 = 1.247$
1962	$t = 3$	$e_3 = 1.235$
1963	$t = 4$	$e_4 = 1.217$
1964	$t = 5$	$e_5 = 1.244$
1965	$t = 6$	$e_6 = 1.219$
1966	$t = 7$	$e_7 = 1.206$
1967	$t = 8$	$e_8 = 1.194$
1968	$t = 9$	$e_9 = 1.158$
1969	$t = 10$	$e_{10} = 1.136$
1970	$t = 11$	$e_{11} = 1.132$

If the points (t_1, e_1), (t_2, e_2) ... (t_{11}, e_{11}) are plotted on a graph, Graph 1 results. We note that the past development was somewhat irregular and that the intake rate for 1960 was considerably lower than for the following years. However, during the period as a whole there was a declining trend. The question now arises : which curve would fit best the scatter of points shown in the graph ? The answer is not obvious as the irregular development displayed by Graph 1 does not fit closely any well known function. In such a case, and in lack of anything better, it is common to fit a <u>straight line</u> to the past observations. Although the straight line, in this particular case, does not approximate very well the past development, it is difficult to propose any better curve and we shall consequently use this function. The weaknesses of this approach will be discussed during the seminar.

The question arises : how do we actually fit a straight line to this scatter of points ? And hence : which is the "best" straight line to fit ? The general problem of finding the equations of approximating lines (which may be linear or non-linear) to fit sets of data is called that of <u>curve fitting</u>.

The following are the general equations of three commonly-used types of approximating curve :

(1) $e = a + bt$ (straight line)

(2) $e = a + bt + ct^2$ (parabola)

(3) $e = ab^t$ (exponential curve)

A scatter diagram will usually suggest which type of curve should be used.

Considering equation (1),

$$e = a + bt$$

the issue is : what are the values of the coefficients a and b, which give the "best-fitting" line to a set of data, e.g. that presented in Graph 1 ?

For the values of a and b determine a unique straight line. The coefficient "a" is the intercept of the line on the e axis (substitute t = 0 ; it follows that e = a). The coefficient "b" is the "slope" or "gradient" of the line. Its value signifies the magnitude of the linear relationship between t and e. It indicates that, on average, for a <u>one</u> unit change in t there will be an associated change of <u>b</u> units in e.

How might a and b be calculated ? One, unsatisfactory, way is simply to draw, by hand, that straight line through the scatter of points which seems, subjectively, to be the best-fitting line. Clearly this has the disadvantage that different persons will obtain different curves and equations.

A much more satisfactory, and widely-used technique, is that of estimating the "regression" line by the technique of "ordinary least squares".

In our example, we are concerned with the regression of e (the "dependent" variable, the apparent intake rate) on t (the "independent" variable, time). The regression line which results from the ordinary least squares technique is that straight line which, when drawn through the scatter of points, minimises the sums of squares of the (vertical) deviations of the points from the line.

It can be demonstrated, by mathematical techniques too advanced to use here, that the line having this "best-fitting" property is defined by the values :

$$b = \frac{\sum_{i=1}^{n} (t_i - \bar{t})(e_i - \bar{e})}{\sum_{i=1}^{n} (t_i - \bar{t})^2}$$

$$a = \bar{e} - b\bar{t}$$

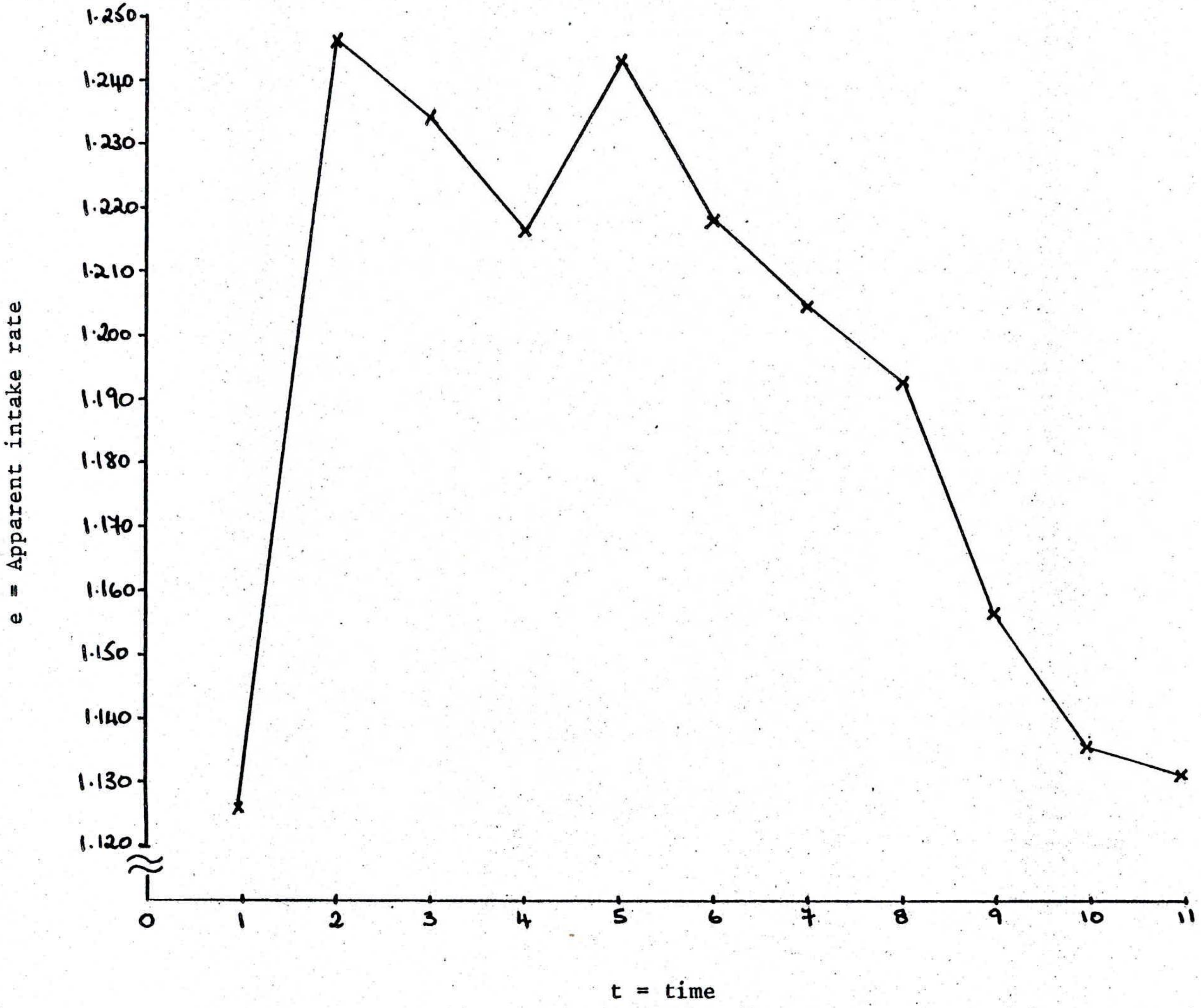
where : $i = 1, 2, \ldots, n$

n = number of data points

$\bar{t}$ = arithmetic mean of t_i

$\bar{e}$ = arithmetic mean of e_i

Graph 1 : Scatter diagram of apparent intake rates and time



Thus, for example, to calculate the regression line from the data presented, we may draw up the following table :

t_i	e_i	$(t_i-\bar{t})$	$(e_i-\bar{e})$	$(t_i-\bar{t})(e_i-\bar{e})$	$(t_i-\bar{t})^2$
1	1.127	-5	-0.065	0.325	25
2	1.247	-4	0.055	-0.220	16
3	1.235	-3	0.043	-0.129	9
4	1.217	-2	0.025	-0.050	4
5	1.244	-1	0.052	-0.052	1
6	1.219	0	0.027	0	0
7	1.206	1	0.014	0.014	1
8	1.194	2	0.002	0.004	4
9	1.158	3	-0.034	-0.102	9
10	1.136	4	-0.056	-0.224	16
11	1.132	5	-0.060	-0.300	25
$\Sigma = 66$ $\bar{t} = 6$	$\Sigma = 13.115$ $\bar{e} = 1.192$			$\Sigma = -0.734$	$\Sigma = 110$

From these calculations, we can see that :

$$b = \frac{\sum_{i=1} (t_i - \bar{t})(e_i - \bar{e})}{\sum_{i=1} (t_i - \bar{t})^2} = \frac{-0.734}{110} = \underline{-0.00667}$$

$$a = \bar{e} - b\bar{t} = 1.192 - (-0.00667 \times 6) = 1.192 + 0.04002 = \underline{1.23202}$$

Hence the estimated ordinary least squares regression line is :

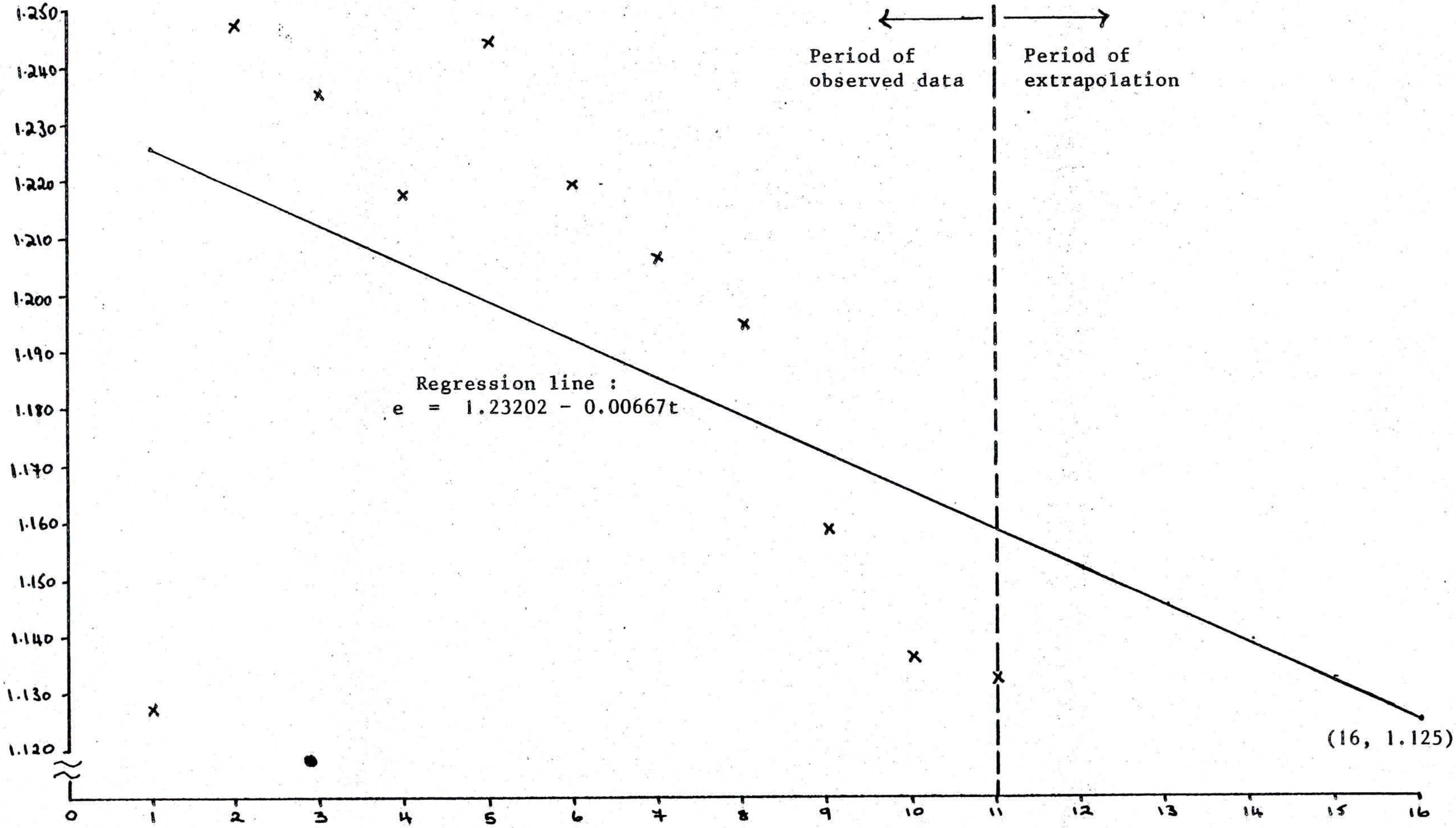
$$e = 1.23202 - 0.00667t$$

This may now be drawn on a graph and is presented in Graph 2.

In the context of educational planning, an important use of the calculated regression line is that it may very easily be extrapolated into the future. This is done in Graph 2 : the straight line, derived from data over the period $t = 1, 2, \ldots, 11$, is simply continued over the next five time periods, that is, to $t = 16$. The regression line, at $t = 16$, projects the value of e (the apparent intake rate) to be 1.125. It is relatively difficult to achieve a high degree of precision by purely graphical methods ; it is more accurate to substitute the value of t into the regression equation, thus :

$$e_{16} = 1.23202 - (0.00667 \times 16) = 1.23202 - 0.10672 = 1.125$$

Graph 2 : Regression of apparent intake rates on time, and extrapolation of the regression line



Exponential curves

The curve

$$Y = ab^X$$

is frequently found in circumstances in which a variable, for example population, is growing at a compound rate over time. By the simple transformation of taking logarithms, the equation of the line becomes :

$$\log Y = \log a + X \log b$$

By writing :

$$\log Y = y$$

$$\log a = A$$

$$X = x$$

$$\log b = B$$

the equation may be written :

$$y = A + Bx ,$$

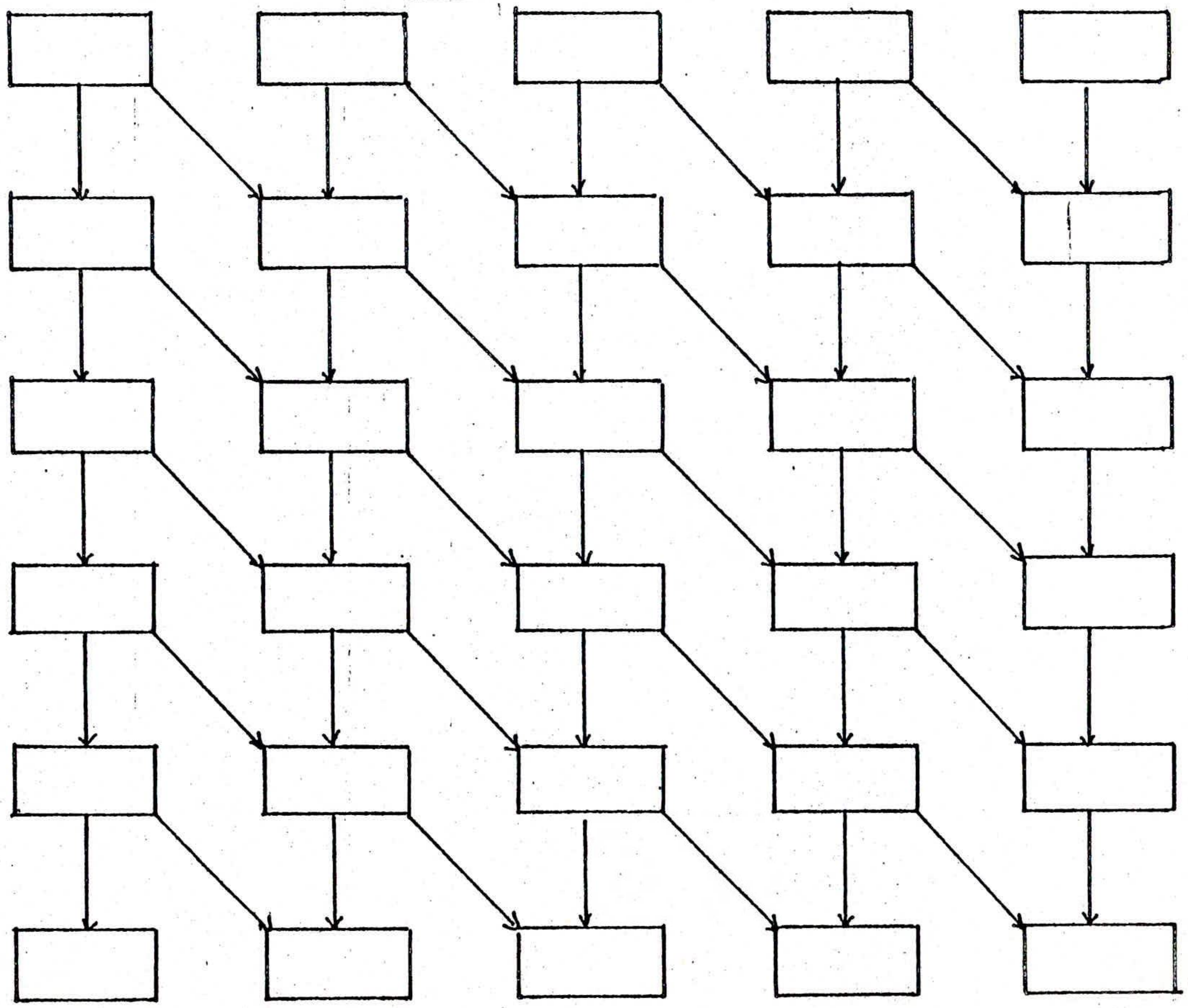
or, using the above symbols :

$$e = a + bt$$

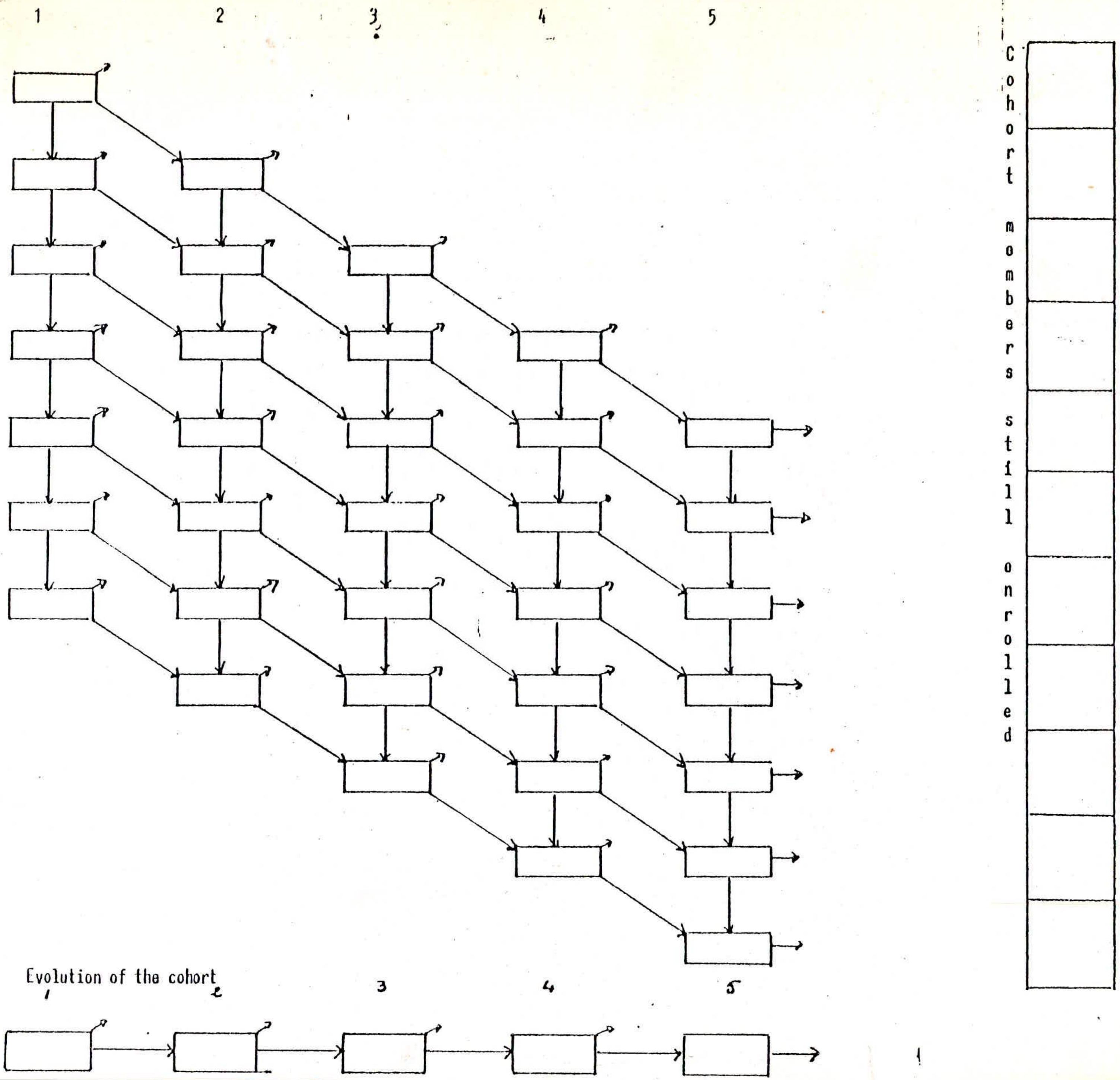
Hence A and B may be estimated by the ordinary least squares formulae.

A N N E X 2

School year	Population aged years	New entrants	Grade I	Grade II	Grade III	Grade IV	Grade V	Total enrolment



A N N E X 2



Grades	Pupil-years
1	
2	
3	
4	
5	
Total	
Out-put (N°of pupils)	
Years input per completing pupil	
Input/output	