# Mathematical Model for the Comparison of Boys and Girls Schooling/Dropouts for Class - I in Public Sector Schools of Sindh, Pakistan

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## ABSTRACT

A substantial number of children of age 4 years, are being admitted in every year in different schools of Sindh Province, among them an adequate number of students enrolled in class-I, and there after dropped out silently in the next class-II due to various reasons. Consequently a tendency of Schooling/Drop-out in both the genders is arising to an alarming state. In this connection a Mathematical Model is being developed to illustrate the effect of Schooling and Drop-out trend of students at initial stage. Moreover, motives for drop-out at early stage shall also be explored and subsequent remedial

actions to exit from the present scenario be discussed to control / improve the situation.

## Keywords

Schooling and Drop-out of both gender, Coefficient of determination, Gender population of 4 years of age, Growth and Decay model functions, Schooling of class-I & II.

## 1 INTRODUCTION

The Universal Declaration of Human Rights, adopted by the United Nations in 1948, asserted that "everyone has the right to education"[1],[2]. It is universally recognized that the education play an important role in the socio-economic development of every country. In Pakistan majority of peoples are illiterate and the huge faction of school going population is out of school [3]. Illiteracy is one of the major and basic problems in Pakistan. High drop-out rates is another major factor obstructing the enhancement of the literacy rate. Moreover, drop-out is also one of the major and serious problem affecting the ongoing efforts towards Government policy "Education for All" (EFA) [4] and Millennium Development Goals (MDG) [5],[6].

Pakistan is presently implementing several policies and programs in line with EFA. The National Education Policy (1998-2010) proposed to enhance the retention and completion of primary education cycle up to 90% students (both boys and girls) by the year 2010. According to all recent UNESCO reports, Pakistan is not on track and has serious risk to attain the goal even by 2015. Unfortunately, the Government in the past could not achieve the desired enrollment

targets/ control the drop-out rate due to various reasons. Official estimation shows that more than 5.5 million primary school children between the ages of 5 and 9 years are left-out during 2003-04. Moreover, a total of 40% boys and 28% girls (both from rural and urban areas) of total enrollments in the Class-I failed to reach middle and secondary schooling levels. However, for rural area, this rate was 58% and 66% for boys and girls respectively [7]. The significant levels of drop-out have hindered optimum utilization of school space, resources and the expected benefits of increased enrollments. Improving retention and completion of primary education, remains one of the major challenges facing the Government, despite all genuine efforts / measure taken by the Govt., the objective could not be achieved in its true letter and spirit.

In the province of Sindh, drop-out individuals in primary schools are increasing in each class every year. Despite allocation of sufficient funds to the institutions and with the implementation of different strategies, no fruitful results could be achieved. According to the SEMIS data [8] the drop-out is much more than in the rural areas of Sindh Govt. sponsored primary schools. As per the data available, about 30 % children remained out of school during 2009-10 and at an average of 29 % children drop-out just after passing class-I, in each year. In this study the schooling/dropout of students at early stage, shall be critically analyzed and remedial measures be proposed with a view to improve the situation and subsequently enhancement of the desired literacy rate.

## 2 Methodology

In order to develop the appropriate model meeting the requirement, let the population of 4 years of age of children in a particular region be $P(t)=P_t$ and $P(t_o)=P_o$ at year $t = t_o$ and the number of schooling children in class-I in the same region be $S(t)=S_t$ and $S(t_1)=S_1$ at year $t = t_1$, and $t_o < t < t_1$

Satisfying $S(t_o) = S_o$ & $S(t_1) = S_1$

Now consider the rate of schooling of class-I boys only which is calculated from their respective projected population P(t) and is denoted by $R_{bs}$. Similarly, the rate of schooling of girls' is denoted by $R_{gs}$

Let us consider factors affecting the increase/ decrease the schooling children in class-I. 'α' is the rate of those Schooling children who were motivated to take admission in class-I due to some monitory incentive initiated in that area during time Δt and 'β' is the rate of those schooling children who were motivated by the education environment in the same region during the same interval of time and ' ' is the rate of schooling children motivated by their parents' willingness during Δt, therefore

$$S(t+\Delta t) \quad S(t) + \alpha S(t)\Delta t + \beta S(t)\Delta t + \gamma S(t)\Delta t]$$

$$\lim_{\Delta t \to 0} \frac{S(t+\Delta t) \quad S(t)}{\Delta t} \quad \lim_{\Delta t \to 0} [\alpha S(t) + \beta S(t) + \gamma S(t)]$$

$$\frac{dS}{dt} = S(t)[\alpha + \beta + \gamma] \quad ; \text{ as } \quad [\alpha + \beta + \gamma] = k$$

$$\ln S = k t + c \qquad (1)$$

By initial condition $S \quad S_o$ and $t \quad t_o$ (1) becomes,

$$S = S_o e^{k(t-t_o)}$$

If $t_o = 0$, then $k > 0 \quad S = S_o e^{kt}$ (A)

Similarly $k < 0 \quad S = S_o e^{-kt}$ (B)

These equations show the exponential growth and decay rate of schooling. The number of schooling children in class-I is increasing in the region shows exponentially growth trend (A) similarly the number of schooling children is decreasing in the region shows exponentially decay trend (B).

## Curve Fitting

Suppose we have n set of observation ( $x_i, y_i$ ) where i = 1,2,3,…n in an experiment we wish to fit an exponential curve of the form

$$y = ae^{bx} \quad (2)$$

To these observations at first we take logarithm of both sides to get

$$\text{Log } y = \text{Log } a + bx \text{Log } e$$

Suppose $\text{Log } y = Y, \quad \text{Log } a = A, \quad bx \text{ Log } e = B$

Then $Y = Bx + A$ (3)

The least square (LS) normal equations are

$$\sum Y_i = B \sum x_i + A \sum \quad (4)$$

$$\sum x_i Y_i \quad B \sum x_i^2 + A \sum x_i \quad (5)$$

$$\sum Y_i = B \sum x_i + nA \quad (6)$$

Table I
Gender Wise Primary Schooling 2001-2013

| Years | Boys Class - I | | | Girls Class - I | | |
|---|---|---|---|---|---|---|
| | $S_b$ | $P_b$ | $R_{bs}$ | $S_g$ | $P_g$ | $R_{gs}$ |
| 2001 | 0.436 | 0.594 | 73% | 0.233 | 0.557 | 42% |
| 2002 | 0.494 | 0.611 | 81% | 0.303 | 0.573 | 53% |
| 2003 | 0.489 | 0.628 | 78% | 0.317 | 0.589 | 54% |
| 2004 | 0.538 | 0.645 | 83% | 0.341 | 0.605 | 56% |
| 2005 | 0.575 | 0.663 | 87% | 0.387 | 0.622 | 62% |
| 2006 | 0.572 | 0.682 | 84% | 0.387 | 0.639 | 61% |
| 2007 | 0.573 | 0.701 | 82% | 0.393 | 0.657 | 60% |
| 2008 | 0.488 | 0.721 | 68% | 0.320 | 0.676 | 47% |
| 2009 | 0.487 | 0.741 | 66% | 0.335 | 0.695 | 48% |
| 2010 | 0.446 | 0.762 | 59% | 0.307 | 0.714 | 43% |
| 2011 | 0.443 | 0.783 | 57% | 0.313 | 0.734 | 43% |
| 2012 | 0,429 | 0.805 | 53% | 0.294 | 0.755 | 39% |
| 2013 | 0.401 | 0.827 | 49% | 0.259 | 0.776 | 33% |
| | | Average | 71 % | Average | 49 % | |

$S_b$ = Boys Schooling

$S_g$ = Girls Schooling

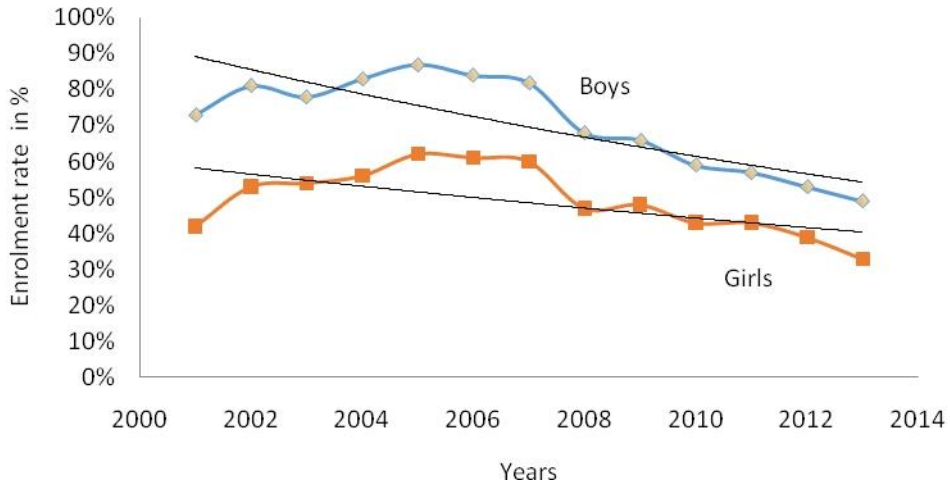
$P_b$ = Boys' Population (Projected)

$P_g$ = Girls' Population (Projected)

$R_{bs}$= Boys' Schooling Rate from their own population

$R_{gs}$= Girls' Schooling Rate from their own population

Fig. I
Comparison - Boys and Girls Class-I Enrolment Sindh Province 2001-2013




Class-I schooling of both gender is shown in Figure I, the trend lines shows the schooling of class-I aged children in public sector primary schools. Both boys and girls enrolment indicate decreasing trend and termed as exponentially decay function. By using (5) & (6) we have the following results.

Boys Schooling: $y = 0.933e^{-0.042x}$ $R^2 = 0.706$

Girls Schooling: $y = 0.597e^{-0.03x}$ $R^2 = 0.364$

From Figure-I, the slightly increasing trend in girls' schooling during 2008-09 may be attributed to the different incentives i.e beneficiary programs [10] and girls stipend program [11],[12] launched by the Govt. for the promotion of girls education. On the other hand boys were ignored or given less priority as such the enrolment not increased in the subsequent years. The Table-1 indicates that at an average, 29% boys and 51% girls are not approaching for the admission

in class-I. Hence, a big gap in schooling has been observed. The bias attitude by the concerned authorities results an adverse effect on boys schooling. To eradicate the bias attitude in early education a balance policy should be enforced to eliminate the gender inequality.

To check the validity of the model, the data from SEMIS in Table-1 is taking into account and are being examine with the help of model presented at (A) and (B). Here we take schooling rate in percentage, and the same is calculated from their respective 4 years age population for entry in class -I as in Table-1. From (A) and (B)

$$k > 0 \quad R_S - R_{S_n} e^{kt}$$
$$k < 0 \quad R_S - R_{S_n} e^{-kt}$$

So the Equation of Boys Schooling $y = 0.933e^{-0.042x}$ (7)

From (7) $R_{bs}$= 0.89 i,e 89% boys schooling recorded initially for class-I in 2001.

Similarly the boys' enrolment in class-I for subsequent years may be obtained.

For year 2002; $R_{bs} = 0.933e^{-0.042(2)} = 86$ ; i.e 86 % Boys Schooling

The above equation shows that the boys Schooling is the exponential decay function. As per the actual data it was 81% during 2002. However, model indicates 86% of their respective age group population, both results are almost same. It confirms that the model is appropriate. Similarly, the boys schooling for the years 2014, 2015 and 2017 is as under:

For year 2014;$R_{bs} = 0.933e^{-0.042(14)}$=52 ; 52% Boys Schooling

For year 2015;$R_{bs} = 0.933e^{-0.042(15)}$ = 50 ; 50% Boys Schooling

or year 2017; $R_{bs} = 0.933e^{-0.042(17)} = 46$ ; 46% Boys Schooling

The expected boys schooling of Class-I for the year 2014, 2015 and 2017 will be approximately 52%, 50% and 46% respectively.

Similarly, for Girls Schooling $R_{gs} \quad R_{gs_0} e^{-kx}$

So, the Equation of Girls Schooling: $R_{gs} = 0.597e^{-0.03x}$ (8)

From (8) $R_{gs}=58$ i,e 58% girls schooling recorded initially for class-I in 2001. Similarly the girls' enrolment in class-I for subsequent years may be obtained.

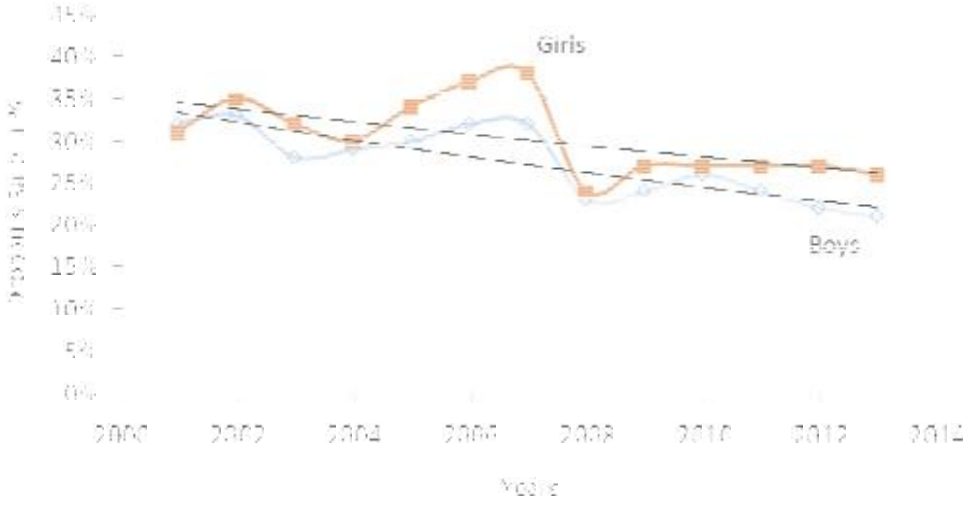
The expected girls schooling for the year 2014, 2015 and 2017 will be approximately 39%, 38% and 36% respectively.

Table II
Gender Wise Primary Dropout2001-2013

| Years | Boys Class - I | | | Girls Class - I | | |
|---|---|---|---|---|---|---|
| | $S_b$ | $D_b$ | $R_{bd}$ | $S_g$ | $D_g$ | $R_{gd}$ |
| 2001 | 0.436 | 0.141 | 32% | 0.233 | 0.073 | 31% |
| 2002 | 0.494 | 0.162 | 33% | 0.303 | 0.107 | 35% |
| 2003 | 0.489 | 0.135 | 28% | 0.317 | 0.100 | 32% |
| 2004 | 0.538 | 0.158 | 29% | 0.341 | 0.104 | 30% |
| 2005 | 0.575 | 0.171 | 30% | 0.387 | 0.132 | 34% |
| 2006 | 0.572 | 0.183 | 32% | 0.387 | 0.144 | 37% |
| 2007 | 0.573 | 0.185 | 32% | 0.393 | 0.148 | 38% |
| 2008 | 0.488 | 0.112 | 23% | 0.320 | 0.076 | 24% |
| 2009 | 0.487 | 0.117 | 24% | 0.335 | 0.089 | 27% |
| 2010 | 0.446 | 0.115 | 26% | 0.307 | 0.084 | 27% |
| 2011 | 0.443 | 0.104 | 24% | 0.313 | 0.085 | 27% |
| 2012 | 0,429 | 0.094 | 22% | 0.294 | 0.079 | 27% |
| 2013 | 0.401 | 0.084 | 21% | 0.259 | 0.067 | 26% |
| | | Average | 25% | Average | 28% | |

$D_b$ = Boys Drop-out
$D_g$ = Girls Drop-out
$P_b$ = Boys' Population (Projected)
$P_g$ = Girls' Population (Projected)
$R_{bd}$= Boys' Drop-out Rate
$R_{gd}$= Girls' Drop-out Rate

Fig. II
Comparison - Boys and Girls Class-I Dropout Sindh Province 2001-2013




Class-I to Class-II drop-out of both genders is shown in Fig II, the trend lines show the drop-out in public sector primary schools. Both genders' drop-out indicates decreasing trend from (5) & (6) we have the following results.

Boys Drop-out: $y = 34.526e^{-0.035x}$ $R^2 = 0.712$

Girls Drop-out: $y = 35.469e^{-0.023x}$ $R^2 = 0.382$

Class-I dropout of both genders is shown in Figure-II. The negative trend are observed in both genders and Table-II indicates that at an average, 25% boys and 28% girls have been dropped-out respectively in every subsequent year.

To check the validity of the model, the data from SEMIS in Table-II is taking into account and are being examine with the help of model presented at (A) and (B). Here we take dropout rate in percentage, and the same is calculated from their respective year of schooling. From (A) and (B)

$$k > 0 \quad R_d \quad R_{d_0} e^{kt}$$

Similarly

$$k < 0 \quad R_{\quad} \quad R_{\quad_0} e^{-kt}$$

Hence

$$R_{bd} \quad R_{bd_0} e^{-kt}$$

For Equation of Boys Drop-out: $y = 34.526e^{-0.035x}$

(9)

From (9) ; $R_{bd}$=33.34 i,e 33% boys dropout recorded initially in 2001.

Similarly the boys' dropout for subsequent years may be obtained. For year

2002; 32% Boys Dropout

The above equation shows that the boys' dropout is the exponential decay rate function. As per the actual data it was 33% during 2002. However, model indicates 32%, of their respective age group schooling, both results are almost same. It confirms that the model is appropriate. Now, similarly, the boys' dropout for the years 2014, 2015 and 2017 will be approximately 21%, 20% and 19% respectively.

Similarly, for girls dropout

For Equation of Girls Drop-out: $R_{gd}$= $y = 35.469e^{-0.023x}$

Hence $R_{gd} \quad R_{gd_o} e^{-kt}$ (10)

From (10) $R_{gd} = 34.66$ i,e 35% dropout recorded initially in 2001, and for year 2002; 34% Girls Drop-out

Similarly the girls' dropout for subsequent years may be obtained

The expected girls' dropout for the year 2014, 2015 and 2017 will be approximately 26%, 25% and 24% respectively.

## 3 Results and Discussion

According to the above studies following model function for boys and girls of schooling as well as drop-out are obtained

Model function for boys schooling: $y = 0.933e^{-0.042x}$ $R^2 = 0.706$
Model function for girls schooling: $y = 0.597e^{-0.03x}$ $R^2 = 0.364$
Model function for boys drop-out: $y = 34.526e^{-0.035x}$ $R^2 = 0.712$
Model function for girls drop-out: $y = 35.469e^{-0.023x}$ $R^2 = 0.382$

Fig I and II, shows 35% decay variability in boys schooling whereas 20% decay variability in girls schooling, on the other hand approximately 14% and 9% decay variability in Drop-out of boys and girls respectively.

The above studies shows that main factor of low schooling in girls education is the social structure of rural areas this may be termed as social factor in the schooling of both to genders. The situation becomes alarming when approximately 28% of the enrolments of girls left their schools in class-II (Table-I & II). Beside social factor there are

also some other main factors like poverty and low learning achievement & physical punishment, which effect on the Schooling and Drop-out:

## 3.1 Social Factors of Dropout:

The 27% (average) dropout rate at initial stage of primary education indicates that the parents have interested in the education of their children but the school environment has not attracting the children due to poor quality of class curriculum, physical punishment at initial classes, poverty situation in their family lives, all of these have forced the children to discontinue their education. The another hidden factor is the social structure of the rural areas of Sindh, in which there is clear difference in feudal who is the land owner and the farmer who with their family works on feudalist land and take interest bear capital from the feudal and face always social pressure which ultimately affect the education of farmers' children. Feudal need workers for miscellaneous jobs, the farmers' families are the manpower and meet all the requirements of the land lord. The feudal always intend to refrain the farmers' children to get education. Because, the feudal knows that if the farmers' children got education, then they have opportunity for better jobs, outside and may exit from the grab circles of feudal.

### Poverty:

The main out-of-school reason for leaving primary school is financial. The poverty forced the parents to keep their children out of school. Almost 79% of drop out are from low income house hold. In these families, children also play the role of wage earner. Children must work to support their families or their families can no longer afford to send them to school.

Low Learning and Physical Punishment:

Low learning children repeatedly failed in their classes and repeated their class year after year, which reduces the benefits of schooling and the lengthening of the school cycle that increases the costs of education. Physical punishment to the students is another reason for the dropout. In 1989, 52% of Pakistani teachers were found to use physical punishment with their students [14]. In the long run reducing dropout rates results, decreases both the direct and opportunity costs of primary schooling. This in turn increases enrolments and is an important step in achieving universal primary education in Pakistan.

While studying the situation of schooling children admitted in class-I it is noticed that the Class-I enrolment is not reasonable with respect to the specific 4 years' aged population. According to the data of SEMIS, Sindh, just about 65% children from the 4 years' aged population are being admitted in their First session of schooling, alternatively 35% of the same age group population is out of school in each year in sindh province. The situation is become alarming when 27% of 65% schooling children left their school or dropped out during or after completing their class-I schooling [9].

In a net shell a large number of students left schooling at an early stage and thus a big difference created between number of children admitted in Class-I with the number of children who passed Class-V after completing their five years of schooling period.

## 4 Conclusion

It is evident from table I & II that the average boys/girls schooling in initial classes are 71% and 49% whereas the average dropout during 2001-13 was 25% and 28% respectively. The girls' dropout happened to be much greater than the boys in the same period. The situation is alarming and need to be addressed forthwith.

The forecasted rate for schooling and dropout for 2014, 2015 and 2017 are appended below.

| | Boys (in %) | | | Girls (in %) | | |
|---|---|---|---|---|---|---|
| Year | 2014 | 2015 | 2017 | 2014 | 2015 | 2017 |
| Schooling | 52% | 50% | 46% | 39% | 38% | 36% |
| Dropout | 21% | 20% | 19% | 26% | 25% | 24% |

From the above the future state of dropout/ schooling may be ascertained. There is a little difference in dropouts of both genders during the year 2014-2017 whereas the schooling of girls is not comparable to the boys in the same period. Hence it is obvious that in the subsequent years the schooling shall be declined and further supplementing the illiteracy rate of the province.

The dropout in early school education is a community, economic and social problems. It rooted in rampant poverty and dearth of resources in the rural areas. Disregard of economic activities would mean a threat to survival and since education does not come with promise of future jobs, there will be little meaning in preferring schooling for the child. Thus, heavy dependence on family labor for livelihood is crucial.

Consequences of dropout is that, it reduces the enrolment rate and obstructs the enhancement of adult literacy. Beside illiteracy and

reducing enrolments rates, high rates of dropout also lead to internal inefficiency in educational system and also increased the unit cost of producing school graduates.

## 5 Recommendations

Following are the recommendations which can help in reducing the dropout rates of initial classes of primary education,

- Develop child bearing curriculum in initial classes (i.e one book curriculum)
- Appoint female teachers for initial classes (female teachers are much polite and tolerant than male teacher for nascent children.)
- Teachers' absenteeism should be strictly monitored.
- The school and class room atmosphere must support the child interest
- The less financial burden should be on the shoulders of parent (i.e one book curriculum, without uniform dress, and use of slate for written practice)
- Initial classes must be in mother tongue only
- Community of the area must be motivated for the children education
- Educational culture should be spread through media

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