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On the Calculation of Pass-Percentage of Students of Two Schools: A Simple Case of Societal Mathematics

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Abstract: ***This study examines the statistical relationship between gender and locality in student pass percentages across two schools-one in a suburban area and another in a rural area-while considering gender-based variations in academic performance. A theoretical framework is developed to analyze the dependency of pass rates on gender and locality, categorizing conditions into four cases: gender-independent and locality-independent, gender-independent and locality-dependent, gender-dependent and locality-independent, and gender-dependent and locality-dependent. The findings suggest that gender and locality can significantly influence pass percentages, revealing potential disparities based on school location and student demographics. The study also introduces a theoretical model using proportionality assumptions to explore the probabilities of various academic outcomes. This framework can serve as a diagnostic tool for identifying biases in educational performance and guiding future policy interventions [1][2].***

Keywords: student performance, gender disparity, locality effect, statistical analysis, education research

1. Introduction

Any two schools with similar infrastructure and class-standard are taken into consideration one of which is located in suburban area while the other one is in rural area of the same district. Numbers of students of both sex, separately and totally of both the schools, the total number of students in two schools, the number of passed out students of both sex of both schools (separately and totally) are the different parameters that are necessary for calculation and determination of all theoretical possibilities regarding passed and plucked students' percentage.

Interpretations of symbols: Suffix 'r' refers to rural area while suffix 's' refers to suburban area. 'B' represents the total number of boys-students while 'G' stands for total number of girls-students in two schools. Co-suffix 'p' indicates the passed out candidates. 'f_i' and 'm_j' are respective coefficients of passing out of female and male students. 'g' and 'b' represent another type of coefficients of passing out for girls and boys students respectively with respect to total students in respective area separately.
(2)

The basic frame-work: $B = B_r + B_s$, $G = G_r + G_s$, $G_p = G_{rp} + G_{sp}$,
$B_p = B_{rp} + B_{sp}$

Proportional measure for passed out candidates of both sex are given separately as
$\frac{B_p}{B} = \frac{B_{rp}+B_{sp}}{B}$ and $\frac{G_p}{G} = \frac{G_{rp}+G_{sp}}{G}$.

Let us assume that $G < B$. The vividly visible two distinct pairs of parametric entities are male and female students and rural and suburban areas. Hence gender- dependence or independence and locality dependence or independence are the main causes of concern upon which the results of one in comparison with other may most probably depend.

Following the principle of Natural Statistical Trend let us consider first another basic assumption that the number of passed out students is proportional directly to the total number of students respectively for both sex separately and totally also.

$$\frac{B_p}{B} = K_B , \frac{G_p}{G} = K_G \text{ and } \frac{B_p+G_p}{B+G} = \frac{K_B B + K_G G}{B+G} = K$$

On the contrary-wise of-course perhaps with least possibility this very proportionality assumption sometimes may be replaced by an inverse relationship whenever the parametric entities are mutually unfavorably interacting or influencing.

The main problem to be addressed here is to find out specific conditions for which g_p' is greater than, equal to or less than b_p and also for which f_i is greater than, equal to or less than m_j and along with those to obtain other associated sequential inferences.

Let us first consider primarily four different combinations of a-priori conditions to proceeding towards achieving goal;
1) Gender-independent and locality independent,
2) Gender-independent and locality dependent,
3) Gender-dependent and locality independent and
4) Gender-dependent and locality- dependent.

1) ***Gender-independent and locality independent***
$K_B = K_G$, $G_{rp} = f_r\, G_r$, $G_{sp} = f_s\, G_s$, $B_{rp} = m_r\, B_r$, $B_{sp} = m_s\, B_s$
(3)

For locality-independence $f_r = f_s = f$ and $m_r = m_s = m$
Then $G_p = f\, G$ and $B_p = m\, B$ and consequently $K_B = K_G = f = m = K$

This implies that for perfect gender-independence and locality-independence all the students' pass-percentages separately for both sex and for two localities totally for girls and boys are all the same and equal to 50%. This is a trivial case.

2) ***Gender-independent Locality-dependent***

$m_r = \frac{B_{rp}}{B_r} = \frac{G_{rp}}{G_r} = f_r$, $m_s = \frac{B_{sp}}{B_s} = \frac{G_{sp}}{G_s} = f_s$

Therefore,
$K_B B + K_G G = (B_p + G_p) = f_r (B_r + G_r) + f_s (B_s + G_s) = m_r (B_r + G_r) + m_s (B_s + G_s)$.
But strict overall gender independence demands that $K_B = K_G$.

Hence $\frac{m_r B_r + m_s B_s}{B_r + B_s} = \frac{f_r G_r + f_s G_s}{G_r + G_s}$ giving one $(m_s - m_r)(G_r B_s - B_r G_s) = 0$.
Therefore $\frac{B_r}{B_s} = \frac{G_r}{G_s}$ or $\frac{B_r}{G_r} = \frac{B_s}{G_s}$.

This is therefore the prior condition for which gender-independent locality- dependence strictly follows and is manifested every way and therefore any of the four above-mentioned ratio may be termed gender-independent locality-dependence index.

For rural and suburban areas the overall pass-percentage of students of both sex are given respectively by

$\frac{B_{rp}}{B_r + G_r} = \frac{m_r}{1 + (\frac{G_r}{B_r})}$ and $\frac{G_{rp}}{B_r + G_r} = \frac{m_r}{1 + (\frac{B_r}{G_r})}$ and $\frac{B_{sp}}{B_s + G_s} = \frac{m_s}{1 + (\frac{G_s}{B_s})}$ and $\frac{G_{sp}}{B_s + G_s} = \frac{m_s}{1 + (\frac{B_s}{G_s})}$

It is hereby found that if total number of girls students is greater than total number of boys students in schools in respective locality then separately for each school girls' pass-percentage is greater than that of boys students and the vice versa. It is though interesting to keep in mind that overall pass percentage of students of both sex in two schools as a whole are same. Therefore, if total number of girls students (4) in one school in one locality is greater than that of boys students then by virtue of the two basic assumptions regarding the total number of girls and boys in two schools as a whole and the condition for strict validity of gender-independence as a whole the total number of girls students in the other school must have to be much lower than that of boys students in that school so that $G < B$ holds true. This result may be looked upon as somewhat morphogenetic inheritance of the basic trend regarding the principle of Natural Statistical Trend mentioned earlier.

3) ***Locality-independent Gender-dependent***

For this to be strictly followed the necessary conditions are
$m_r = m_s$ and $f_r = f_s$
which means $\frac{B_{rp}}{B_r} = m_r = m_s = \frac{B_{sp}}{B_s} = \frac{B_p}{B} = K_B$ and
$\frac{G_{rp}}{G_r} = f_r = f_s = \frac{G_{sp}}{G_s} = \frac{G_p}{G} = K_G$ and generally $m_r \neq f_r$ and $m_s \neq f_s$
and also $K_B \neq K_G$

Then only two pairs of the possible four preconditions may be satisfied; These are
i) $m_r > f_r$ and $m_s > f_s$, ii) $m_r < f_r$ and $m_s < f_s$ and consequently either $K_B > K_G$ or $K_B < K_G$.

Now we are to find out the following percentages in comparison with other of a pair;
$\frac{B_{rp}}{B_r + G_r}$ and $\frac{G_{rp}}{B_r + G_r}$, $\frac{B_{sp}}{B_s + G_s}$ and $\frac{G_{sp}}{B_s + G_s}$, $\frac{B_p}{B + G}$ and $\frac{G_p}{B + G}$.
$\frac{B_{rp}}{B_r + G_r} = \frac{m_r}{1 + \frac{G_r}{B_r}} = \alpha$ (say) , $\frac{G_{rp}}{B_r + G_r} = \frac{f_r}{1 + \frac{B_r}{G_r}} = \beta$(say) , $\frac{B_{sp}}{B_s + G_s} = \frac{m_s}{1 + \frac{G_s}{B_s}}$, $\frac{G_{sp}}{B_s + G_s} = \frac{f_s}{1 + \frac{B_s}{G_s}}$,
$\frac{B_p}{B + G} = \frac{K_B}{1 + \frac{G}{B}} = \frac{m_r}{1 + \frac{G}{B}} = \varphi$ (say) and $\frac{G_p}{B + G} = \frac{K_G}{1 + \frac{B}{G}} = \frac{f_r}{1 + \frac{B}{G}} = \psi$(say) .

Under the primary preconditions and the secondary preconditions, as satisfied under 3rd point of restriction/constraint altogether the following schemes do hold;

For $B > G$

$$1)\ m_r > f_r \begin{cases} B_r > G_r \rightarrow \alpha > \beta \\ B_r = G_r \rightarrow \alpha > \beta \\ B_r < G_r \rightarrow \alpha \gtreqless \beta \end{cases}$$

$$2)\ m_r < f_r \begin{cases} B_r > G_r \rightarrow \alpha \gtreqless \beta \\ B_r = G_r \rightarrow \alpha < \beta \\ B_r < G_r \rightarrow \alpha < \beta \end{cases}$$

Under the above-stated primary precondition the relative probabilities of $B_r > G_r$, $B_r = G_r$, $B_r < G_r$ are (3/5) , (1/5) , (1/5) respectively and consequently the (5) relative probabilities of $\alpha > \beta$, $\alpha = \beta$, $\alpha < \beta$ are (16/30) , (4/30) and (10/30) respectively. The values of similar theoretical probabilities of ρ > 1
ρ = 1 and ρ < 1 where
$\rho = \frac{\frac{B_p}{B+G}}{\frac{G_p}{B+G}} = \frac{B_p}{G_p} = \frac{(m_s - m_r)B_s + m_r B}{(f_s - f_r)G_s + f_r G} = \frac{(m_r - m_s)B_r + m_s B}{(f_r - f_s)G_r + f_s G}$
are (4/6), (1/6) and (1/6) respectively.

The similar relative probabilities all the above-mentioned entities for other two possible primary conditions such as $B = G$ and $B < G$ are found out to be $(\alpha > \beta)$ x $(\alpha = \beta)$ x $(\alpha < \beta) \equiv$ (4/9) x (1/9) x (4/9) , (ρ > 1) x (ρ = 1) x (ρ < 1) ≡ (1/2) x0 x (1/2) and $(\alpha > \beta)$ x $(\alpha = \beta)$ x $(\alpha < \beta) \equiv$ (10/30) x (4/30) x (16/30) , (ρ > 1) x (ρ = 1) x (ρ < 1)≡ (1/6) x (1/6) x (4/6) respectively. The way of calculations are given in details in the next section.

4) ***Gender-dependent and location-dependent***

The associated preconditions are $m_r \neq m_s$, $f_r \neq f_s$, $m_r \neq f_r$, $m_s \neq f_s$.

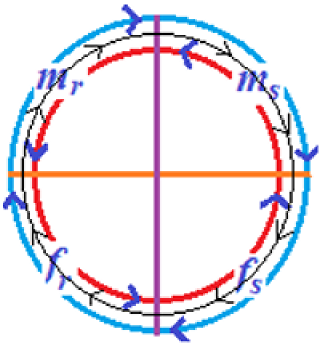
The primary precondition $G < B$ restricts all probable interrelations among four parameters G_s , G_r , B_s , B_r within a small set of pairs of interrelations as follows;
$[B_r > G_r , B_s > G_s]$, $[B_r > G_r , B_s < G_s]$, $[B_r > G_r , B_s = G_s]$ and
$[B_r = G_r , B_s > G_s]$, $[B_r < G_r , B_s > G_s]$.

But since the following interrelations hold true such as $B_{rp} \leq B_r$, $B_{sp} \leq B_s$, $G_{rp} \leq G_r$, $G_{sp} \leq G_s$ combining these with the associated preconditions under this constraint (constraint no.4) a totality of sixteen probable pairs of interrelations may hold.

1) $m_r > f_r$, $m_s > f_s$ and $m_r > m_s$, $f_r > f_s$
2) $m_r > f_r$, $m_s > f_s$ and $m_r > m_s$, $f_r < f_s$
3) $m_r > f_r$, $m_s > f_s$ and $m_r < m_s$, $f_r > f_s$
4) $m_r > f_r$, $m_s > f_s$ and $m_r < m_s$, $f_r < f_s$
5) $m_r < f_r$, $m_s < f_s$ and $m_r > m_s$, $f_r > f_s$
6) $m_r < f_r$, $m_s < f_s$ and $m_r > m_s$, $f_r < f_s$
7) $m_r < f_r$, $m_s < f_s$ and $m_r < m_s$, $f_r < f_s$
8) $m_r < f_r$, $m_s < f_s$ and $m_r < m_s$, $f_r > f_s$
9) $m_r > f_r$, $m_s < f_s$ and $m_r > m_s$, $f_r > f_s$
(6)
10) $m_r > f_r$, $m_s < f_s$ and $m_r < m_s$, $f_r < f_s$
11) $m_r > f_r$, $m_s < f_s$ and $m_r > m_s$, $f_r < f_s$
12) $m_r > f_r$, $m_s < f_s$ and $m_r < m_s$, $f_r > f_s$
13) $m_r < f_r$, $m_s > f_s$ and $m_r > m_s$, $f_r > f_s$
14) $m_r < f_r$, $m_s > f_s$ and $m_r < m_s$, $f_r < f_s$
15) $m_r < f_r$, $m_s > f_s$ and $m_r < m_s$, $f_r > f_s$
16) $m_r < f_r$, $m_s > f_s$ and $m_r > m_s$, $f_r < f_s$

One should keep in mind that interrelation between m_r and f_s and similar relation between m_s and f_r has no meaning and that is why these two inter- relations are not considered. Thus, the number of probable valid pairs of interrelations is obtained in the following way; $N = 4!$ - ($^4C_3$) X 2! = 16. Among the above-mentioned 16 pairs of interrelations the 12th and the 16th are red-marked because they are as a whole self-contradictory and thus, they are discarded. As the rest 14 pairs of valid interrelations are all equally probable the theoretical probability of each such set of interrelation is naturally approximately 7.1% (≈1/14).

Inequality-cycle representation: In connection with the above set of combination of valid pairs of inequalities an interesting representation is seen to comply with the ultimate result satisfying all the conditions and constraints. This representation, which may be termed as 'inequality-cycle' is given below;



m_r	m_s	f_s	f_r	ways to go round cycle(Clockwise)
>	>	>	>	B B B B
<	<	<	<	R R R R
<	<	>	>	R R B B
>	>	<	<	B B R R
>	<	>	<	B R B R
………				
………				

Figure 1

(7)

In this way one gets 14 set of combinations that are valid functionally and meaningfully. As because the parameters are sequenced in such a manner so as to imply only meaningfully valid probabilities and as the representation relates to a complete cycle (closed relation either clockwise or counter-clockwise or mixed) the first two sequences (highlighted with red colour) of symbols that refers to 12th and 16th of the earlier-mentioned list are self-contradictory and therefore to be rejected.

The arrows along the outside-circle [blue(B)] represents clockwise greater than while arrows along inner loop [red(R)] represents counter-clockwise less than and the thin black line shows the direction of proceeding along only B-path or only R-path or both B and R path to complete the cycle.

Moreover parameters' pairs {m_r, f_s} and {m_s, f_r} are positioned diagonally opposite to each other and are not directly related to each other. Therefore, the meaningless relations do not naturally appear in this representation. In addition to all these male-students' section is diametrically opposite to the section of female-students and on the other way the suburban locality set is also diametrically opposite to the rural set of students in this representation. The two diameters (shown with orange and purple colour in Fig.1respectively) being orthogonal to each other which if segregates between the sets perfectly would imply that gender-dependence and locality-dependence are mutually non-correlated events.

Hence the inequality-cycle representation has sufficient significance in such cases.

Theoretical probabilities of pass-percentages:

$\frac{m_r}{1+\frac{G_r}{B_r}}$, $\frac{f_r}{1+\frac{B_r}{G_r}}$

If $m_r > f_r$ and $G_r \leq B_r$ then rural boys' pass-percentage is certainly greater than rural girls' pass-percentage. But if $m_r > f_r$ and $G_r > B_r$ then all possibilities for the pass-percentage of both boys and girls may happen one at a time. Similarly if $m_r < f_r$ and $G_r \geq B_r$ then the rural boys' pass-percentage will be less than that girls. Again if $m_r < f_r$ and $G_r < B_r$ then all possible relative pass-percentage of both boys and girls will occur one at a time. Exactly similar arguments follow for (8) the students of suburban sector.

As all the relations are equally probable (unbiased /independent) hence for rural students the theoretically calculated pass percentage for boys being greater than for girls is

$(\frac{7}{14} \times \frac{4}{5}) + (\frac{7}{14} \times \frac{1}{5} \times \frac{1}{3}) + (\frac{7}{14} \times \frac{3}{5} \times \frac{1}{3}) = \frac{8}{15} \approx 53.33\%$ (approx)

Probability for boys' pass-percentage being less than that of girls will be

$(\frac{7}{14} \times \frac{2}{5}) + (\frac{7}{14} \times \frac{1}{5} \times \frac{1}{3}) + (\frac{7}{14} \times \frac{3}{5} \times \frac{1}{3}) = \frac{1}{3} \approx 33.33\%$ (approx)
and probability of boys' pass-percentage being equal to that of girls will be
$(\frac{7}{14} \times \frac{1}{5} \times \frac{1}{3}) + (\frac{7}{14} \times \frac{3}{5} \times \frac{1}{3}) = \frac{2}{15} \approx 13.33\%$ (approx)

The above calculations have been done on the basis of above-mentioned five interrelations among G_s , G_r , B_s , B_r and fourteen valid interrelations among m_r m_s f_s f_r. Exactly similar scenario will be obtained for students of suburban area too.

Now to investigate the proportional value of the following;

$$\rho = \frac{\frac{B_p}{B+G}}{\frac{G_p}{B+G}} = \frac{B_p}{G_p} = \frac{(m_s - m_r)B_s + m_r B}{(f_s - f_r)G_s + f_r G} = \frac{(m_r - m_s)B_r + m_s B}{(f_r - f_s)G_r + f_s G}$$

The first ratio is considered for calculations of probability which are given below;

The possible combinations of determining parameters are eighteen in number in totality that are given below:

$(m_s - m_r) > (f_s - f_r)$ -----$B_s > G_s$ -----$m_r > f_r$ ---- $\rho > 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s > G_s$ -----$m_r < f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s = G_s$ -----$m_r > f_r$ -----$\rho > 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s = G_s$------$m_r < f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s < G_s$ -----$m_r > f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s < G_s$ -----$m_r < f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s > G_s$ -----$m_r > f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s > G_s$ -----$m_r < f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s = G_s$ -----$m_r > f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s = G_s$ -----$m_r < f_r$ -----$\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s < G_s$ -----$m_r > f_r$ -----$\rho \gtreqless 1$
(9)

$(m_s - m_r) < (f_s - f_r)$ -----$B_s < G_s$ -----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s > G_s$ -----$m_r > f_r$ ---- $\rho > 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s > G_s$ -----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s = G_s$ -----$m_r > f_r$ ---- $\rho > 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s = G_s$ -----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s < G_s$ -----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s < G_s$ -----$m_r > f_r$ ---- $\rho \gtreqless 1$

As the value of ratio 'ρ' depends on basically mutually independent inequality-relations in one set such as, between $(m_s - m_r)$ and $(f_s - f_r)$, between B_s and G_s and between m_r and f_r or in the other set between $(m_r - m_s)$ and $(f_s - f_r)$, between B_r and G_r and between m_s and f_s the theoretical probability of 'ρ' being either greater than or equal to or less than '1' will simply be given by,

$P_\rho(\rho > 1) = \frac{18}{46} = 39.13\%$ (Approx.)
$P_\rho(\rho = 1) = \frac{14}{46} = 30.435\%$ (Approx.)
$P_\rho(\rho < 1) = \frac{14}{46} = 30.435\%$ (Approx.)

Checking for results of similar calculations following similar sets of arguments under the preconditions' set no.(4) for two other possible primary preconditions:

The other two primary preconditions are respectively
$G = B$ and $G > B$

For $G = B$ the only possible three sets of inequality-relations are as follows;
$[B_r > G_r , B_s < G_s]$, $[B_r = G_r , B_s = G_s]$ and
$[B_r < G_r , B_s > G_s]$.

With each of these sets there are two possible subsets of inequality each for both rural and suburban locality.

$[B_r > G_r , B_s < G_s]$

$m_r > f_r$ ----- $B_{rp} > G_{rp}$ $m_s > f_s$ ------$B_{sp} \gtreqless G_{sp}$
$m_r < f_r$ ----- $B_{rp} \gtreqless G_{rp}$ $m_s < f_s$ ------$B_{sp} < G_{sp}$

(10)
$[B_r = G_r , B_s = G_s]$

$m_r > f_r$ ------- $B_{rp} > G_{rp}$ $m_s > f_s$ ------$B_{sp} > G_{sp}$
$m_r < f_r$ ------- $B_{rp} < G_{rp}$ $m_s < f_s$ ------$B_{sp} < G_{sp}$

$[B_r < G_r , B_s > G_s]$

$m_r > f_r$ --------- $B_{rp} \gtreqless G_{rp}$ $m_s > f_s$ --------$B_{sp} > G_{sp}$
$m_r < f_r$ -------- $B_{rp} < G_{rp}$ $m_s < f_s$ -------$B_{sp} \gtreqless G_{sp}$

The theoretical probability that boys' pass-percentage separately for each locality being greater than girls' pass-percentage in both the localities will be
$\frac{1}{2} \times \frac{2}{3} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} = \frac{4}{9} = 44.44\%$

Similarly theoretical probability of boys' pass-percentage being equal to that of girls separately in two localities will be
$\frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} = \frac{1}{9} = 11.11\%$

Theoretical probability of girls' pass-percentage being greater than boys' pass- percentage is given by
$\frac{1}{2} \times \frac{2}{3} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} + \frac{1}{2} \times \frac{1}{3} \times \frac{1}{3} = \frac{4}{9} = 44.44\%$

With primary precondition $G > B$ the whole set of calculations follows exactly the same for precondition $B > G$ but reversing the symbols in each step and the result is also the very same with reversing symbols as given below; Theoretical probability of girls' overall pass-percentage being greater than that of boys is 53.33% while for being mutually equal is 13.33% and for girls' overall pass percentage being less than boys' pass percentage is 33.33%.

Now with these primary preconditions i,e. $G = B$ and $G > B$ P_ρ s are calculated as given below;

$(m_s - m_r) > (f_s - f_r)$ ----$B_s > G_s$ ----$m_r > f_r$----- $\rho > 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s > G_s$ ----$m_r < f_r$---- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s = G_s$ ----$m_r > f_r$---- $\rho > 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s = G_s$ ----$m_r < f_r$---- $\rho \gtreqless 1$
(11)

$(m_s - m_r) > (f_s - f_r)$ -----$B_s < G_s$ ----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ -----$B_s < G_s$ ----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s > G_s$ ----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s > G_s$ ----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s = G_s$ ----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s = G_s$ ----$m_r < f_r$ ---- $\rho < 1$
$(m_s - m_r) < (f_s - f_r)$ -----$B_s < G_s$ ----$m_r > f_r$ ---- $\rho \gtreqless 1$

$(m_s - m_r) < (f_s - f_r)$ -----$B_s < G_s$ ----$m_r < f_r$ ---- $\rho<1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s > G_s$ ----$m_r > f_r$ ---- $\rho>1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s > G_s$ ----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s = G_s$ ----$m_r > f_r$ ---- $\rho>1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s = G_s$ ----$m_r < f_r$ ---- $\rho<1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s < G_s$ ----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ -----$B_s < G_s$ ----$m_r < f_r$ ---- $\rho<1$

Theoretical probability of 'ρ' being either greater than or equal to or less than '1' will simply be given by(for $G = B$),

$P_\rho(\rho > 1) = \frac{14}{38} = 36.84$ % (Approx.)

$P_\rho(\rho = 1) = \frac{10}{38} = 26.32$ % (Approx.)

$P_\rho(\rho < 1) = \frac{14}{38} = 36.84$ % (Approx.)

For $G > B$

$(m_s - m_r) > (f_s - f_r)$ ----$B_s > G_s$ -----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s > G_s$ -----$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s = G_s$ -----$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s = G_s$ -----$m_r < f_r$----- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s < G_s$ -----$m_r > f_r$----- $\rho \gtreqless 1$
$(m_s - m_r) > (f_s - f_r)$ ----$B_s < G_s$ -----$m_r < f_r$----- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ ----$B_s > G_s$ -----$m_r > f_r$----- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ ----$B_s > G_s$ -----$m_r < f_r$----- $\rho \gtreqless 1$
(12)

$(m_s - m_r) < (f_s - f_r)$ ----$B_s = G_s$ ------$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ ----$B_s = G_s$ ------$m_r < f_r$ ---- $\rho<1$
$(m_s - m_r) < (f_s - f_r)$ ----$B_s < G_s$ ------$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) < (f_s - f_r)$ ----$B_s < G_s$ ------$m_r < f_r$ ---- $\rho<1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s > G_s$ ------$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s > G_s$ ------$m_r < f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s = G_s$ ------$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s = G_s$ ------$m_r < f_r$ ---- $\rho<1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s < G_s$ ------$m_r > f_r$ ---- $\rho \gtreqless 1$
$(m_s - m_r) = (f_s - f_r)$ ----$B_s < G_s$ ------$m_r < f_r$ ---- $\rho<1$

Theoretical probability of 'ρ' being either greater than or equal to or less than '1' will simply be given by

$P_\rho(\rho > 1) = \frac{14}{46} = 30.435$ % (Approx.)

$P_\rho(\rho = 1) = \frac{14}{46} = 30.435$% (Approx.)

$P_\rho(\rho < 1) = \frac{18}{46} = 39.13$ % (Approx.)

(13)

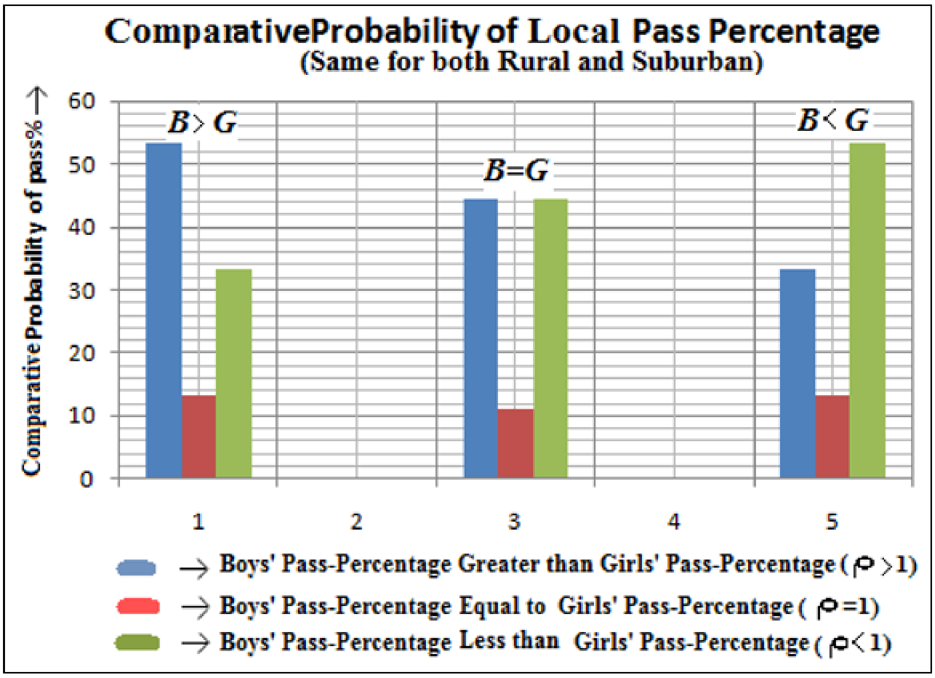


Figure 1

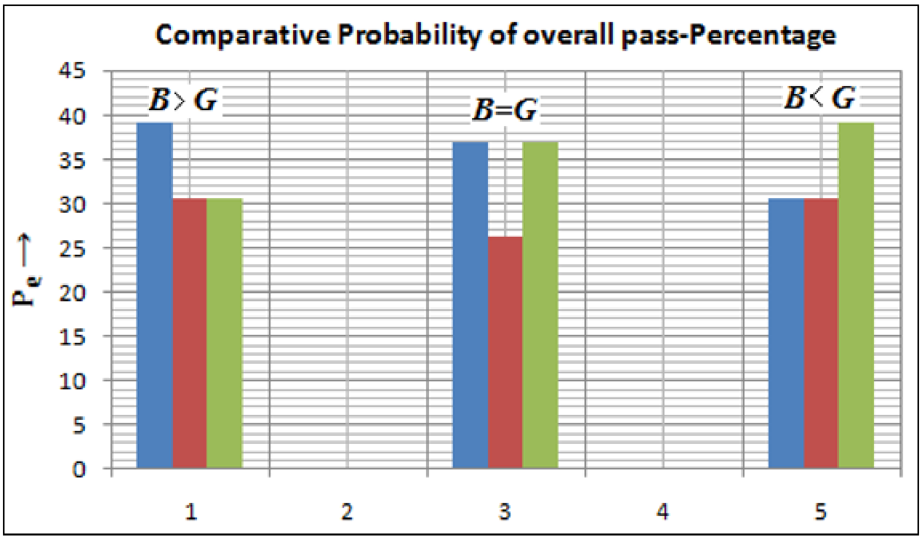


Figure 2

2. Discussion

In all the simply unbiased cases of calculations of theoretical probability under different primary and secondary preconditions subject to both locality- and gender-dependence it is found that the probability of boys' pass-percentage being equal to girls' pass-percentage, either separately for localities or in an overall estimate is never a maximum while the same entity for other two possibilities i, e. one being greater or less than the other has a maximum depending on and following the primary precondition. Yet the probability of equality between the pass-percentages of boys and girls is found to have a minimum in some cases. This result is very interesting and intriguing also because of the fact that the theoretical probability of non-equality between boys' and girls' pass-percentages is numerically found to be symmetrically placed on the two sides of equality condition.

Another very interesting feature of the analysis is that there are sharply particular values of proportions in different cases of probability-calculation under different precondition. For $B > G$ the proportion of probabilities for boys' pass-percentage (14) being greater than, equal to or less than girls' pass-percentage respectively in a locality (be it rural or suburban, all the same) is found to be 8:2:5. Under the same precondition the proportion of probabilities for overall pass percentage of boys being greater than, equal to and less than that of girls respectively is found to be

$$P_\rho(\rho > 1) : P_\rho(\rho = 1) : P_\rho(\rho < 1) \equiv 9:7:7 .$$

For $B = G$ the above-mentioned two proportions are found respectively to be 4:1:4 and 7:5:7. For $B < G$ these are 5:2:8 and 7:7:9 respectively.

Probability of pass-percentage for boys and girls being mutually equal to each other is always lesser or the least. This is really very interesting result that needs more careful scrutiny, analytically to the core of the heart of the matter if something mysterious be revealed at the root of such bias.

Results in case of completely independent of all factors shows no particular bias for any probability regarding pass-percentage of boys and girls in both the locality and also in an overall estimation.

For only locality-dependent (yet gender-independent) the pass-percentage of students of a particular gender, both in particular locality and also in an overall estimation the probability of pass-percentage of that gender is found to accordingly follow relative total number. If the total number girl-students is greater than that of boys then girls' pass-percentage is greater than that of boys and the vice-versa. This is also the case for an overall estimation.

For only gender-dependent yet locality independent case the calculations need consideration of detailed analysis. It is seen that the theoretical probability of pass- percentage for boys being greater than, equal to or less than that of girls for two schools separately under the constraint of three primary conditions such as $B > G$,

$B = G$, $B < G$ are in the proportions (16/30) : (4/30) : (10/30), (4/9) : (1/9) : (4/9) and (10/30) : (4/30) : (16/30) respectively. Similarly for an overall estimation the same entities under those three primary conditions are in the proportions (4/6) : (1/6) :
(1/6), (1/2) : (0) : (1/2) and (1/6) : (1/6) : (4/6) respectively. In simplified form the ratios are 8: 2: 5, 4:1:4 and 5:2:8 and for overall estimation 4:1:1, 1:0:1 and 1:1:4 respectively.

It is to be noted that the proportion of theoretical probabilities for boys' pass-percentage (15) greater than, equal to or less than girls' pass-percentage separately in two schools for the three primary preconditions for gender-dependent-locality-dependent case and for gender-dependent-locality-independent case are mutually equal to each other. But in case of overall estimation the results in terms of similar proportions under the above- mentioned two different types of dependence are found to be different. This is of-course quite natural because in both the type of case of dependence, separately in two schools, gender-dependence considerations remain perfectly delinked with locality-dependence and exactly similar calculations follow both for rural and suburban locality even in terms of magnitude.

Yet of-course the particular sets of numerical values in all such obtained proportions are certainly a key-feature of the basis of the method of analysis here. The intricacies of gender-dependence and locality-dependence are implicitly functions of large number factors such as social well-being, socio-economical and cultural, ecological, availability and accessibility based infrastructural and similar other so many factors and that the normal indices considered here as defined parameters representing the different dependences ,namely m_s , m_r , f_s , f_r, K_B, K_G may be thought to be more complex function of such and such so many factors as mentioned above. Those factors are somehow directly or indirectly correlated to different human developmental indices that are used today in diagnosing problems and difficulties and their level and to help deliver immediate solution and resolution.

3. Conclusion

Gender and location-area are two basic practical entities that are primarily essential for investigating the general statistical trend and also bias if any at all, substantiated through accumulated raw data and their rigorous statistical analysis. Schools impart education to the offspring of the society in a systematic way along with moral and ethical culture of wellbeing. Therefore school-students, who can practically be considered as clean-slates are perhaps the best means of investigation without logistic interference of other unwanted complicacies. Gender-dependence is more a natural factor while dependence on location-area may somehow be regarded as a semi-empirical factor comprising both natural and artificial interactions implicitly. Inherent capacity of learning and improvising of the students may depend implicitly on specific biological characteristics and also on a set of mutually interacting multiple (16) entities under, so to say, social networking [3][4].

Three primary properties of relative quantitative measurement of parallel sets of competing operators are three in number; namely 'greater than', 'equal to', and 'less than' which are mathematically represented through inequalities. These inequalities represent some limit of variation that the value of the defined parameters are subject to. The simple theoretical framework discussed in this article may and should undergo sincere and careful trials for verification by comparing directly with the results from collected real-life raw data with truly reliable statistical significance. If both the theoretically expected results within this framework and results obtained from direct real-life data match to a great extent then the whole process might be thought to show approximately unbiased development. Otherwise any type of bias will directly be indicated. Thus, the theoretical framework discussed here may well be used as a diagnostic tool for examining whether there is any implicit bias in such a process or not.

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