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RESEARCH ARTICLE

LEARNERS' CONSISTENCY IN MATHEMATICS PERFORMANCE – AN INVESTIGATION THROUGH STATISTICAL PROCEDURE

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ABSTRACT

This paper deals with the study of consistencies of performance in mathematics of 21 randomly selected schools in Nalbari District of Assam. Ideally the performance in mathematics should be improved consistently. The mathematics performances measured by the class average scores of three tests viz. Class VIII Annual Examination, Class IX Annual Examination and Mathematical Ability Test (MAT) conducted in Class X were used to investigate the consistency of performances of all the 21 schools. For examining the consistency it was assumed that each individual learner was subjected to identical treatments in the three consecutive years. Consistencies of current Class X students of each school were evaluated through a standard procedure. Overall, only 28.28% learners are showing consistent improvement in mathematics performance. On the other hand, performance of 18.03% learners is deteriorating. Remaining (more than half) population of learners indicated complete lack of consistency. Later key results were analyzed using the educational environment factors. Consistencies in performances cannot be fully explained by the managerial conditions of the schools. In spite of better managerial inputs, only 18.75% learners of an urban located government school are showing consistent improvement in mathematics. Similarly, in spite of better educational environment, about 90% of the learners of one urban located private school could not show consistent improvement in mathematics.

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INTRODUCTION

Education is considered as an important index to measure societal development. This is the reason that education is taken as priority sector for development by all nations. Every nation develops the system of education to express and promote its unique socio-cultural identity and also to meet the challenges of the times. The role of educational development in mitigating several problems of the human society has been realized at all levels. School education is an important segment of the whole educational structure and it is considered as a powerful instrument to develop students' behavior and hence the society. There have been many studies related to education issues in India. While discussing the education and cast in India, Chauhan (2008) pointed that low school enrolment and completion rates, high dropout and failure rates are reported are the characteristics amongst the weaker section of the society. Shortcoming related to teaching staff has also been identified as the major problems in effective teaching learning (Desai, 1999). Despite of government's effort to provide uniform level of education for its citizen, non-uniform academic experiences of students belonging to different schools are evident in India.

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Such differences are not only between urban and rural schools, but also amongst the schools having similar location. The existences of varying academic experiences viz., rich and poor, rural and urban in India are also reported (Banaji, 2005). The micro level investigations are also conducted to assist effective teaching-learning in India. The importance of curriculum reform through changes in evaluation process in effective teaching-learning process is evidenced by such study (Agrawal, 2004). The importance of quality education in nation building has also been realized by several nations including developed countries. Several developed nations including USA realized that their role as leaders in the world's economy and their capacity to produce wealth and quality jobs depend directly on the ability of education system to produce students who can compete in mathematics and science dominated industries of the future. Thus, improving mathematics and science education has been the priority of the policymaking agenda (Anon, 2005). Students' performance in mathematics subject has been investigated through bilateral surveys in two European countries (Robertson, 2000). Requirements of changes in national policies suiting their respective culture are emphasized in order to minimize the differences in performances amongst the countries. The interactions of a large number of socio-economic as well as academic environmental factors influence the student's performance in school.

Poor school performance not only results in the child having a low self-esteem, but also causes significant stress to the parents (Karande and Kulkarni, 2005). Identification of causes of poor performance and execution of corrective action plan so that the students can perform up to their full potential is required. A psychological aspect of female students with special reference to mathematics subject has been matter of investigation in past reporting that high mathematics anxiety is associated with low mathematics achievement (Yee, 1987). Another interesting finding of such study was that for the most capable students, test anxiety seems to act as a facilitator in their mathematics performance. The role of teachers has also been pointed out by the study stating that students' scores on the perception of their mathematics teachers have the strongest correlation with their mathematics anxiety scores. Teacher's quality supported by training and experiences has influencing role in effective teaching-learning. Teaching experience plays important role in success of education (Tui, 1987).

From the above discussion it is evident that education has not only the priority area of policy makers, but adequate attention has also drawn to many researchers. The present investigation is concerning the secondary school education prevailing in a region of India. India is a developing country with vast chunk of human resources. The Indian Government has realized the importance of educational development and therefore, provides required importance in education. A multi-level structured education system prevails in India. The levels and major governing bodies of education prevailing in India are presented in Table 1 and Table 2, respectively. The present investigation is pertaining to secondary school education and schools considered in the present study are under the state government board. The Indian Government has initiated several plans such as 'Sarva Siksha Abhiyan (SSA), District Primary Education Program (DPEP), Operation Blackboard, Mid Day Meal etc, mainly to improve the level of primary education and to reduce illiteracy.

Government also makes plan and policy to address issues related to upper levels of education including secondary education. The national policy of education (1986) and program of action (1992) states that the curriculum of secondary education should expose the students to differentiated roles of science, the humanities, and social science. The roles of teacher and infrastructure facility for effective education are also realized and mentioned in the policy documents. Progress in education scenario is remarkable in India probably due to Government policy and programmes. However, some areas still require attention. The quality of secondary education is such an area which needs special intervention and attention.

There are several subjects taught at school e.g. language, literature, social studies, science and mathematics. Subject wise performance variations are generally reported. Amongst the subjects taught in schools, mathematics is considered as one of the toughest subjects with poor performances of students. The lower level of pass percentage has been a matter of serious concern. Thus, science subject in general and mathematics in particular has been a problem area for majority of secondary schools in India. The state of Assam is one of the economically backward regions of India located in north-eastern region. The state has witnessed several socio-political turmoil in recent past centering on the younger population. Provision for appropriate employment could distract the younger generation from such disturbing activities. The entire north-eastern region has agricultural dominancy with lower economical and industrial activities. The oil and tea are two major industries absorbing manpower based on certain level of academic skill. Similarly, appointments in other local and national sectors also demand competitive academic skill. It is true that secondary school curriculum is prepared to impart necessary academic training for higher education as well as for such academic skill. The course curriculum is only one factor responsible for imparting quality education.

Table 1. Levels of education system in India

Sl. No	Level	Description
1	Pre- Primary	It consists of children of 3-5 years of age studying in nursery, lower kindergarten and upper kindergarten.
2	Primary	It includes the age group of children of 6-11 years studying in classes from 1 st first to 5 th
3	Middle	It consists of children studying in classes from 6 th to 8 th
4	Secondary	it includes students studying in classes 9 th and 10 th
5	Higher Secondary	Includes students studying in 11 th and 12 th classes
6	Undergraduate	Here, a student goes through higher education, which is completed in college. The duration of undergraduate course may vary according to the subject pursued by the student.
7	Postgraduate	After completing graduation a student may opt for post graduation

Education Governing bodies in India

Sl No	Level	Description
1	The Central Board of Secondary Education (CBSE)	This is the official governing body of education system in India. It conducts examination and looks after the functioning of schools accredited to central education system from primary to higher secondary level
2	The State Government Boards	Apart from CBSE and CISCE each state in India has its own State Board of education, which looks after the educational issues up to higher secondary level. Some states have separate board for secondary and higher secondary levels
3	The Council of Indian School Certificate Examination (CISCE)	It is a board for Anglo Indian Studies in India. It conducts two examinations 'Indian Certificate of Secondary Education' and 'Indian School Certificate'. Indian Certificate of secondary education is a k-10 examination for those Indian students who have just completed class 10 th and Indian school certificate is a k-12 public examination conducted for those studying in class 12 th
4	The National Open School	It is also known as National Institute of Open Schooling. It was established by the Government of India in 1989. It is for those students who cannot attend formal schools.
5	The International School	It controls the schools, which are accredited to curriculum of international standard

There are other academic environment factors governing the success of secondary education to achieve its goal. If socio-political disturbances involving youth of this region are considered as a yardstick of educational performance, then analysis of the existing education system prevailing in this region is imperative. It is being often told that there exists phobia towards mathematics learning amongst the student communities of secondary schools. Mathematical skill is essential not only for the higher education aspiring section, but also success in several competitive examination for jobs depends upon the basic understanding in mathematics. Thus, perfect teaching-learning in secondary schools in all subjects in general and mathematics subject in particular has been a serious issue needing investigation.

Description of study area and schools

Study Area

The study covers some selected schools of Nalbari, a rural dominated district of Assam (India). The selected schools follow the course curriculum of a state government managed academic organization called Board of Secondary Education, Assam (SEBA). The Nalbari is one of the 28 districts of Assam located between 26°N and 27° N latitude and 91°E and 97°E longitude. The northern side of the district is bounded by the Indo-Bhutan International boundary and the southern side by the mighty Brahmaputra. The district with 2.88% area of the state shelters about 4.27 % of the state's total population. The population density of the district is 504 persons per square km as against 340 persons per square km for the state as a whole. Nearly, 97.59% of the total populations (0.67 million) of the district live in villages. The literacy rate of Nalbari is 68.08% which is marginally higher than that of the State (64.28%). There are 223 secondary schools with variations of managerial status and socio-economic conditions in the District. Schools of Nalbari district is considered to be representative of schools of Assam and therefore, selected for the present study.

Selection of School

List of schools with SEBA (Board of Secondary Education, Assam) curriculum of Nalbari district is collected from the official record of Government education department. The prevailing classification criteria of schools are based on the financial and managerial assistance of the Government or private initiative. According to such criteria the schools are categorized into five distinct groups *viz.*, (i) Government (GO: fully managed by Government), (ii) Provincialized (PZ: partially managed by Government), (iii) Recognized (RG: Government has recognized for provincialization, but has not come under government management/assistance), (iv) Non-recognized (NR: established by private effort and only with permission of Government) (v) Private (PR: established and run by private party). Again, location of the schools is also considered as one of the criteria for grouping. Accordingly schools are classified into urban (U) and rural (R).

Assessment of performance based on specially designed test on Mathe-matics *i.e.* Mathematical Ability Test (MAT)

A question paper on mathematics was designed for testing mathematics ability of the selected students. The specially

designed question paper has the capacity to judge students' performance in different topic besides testing comprehensive ability. The test of each of the selected students is conducted under direct physical supervision of the investigator. The MAT question paper has been provided in Appendix 3.5 and detail of procedure of setting up of MAT question paper is given below.

The procedure and structure of MAT question paper

The MAT question paper had the ability to test the performance in the areas of

- number sense;
- idea of set;
- square formula, cubic formulae and their application;
- HCF and LCM;
- algebraic fraction;
- variation;
- linear simultaneous and quadratic equation;
- graph;
- ratio and proportion;
- statistics;
- trigonometry;
- geometry and
- interest and discount.

Strength and weaknesses of the schools in each of the above mentioned areas were analyzed based on the MAT results.

Testing learner's consistency in performances in mathematics during three consecutive years

As mentioned earlier, MAT was taken for the current class X students who would appear HSLCE. The marks obtained by this group of students in mathematics subject pertaining to class VIII and IX along with the MAT score were used as the performance of mathematics in three consecutive years. Thus, the consistency of individual students in mathematics subject during the last three years could be tested by these three tests in mathematics. For examining the consistency, it was assumed that each individual learner was subjected to identical treatments in the three consecutive years and their ability in the relevant areas of mathematics (which were taught in the classes) was tested. Four levels of consistency as shown in the Table 3.1 were defined to test the consistency of the individual student. Further, the percentage of learners in each level of consistency in each school was determined.

Table 3.1. Defining level of consistency

Level of consistency	Definition
Consistent improvement	$\text{MAT} > \text{Math(IX)} > \text{Math(VIII)}$
No consistency, deteriorating	$\text{MAT} < \text{Math(IX)} > \text{Math(VIII)}$
No consistency, improving	$\text{MAT} > \text{Math(IX)} < \text{Math(VIII)}$
Deteriorating	$\text{MAT} < \text{Math(IX)} < \text{Math(VIII)}$

Use of average MAT score as mathematics performance indicator of schools

As mentioned earlier care was taken to design and conduct MAT under the direct supervision of the investigator for all the selected group of learners belonging to the different schools.

The selected group of students was considered as representative of their respective schools. The average MAT score of a group of learners belonging to a particular school was considered the measure of mathematics performance of that school. Thus, mathematics performance of a school was estimated using the following relationship:

$$MP = MAT_{av} \dots\dots\dots (3.4)$$

Where, MAT_{av} is the average MAT scores of the group of learners belonging to a school and MP is the measure of performance in mathematics of that school. Average is only one indicator of performance of a group.

RESULTS AND DISCUSSION

Consistency in mathematics performance during three consecutive years

Table 4.7. School wise percentage of learners under different levels of consistency in mathematics subject

Sl No	Schools	School wise % of learners under each category			
		Consistent improvement	No consistency, deteriorating	No consistency, improving	Deteriorating
1	S _{GO_U_119}	18.75	37.50	6.25	37.50
2	S _{PR_U_021}	10.53	52.63	15.79	21.05
3	S _{PZ_R_044a}	53.33	6.67	20.00	20.00
4	S _{PZ_R_039}	63.64	36.36	0.00	0.00
5	S _{PZ_R_048}	8.33	nil	83.33	8.33
6	S _{PZ_R_028}	33.33	20.00	26.67	20.00
7	S _{PZ_R_024}	33.33	nil	55.56	11.11
8	S _{PZ_R_045}	46.67	53.33	nil	nil
9	S _{PZ_R_053}	45.00	15.00	25.00	15.00
10	S _{PZ_R_044b}	nil	22.22	55.56	22.22
11	S _{PZ_R_050}	50.00	18.75	25.00	6.25
12	S _{PZ_R_059}	7.69	23.08	53.85	15.38
13	S _{PZ_U_078}	nil	41.67	41.67	16.67
14	S _{RG_R_017b}	0.00	25.00	41.67	33.33
15	S _{RG_R_017a}	37.50	25.00	37.50	nil
16	S _{RG_R_019a}	50.00	25.00	12.50	12.50
17	S _{RG_R_022}	14.29	71.43	14.29	nil
18	S _{RG_R_029}	nil	42.86	nil	57.14
19	S _{RG_R_019b}	40.00	20.00	20.00	20.00
20	S _{NR_R_015}	62.50	nil	25.00	12.50
21	S _{NR_R_009}	nil	28.57	0.00	71.43

Ideally the performance in mathematics should be improved consistently. The mathematics performances measured by the class average scores of three tests viz., (a) annual class VIII examination, (b) annual class ix examination and (c) MAT conducted in class X were used to investigate the consistency of performances of all the 21 schools. The key results will also be analyzed using the educational environmental factors later. As seen from the Table 4.7 only two schools $S_{PZ_R_039}$ and $S_{NR_R_015}$ are seen with more than 60% learners of consistent improvement. It should be mentioned here that although performances of these two schools on PSLCE, CAO and CAM are very weak in comparison to most of our selected schools, yet 63.64% learners of school $S_{PZ_R_039}$ and 62.50% learners of school $S_{NR_R_015}$ are showing consistent improvement. In case of remaining 19 schools consistency level varies as follows:

Percentage of learners fall within 40% to 60% of 6 schools, 20% to 39% of 3 schools, and 5% to 19% of 5 schools are showing consistent improvement. But consistent improvement of five schools is nil. Usually two special characteristics are seen in learner’s performance. During the study some learners are seen whose VIII to IX performance is improving but IX to X performance is deteriorating. Learners whose VIII to IX

performance is increasing but IX to X performance is decreasing belong to a most unexpected category named as ‘no consistency & deteriorating category’. It is seen that no learners of 3 schools viz, $S_{PZ_R_048}$, $S_{PZ_R_024}$ and $S_{NR_R_015}$ belong to this category. The highest (71.43%) percentage of learners of school $S_{RG_R_022}$ belongs to ‘no consistency and deteriorating category’ followed by 52.63% of school $S_{PR_U_021}$. This trend is very harmful to the present scenario of mathematics education. In the table it is seen that the percentage of learners of this typical quality falls within 40% to 60% of 5 schools, 20% to 39% of 7 schools, 5% to 19% of 4 schools and 83.33% learners of school $S_{PZ_R_048}$. With reference to the learners belonging to the category of this typical quality case by case investigation should be done for initiating appropriate corrective measures. During our investigation some other learners are also seen whose VIII to IX performance is deteriorating but IX to X performance is improving.

Learners whose VIII to IX performance is decreasing but IX to X performance is increasing belong to an expectable category named as ‘no consistency & improving category’. It is seen that no learners of 4 schools viz, $S_{PZ_R_039}$, $S_{PZ_R_045}$, $S_{RG_R_029}$ and $S_{NR_R_009}$ belong to this category. Highest (83.33%) percentage of learners of school $S_{PZ_R_048}$ belong to ‘no consistency & improving category’ followed by 55.56% of school $S_{PZ_R_024}$. Percentage of learners of this trend fall within 40% to 60% of 5 schools, 20% to 39% of 7 schools, 5% to 19% of 4 schools and 83.33% learners of school $S_{PZ_R_048}$. In our investigation another section of learners are also observed belonging to a most unexpected category. In this category learner’s performance is deteriorating through VIII to IX. In the table it is seen that the percentage of learners of this category falls within 20% to 40% of 7 schools, 5% to 19% of 8 schools, 57.14% of school $S_{RG_R_029}$ and 71.43% learners of school $S_{NR_R_009}$. However no learners of four schools belong to that category. Here it is seen that the school $S_{NR_R_009}$ is the worst case, where 71.43% learners are showing deteriorating performance. This trend is a matter of serious concern for parents & teachers. It is to be noted that Lack of infrastructural facility and quality teacher are two main factors for deteriorating performance.

During the study analyzing mathematics marks of class examinations (VIII and IX) and % of marks of MAT test of the selected students of all the 21 schools it is observed that only 28.28% of learners are showing consistent improvement in mathematics performance. Performance of 18.03% of the selected learners is deteriorating. More than half of the samples indicating complete lack of consistency. It is also observed that 27.05% of learners are seen with no consistency and deteriorating performance, that is, mathematics marks of class IX compared to class VIII is increasing and on the other hand, mathematics marks of MAT compared to class IX is increasing. Similarly 26.64% of learners are observed with no consistency & improving performance, that is, mathematics marks of class IX compared to class VIII is decreasing and on the other hand mathematics marks of MAT compared to class IX is increasing.

A non-recognized rural base 9 year old school $S_{NR-R-009}$ is the worst possible care, where more than 70% are showing deteriorating performance. In spite of better educational environment scores of an urban located govt. school $S_{GO-U-119}$, only 18.75% learners of this school are showing consistent improvement. Urban located private school $S_{PR-U-021}$ has attained the highest DS (0.684), EE (0.670) & MP (76.11) scores among the 21 selected schools. SC (0.725) & TC (0.600) scores are also satisfactory. But it is a matter of serious concern that only 10.53% learners of this school are showing consistent improvement. Urban located provincialized school $S_{PZ-U-078}$ has attained the highest SC (0.813), DS (0.621), EE (0.661) & MP (56) scores. But it is an unexpected event is that no learners of this school are showing consistent improvement. No learners of schools $S_{PZ-R-044b}$, $S_{PZ-U-078}$, $S_{RG-R-029}$ and $S_{NR-R-009}$ are showing consistent improvement. It is observed that SC, TC, DS, EE and MP scores of schools $S_{PZR-044b}$, $S_{RG-R-029}$ & $S_{NR-R-009}$ are found to have below average except DS score of $S_{PZ-R-044b}$, and TC score of $S_{NR-R-009}$.

Overall Results

Consistencies of performance in mathematics subject for three consecutive academic years (VIII, IX and X) of selected groups of students of all the schools under study were evaluated through a standard procedure. The specific findings are noted below:

Overall, only 28.28% learners are showing consistent improvement in mathematics performance. On the other hand, performance of 18.03% learners is deteriorating. Remaining (more than half) population of learners indicated complete lack of consistency. Consistency in performances cannot be fully explained by the managerial conditions of the schools. For example, in spite of better managerial inputs, only 18.75% learners of an urban located government school (119 years old) are showing consistent improvement in mathematics. Similarly, about 90% of the learners of one urban located private school could not show consistent improvement in mathematics. However, more than 70% of learners showed deteriorating performance in mathematics of a non-recognized rural 9 years old school.

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