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A Guide to Read, Interpret and Use Large Scale Assessment Data

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Motivation

Government officials in the education sector are primarily involved in academic and administrative roles. A critical component of officials' work in administrative roles is to plan for educational improvement in districts. This involves inspecting schools and block education offices; opening new primary schools; upgrading existing schools; providing grants to schools, appointing teachers and staff; maintaining the pupil–teacher ratio; estimating budgets, and submitting expenditure statements. Additionally, they are involved in assessing the status of teaching–learning processes in classrooms and collecting and reporting data for large-scale assessments.

These officials will be able to perform their roles and responsibilities effectively if they are able to track gaps in the educational system and base decisions on valid evidence. To enable this, the government has consistently prioritized efforts to estimate the health of the education system through the systematic collection and interpretation of data of students' learning levels using large scale assessments (LSAs) such as National Achievement Survey (NAS), State Learning Achievement Survey (SLAS), and Annual Status of Education Report (ASER). However, the use of such data by education officials remains limited. According to the SSA JRM (2015) report SLAS and NAS results are not being communicated in a meaningful or actionable way. Only presenting results for students, schools, or districts in the form of an average score or percentage correct (or even a grade) does not say much about students' mastery of the corresponding domain or subject area. It is difficult for a teacher, head teacher, district official, or State official to know what is to be done with this information in terms of devising next steps for instruction or training.

To use data from LSAs effectively, officials need to acquire the following abilities:

- the ability to read data
- the ability to interpret data for drawing inferences
- the ability to use these inferences in planning and decision-making processes

This note proposes a framework to enable reading, interpreting, and using LSA data, thereby providing an effective resource for education officials to engage with data, gather evidence and use them to improve students learning by taking effective decisions.

Introduction to LSAs

Class 10 board examinations are the culmination of the entire learning process that unfolds during 10 years of schooling. The outcome of the board examinations is not just the measure of a student's learning and performance: it reflects the effectiveness of the education process during their years in school. However, this revelation comes very late and might not be a very useful data point for education officials. To ensure the effectiveness of school education at an early stage, LSAs are designed and administered at transition points to track the effectiveness of the entire education process. In other words, LSAs help gauge the health of an education system. Data from LSAs helps identify both positive and worrisome findings and trends. Areas of improvement can be identified for interventions and corrective measures, while good measures can be replicated at a systemic level.

LSAs are generally administered with a representative sample of students in a district, state, or country. The primary purpose of such assessments is to ensure if the inputs (teaching and learning, school facilities, curriculum, programs, etc.) are leading to the right outputs (students' performance and outcomes). Since such tests are administered with a large number of students, these consist of mostly multiple-choice questions that are amenable for automatic evaluation.

These tests are administered at major transition points from one level of schooling to another, such as:

- pre-primary to primary-class 3
- primary to upper primary-class 5
- upper primary to secondary-class 8
- secondary to higher secondary-class 10.
- secondary-class 10 to secondary-class 12

Conducting tests during these transition stages helps determine students' learning levels and identify appropriate remedial interventions. These tests are standardized in nature: there is uniformity of content, questions, scoring procedures, administration, and interpretation of the test results. Mostly, these tests are conducted periodically to obtain information on current levels of students' educational attainment and to monitor possible changes over time. LSAs are conducted at various levels: a) at the international level, b) at the national level c) at the state and district level.

LSAs at the international level

LSAs at the international level provide information about an education system in relation to one or more other systems. These assessments help understand global trends and evolving systems in education. Results of international assessments are often used by individual countries to carry out their own within-country analyses. One such large scale assessment is Programme for International Student Assessment (PISA) which is conducted with 15-year-old students once in every 3 years. PISA assesses students' abilities to use reading, mathematics, and science conceptual knowledge and skills for solving real-life problems (OECD, n.d.). The ability to solve real-life problems is a proxy for work readiness. Reading, Mathematics and Science are assessed in PISA. Other widely used international large-scale assessments are Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS). TIMSS assesses the mathematics achievement of students in classes four and eight, while PIRLS assesses the literacy and reading skills of students in class four.

LSAs at the national level

The focus of national level assessments is reporting and tracking long-term trends across states, location (urban/ rural), cycle of administration, content, and skill areas for each subject with respect to learning outcomes. National Achievement Survey (NAS) is conducted by NCERT annually at national level with a representative sample of government and government-aided schools from all the districts for class 3, 5, 8 and 10 in Languages, EVS, Science, Social Science and Mathematics. Annual Status of Education Report (ASER) is the largest citizen-led and household assessment in the world conducted by Pratham with children of 6 to 14 years. It assesses the content domains of literacy and numeracy.

LSAs at the state and district level

LSAs at the state and district level are conducted to independently evaluate states' and districts' accountability plans and checking what is working best in each state and district. They help provide evidence for the performance of teachers, administrators, schools and districts relative to established learning outcomes. They further help diagnose strengths or weaknesses with respect to certain content or skill areas for a subject and are thereby used in making appropriate changes to curricula and teaching–learning processes.

In Karnataka, a census-based state achievement survey (CSAS) is conducted annually by the Karnataka State Quality Assessment and Accreditation Control (KSQAAC) for students from class 4 to 10. Student Level Achievement Survey (SLAS) is administered annually in Andhra Pradesh, Delhi, Manipur and Punjab by their respective SCERTs with students in the elementary grades. Gunotsav is conducted by the Gujarat Council for Education Research and Training (GCERT) with students of class 2 to 5 to assess their skills of reading, writing and numeracy. Pratibha Parv is conducted with students of primary and upper-primary schools in Madhya Pradesh by Rajya Shiksha Kendra.

Vocabulary to read and infer large scale assessment data

This section introduces few statistical terms and data visualization plots that one often comes across in LSAs and other educational reports. Each term is described and illustrated with the help of an example. The documents cited in the examples are also listed for reference.

1. Variable

A variable is a quantity that assumes many values (Columbia University, n.d.). For instance, consider the height and weight data for all the students in a class. Height and weight are variables in this instance as their values are different for each student.

2. Arithmetic Mean

An arithmetic mean, also called a mean or an average, is the sum of all observations divided by the total number of observations (Earl & Nicholson, Mean, 2021). Thus, a mean is a value that summarises data by providing a "typical" or representative value for a variable (NCERT, 2006). In large data sets, means are calculated for thousands of observations for variables like student test scores.

For instance, consider this statement: on average, 92% of children have lost at least one specific language ability from the previous year across all classes. Here, 92% represents a typical value of the data set collected for understanding students learning loss. This means that a typical hypothetical child in the sampled population is likely to lack one language ability that they had earlier. The finding entails that teachers will have to spend a lot of time helping the children in their classes recover lost learning, instead of moving on with the grade-appropriate curriculum.

LO Code	Learning Outcome Class 3	Average Performance (In Percent)
M303	Solves simple daily life problems using addition and subtraction of three digit numbers with and without regrouping	54
M304	Constructs and uses the multiplication facts (up till 10) in daily life situations	61
M305	Analyses and applies an appropriate number operation in the situation/ context	45
M306	Explains the meaning of division facts by equal grouping/ sharing and finds it by repeated subtraction	59
M309	Identifies and makes 2D-shapes by paper folding, paper cutting on the dot grid, using straight lines etc	87
M311	Fills a given region leaving no gaps using a tile of a given shape	49
M312	Estimates and measures length and distance using standard units like centimetres or metres & identifies relationships	26
M317	Reads the time correctly to the hour using a clock/watch	71
M318	Extends patterns in simple shapes and numbers	54
M319	Records data using tally marks, represents pictorially and draws conclusions	87

Source: NAS 2017

This table provides the average scores of class 3 students for learning outcomes in mathematics for Tamil Nadu (NCERT, 2017). Outcome M312 has the lowest mean score of 26. This indicates that the mean score of students all over India for outcome M312 is 26. In other words, on an average, 26% of students have attained the outcome M312. Such a low average performance finding may be worrisome for educators. They may reflect on the pedagogical approaches and assessment strategies that are used for the M312 outcome.

3. Ratio

A ratio indicates the relative magnitude of two quantities with respect to each other (Earl & Nicholson, Ratio, 2021). A ratio is written as *x*: *y*, where *x* and *y* are the quantities or terms of the ratio. Ratios can also be expressed as fractions of *x* and *y*. For instance, a recipe of khichdi uses 2 cups of daal and 3 cups of rice per dish. The ratio of daal and rice for this khichdi recipe can be written as 2:3 or ⅔. A few commonly used ratios in educational statistics in India are enrolment ratios [Pupil-Teacher Ratio (PTR), Gross Enrolment Ratio (GER), Net Enrolment Ratio (NER) and Classroom-Teacher Ratio].

- PTR is the ratio of the number of pupils for one teacher (NIEPA, 2016). The Right to Education Act, 2009, mandates a PTR of 30:1 at the primary level and 35:1 at the secondary level.
- GER is the enrolment of children in all ages divided by the total number of children of the target age group (NIEPA, 2016). For instance, a GER of 97 indicates that 97 out of 100 children in an area are enrolled in school. GERs over 100, such as 113, indicate that children over the age of the target population are also enrolled in school.
- NER is the number of children of the target age group enrolled in school divided by the total number of children (NIEPA, 2016). For instance, an NER of 97 indicates that 97 out of 100 children in the target age group are enrolled in school.

DISTRICT		ELEMENTARY EDUCATION REPORT CARD: 2016-17						ASSAM-Map
State	ASSAM	District	DHUBRI					
Primary Cycle	1-5	Upper Primary Cycle	6-8	Ratio of Pri. to Upper Primary Schools/Sections	2.54			
Data Reported from	Districts		Blocks	7	Clusters	200	Villages	1,043	Schools	4,265
Basic Data :Census 2011	Total Population (In 000's)	1,949	Urban Population	10.4	Sex Ratio	952		
Decadal Growth Rate	24.4	% 0-6 Population	18.42	% SC Population	3.6	% ST Population	0.3	Area (In Sq.Km.)
Overall Literacy Rate	59.4	Male Literacy Rate	64.2	Female Literacy Rate	54.3			2,176

Performance Indicators (in percentage)	Primary Only		Primary with U.P.		Primary with U.P & Sec. & H.Sec.		Upper Pri. Only		U.P. with Sec. & H.Sec.		Pri. with U.Pri. & Sec.		U.P.with Secondary		All Schools	
	15-16	16-17	15-16	16-17	15-16	16-17	15-16	16-17	15-16	16-17	15-16	16-17	15-16	16-17	15-16	16-17
Single-Classroom Schools	38.0	37.9	4.9	6.0	0.0	0.0	3.8	4.0	2.8	2.8	2.9	1.4	4.9	2.4	28.2	27.8
Single-Teacher Schools	2.9	6.8	11.3	7.7	0.0	0.0	0.0	0.1	0.0	0.0	2.9	2.8	0.0	0.0	2.5	5.1
Schools Approachable by All Weather Road	76.2	75.2	90.1	91.2	100.0	100.0	80.3	80.7	91.7	91.7	98.6	98.6	85.4	87.8	78.2	77.8
Schools with Playground Facility	71.4	72.7	50.0	52.2	75.0	100.0	80.5	81.7	61.1	66.7	37.1	38.9	78.0	68.3	72.1	73.2
Schools with Boundary wall	9.2	9.6	32.4	40.1	75.0	100.0	8.6	9.7	66.7	72.2	71.4	76.4	31.7	34.1	11.6	12.8
Schools with Girls' Toilet	75.2	71.7	83.1	76.9	100.0	100.0	55.3	49.2	91.4	77.1	90.0	84.7	68.3	53.7	71.4	67.0
Schools with Boys' Toilet	74.2	75.4	76.6	85.1	50.0	100.0	50.0	57.0	65.7	100.0	87.1	95.8	65.8	78.9	69.3	72.6
Schools with Drinking Water	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Schools Provided MDM #	98.8	99.3	100.0	98.1	0.0	0.0	96.4	95.2	94.3	94.3	0.0	0.0	92.3	92.3	98.0	97.9
Schools with Electricity	7.6	7.7	37.3	35.2	75.0	100.0	26.4	25.5	97.2	100.0	55.7	59.7	73.2	75.6	15.0	15.1
Schools with Computer	0.6	0.7	15.5	16.5	0.0	0.0	10.3	10.5	69.4	77.8	35.7	34.7	43.9	46.3	4.8	5.2
Schools with Ramp	55.0	15.3	38.0	11.0	0.0	0.0	34.7	12.7	16.7	27.8	2.9	0.0	19.5	19.5	48.4	14.4
Schools Established Since 2001	14.6	14.5	59.2	67.6	0.0	0.0	10.0	10.6	2.8	5.6	67.1	65.3	2.4	0.0	15.7	16.6
Schools with Kitchen-shed #	63.2	65.7	70.4	69.8	0.0	0.0	33.6	38.9	60.0	63.6	0.0	0.0	61.5	60.0	57.7	58.4
Schools with Enrolment <=50	27.6	24.4	3.5	6.6	0.0	0.0	20.4	16.1	2.8	2.8	1.4	0.0	12.2	2.4	24.4	21.0
Schools with SMC #	100.0	100.0	100.0	100.0	100.0	100.0	99.7	99.8	100.0	94.3	0.0	0.0	100.0	84.6	99.9	99.7
Pupil-Teacher Ratio	38	31	24	21	20	14	16	17	11	12	17	19	10	11	25	24
Student-Classroom Ratio	35	36	25	23	33	27	27	29	46	52	26	26	36	37	32	33
Average Teachers per School	2.5	3.1	8.2	8.6	17.8	15.0	6.4	6.2	23.4	22.9	18.0	17.3	15.7	15.3	4.1	4.6

Source: UDISE District Report Cards 2016-2017

Consider the data from the UDISE District Report Card 2016-2017 for Dhubri district in Assam (NIEPA, 2017). The data shows that in 2015-2016, the PTR for primary-only schools was 38 (38:1), which is well over the RTE-mandated PTR of 30:1. The PTR improved to 31 (31:1) in 2016-2017. However, Dhubri district still requires more primary-school teachers to comply with the RTE rules.

4. Percent/Percentage

A percentage is a ratio with a denominator of 100, where the denominator may be replaced by a % sign (Earl & Nicholson, Percentage, 2021). For instance, the fraction 20/100 can be expressed as 20%. Two different examples are considered to illustrate how percentages are used differently in different LSAs of India. The first example is from ASER 2018, while the second example is from NAS 2017. The use of percentages in ASER and NAS is different. **ASER data indicates the percentage of**

children at each stage of reading and mathematics development. In contrast, NAS data indicates the mean percentage of a learning outcome attained. This is an important difference between ASER and NAS that should be kept in mind while interpreting data from these large-scale assessments.

Table 4: % Children by grade and reading level
All children 2018

Std	Not even letter	Letter	Word	Std I level text	Std II level text	Total
I	42.7	32.6	13.7	5.2	5.8	100
II	21.3	30.2	21.3	12.5	14.7	100
III	12.1	22.6	20.8	17.3	27.2	100
IV	7.6	15.9	16.6	19.3	40.7	100
V	5.9	11.7	13.0	19.1	50.3	100
VI	3.8	8.8	10.5	17.2	59.8	100
VII	2.5	6.5	8.3	15.0	67.7	100
VIII	1.9	5.3	6.7	13.2	72.8	100

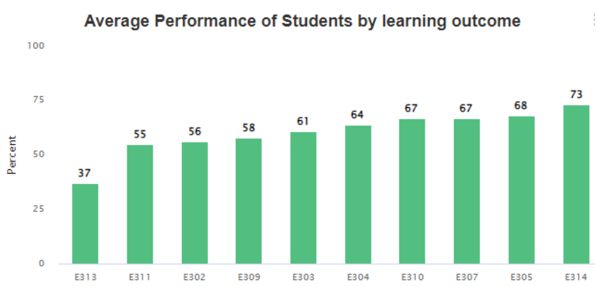
The reading tool is a progressive tool. Each row shows the variation in children's reading levels within a given grade. For example, among children in Std III, 12.1% cannot even read letters, 22.6% can read letters but not words or higher, 20.8% can read words but not Std I level text or higher, 17.3% can read Std I level text but not Std II level text, and 27.2% can read Std II level text. For each grade, the total of these exclusive categories is 100%.

Source: ASER 2018 Report

Consider the excerpt from the ASER 2018 report (ASER Centre, 2019, p. 52). It contains the percentage of sampled children from classes 1 to 8 at various reading levels all over India. The data can be read as follows:

- In class 1, 42.7% of children in class 1 cannot even read letters.
- Only 32.6% of children in class 1 can read letters but not words.
- 13.7% of children in class 1 can read words but not texts.
- Only 5.2% of children in class I can read simple texts suitable for class 1 children.
- Only 5.8% of children can read texts suitable for class 2 children.

Since only 11% of children in class 1 can read at or above grade level, we can conclude that most children at class 1 have not attained grade-level reading proficiency. Thus, there is a need for efforts to improve reading levels among children in class 1.



Source: NAS 2017

Data from the NAS 2017 report for all-India class 3 EVS learning outcomes is presented in this excerpt (NCERT, 2017). The excerpt contains a graph that shows all-India average performance for all learning outcomes in class 3 EVS. The average performance for outcome E313 is 37% which indicates that only 37% of the total students attained outcome E313. Educators may be interested in examining and remedying reasons for the low mean score.

5. Percentage Change

A percentage change is a change in a value relative to the original value expressed as a percentage (Reed College, n.d.).

DISTRICT	ELEMENTARY EDUCATION REPORT CARD: 2016-17								
State	PUNJAB		District	AMRITSAR					
Primary Cycle	1-5		Upper Primary Cycle	6-8	Ratio of Pri. to Upper Primary Schools/Sections			1.47	
Data Reported from	Districts		Blocks	9	Clusters	125	Villages	816	Schools 2,254
Basic Data :Census 2011	Total Population (In 000's)			2,491	Urban Population		55.2	Sex Ratio	884
Decadal Growth Rate	15.5	% 0-6 Population		10.70	% SC Population		31.0	% ST Population	0.0
Overall Literacy Rate	77.2	Male Literacy Rate					81.2	Female Literacy Rate	72.8

Key Data	Primary Only	Primary with U.P.	Primary with U.P.& Sec. & H.Sec.	Upper Pri. Only	U.P. with Sec. & H.Sec.	Pri. with U.Pri & Sec.	U.P.with Secondary	No Res. & Oth. Cat.
Total Schools (2016-17)	1,024	331	206	195	131	252	115	0
Total Schools (2015-16)	1,026	328	200	207	108	256	126	0
Goverment Schools	999	320	190	194	122	242	112	0
Private Schools	16	8	15	1	9	6	3	0
Madarsas & Unrecognised Schools	9	3	1	0	0	4	0	0
Goverment Schools: Rural	788	126	95	171	82	103	97	0
Private Schools: Rural	0	0	2	0	4	0	2	0
Total Enrolment (2016-17)	97,192	49,014	100,148	14,486	26,279	67,748	15,617	0
Total Enrolment (2015-16)	101,700	48,218	97,110	16,885	21,342	69,271	19,070	0
Enrolment in Goverment Schools	94,410	46,581	94,180	14,390	25,307	65,298	15,117	0
Enrolment in Private Schools	2,404	1,920	5,613	96	972	1,908	500	0
Enrolment in Madarsas & Unrecog.	378	513	355	0	0	542	0	0
Enrolment In Govt. Schools: Rural	64,712	16,553	32,254	11,971	14,644	24,399	12,018	0
Enrolment in Private Schools: Rural	0	0	458	0	543	0	401	0
Total Teachers(2015-16)	4,191	3,240	6,194	816	2,697	3,778	1,330	0
Teachers in Goverment Schools	4,225	3,176	6,385	692	2,926	3,734	1,033	0
Teachers in Private Schools	61	58	257	3	141	54	15	0
Teachers in Madarsas & Unrecog.	45	24	16	0	0	47	0	0

Source: UDISE District Report Cards 2016-2017

Consider the UDISE data for Amritsar district in Punjab in 2016-2017 (NIEPA, 2017). The total enrolment in primary-only schools in 2016-2017 was 97,192. The total enrolment in primary-only schools in 2015-2016 was 101,700.

Percentage change in enrollment

$$= \frac{\text{Enrollment in } 2015-16 \ - \text{Enrollment in } 2016}{\text{Enrollment in } 2015-16} \times 100$$

$$= \frac{97{,}192 \text{ students } - 101{,}700 \text{ students}}{97{,}192 \text{ students}} \times 100$$

$$= -4.63\%$$

The negative sign in –4.63% indicates that enrolment in primary-only schools in Amritsar decreased by 4.63% in 2016-2017 from 2015-2016. Such a decrease in enrolment may present a cause for concern. Thus, reasons for the percentage decrease in enrolment should be identified and remedied.

6. Percentage Point

A percentage point is the difference between two percentages. For instance, the difference between 50% and 40% is 10 percentage points. **Note that a percentage point difference should not be confused with a percentage difference** (Reed College, n.d.). While the percentage point difference between 50% and 40% is 10 percentage points, the percent difference between 50% and 40 % is 25%, which can be calculated using the formula provided in the definition of percentage change.

Table 7: Trends over time: Govt schools Arithmetic levels in Std I, Std II and Std III 2014, 2016, 2018 and 2021

Year	% Children who can recognise single digit numbers (Govt schools)		% Children who can do at least subtraction (Govt schools)
	Std I	Std II	Std III
2014	47.3	78.2	9.6
2016	52.6	84.7	14.5
2018	53.0	86.3	16.0
2021	44.1	72.2	6.1

Source: ASER 2021 Chhattisgarh Presentation

Consider the following excerpt from the ASER 2021 Chhattisgarh presentation (ASER Centre, 2022). The excerpt compares the mathematical proficiency of children in classes 1, 3, and 5 from 2014 to 2021. There is a decrease in mathematics learning levels between 2018 and 2021. The difference between class 1 children who can recognise single digit numbers in 2018 and 2021 is 8.9 percentage points (53.0% – 44.1% = 8.9 percentage points).

Note that this difference is not the same as 8.9% and cannot be interpreted as 91.1% of children from 2018 being able to recognise single-digit numbers in 2021. Similarly, the difference between class 3 children who can recognise single-digit numbers in 2018 and 2021 is 14.1 percentage points.

7. Trend

The direction of change of a variable over a period of time is called a trend. Suppose the percentage of girls being enrolled at government schools has been increasing every year for five years. In such a scenario, it can be said that there has been a trend of increasing school enrolment among girls.

For instance, consider the following excerpt from PISA 2018 (Schleicher, 2019). This excerpt shows trends in the reading scores of participating countries. The main types of trends identified are as follows:

Positive average trend: A positive average trend means that a country's average reading score has been increasing over the years. Such an increase can be rapid/exponential, steady, or flattening.

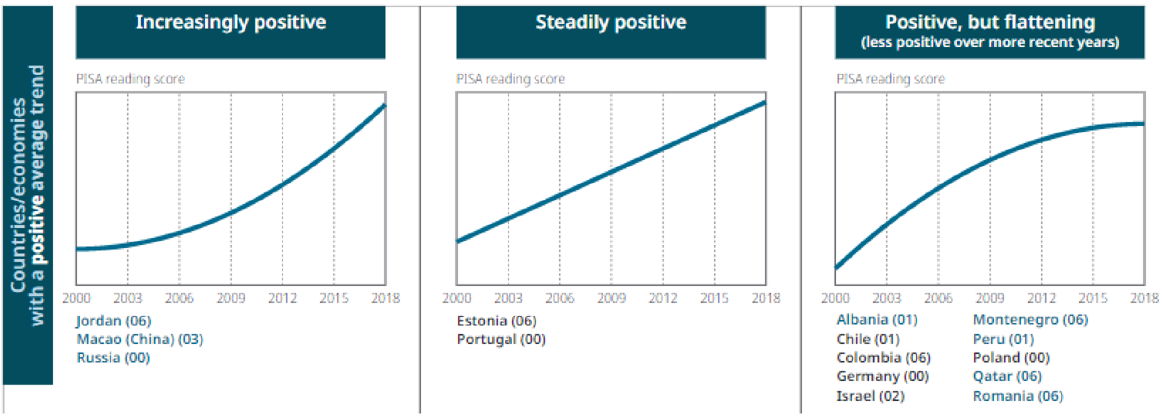
No significant average trend: No significant average trend means that a country's average reading score has not been increasing or decreasing much over the years.

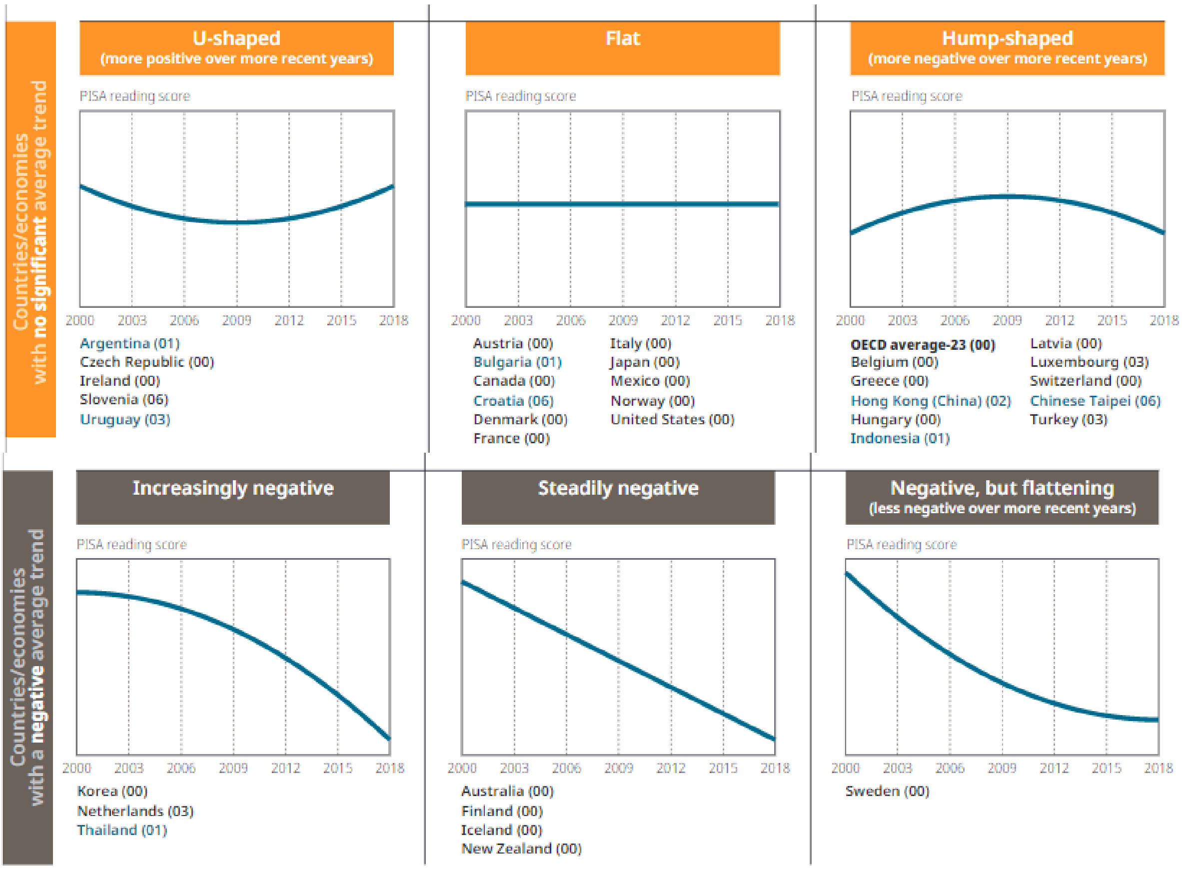
Negative average trend: A negative average trend means that a country's average reading score has been decreasing over the years. Such a decrease can be rapid/exponential, steady, or tapering.

Source: PISA 2018: Insights and Interpretations by Andreas Schleicher

Figure 5 • Curvilinear trajectories of average performance in reading across PISA assessments

Direction and trajectory of trend in mean performance





Source: PISA 2018: Insights and Interpretations by Andreas Schleicher

When such graphs on reading performance are presented, some interpretations can be made:

- A rapid increase in average reading performance in Macao, Jordan, and Russia is a very positive finding. Reasons for increases in average reading performance, such as reforms, should be identified. Such reforms can probably be replicated in other countries.
- Growth in average reading performance is flattening or tapering off in countries such as Germany, Israel, Columbia, Albania, etc. So, reading performance in these countries is increasing less slowly than earlier. Whether or not this flattening is a matter of worry depends on a country's prior reading performance in general. If a country's performance was good to begin with but has stopped growing rapidly, then, perhaps, there is not much to worry about. But if a country's reading performance was poor, then improved rapidly, then stalled, then reasons for such a decline in growth should be identified and remedied.
- A rapid decrease in average reading performance in countries such as Korea, Netherlands, and Thailand is a worrisome trend. Reasons for decreased reading performance should be identified and remedied.

8. Correlation

A correlation is a number that indicates the strength and direction of the relationship between two variables (Mindrila & Balentyne, n.d.). The value of a correlation ranges from –1.00 to 1.00. Consider two variables *x* and *y*. A positive correlation between *x* and *y* indicates that as *x* increases, *y* also increases. A negative correlation between *x* and *y* indicates that as *x* increases, *y* decreases. The following table summarises how to read and interpret correlations between two variables (Mindrila & Balentyne, n.d.).

	No Correlation	Very Weak Correlation	Weak Correlation	Moderate Correlation	Strong Correlation
Positive	0	0.01 to 0.29	0.30 to 0.49	0.50 to 0.69	0.70 to 1.00
Negative		–0.29 to –0.01	–0.49 to –0.30	–0.69 to –0.50	–1.00 to –0.70

Consider the following excerpt from *PISA 2006 Science Competencies for Tomorrow's World: Volume 1: Analysis* (OECD, 2007, pp. 246–247). The excerpt relates a country's mean science score with background variables relating to school's autonomy. These variables include establishing disciplinary and assessment policies, choosing students for school admissions, selecting textbooks and curating course content.

This excerpt indicates that there is a weak positive correlation between science achievement and principal's autonomy in administrative decisions like establishing disciplinary processes, assessment policies, and choosing students for school admissions. It indicates that more autonomy for principals in administrative decisions has a weak influence on science achievement. Similarly, there is a moderate positive correlation between science achievement and principals' autonomy in curricular decisions like choosing textbooks, deciding on which courses to offer, and selecting course content. This indicates that more autonomy for principals in curricular decisions has considerable influence on science achievement. However, this does not necessarily mean that autonomy for principals in curricular decisions causes science achievement. Other statistical tests are needed to establish whether autonomy for principals causes science achievement.

Figure 5.11 [Part 2/2]

Involvement of schools in decision making

- Only school has considerable responsibility
- Both school and government have considerable responsibility
- Only government has considerable responsibly

Percentage of students in schools where the principal reported responsibility for

	Establishing student disciplinary policies	Establishing student assessment policies	Approving students for admission to the school	Choosing which textbooks are used	Determining course content	Deciding which courses are offered
Cross-country correlation between the percentage of schools having considerable responsibility ("school only" and "school and government") and performance in science[1]	0.41	0.43	0.27	0.51	0.52	0.58

9. Random sample

A random sample is a sample where each member of the population being sampled has an equal chance of being selected. This prevents a sample from being biased, that is, containing more members from certain groups and no members from other groups in the target population. Most large-scale assessments use random sampling so that the performance of the sample is a representative proxy for the performance of the population.

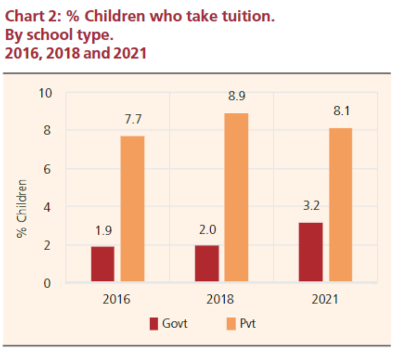
The following example from the ASER 2018 survey will help illustrate how a random sample is chosen.

ASER 2018 had a two-stage random sampling design. In the first stage, 30 villages in each district were randomly chosen from the Census 2011 village directory. In the second stage, 20 households were randomly chosen from each village. To ensure that each part of the village was likely to be represented, the village was divided into four parts. To ensure randomness, in each part, the surveyor started in one central location. Then, the surveyor visited every 5th house from the central location until they had visited 5 households in one part. This process was repeated for the three other parts. Thus, 20 households were randomly chosen in every village and 600 households in every district.

ASER 2018

10. Bar Plots

Bar plots use bars to show numerical data associated with categorical variables (Valcheva, n.d.).

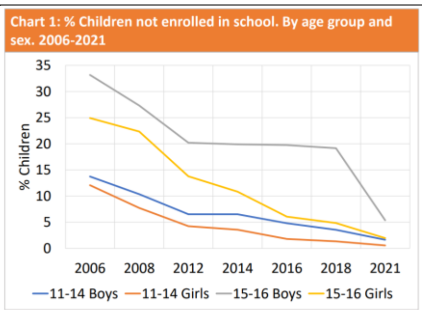


Source: ASER 2021 Chhattisgarh Presentation

The bar plot from the ASER 2021 Chhattisgarh report depicts the percentage of children in government and private schools who take tuitions (ASER Centre, 2022). The categorical variables are government and private schools. The numerical data associated with the categorical variables are the percentages of children in government schools and private schools who take tuitions. From these graphs, it is clear that a higher percentage of private school students than government school students avail of tuitions.

11. Line Graphs

Line graphs show changes in a quantity over time (Valcheva, n.d.).



Source: ASER 2021 West Bengal Report

The line graph from the ASER 2021 report for West Bengal shows trends in the proportion of children not enrolled in school across 15 years (ASER Centre, 2022). The proportion of children not enrolled in school has dropped steadily since 2006. This is a positive development, which indicates that more children have been attending school. Reasons for the decline of not-enrolled numbers should be identified, and positive measures should be replicated in other states and districts if possible.

12. Heat Maps

Heat maps are maps that use colour codes to compare data in different geographical areas (MarketingTerms.com, n.d.).

Source: NAS 2017

The heat map from NAS 2017 compares the performance of class 5 students in mathematics across different states (NCERT, MHRD, 2019).

In class 5 mathematics, 8 States/UTs performed significantly above the national average, 11 States/UTs performed significantly below and 17 States/UTs showed no significant difference from the national average.

The performance of class 5 students in the learning outcomes of mathematics is significantly low in Arunachal Pradesh, Sikkim, Meghalaya, Delhi and Daman & Diu.

This heat map provides a quick snapshot of states with good and poor performance relative to the national average in mathematics for class 5. Thus, it can help educators and policymakers decide which parts of the country or which regions require attention for improving reading levels.

A framework to engage with LSA data

Data-driven school improvement policies and measures require administrators to challenge their own assumptions. Almost every district has common beliefs about a school or groups of students. Data help administrators determine whether their perceptions match reality. Often administrators find data confusing, even intimidating. If sound questions can be created, the data needed to answer these questions becomes more logical and less confusing. For example, for 'How well are we doing?', one would probably want to look at students' achievement results on standardized tests and state or district assessments to understand how students in the district are doing across different learning outcomes. For the question, 'Are all students learning?', one might want to take the students' achievement analysis to a deeper level, looking at the distribution of test scores to understand which students are scoring below mastery, and how far they are scoring below mastery. As one digs deeper for answers to such questions, patterns and trends in students' performance are observed.

This section proposes a four-stage process that can be used by an administrator while engaging with a report or a data set. Each stage includes a set of questions that can be used to better understand, engage with, infer from and use the data provided in the report.

Exploring the right data set and report

1. For what purpose is the data needed?
2. Which data is suitable for such a purpose? What types of data are necessary to create an effective accountability plan?
3. What kind of data exist in the district?
4. What is the structure of the report/dataset? Which sections of the report will give the data needed?
5. What are the best indicators of student achievement upon which the district should base its decisions?
6. Which indicators of student achievement are collected regularly throughout the year to inform data-driven decisions?
7. Which kinds of relationships between indicators need to be established from the analysis? What are the required statistics?

Understanding the scope of the report

1. What is the scope of the study?
2. What is the data about? What is this report about?
3. What is the size of the data provided? Is the sample size adequate for making reliable conclusions?
4. Does the sample represent the population well? Is there a good balance between the number of boys/girls, types of school, etc?
5. What is being captured in the rows and the columns of the tables in the report?
6. What is the header of the columns? What is the relationship between the various headers of the columns?
7. What are the criteria against which students are assessed?

Engaging with the data

1. How does my population of interest perform in the assessment? By itself and relative to other populations?
2. How have Indian students performed in international LSAs? What can be learnt from better-performing countries?
3. How are students performing in NAS and ASER? What can be learnt from better-performing states?
4. How can we interpret the average learning levels of students for a state?
5. What are broader level patterns in students' learning levels across different areas (districts, subjects, class, etc)?
6. Are learning levels improving across grades?
7. How is the distribution of the scores for different classes and subjects?
8. Is there a gender divide in learning?
9. Are government-aided schools doing better than government schools?
10. Is there a rural-urban divide in learning?
11. How can we interpret the average learning levels of students from the district wise data of a state?
12. Is there any difference between students’ performance in a district for different subjects?
13. What are the poor-performing learning outcomes across different districts? Is there any trend in the kind of learning outcomes in which students are performing poorly?
14. What different types of data should can be used when assessing student performance? How does students’ performance in better-performing districts correlate with school, facility, teacher, and enrolment indicators?

Drawing conclusions and making inferences

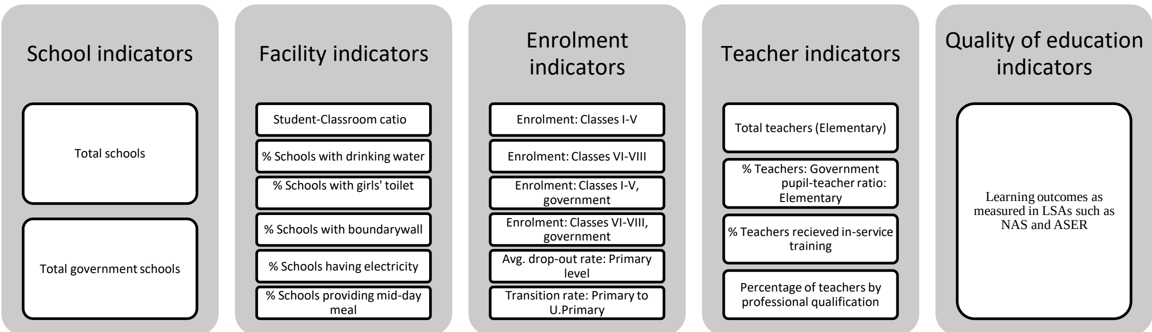
1. What can be the possible reasons for getting the results the way they are showing in the assessment data?
2. How can the findings of datasets be used to improve students' learning levels for a district/ state/ country?
3. Is there a scope for sharing the best practices of some classes within and outside the district/ state/ country?
4. Does the report make any recommendations to decrease educational differences and disadvantages? If so, can these be implemented in my geography?

Relating LSA data with other reliable data sets- A case study

It is often a useful exercise to examine educational inputs and outputs together to draw useful insights about significant inputs that might be positively influencing students' learning levels in a region. Such insights might help administrators decide upon necessary interventions at the level of the state. Educational inputs can be School indicators, Facility indicators, Teacher indicators and Enrolment indicators. Educational outputs here are students' learning levels as reported in LSAs. With a better understanding of relationships between educational inputs and outputs, administrators will be able to make data-driven decisions for improving students' learning levels in a region.

Unified District Information System for Education (UDISE), initiated in 2012-13, integrates DISE data for elementary and secondary education. It is one of the largest Management Information Systems (MIS) on school education and covers more than 1.5 million schools, 9.6 million teachers and 264 million students' data which is run by the Department of School Education and Literacy (DoSEL), Ministry of Education (MoE), Government of India. DISE provides district-level data to enable better planning and management of schools.

DISE incorporates key indicators on all aspects of elementary education with respect to school, facilities, teacher, and enrolment indicators as shown in the figure.

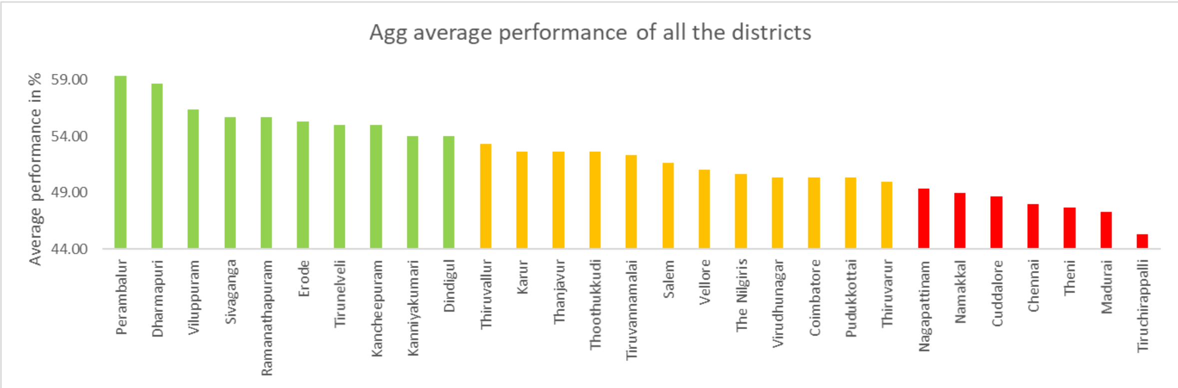


In this section, educational inputs and outputs are examined for Tamil Nadu state. District-wise average performance was identified from the NAS 2017 report for all the 29 districts and subjects for classes 3, 5 and 8. The average performance was aggregated at the level of class. Based on the aggregation, the districts were categorized as follows:

- Green (high performing)- districts with aggregate average performance more than 55%*.
- Yellow (moderate performing)- districts with aggregate average performance in the range of 50 to 55%*.
- Red (low performing)- districts with aggregate average performance less than 50%*.

* The criteria of categorization can be defined as per mutual consensus.

The plot below represents the aggregated average performance of all districts as Green, Yellow, and Red as per the description above.



In the table below, for each class and subject (at the column level), conditional formatting (green for high performing district to red for low performing district) was applied to identify how districts were performing relatively.

Districts	Class 3 Language	Class 3 Mathematics	Class 3 EVS	Class 5 Language	Class 5 Mathematics	Class 5 EVS	Class 8 Language	Class 8 Science	Class 8 Mathematics	Class 8 SST
Perambalur	67.70	67.40	71.00	64.50	60.80	61.00	60.50	43.00	42.90	40.40
Dharmapuri	71.70	72.80	75.00	61.00	57.10	60.20	56.90	41.50	40.40	35.90
Viluppuram	68.10	67.50	69.10	61.10	55.60	58.50	54.50	40.40	40.30	37.50
Sivaganga	66.30	66.40	71.40	62.00	53.70	55.20	61.30	37.90	36.50	32.90
Ramanathapuram	61.10	64.50	69.90	61.10	55.40	56.50	61.90	38.00	38.90	36.20
Erode	64.10	64.10	68.00	65.00	53.10	57.40	60.40	37.00	35.70	33.80
Tirunelveli	67.60	65.50	70.90	61.40	50.10	52.90	60.00	36.40	37.50	33.80
Kancheepuram	67.90	64.60	69.70	63.00	52.40	57.40	53.60	36.70	36.80	32.90
Kanniyakumari	63.70	65.80	66.20	61.10	50.50	53.00	61.60	37.80	35.90	32.60
Dindigul	61.30	59.40	65.60	63.30	52.70	55.00	58.40	39.20	37.50	35.30
Thiruvallur	63.40	61.90	64.40	60.90	52.50	54.20	55.10	38.40	37.40	35.00
Karur	64.50	65.00	67.60	58.30	48.30	52.70	55.30	33.70	33.30	31.80
Thanjavur	63.20	63.10	67.10	56.00	47.20	51.30	58.70	36.80	35.20	35.60
Thoothukkudi	64.70	60.20	66.60	60.10	48.20	51.80	61.30	35.50	35.30	33.40
Tiruvannamalai	64.10	65.80	64.90	57.20	48.80	50.90	53.20	36.00	35.10	35.50
Salem	60.00	62.00	64.90	55.00	50.40	53.50	55.30	35.60	34.30	33.30
Vellore	57.50	58.90	62.10	58.50	51.60	54.70	49.20	33.80	35.10	32.00
The Nilgiris	63.40	61.10	65.30	52.80	47.20	50.00	57.80	34.50	31.10	32.20
Virudhunagar	61.40	60.70	66.40	55.60	43.50	47.10	58.00	33.80	33.80	32.10
Coimbatore	58.90	55.80	59.80	56.90	48.40	49.60	62.90	35.00	33.20	32.20
Pudukkottai	53.70	56.00	63.30	59.00	48.90	52.40	58.80	35.00	32.40	31.80
Thiruvarur	59.70	59.20	64.80	56.20	46.20	50.50	54.50	33.30	32.60	31.40
Nagapattinam	56.60	58.40	63.40	58.80	45.20	50.10	55.50	34.20	32.50	31.10
Namakkal	55.10	57.30	59.30	54.50	47.80	48.70	58.50	35.20	34.50	32.00
Cuddalore	55.70	60.80	61.50	51.00	43.90	45.90	57.00	35.10	35.70	31.80
Chennai	61.60	58.90	61.90	53.70	44.50	46.30	51.40	29.80	31.20	28.80
Theni	53.40	54.30	59.70	53.80	43.20	46.30	55.20	34.20	32.70	32.10
Madurai	54.20	55.80	61.50	51.40	43.10	46.50	56.10	32.70	32.50	29.70
Tiruchirappalli	53.00	52.50	57.10	52.60	39.00	44.20	55.40	31.70	30.90	30.50

From the UDISE website, raw data from the Elementary district-wise report card for the year 2016-17 was identified for all the districts. Each of the factors on which the data were available were mapped to the indicators below:

- School indicators

  Provides information about number of schools, number of government and private schools.

- Facility indicators

  Provides information about facilities provided in schools which includes number of classrooms, drinking water, boundary wall, toilet, playground, electricity, and mid-day meal.
- Enrolment indicators

  Provides detailed information about number of students in primary and upper primary stage, ratio of girls and boys, enrolment in different social categories, dropout rate and transition rate.
- Teacher indicators

  Provides information related to number of teachers, percentage of teachers given in-service and professional training, etc.

To identify if these factors have any association with the aggregate performance of the districts, a correlation analysis was run between the aggregated average performance and the identified factors across districts. The table below has the correlation coefficients for all the districts that were previously categorized as Green (high performing), Yellow (moderate performing) and Red (low performing). The column 'Overall' has the correlation coefficient when the correlation analysis was run on all the districts.

Category of indicator	Factors	Overall	Green	Yellow	Red
	Literacy Rate of the population	-0.3842	-0.6776	-0.1237	-0.2211
Total schools	Teachers by School Category (Government)	-0.0703	0.0145	-0.4191	-0.3663
Teacher indicator	Single-Teacher Schools	0.2713	0.1762	-0.0004	0.1283
	Schools Approachable by All Weather Road	0.0847	-0.2642	0.0665	
Facility indicator	Schools with Playground Facility	0.1939	-0.3035	0.0802	-0.3974
Facility indicator	Schools with Electricity	0.0214	-0.2587	-0.3306	-0.3522
Facility indicator	Schools with Computer	0.1389	-0.2751	-0.4014	-0.3396
	Schools Established Since 2001	0.1328	-0.0570	-0.2424	-0.2582
Enrollment indicator	Schools with Enrolment <= 50	0.1389	-0.2751	-0.4014	-0.3396
School indicator	Schools Constituted School Management Committee(Government & Aided Schools)	0.1328	-0.0570	-0.2424	-0.2582
	Number of Classrooms by School Category	-0.1685	-0.3969	-0.4417	-0.3658
Teacher indicator	Professionally Qualified Teachers: Government- regular	-0.0304	0.0129	-0.4340	-0.4350
Teacher indicator	Professionally Qualified Teachers: Government-contractual	-0.1946	0.0171	-0.2057	-0.0048
	Grants-TLM-Expended	0.1103	-0.1792	-0.1036	0.4371
	Grants-TLM-Received	0.1099	-0.1792	-0.1036	0.4470
	Grants-School Development-Expended	0.1385	-0.1167	-0.2085	-0.2993
	Grants-School Development-Received	0.1341	-0.1205	-0.2123	-0.3202
	Sum of instructional days- Primary	0.0228	-0.2826	-0.3164	-0.3408
	number of schools given instructional days-primary	0.0157	-0.2890	-0.3370	-0.3395
	Sum of instructional days- upper primary	-0.0210	-0.2809	-0.4021	-0.3930
	number of schools given instructional days- upper primary	-0.0286	-0.2848	-0.4141	-0.3825
Teacher indicator	Schools with PTR-Above 30-Primary Level	0.0653	-0.0864	0.0276	-0.2210
Teacher indicator	Schools with PTR-Above 35-Upper Primary	-0.0439	-0.3899	-0.0100	-0.3716
Facility indicator	Schools with SCR-Above 30-Primary Level	-0.1267	-0.2696	-0.3350	-0.2072
Facility indicator	Schools with SCR-Above 35-Upper Primary	-0.1444	-0.1568	-0.3433	-0.2791
	Non-Teaching Assignment-Total Days	-0.2257	0.1289	-0.4276	-0.0895
	Non-Teaching Assignment-Total Teachers involved	-0.0083	-0.0663	-0.3618	0.0606
Teacher indicator	teachers who received inservice training	0.0065	-0.2017	-0.2662	-0.5389
	school with girls toilet	0.0251	-0.2589	-0.3326	-0.3446
	schools with boy's toilet	0.0319	-0.2651	-0.3320	-0.3452
	schools with safe drinking water	0.0229	-0.2642	-0.3316	-0.3557

A positive correlation coefficient indicates a degree of association between that factor and the aggregated average performance. Through this analysis, it is clear that districts with high average performance in NAS have a higher number of government schools, better facilities in schools such as SMCs, electricity, playground, TLMs and professionally qualified teachers.

If a district wants to improve the learning levels of the students, they should be intervening for the factors that have a positive correlation, like establishing more elementary schools with electrification of the classroom and playground, and have an SMC constituted to audit the functioning of the school. Such schools should also spend their grants on TLMs to bring better learning experiences to the students. Also, administrators need to invest adequate time, effort, and attention to teacher education, both at the pre-service and in-service to promote teachers' teaching skills, master new knowledge, develop new proficiency, which in turn, will help improve students' learning.

Discussion

LSAs are an excellent medium to draw attention to the functioning of an education system at the systemic level. Educational administrators are increasingly expected to use LSAs data to monitor students' performance, diagnose areas for improvement and make informed decisions to improve the quality of education efficiently and effectively. It is also important to triangulate and use multiple data sources rather than having an over-reliance on LSA data. However, in order to realize the full potential of such data, more insight is needed urgently in terms of the best ways to read, infer and use data. Administrators can use this note as a starting point while using data to improve the quality of students' learning.

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