Strategies to Transform Dream into Reality: How can India Participate for Better Performance in Mathematics at Timss?

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Abstract- *Trends in International Mathematics and Science Study (TIMSS) is established by International Associations for the Evaluation of Educational Achievement (IEA), U.S.A and aimed at allowing educational systems worldwide to compare students' educational achievement as well as to learn from the experiences of others in designing effective education policy. TIMSS has been held every four years since 1995 and it includes a test for grades 4 and 8 in Mathematics and Science subjects. India, dreaming of becoming a developed nation in the world, has an attitude of not participating at international assessment programmes. Such attitude is not only depriving Indian Education System of international quality but is also obstructing the transformation process of India from a developing to a developed nation.*

This study is an investigation of three research questions: What is the system of TIMSS in the subject of Mathematics? What is the present status of Mathematics Education in India with reference to the system of TIMSS? What strategies should India adopt to participate for better performance in Mathematics at TIMSS? The study revealed that overall scenario of Mathematics Education in India, with reference to the system of TIMSS, is very poor. The study identified certain major barriers, such as, lack of linkage of the international assessment norms with the Mathematics textbooks, inability of the system to identify and to develop the Mathematical skills of the gifted children, lacking of policy international norms as well as parameters in terms of achieving global competitiveness, corruption, non-uniform policy in Mathematics Education across the country, non professional attitude of teachers, sub-standard provisions for the professional development of Mathematics teachers, inefficiency of the monitoring and assessing system etc. in achieving the dream of better performance of India at TIMSS. The study suggested appropriate strategies in overcoming these barriers.

Key Words: *TIMSS system, Mathematics Education, Performance in Mathematics, Strategies.*

Introduction

India is a developing country and it is dreaming to be a developed nation. To transform this dream into reality, India must have an education system comparable to that of the developed nations in the world. In order to develop the education system of India up to the international standards and quality, the existing education system must be periodically assessed internationally and the outcomes of such assessments must be incorporated for higher qualitative improvement in the education system of India. Unfortunately, India has the tendency of not participating in international assessment programmes which not only deprives India of developing sound education system that can compete globally but also obstructs the process of transformation of our nation from a developing to a developed nation. Hence, it is now high time for India to change this tendency and to plan the strategies to perform the best by participating in international assessments.

Among many international assessments in education, Trends in International Mathematics and Science Study (TIMSS) is a very renowned and well established assessment system. TIMSS is established by International Associations for the Evaluation of Educational Achievement (IEA), U.S.A and aimed at allowing educational systems worldwide to compare students' educational achievement as well as to learn from the experiences of others in designing effective education policy. TIMSS has been held every four years since 1995- the longest of any international education study and includes a test for Grades 4 and 8 in Mathematics and Science subjects. TIMSS assesses 4th and 8th grade students, while TIMSS Advanced assesses students in the final year of secondary school in advanced mathematics and physics. Since 2019 cycle, eTIMSS, an electronic version of TIMSS has been implemented. eTIMSS offers an engaging, interactive, and visually attractive assessment that assesses complex areas of the frameworks and increases operational efficiency in translation, assessment delivery, data entry, and scoring.

The TIMSS assessments collect detailed information about curriculum and curriculum implementation, instructional practices, and school resources. The participating students come from a diverse set of educational systems (countries or regional jurisdictions of countries) in terms of economic development, geographical location, and population size. In each of the participating educational systems, a minimum of 4,500 to 5,000 students is evaluated. TIMSS enables countries around the world to measure how effective they are in teaching mathematics and science.

(https://en.wikipedia.org/wiki/Trends_in_International_Mathematics_and_Science_Study#cite_note-TIMSS_2015_and_TIMSS_Advanced_2015_International_ Results-1)

As a part of the policy, TIMSS has a quasi-longitudinal design, with the fourth grade student cohort assessed four years later at the eighth grade. Assessing fourth grade students can provide an early warning for necessary curricular reforms, and the effectiveness of reforms can be further monitored at the eighth grade. TIMSS also collects important information about the students' contexts for learning mathematics and science. The participating countries and the students, as

well as their parents, teachers, and school principals complete questionnaires about home and school learning experiences and instruction. Data from the questionnaires can raise important issues about the implementation of educational policies and practices. (https://timssandpirls.bc.edu/timss2019/)

This research study is focused on how India can participate to perform better in Mathematics at TIMSS. The study highlights the system of TIMSS in the subject of Mathematics. The study, on the basis of the results of National Achievement Surveys (NAS), further analyses the present status of Mathematics Education in India with reference to the system of TIMSS in the subject of Mathematics. The study identifies certain major barriers for better performance at TIMSS and suggests appropriate strategies in overcoming these barriers.

Research Questions

The study has been based on three research questions:

- What is the system of TIMSS in the subject of Mathematics?
- What is the present status of Mathematics education in India with reference to the system of TIMSS?
- What strategies should India adopt to participate for better performance in Mathematics at TIMSS?

Delimitation of the study

- The study has been delimited only to Mathematics subject for Grades 4 and 8 of TIMSS system.
- Determining the present status of Mathematics education in India with reference to the system of TIMSS in this study has been delimited to the availability of the data related to the National Achievement Surveys (NAS) conducted by NCERT.
- NAS data for Class-4 is not available because the NAS are not conducted for Class-4 but it is available for Class-8. Hence this study has been delimited to analysis of Class-8 data of NAS with only Grade 8 of TIMSS system and not that of Grade-4.

Timss mathematics assessment framework: an overview

There are two assessment frameworks in Mathematics for TIMSS: One for grade-4 and the other for grade-8. Each of the two assessment frameworks is organized around two dimensions:

- Content dimension, specifying the subject matter to be assessed, and
- Cognitive dimension, specifying the thinking processes to be assessed.

Both of these assessment frameworks have been described separately in terms of the dimensions.

TIMSS Mathematics Assessment Framework (TMAF) in terms of Content Dimension

The Mathematics assessment frameworks of TIMSS in terms of content dimension for grade-4 and Grade-8 have been presented respectively in Table-1 and Table-2

Table: 1
Content dimension of TMAF for Grade-4

Content Domains	**Target Percentages**	**Topic Area**
Number	50%	• Whole Numbers (25%) • Expressions, Simple equations and relationships (15%) • Fractions and Decimals (10%)
Measurement and Geometry	30%	• Measurement (15%) • Geometry (15%)
Data	20%	• Reading, interpreting and representing data (15%) • Using data to solve problems (5%)

Table: 2
Content dimension of TMAF for Grade-8

Content Domains	**Target Percentages**	**Topic Area**
Number	30%	• Integers (10%) • Fractions and Decimals (10%) • Ratio, Proportion and Percent (10%)
Algebra	30%	• Expressions, Operations and Equations (20%) • Relationships and Functions (10%)
Geometry	20%	• Geometric shapes and measurements (20%)
Data and Probability	20%	• Data (15%) • Probability (5%)

The data in Table-1 and Table-2 revealed that the content domains differ for the fourth and eighth grades, reflecting the mathematics widely taught at each grade. There is more emphasis on number at the fourth grade than at the eighth grade. At the eighth grade, two of the four content

domains are algebra and geometry. Because these generally are not taught as separable areas in primary school, the introductory or pre-algebra topics assessed at the fourth grade are included as part of number. The fourth grade data domain focuses on collecting, reading, and representing data, whereas at the eighth grade it includes more emphasis on interpretation of data, basic statistics, and the fundamentals of probability.

TIMSS Mathematics Assessment Framework in terms of cognitive dimension

The Mathematics assessment frameworks of TIMSS in terms of cognitive dimension for grade-4 and grade-8 have been presented respectively in Table-3

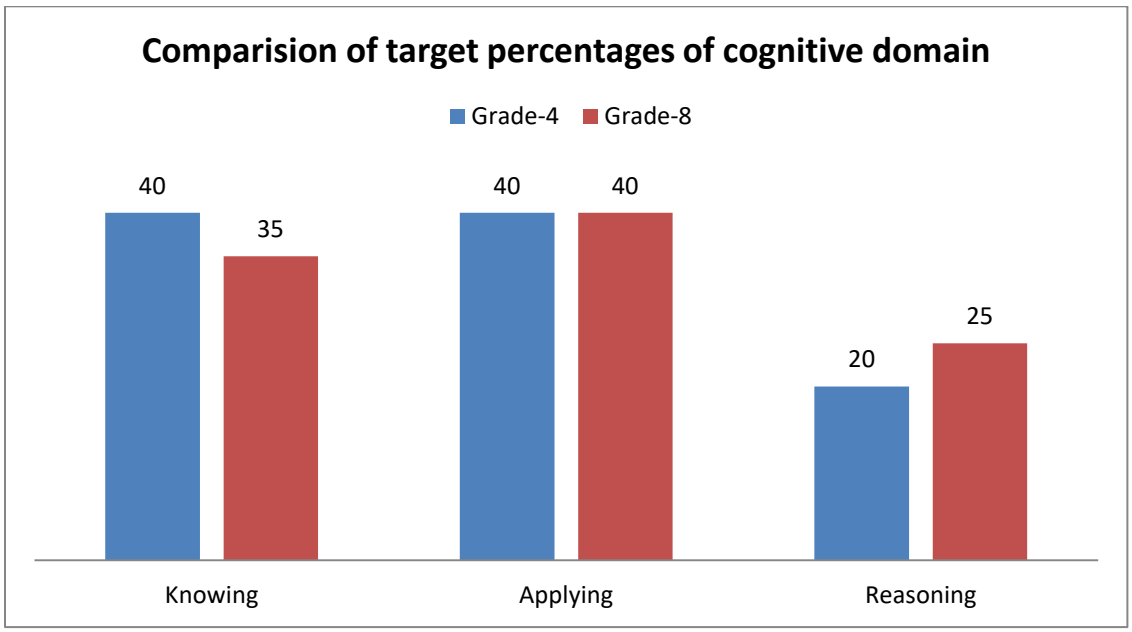
Table-3
Cognitive Dimension of Mathematics Assessment Framework for Grades-4 and 8

Cognitive Domain	**Target Percentages**		**Area**	**Procedure**
	Grade-4	**Grade-8**		
Knowing	40%	35%	Recall	Recall definitions, terminology, number properties, units of measurement, geometric properties, and notation (e.g., $a \times b = ab$, $a + a + a = 3a$).
			Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).
			Classify/ Order	Classify numbers, expressions, quantities, and shapes by common properties.
			Compute	Carry out algorithmic procedures for +, –, ×, ÷, or a combination of these with whole numbers, fractions, decimals, and integers. Carry out straightforward algebraic procedures.
			Retrieve	Retrieve information from graphs, tables, texts, or other sources.
			Measure	Use measuring instruments; and choose appropriate units of measurements.
Applying	40%	40%	Determine	Determine efficient/appropriate operations,

				strategies, and tools for solving problems for which there are commonly used methods of solution.
			Represent/ Model	Display data in tables or graphs; create equations, inequalities, geometric figures, or diagrams that model problem situations; and generate equivalent representations for a given mathematical entity or relationship.
			Implement	Implement strategies and operations to solve problems involving familiar mathematical concepts and procedures.
Reasoning	20%	25%	Analyze	Determine, describe, or use relationships among numbers, expressions, quantities, and shapes.
			Integrate/Synthesise	Link different elements of knowledge related representations, and procedures to solve problems.
			Evaluate	Evaluate alternative problem solving strategies and solutions.
			Draw Conclusions	Make valid inferences on the basis of information and evidence.
			Generalize	Make statements that represent relationships in more general and more widely applicable terms.
			Justify	Provide mathematical arguments to support a strategy or solution.

In Table-5.1.3, three cognitive domains, namely, knowing, applying and reasoning with corresponding areas and procedures have been presented. The target percentages in each domain for grades-4 and 8 given in Table-3 have been compared in Figure-1

Figure:1
Comparison of target percentages between Grade-4 and Grade-8



TIMSS assesses a range of problem solving situations within Mathematics, with about two-thirds of the items requiring students to use applying and reasoning skills. The applying domain is same for both grades. Compared to the fourth grade, the eighth grade has less emphasis on the knowing domain and greater emphasis on the reasoning domain.

Present Status of Mathematics Education in India in Terms of TIMSS System

The most authentic source of data available to know about the present status of Mathematics Education in India in terms of TIMSS system is the reports of the National Achievement Surveys (NAS) carried out by NCERT periodically throughout the country. The major objective of NAS is to improve children's learning level and to bring about qualitative improvements. The most recent NAS for Classes 3, 5 and 8 was conducted on November 13, 2017 in government and government aided schools. The survey tools used multiple test booklets with 45 questions in Classes III and V and 60 questions in Class VIII in Mathematics, Language, Sciences and Social Sciences.

(http://www.ncert.nic.in/programmes/NAS/SRC.html).

The learning outcomes of the NAS-2017 in Mathematics of Class-8 along with average performance of students have been presented in Table-4

Table:4 Learning outcomes of Class-8 in Mathematics in NAS-2017

Learning Outcomes[#]	Description[#]	Average performance of students by learning outcome* (Figures are in %)
M601	Solves problems involving large numbers by applying appropriate operations	40
M606	Solves problems on daily life situations involving addition and subtraction of fractions / decimals	43
M620	Finds out the perimeter and area of rectangular objects in the surroundings like floor of the class room, surfaces of a chalk box etc.	42
M621	Arranges given/collected information in the form of table, pictograph and bar graph and interprets them	39
M702	Interprets the division and multiplication of fractions	40
M705	Solves problems related to daily life situations involving rational Numbers	40
M706	Uses exponential form of numbers to simplify problems involving multiplication and division of large numbers	38
M707	Adds/subtracts algebraic expressions	51
M710	Solves problems related to conversion of percentage to fraction and decimal and vice versa	34
M717	Finds out approximate area of closed shapes by using unit square grid/graph sheet	34
M719	Finds various representative values for simple data from her/his daily life contexts like mean, median and mode	53
M721	Interprets data using bar graph	52
M801	Generalizes properties of addition, subtraction, multiplication and division of rational numbers through patterns	32
M802	Finds rational numbers between two given rational numbers	41
M803	Proves divisibility rules of 2, 3,4, 5, 6, 9 and 11	49
M804	Finds squares, cubes, square roots and cube roots of numbers using different methods	46
M808	Uses various algebraic identities in solving problems of daily life	45
M812	Verifies properties of parallelogram and establishes the relationship between them through reasoning	37
M818	Finds surface area and volume of cuboidal and cylindrical object	28
M819	Draws and interprets bar charts and pie charts	42

#Source: http://www.ncert.nic.in/programmes/NAS/SRC.html
*Source: http://nas.schooleduinfo.in/dashboard/nas_ncert#/

Also, the range of percentage of students who answered correctly in Mathematics in Class-8 in NAS-2017 has been presented in Table-5 and Figure-2.

Table:5
Range of percentage of students who answered correctly in Class-8

Range :→	Below 30%	30% - 50%	50% - 75%	Above 75%
% of students:→	36	31	24	9

*Source: http://nas.schooleduinfo.in/dashboard/nas_ncert#/

The data in Table-5 has been presented through a chart in Figure-2.

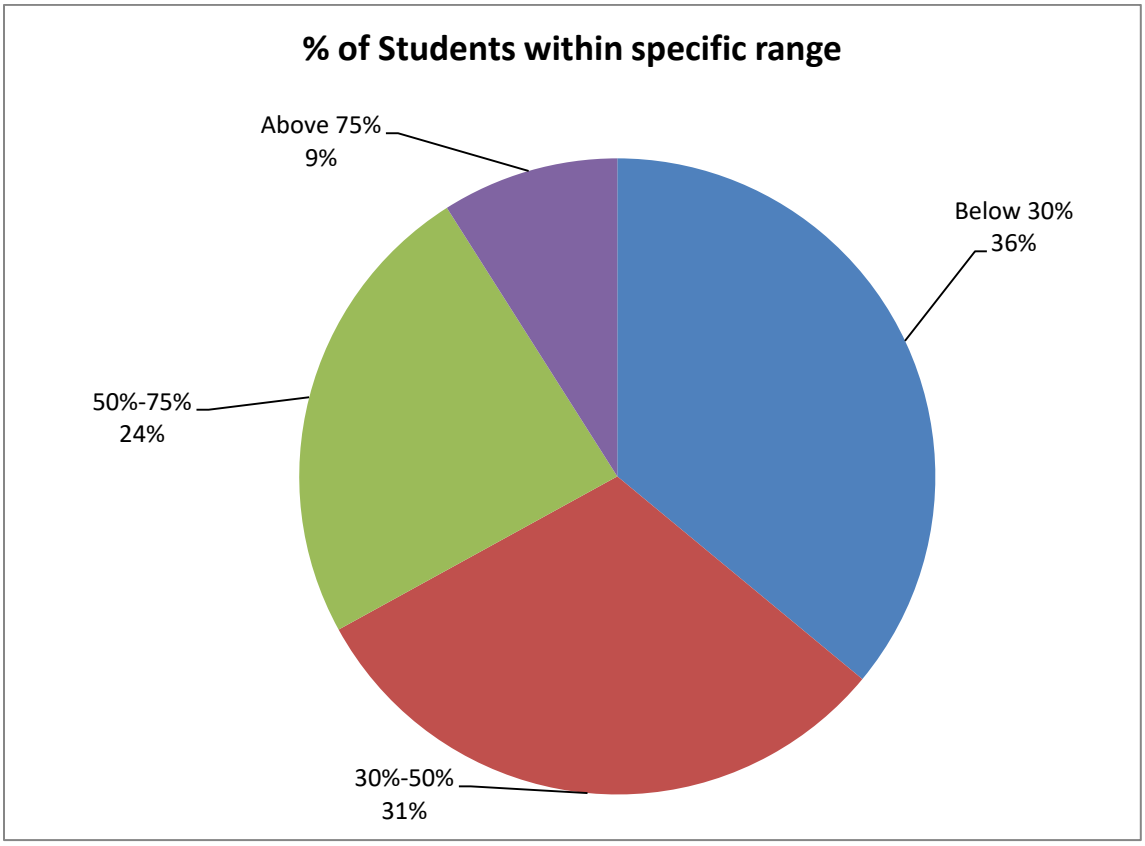


Figure:2
Range of % of students who answered correctly in Mathematics of Class-8

The data in Table-5.1.5 and Figure-5.1.2 reveals that only 9% students scored above 75% and 36% students scored below 30% which exhibits the poor status of Mathematics education in Class-8.

Analysis of NAS learning outcomes in terms of content dimension of TIMSS Mathematics Assessment Framework for Grade-8

The learning outcomes of NAS-2017 in Mathematics for Grade-8 presented in Table-4 have been analyzed in terms of the content dimension of TMAF for Grade-8 in Table-6.

Table:6 Content dimension of TMAF and NAS learning outcomes for grade-8

Content dimension of TIMSS Mathematics Assessment for Grade-8		**NAS result in Mathematics for Class-8**			
Content Domains	**Topic Area**	**NAS learning Outcome**	**Average Performance (%)**	**Topic Area Avg(%)**	**Domain Average (%)**
Number	Integers	M601: Solves problems involving large numbers by applying appropriate operations	40	43	39.5
		M705: Solves problems related to daily life situations involving rational Numbers	40		
		M803: Proves divisibility rules of 2, 3,4, 5, 6, 9 and 11	49		
	Fractions and Decimals	M606: Solves problems on daily life situations involving addition and subtraction of fractions / decimals	43	41.5	
		M702: Interprets the division and multiplication of fractions	40		
	Ratio, Proportion and Percent	M710: Solves problems related to conversion of percentage to fraction and decimal and vice versa	34	34	
Algebra	Expressions, Operations and Equations	M706: Uses exponential form of numbers to simplify problems involving multiplication and division of large numbers	38	45	40.75
		M707: Adds/subtracts algebraic expressions	51		

		M804: Finds squares, cubes, square roots and cube roots of numbers using different methods	46		
		M808: Uses various algebraic identities in solving problems of daily life	45		
	Relationships and Functions	M801: Generalizes properties of addition, subtraction, multiplication and division of rational numbers through patterns	32	36.5	
		M802: Finds rational numbers between two given rational numbers	41		
Geometry	Geometric shapes and measurements	M620: Finds out the perimeter and area of rectangular objects in the surroundings like floor of the class room, surfaces of a chalk box etc.	42	35.25	35.25
		M717: Finds out approximate area of closed shapes by using unit square grid/graph sheet	34		
		M812: Verifies properties of parallelogram and establishes the relationship between them through reasoning	37		
		M818: Finds surface area and volume of cuboidal and cylindrical object	28		
Data and Probability	Data	M621: Arranges given/collected information in the form of table, pictograph and bar graph and interprets them	39	46.50	23.25
		M719: Finds various	53		

		representative values for simple data from her/his daily life contexts like mean, median and mode			
		M721: Interprets data using bar graph	52		
		M819: Draws and interprets bar charts and pie charts	42		
	Probability	**Not included in Std:8 Mathematics Syllabus**	_____		

The average percentage of the topic area as well as that of the content of the domain of the learning outcomes in Mathematics of class-8 in Table-6 has been presented through a chart in Figure-3.

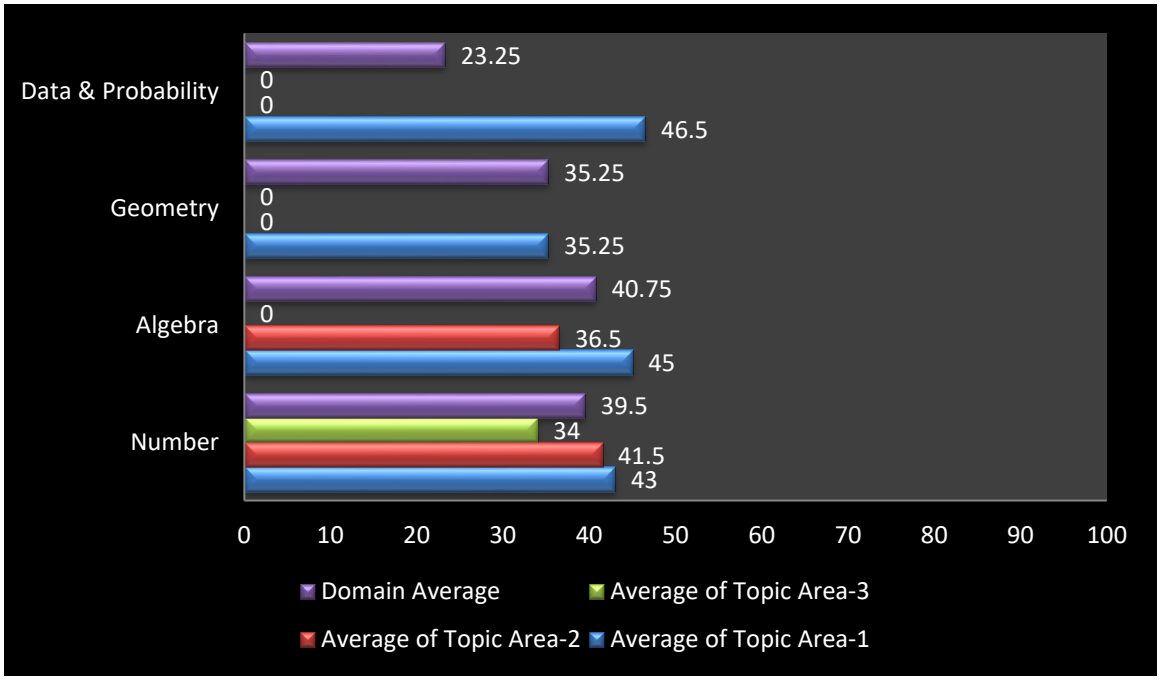


Figure:3

Analysis of NAS learning outcomes in terms of content domain of TMAF for Grade-8

The data revealed that the average percentage of the learning outcomes of NAS-2017 in mathematics for Class-8 were 23.25% in Data domain, 39.50% in Number domain, 40.75% in Algebra domain and 35.25% in Geometry domain. **The average of all the domains is less than 50% whereby the author feels that to is indicative of a below average status of Mathematics Education of Class-8 in India in terms of the TMAF for Grade-8 within the limitations of NAS data condueted by NCERT.**

Data also revealed that **the probability topic of the content domain in TMAF for Grade-8 is not included in the textbook of class-8 of NCERT which points at the low grade syllabus of mathematics for class-8 compared to TMAF.** The findings also point to the fact that there is a scope for important of the teaching-learning process in the classrooms of Class-8 in Mathematics subject**.**

Analysis of NAS learning outcomes in terms of Cognitive dimension of TMAF for Grade-8
The learning outcomes of NAS-2017 in Mathematics for Grade-8 presented in Table-4 have been analysed in terms of the cognitive dimension of TMAF for grade-8 in Table-7.

Table: 7
Cognitive dimension of TMAF and NAS learning outcomes for Grade-8

Cognitive Dimension of TMAF for Grade-8			**NAS result in Mathematics for Class-8**	
Cognitive Domain	**Area**	**Procedure**	**NAS learning outcome**	**Average Performance (%)**
Knowing	Recall	Recall definitions, terminology, number properties, units of measurement, geometric properties, and notation (e.g., $a \times b = ab$, $a + a + a = 3a$).	----NQRAA** ----	----NA# -----
	Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).	----NQRAA----	----NA-----
	Classify/ Order	Classify numbers, expressions, quantities, and shapes	----NQRAA----	----NA-----

		by common properties.			
	Compute	Carry out algorithmic procedures for +, –, ×, ÷, or a combination of these with whole numbers, fractions, decimals, and integers. Carry out straight forward algebraic procedures.	M707: Adds/subtracts algebraic expressions	51	Area Average 46%
			M802: Finds rational numbers between two given rational numbers	41	
	Retrieve	Retrieve information from graphs, tables, texts, or other sources.	----NQRAA----	----NA-----	
	Measure	Use measuring instruments; and choose appropriate units of measurements.	----NQRAA----	----NA-----	
Applying	Determine	Determine efficient/appropriate operations, strategies, and tools for solving problems for which there are commonly used methods of solution.	M620: Finds out the perimeter and area of rectangular objects in the surroundings like floor of the class room, surfaces of a chalk box etc.	42	Area Average 41.75%
			M710: Solves problems related to conversion of percentage to fraction and	34	

			decimal and vice versa		
			M804: Finds squares, cubes, square roots and cube roots of numbers using different methods	46	
			M808: Uses various algebraic identities in solving problems of daily life	45	
	Represent/Model	Display data in tables or graphs; create equations, inequalities, geometric figures, or diagrams that model problem situations; and generate equivalent representations for a given mathematical entity or relationship.	M717: Finds out approximate area of closed shapes by using unit square grid/graph sheet	34	Area Average 43%
			M721: Interprets data using bar graph	52	
	Implement	Implement strategies and operations to solve problems involving familiar mathematical concepts and procedures.	M601: Solves problems involving large numbers by applying appropriate operations	40	
			M606: Solves problems on daily life situations involving addition and	43	Area Average 37.25%

			subtraction of fractions / decimals		
			M706: Uses exponential form of numbers to simplify problems involving multiplication and division of large numbers	38	
			M818: Finds surface area and volume of cuboidal and cylindrical object	28	
Reasoning	Analyze	Determine, describe, or use relationships among numbers, expressions, quantities, and shapes.	----NQRAA----	----NA-----	
	Integrate/Synthesize	Link different elements of knowledge, related representations, and procedures to solve problems.	M621: Arranges given/collected information in the form of table, pictograph and bar graph and interprets them	39	
	Evaluate	Evaluate alternative problem solving strategies and solutions.	----NQRAA----	----NA-----	
	Draw Conclusions	Make valid inferences on the basis of information and evidence.	M702:Interprets the division and multiplication of fractions	40	Area Average
			M803: Proves divisibility rules	49	

			of 2, 3,4, 5, 6, 9 and 11		42%
			M812: Verifies properties of parallelogram and establishes the relationship between them through reasoning	37	
	Generalize	Make statements that represent relationships in more general and more widely applicable terms.	M705: Solves problems related to daily life situations involving rational Numbers	40	Area Average 41.75%
			M719: Finds various representative values for simple data from her/his daily life contexts like mean, median and mode	53	
			M801: Generalizes properties of addition, subtraction, multiplication and division of rational numbers through patterns	32	
			M819: Draws and interprets bar charts and pie charts	42	

	Justify	Provide mathematical arguments to support a strategy or solution.	----NQRAA----	----NA-----

** NQBAA stands for "No Question Relating to that Area was Asked" # NA stands for "Not Applicable"

From the data in Table:7, it was revealed that:

- In the type "Knowing" of the cognitive domain, two (2) questions (M-707 and M-802) were asked which were relating to the 'compute' area and average performance of this area was 46%. No questions relating to other areas, namely, recall, recognize, classify/order, retrieve, and measure were asked.
- In the type "Applying" of the cognitive domain, questions relating to each area were asked. Four (4) questions (M-620, M-710, M-804 and M-808) were relating to area 'determine', two (2) questions (M-717 M-721) were relating to area 'represent/model' and four (4) questions (M-601, M-606, M-706 M-818) were relating to area 'implement'. The average performances of these areas in NAS were 40.67%, 43% and 37.25% respectively.
- In type "Reasoning" the cognitive domain, one (1) question (M-621) relating to area 'integrate/synthesise' was asked and the average performance of this area was 39%; three (3) questions (M-702, M-803 and M-812) relating to area 'draw conclusions' were asked and the average performance of this area was 42%; and four (4) questions (M-705, M-719, M-801 and M-819) relating to area 'generalise' were asked and the average performance of this area was 41.75%. No questions relating to other areas, namely, analyse, evaluate and justify, were asked.
- The percentage of average performance of any area of any type of the cognitive domain was less than 50%.

Strategies that India should be Adopted to Participate for better Performance in Mathematics at TIMSS

The analysis of the learning outcomes in Mathematics of Class-8 in NAS-2017 in terms of TMAF revealed that the present status of Mathematics Education, with reference to TMAF, is poor. From the findings of the data of NAS-2017 with reference to TMAF, it is also revealed that the Mathematics Education in Class-8 in India is lagging far behind the equivalent international Mathematics Education for Grade-8 in terms of content as well as cognitive domains. Within the framework of this reality, the strategies that India should adopt to participate for better performance in mathematics at TIMSS may broadly be divided in two steps discussed as under:

STEP-1: Identifying the Potential Barriers for Better Performance in Mathematics at TIMSS

With reference to TMAF, some of the major potential barriers for better performance in Mathematics at TIMSS have been identified as under:

Lack of linkage of the international assessment norms with the Mathematics textbooks

The assessment norms must be in strict accordance with those of TIMSS and also must be incorporated in the textbook of Mathematics so that the teacher can assess the student as per international norms. The content of the mathematics textbooks must contain the examples as well as exercises that can train the students' mind in mathematics in accordance to the TMAF.

Inability of the system to identify and to develop the Mathematical skills of the gifted children

The NAS-2017 result of Class-8 in Mathematics has only 9% students with range of score more than 75%. The gifted children are within this range. Unfortunately, our education system neither have a provision to identify the gifted children nor to have a special training, treatment nor teaching for the gifted students. The gifted students in mathematics should be identified and should be trained as per TMFA. With the participation of such students at TIMSS, India can have better chances of good performance at TIMSS.

Policy lacking of international norms as well as parameters in terms of achieving global competitiveness

So far in India, no education policy has a specific vision and guidelines of participating and achieving particular rank at TIMSS or any other international assessment programmes. Such attitude of our governments has deprived and is depriving our nation of achieving the spirit of global competitiveness.

Non-uniform policy in Mathematics Education across the country

India, being a diversely cultured country, has different syllabus in different states in different languages. There is no 'single and same' syllabus and Education Board across the country and such non-uniformity in education policy is a major barrier to perform better at TIMSS.

Non professional attitude of teachers

Poor performance of Class-8 students in Mathematics is the reflection of non-professional attitude of teachers. The position paper of National Focus Group of NCERT on Teaching of Mathematics (2006) rightly stated that, "At two ends of the spectrum, mathematics teaching poses special problems. At the primary level, most teachers assume that they know all the mathematics needed, and in the absence of any specific pedagogic training, simply try and uncritically reproduce the techniques they experienced in their school days. Often this ends up perpetuating problems across time and space". (p-6). The teachers must have a professional attitude to prepare students for better performance at TIMSS.

Sub-standard provisions for the professional development of Mathematics teachers

One of the major reasons for poor performance in Mathematics in NAS-2017 is the sub-standard provisions for the professional development of Mathematics teachers. Such sub-standard provisions include the absence of any content related to international assessment in the curriculum of teachers' training colleges, the lack of regular workshops/seminars/training programmes, lack of infrastructures, lack of suitable policy to assess the Teachers' performance etc. The provisions for the professional development of mathematics teachers must be made to achieve the goal of better performance at TIMSS.

Inefficiency of the monitoring and assessing system

The government established monitoring and assessing system (Government Education officials) either cannot or do not perform their basic duty efficiently due to the reasons such as lack of staff, over work load, corruption etc. In the absence of proper monitoring and assessment, the quality as well as standard of education, particularly in government schools, has been deteriorated.

STEP-2: Formulating and implementing strategies to overcome the identified potential barriers

In order to achieve the goal of better performance at TIMSS in Mathematics, the strategies should be so formulated as well as implemented that the identified potential barriers can be overcome. Some of such strategies have been suggested as under:

Special education policy for TIMSS

Like the developed countries participating in TIMSS, for example UAE, India should formulate special education policy focused only on TIMSS. The policy may include the vision, goal, time line, training to the stakeholders, training for the teachers as well as students, appropriate and strict monitoring as well as assessment system, developing TIMSS friendly infrastructure etc.

Special training to gifted children

The gifted children are the real assets of the nation. The gifted children in Mathematics should be identified at an earliest level and should be trained within TMAF in a planned way.

Updated Text books by linking them with norms of TIMSS

The textbooks must include the TMFA related content so that teachers as well as student can develop their mindset as per TIMSS norms and can participate confidently at TIMSS to perform better.

Corruption controlling strategies

Corruption is nothing but cancer to the nation and must be eradicated at least from education system of India. Formulating suitable strategy like 360 performance assessment and implementing it with firm determination, corruption can be controlled/minimized. (Parekh, 2019).

Provisions for continuous professional development of Mathematics teachers

The quantity and quality of success of India at TIMSS in Mathematics is directly proportional to the professionalism of Mathematics teachers. Ultimately, it will be the teacher who is going to play the greatest role. Hence, there must be provisions for the continuous professional development of mathematics teachers in terms of TMFA.

Conclusion

In order to achieve the dream of becoming a developed nation, India must have a system of education equivalent to that of the developed countries. This can be possible if and only if India, by changing the tendency of not participating at international assessment programmes, participates at international assessment programmes along with the developed countries. Trends in International Mathematics and Science Study (TIMSS) is one such assessment system aimed at allowing educational systems worldwide to compare students' educational achievement as well as to learn from the experiences of others in designing effective education policy. TIMSS assesses 4th and 8th grade students in Mathematics and Science in terms of content as well as cognitive domains.

Analyzing the results of National Achievement Survey (NAS)-2017 in terms of TMFA with the content and cognitive domains, it was concluded that the average performance of the students of Class-8 in Mathematics was poor which reflects the poor status of Mathematics education in Class-8 with reference to TMFA. Also, the textbook of Mathematics of Class-8 has low graded content compared to that of TMFA.

In order to perform better by participating at TIMSS, India must overcome certain potential barriers, such as, lack of linkage of the international assessment norms with the mathematics textbooks; Inability of the system to identify and to develop the Mathematical skills of the gifted children; policy lacking of international norms as well as parameters in terms of achieving global competitiveness; corruption; non-uniform policy in Mathematics education across the country; non professional attitude of teachers; sub-standard provisions for the professional development of Mathematics teachers; and inefficiency of the monitoring and assessing system. To overcome these barriers, the strategies, such as, special education policy for TIMSS; special training to gifted children; updated text books by linking them with norms of TIMSS; corruption controlling strategies; and provisions for continuous professional development of Mathematics teachers should be adopted/formulated.

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