

## THREE LEVELS OF CURRICULUM AND TESTING IN MATHEMATICS

The overarching goal of Mathematics curriculum is to enable students make informed decisions in life, undertake courses for employment pathways, pursue entrepreneurial journey; further contribute to Science, technology and pure & applied Mathematics fields. This requires seeding from schooling stage onwards. The functionality of Math curriculum is to support vast range of student achievement and performance levels. The global best practices in Math curriculum significantly follow three levels of Math performance. The three levels are broadly to enable all students to have access to Mathematics curriculum that matches with their performance and achievement levels, leading towards higher education, professional & technical and training sector programs.

Normally in schools, Math is tested at one level. The concept of ***one size fits all*** does not hold relevance today. There is a need to have three different significant levels of Math to enable all students to perform well in Math program. Currently, a single advanced Math program is administered for all students appearing for class X level. This requires a change. There are many students who do not understand or relate to advanced theoretical and abstract Mathematical constructs. Such advanced Math curriculum robs the vast majority of students the precious learning time or causes undue frustration and burden on young minds. The current single Math paper at classes IX-X takes away time to learn other subject content that may be related to the courses students could pursue in higher education or sector skills training pathways.

Kovida Ltd recommends in introducing three levels of Math at Class IX level:

- **Mathematics 1(M1):** A combination of Composite/ Academic Math and Applied General Math
- **Mathematics 2 (M2):** Applied General Math with basic Algebra
- **Mathematics 3 (M3):** Basic Math Concepts

This is a first step in the right direction. The rigor in the Mathematics curriculum has increased worldwide. The West increased Math rigor in the last decade in response to rising Math levels in Korea, China, India and to face to Asian competition. Ironically, India needs to work extremely hard to play catch-up with rest of Asian peers and the world in education and skills space.

### Improvement of SLOs

The three Mathematics levels will enable students to take up Mathematics aligned to their ability and interest. Therefore, the students who can appreciate and handle high intensity, theoretical and abstract Mathematics can benefit vastly and be in the cohort of students to move through curriculum with necessary speed and depth. All students in the range of 75% above performance in Math will enable the classroom interactions dynamics to be very proactive, leading to higher and better learning outcomes.

The students who find abstract and theoretical Mathematics difficult could opt for M2 and M3 to reduce or do away with the abstract Mathematics curriculum. This will enable students to unburden themselves and improve Mathematics SLO and other subject SLOs. This may happen due to more time available and less frustration they normally face with abstract or theoretical

Mathematics content. Practical Mathematic and sector specific Mathematics students may find the subject interesting and easy to learn, as this opens scope for future courses and employment pathways.

### **Introduction of Different Levels of Mathematics:**

Students of classes I – VIII are to have same curriculum; as these inputs are considered to be the absolute basics. At class IX, students must be provided with an option to choose the level of Math they would like to take based on their interest and needs. These course selections largely determine student educational pathways and will have the potential influence on their post secondary options of college and career qualification pathways. Students opting for a Technical or Professional College track can select Composite Math / Academic Math and students opting for College/ Career track can select Applied General Math. This will pave the direction for employability of 26+ Crores secondary school students in India.

### **Rationale for three levels Mathematics Curriculum:**

- **To improve Student Learning Outcomes:** Keeping Mathematics to the level of student ability could free student time to study other subjects, thus improving SLOs. It is necessary to improve learning outcomes while focusing on the basics that are essential for living in the 21<sup>st</sup> century. Every student is important; each student must achieve his / her potential and meet the laid out student learning outcomes aligned with defined difficulty level.
- **De-stress learners and reduce fear of Mathematics:** Many students fail in Mathematics; face social stigma, humiliation and frustration as they cannot understand or relate to the content. No amount of counseling will work when students do not have inherent demonstrable ability to perform well. Putting them under pressure with high level Math will not help their cause. Student suicide or negative behaviors are rampant as the stress for students could be unbearable.
- **Make education relevant for future college and career planning:** Motivating students from not dropping out of school, pursue school completion and take up courses that lead towards jobs or new opportunities in entrepreneurship is urgently required. Career and college pathways needs to be planned from secondary schooling stage; at present such a systematic approach is missing. Students find school subjects abstract and cannot see school relevance for employability; these students drop out of school earlier, as the schools do not provide them the opportunity to plan for career, entrepreneurship or courses that align with their capability.
- **Learners can concentrate on subjects of their choice, rather than invest time on Abstract Math that is of less /no interest:** Respecting the student choice, today's students have ample exposures and can take their own decisions. This advantage should not be nipped in the budding stage. Independent study and student work experience could yield very positive results in grooming the youth in India. In the 21<sup>st</sup> century, the Indian Education system is languishing, based on the previous era template of dealing with student interest and ability. The three levels of Mathematics approaches have to be part and scope of how the Indian education system must operate and manage student learning pathways that improves employability and school completion to avoid school dropouts.

- **Facilitates student streaming into college, career and skill development programs:** A systematic methodology can be evolved to facilitate student mobility into college and career training pathways. These innovations cannot wait any longer, in the backdrop of India's huge youth demographics. The skill development training providers are giving whatever course is offered by the training providers to students without any procedural protocols to improve and address student fitment into the training courses. This is grossly overlooked and huge budgets of skill development programs are wasted.
- **Improves ethics standards and norms in examinations; due to reduced pressure towards achievement beyond student capabilities:** Board Examination of class X is a most stressful time to students, families, school leaders, teachers and school examination bodies. There are vast and varied malpractices that are resorted to. The low ethics approach is painful, punishing and robs many people in the system of their mental peace. Approximately only 10 -15 % students may appreciate the high level of the current Mathematics curriculum, while an overwhelming majority of students find it difficult or impossible. That stakeholders in the education system have to produce results better than previous year is a syndrome that make them resort to means that are not commendable or worth mentioning.
- **Curriculum aligned to Applied Mathematics will improve candidate pools into a vast array of sector oriented qualification pathways and wean students from traditional Engineering, Medicine, Law, Accountancy etc pathways:** Students need a vast range of courses that fits their ability, aptitude, attitude, skills and interest. At present, many courses are becoming sector aligned; for example Business Management courses are specific to sectors, such as Retail Management, Design Management, Hospitality Management, Broadcast Management, Agricultural Sciences and Management etc. The 20+ priority sectors that are identified could be introduced from secondary stage is right opportunity for Indian youth has to be planned to support youth demographic dividend.

Kovida has reviewed the current test books of both Andhra Pradesh and Telangana State and Central Syllabus of Mathematics (CBSE). It is noted that the curriculum deals very scantily with Applied Math which is very essential for day to day life. A balanced curriculum for all the three levels of Mathematics has to be thought through for enabling student well-rounded student development at three different levels of Math.

**Mathematics 1** – This Mathematics encompasses a **combination of Composite/Academic Math and Applied General Math**. This form a pre - requisite for a range of Technical and professional destination based courses in class XI & XII. Academic courses intent is to focus on application of essential concepts and Applied General Math stresses practical, concrete application concepts. This offers high quality educational experience and equally rigorous standards. Students opting Mathematics 1 should be tied to student achievement in class VIII. A minimum of 75% achievement is essential scope for opting Mathematics 1 class IX and X class secondary stage.

Students seeking technical and professional education course in engineering, technology, quantitative Mathematics, pure Mathematics etc course require the current curriculum with

minimal changes to include the applied Mathematics inputs to bring well rounded approach to student learning needs to be scoped.

**Recommended Mathematics 1 curriculum – A Sample Illustrative Plan:**

<b>Applied General Mathematics</b>	<b>Composite/ Academic Mathematics</b>
<ul style="list-style-type: none"> <li>• Percentages</li> <li>• Profit and Loss – Selling / Gross / Net</li> <li>• Ratio and Proportion</li> <li>• Discount – Sales</li> <li>• Interest – Simple / Compound/ Complex</li> <li>• Plinth / Area Carpet area – Mensuration</li> <li>• Time / Speed / Distance Travel</li> <li>• Measurements Weight / Volume/ Lengths</li> <li>• Water flow - Volume</li> <li>• Time / work / unit cost / production</li> <li>• Statistics</li> <li>• Linear equations</li> <li>• Basic - Algebra</li> <li>• Graphs / Pie / Bar / Line graph</li> <li>• Exponents</li> <li>• Basic Geometry</li> </ul>	<ul style="list-style-type: none"> <li>• Simple equations</li> <li>• Algebraic expression</li> <li>• Powers and Exponents</li> <li>• Direct and Inverse proportions</li> <li>• Frequency distribution tables and graphs</li> <li>• Polynomials and Factorization</li> <li>• Quadrilaterals</li> <li>• Probability</li> <li>• Sets - Theory</li> <li>• Progression</li> <li>• Trigonometry and its applications</li> <li>• Calculus</li> </ul>

**Mathematics 2** – A range of Math performance that encompasses **Basic Arithmetic of 8 class level and Applied Math concepts at class IX – X**. This is needed to support vast range of courses that will improve employability of students that is essential to bring transformational change. Applied Math is practical and career oriented. It is best suited for the learners opting for college / career tracks. Applied Math allows learners to get more hands-on instructions related to 20+ Priority Sectors. It helps establish connection between the concepts and practical uses that is more relevant to College\ Career track. Applied Math teaches learners the basic Math used in real life situations and also includes how Math is used in the workplace. It can include time and distance problems for Travel and Tourism Sector, Ratio and Proportion for Food and Food Processing Industry, Geometry problems for Agriculture Sector etc Applied Math includes basic Arithmetic operations and problem solving techniques as well as job related skills such as data handling and Statistics.

Applied Mathematics has a potential to develop student feeder pools into new courses qualifications: Diploma, Advanced Diploma and Degree etc in Event Management, Retail Management, Hospitality Management, Textile Design Management, Healthcare Service

Management, Agriculture, Aquaculture, Dairy Management etc, Media and Film Production Management etc. This is huge opportunity meant to address the trajectory of student learning towards MSME –entrepreneurship pathways can be enabled to improve overall employability in India.

**Recommended Mathematics 2 Curriculum – A Sample Illustrative Plan:**

<ul style="list-style-type: none"> <li>• Basic Math concepts of Class level VIII topics</li> <li>• Profit and Loss – Selling / Gross / Net</li> <li>• Cost price, selling price, Unit Cost</li> <li>• Discount – Sales</li> <li>• Plinth / Area Carpet area – Mensuration</li> <li>• Exponents</li> <li>• Basic - Algebra</li> <li>• Basic Geometry</li> <li>• Factorization</li> </ul>	<ul style="list-style-type: none"> <li>• Ratio and Proportion</li> <li>• Percentages</li> <li>• Interest – Simple /Compound / Complex</li> <li>• Money /Time / Speed / Distance Travel</li> <li>• Measurements Weight / Volume/ Lengths</li> <li>• Statistics and Data handling</li> <li>• Linear equations</li> <li>• Graphs / Pie / Bar / Line graph</li> </ul>
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**Mathematics 3:** This Math benefits learners who have less or no inclination towards the subject. A range of Math performance that is limited to class 5 Level – **Basic Arithmetic and functional Math for daily life** and to pursue course from NSQF Certificate Level 1 – 4. It is sufficient for students who opt for entry level certificate courses and certain subjects like Social Sciences / Humanities/ Entertainers / Art / Actors/ Sports persons/ Chef / Beauticians / some types of technicians etc. Students can take up entry level courses that lead to jobs with skill development training programs.

The dancers, singers, sportsmen, crafts, entertainers etc have to invest huge number of hours into practice to reach a level of perfection to become champions or to attain competence to support livelihood. Thomas Friedman authored a book titled, The Outliers – with evidence it was shown that some of the experts or high end sports persons have invested close to 10,000 hours or more to reach perfection to rise to exceptional level of achievement and performance. The time a student invests in these endeavors has to be accounted and encouraged into school curriculum and provide scope for unburdening the students from learning one-size fits all Mathematical teaching, learning and testing approach. This could be one reason we a very miniscule population representing India at Olympics or many sports events etc. There could be many avenues for student special talents that require support must be scoped through system driven process of introducing the Mathematics level 3.

**Recommended Mathematics 3 Curriculum – A Sample Illustrative Plan:**

<ul style="list-style-type: none"> <li>• Math Concepts of Class V</li> <li>• Profit and Loss – Selling / Gross / Net</li> <li>• Cost price , selling price, Unit Cost</li> <li>• Discount – Sales</li> <li>• Basic Mensuration</li> </ul>	<ul style="list-style-type: none"> <li>• Ratio and Proportion</li> <li>• Interest – Compound / Simple / Complex</li> <li>• Money /Time / Speed / Distance Travel</li> <li>• Measurements Weight / Volume/ Lengths</li> <li>• Percentages</li> </ul>
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The Mathematics curriculum needs to pave way towards streaming paradigm in India. Since world over streaming is common approach that is applied at various stages of schooling to introduce and lead students towards further qualifications. The following is an illustrative application - approach presented below to bring about the transformation of Mathematic curriculum.

### Application of Three Levels of Mathematics

Sl. No	Mathematics level	Qualification Planning
1.	<p><b>Mathematics 1: M1</b>  <b>A combination of Advanced Math / Composite Math and Applied General Mathematics.</b></p> <p>This offers high intensity Mathematics educational experience and rigorous standards into +2 level Mathematics program</p>	Engineering, Technology, Quantitative Analysts, Technical / Higher Education professional courses etc.
2.	<p><b>Mathematics 2: M2</b>  <b>Applied &amp; General Math</b> (Math at Cass VIII - Not including Calculus, Trigonometry, Advanced Algebra etc) +2 level Applied Mathematics and sector orientation.</p> <p>Applied Mathematics for sector related inputs for getting a job or further study into Retail Services sector, Health Care Management, Banking, Finance and Accountancy, Agriculture, Dairy Management, Travel and Tourism Management, Animation, entrepreneurial pathways etc at +2 senior secondary schooling stage</p>	Medicine, courses in Humanities, Art, Agriculture, Architecture, Hospitality etc.
3.	<p><b>Mathematics 3 : M3</b>  <b>Basic General Math</b> (Math at Class V – Ample Applied / Functional Math curriculum)</p> <p>Class V level Math and few concepts of Applied Math. The option to leave school at Class X stage to pursue intensive training and skill development programs. Provides scope for many hours of practice that leads to perfection; many sport persons, musicians,</p>	Certificate courses, Beauticians, Actors, Craftsmen, Drivers, Sportsmen, Dancers, Singers, Electrician, Mechanic, Chef, Actors etc.

	crafts people require time away from rigor of current Abstract Mathematics	
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**Implementation Perspective for M1, M2 and M3:** The unbundling and repackage is essential for developing the three different strands of Math to match with the student pool eligibility for entering the higher education, professional education and skill development programs. Various policy and administrative approaches, protocols and procedures are essential for rolling out the three levels of Mathematics at secondary schooling stage.

**The role of UGC and Sector Skills Councils:** There is huge need to build bridges between the secondary school and higher education bodies to ensure there is seamless communication and facilitation is essential for the roll out of this transformation in Mathematics curriculum. A host of many new course and training pathways needs to be articulated and scoped to provide students with many more opportunities are to be planned.

- Credit frame work facilitation has to take towards independent study programs, employability and entrepreneurship pathways root from the secondary schooling stage to bring more efficient way of educating youth.
- Independent study programs and depth of study in the students will increase due to unpacking of the Mathematics curriculum.
- The students entering higher education program, technical & professional course need to demonstrate capability for writing skills and research skills so that India will have better student pools into university programs who could produce and generate original intellectual property rights, copy rights and innovations to support economic and social growth in India.

*The need for having three levels of science and languages:* There could be a need to relook at these other subject requirements. As high end science or social studies or Language may not be needed for the M3 students these kind of choices may crop up; which the policy makers, schooling systems and school leaders need to understand education service and skills delivery from a transformational perspective to enable students to reach their fullest potential possible instead of giving content beyond their scope to make students feel inadequate and not up to the tasks.

*The text book preparation for M1, M2 and M3:* The NCERT and SCERT need to coordinate with Sector Skills Councils and other agencies to bring to speed in preparation. Practically producing text books is task that takes too long in the government space due to various political and administrative constraints and compulsions. An innovative approach has to be scoped to bring speed that is essential to address a range of opportunities for youth.

### **Assessment for Mathematics Learning**

In leading transformational change the first step is assessment. The assessment driven culture is very much part of India Education System. Therefore, it is practical and prudent to drive transformational change from assessment leading to direct the teaching and learning at policy and practice perspectives. Then only the education and skills eco-systems in India can be built

efficiently. Adopting Assessment Design Framework (ADF) facilitates to make the Mathematics assessment meaningful, seamless and coherent.

**Advantages of ADF for Mathematics Assessment**

- Will enable synchronization among various State School Boards in India to improve comparability, validity, reliability, facilitate student migration and normalization policies
- Will drive the teaching and learning towards knowledge, application and Higher Order Thinking Skills / reasoning ability: a practical step towards eliminating rote learning
- Enable School Boards to address accountability and transparency issues
- Provide better quality student pools for higher education and training courses
- Strong leading steps towards improvement of employability and work place productivity

The Mathematics 1, 2, and 3 all curriculum needs to be tested for understanding levels, Application levels and Higher Order Thinking. The recommended weightage allotted for assessment of various Cognitive skills include:

Cognitive Skills	Mathematics 1 Weight age	Mathematics 2 Weight age	Mathematics 3 Weight age
Understanding	20	30	30
Application	50	50	50
Higher Order Thinking Skills	30	20	20

**Reporting Norms for Assessment:** It is highly recommended that when the transcript or mark sheet to display the bifurcation of student achievement section wise: Understanding, Application and HOTS is to enable deciphering the student performance quality will pave way towards right candidate selection for various university, college and training sector programs.

Innovation and convergence of various resources from many agencies, institutions in public and private domain are to be consulted and engaged to leading this transformational change that will enable India to address better Mathematics program standards leading towards superior SLO to improve student feeder quality entering higher education programs and training sector programs. This is to ultimately benefit students with improved employability and entrepreneurship pathways.