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Ref No- Cir/RBS/2017-18/No.17 **Date-** 22/07/17

To: Parents (Class 1 to Class 8)
From: The Principal
Subject: Maths Program Improvement

Dear Parents,

At Redbricks School, we believe in bringing excellence in teaching-learning methodologies across all subjects.

Our effort is to continuously review our academic programme, and invest resources and efforts in its improvement. Our ultimate goal is that each child should learn effectively through diverse and well-researched teaching-learning methods, which result in acquisition of deep understanding and transferable skills. As a part of such efforts, this year we are reviewing and bringing further excellence in our Maths program. The school has also engaged an external subject expert as a mentor to review and guide us in the improvement process.

The profile of the expert is mentioned as under:

Veena Parankush Das is an educator who has gained her experiences through research based teaching of children as young as 2 years through high school. A science graduate from Mount Carmel College, Bangalore, her exposure to excellence in teaching formed the back bone of her teaching career. Opportunities like writing papers on 'How to teach Children Math', editing math text books for Cambridge, mentoring math and science teachers, across boards in schools across the country, creating easy to use math resources, makes her an expert on understanding how children understand math and how schools can make math a subject that can be psychologically uplifting for children.

Also, attached here is a document outlining the background of Maths program improvement at Redbricks School this year. It is created in the form of '*Frequently Asked Questions'* for parents to relate better. For any further details or discussion you may contact your child's Maths teacher/Academic Coordinator/Principal.

We look forward to your support and feedback in this program improvement process.

With warm regards
The Principal
Redbricks School

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MATHS PROGRAM- 2017-18 (CLASS 1 TO CLASS 8)

FREQUENTLY ASKED QUESTIONS FOR PARENT REFERENCE

CURRICULUM DESIGN:

1. What is your approach towards Maths curriculum?

Galileo said that the universe was written in the language of Math!
If one looks around, we realise that no description of our lives is complete without the use of numbers – be it quantity, space, distance and time.

And therefore, we come to the crux of what math is – *the language that describes everything we see and do in very precise terms.* And like 'language', be it Hindi, Gujarati or English, the language of math has its own vocabulary, mechanics and syntax, which the curriculum is all about. *Students will get multiple opportunities to experience and translate everyday experiences into mathematical language.*

Mathematical literacy develops when children are active and engaged in learning. "The development of the knowledge and skill go hand-in-hand with their application" (Perry 2000, 12). Everyday activities provide ample, rich opportunities for learning and doing mathematics.

2. What is the Maths syllabus for each year? What will students learn?

The Maths syllabus for each year at Redbricks School (RBS) is outlined in the form of '*Yearly Learning Outcomes*' and this is posted on the Parent Space website. The syllabus has been designed to align with the CISCE board curriculum requirements.

The Math syllabus at RBS focuses on two major aspects of Math:

a) *Content: This includes all the content strands of Math* – ***Number Sense (Arithmetic, Algebra), Measurement, Geometry, Data Handling***
b) *Processes: This includes important mathematical processes* -***Representation***, ***Connections***, ***Communication***, ***Reasoning, Problem Solving***

3. How does this syllabus compare with that of the other boards/schools?

The Math syllabus (RBS/CISCE) is also at par with the syllabus of the CBSE board. The content covered is based on Universal Math benchmarks, which are largely constant and common across national and international boards. Therefore, Redbricks students will not have any issue when transferring to any other board/school in regards to the content learnt.

4. On what basis have you selected the student textbook?

The student textbook selected is as per the CISCE curriculum.

5. On what basis have you selected the student notebook designs?

The student notebook designs have been selected in line with appropriate Math pedagogy –

Class 1 to Class 3 –

- In younger classes, single - lined portrait books have been selected vis a vis square-box books, as square-box books artificially divide mathematical representations creating lack of meaningful understanding of mathematical quantities and their representations for children.

(a) (b)

In the example (a), the learner reads 1 and 9 as two separate digits whereas in the example (b), the learner reads 19 as a whole number. The brain processes these visual stimuli differently – in the first compartmentalized, while in the second as a whole.

- The single line is also '**wide-ruled'** to give children space to write while their handwriting is still comparatively bigger.

Class 4 to Class 6 –

- In these classes, single-lined landscape books are selected with rough working columns on the right hand side.
- The format of this book helps children to segregate rough work from regular work.
- It also helps children to see continuity in solving problems/sums from the top to the bottom page.
- Children are encouraged to do only one problem/sum per page, to avoid psychological fear arising from an incorrect sum transferring to the next sum.
- Children also have a separate Geometry book and Graph book for specific representational requirements of these strands.

6. What other reference/practice material do the students use?

Teachers are equipped with multiple reference books such as multiple publisher textbooks of CISCE, CBSE, CIE boards. Teachers design and create additional worksheets/exercises for students to give rigour and practice of a wide variety of sums/problems.

One's problem solving capacity arises from the practice of translating various situations into mathematical statements and solving them. As such, the spectrum of problems that children can access is key to developing strong mathematical ability.

But the very first step to developing the above ability is that while learning any new concept, students are provided with lots of hands-on manipulatives like counters, straws, measuring tapes, weighing scales, etc., in order to practically understand the concept. Every classroom has a calendar and a clock to continuously reinforce the concept of time through short activities.

7. What are the USP's of this program?

1) Understanding the Language of Math: This program is designed to help children think and discover for themselves the *language of Math* through practical experiences in the context of their real-life and environment.

2) Concrete to Abstract Progression: It helps children to concretely experience mathematical concepts before moving on to the abstract task of representing these concepts through mathematical symbols (i.e. Situation -> mathematical statement-> manipulation through choice of appropriate strategies –make visible reasoning and hence proof of understanding).

3) Holistic Learning Outcomes: This program develops deeper understanding regarding the 'content' and equips children with the cognitive 'processes' required for problem-solving ability in Math and this ability is transferred into other domains. There is enough rigour and practice provided to develop *computational fluency* along with *procedural learning.*

4) Confidence in Math: Such a program helps each child to learn Math without fear and instills a sense of confidence in one's own Math abilities. Children start enjoying Math which itself sets the stage for higher learning. Learners of varying abilities and learning styles are able to learn using multiple methods.

TEACHING METHODOLOGY:

8. How is the timetable distributed? What is the rationale for this kind of weekly distribution in the timetable?

The break-up of the weekly timetable is distributed across all content stands of Math: ***Number Sense (Arithmetic, Algebra), Measurement, Geometry, Data Handling. An average weekly distribution of these periods will look as under:***

Number Sense	*Measurement*	*Geometry/ Data Handling*	*Rigour and Practice of concepts taught*
2 periods/wk	2 periods/wk	1 period/wk	1 period/wk

Rationale:

- *The above break-up allows children to learn Math holistically, drawing connections across multiple strands.*
- *It also presents content within each strand in a simple to complex progression through the year.*
- *Children tend to forget concepts when they are only taught at a point in time. Through regular focus on each strand and its concepts, children retain understanding better and develop more fluency through ongoing recall and practice.*
- *The mind grows in the connections it can make if opportunities for constructing knowledge is made available. Which means, the child is in control of making sense of more than what a teacher can 'teach'.*

9. Your sequence of teaching concepts is in contradiction to the sequence taken up in textbooks/tuitions. Won't it create confusion for the child?

The textbook serves as a 'tool' for practice once a concept has been understood. It is NOT a bible and it need not to be followed in a particular sequence. As and when children learn new concepts, the textbook is used to practice sums/problems, without creating any confusion.

Tuitions are unnecessary and focus largely on rote memorization and computational fluency without developing real-life conceptual understanding of the content. We discourage children to enroll for tuitions. They can seek their schoolteacher's guidance in developing clarity on confusions/ for extra practice material.

10. How do you teach each concept?

The sequence of learning any new concept is –

a. **Creating situations** where the concept is visible.
b. **Introduction** and demonstration by the teacher
c. **Concrete experience/handling manipulatives** by the child for gaining concept clarity under teacher's guidance
d. **Representation** of learning in writing (concrete to abstract, understanding connections between concepts)
e. **Rigour and practice** through the text book /other exercises (for developing automaticity and computational fluency)

Apart from this, **Mental Math** is practiced separately at least twice a week for 10 minutes each. This covers various concepts, which have already been taught.

Math is not about solving sums in the book. It is dependent on the mind's ability to visualize. And Mental math provides an opportunity where children can appreciate the value of 'listening' and discovering their own abilities and strategies in mental computation.

11. Why are there so many activities? Do they get time to study and practice?

The activities are meant for developing 'conceptual understanding'. What follows after the activities is solving exercises and practice on paper/mentally to establish 'computational skills'. All of these together are termed as 'study' for learning. In fact, in a learner's context an 'activity' is better termed if it is an 'experience' – for an activity is superficial while the experience is soul stirring.

12. How is enough rigour and practice provided for each concept?

After each concept is introduced, children solve textual exercises. They are also given additional sums from other reference books. Once a week, there is a dedicated session for rigour and practice through mixed bag exercises covering various concepts taught in the week. Mental Math practice is provided twice a week for 10 minutes by solving mental math exercises read aloud by the teacher.

Rigor for the mind and rigor in writing are both addressed in this manner.

13. What is the purpose of Mental Math and how do we get our children to do well in this?

Mental Math helps children to develop automaticity in solving sums/problems. It enhances their ability to visualize mentally and solve problems without the need to writing down each step. It is an important mathematical skill which gets better with practice. The school provides two opportunities every week for children to develop their 'listening comprehension' ability of mathematical language/situations. Parents can also pose such problems to children at home to enhance their capacity for listening carefully and computing mentally.

14. How do you teach operations?

The four operations of addition, subtraction, multiplication and division are procedures for manipulating numbers for desired results, under any number system (whole numbers, fractions, integers etc.). These 'operations' are to be understood in context before the computational aspect is addressed.

The first is through hands on experiences in the environment or through the use of manipulatives in the class. Only after these sessions where situations are translated into math language, will the computational aspect be addressed through drill sheets.

15. How do children learn Multiplication Tables?

Tables are an essential tool for computing as well as to help learners understand patterns in numbers. As such, learning the multiplication tables without understanding the 'why' of it will become tedious and a burden.

At RBS, children discover the 'tables' of 2,3,5,10 through the use of manipulatives, learn to express it in mathematical notation and then start to learn the tables by heart.

16. Are your teachers trained for this method of teaching?

Our teachers have been following inquiry based and student-centric teaching learning methods across various subjects. They are now being specifically trained and coached to adopt these methods in the area of 'Math' by a Math expert. They are also exposed to various other workshops and resources for developing their understanding and skills in the area of Math teaching. Teaching for Excellence is an ongoing process, and our teachers are committed to develop such excellence with ongoing professional development.

17. How much homework do you provide? Is it enough for rigour?

The homework policy in Math is given below for reference. This is enough for rigour as per the age requirements-

CLASS	MATHS
Class 1 and Class 2	Once/week ***Expected Duration*:** 15 minutes a day
Class 3 and Class 4	Twice/week ***Expected Duration*:** 20 minutes a day
Class 5 and Class 6	Twice/week + Once in every alternate week ***Expected Duration*:** 30 minutes a day
Class 7 and Class 8 - ICSE	Five times a week ***Expected Duration*:** 30 minutes a day

18. What kind of homework can we expect?

Children will be given various kinds of homework related to specific purposes, such as-

- Gathering data – for mathematical experiences
- Solving sums/problems- for practice/rigour

These will be in the form of tasks, worksheets, text book exercises, etc.

19. What can we do at home for rigour/practice?

Parents can support/extend the school learning by helping children in one or more of the following ways:

- Providing more real-life experiences related to mathematical concepts
- Discussing with children about the real-life experiences in school and conceptual learning gained from those
- Providing extra exercise books or material for additional practice of sums/problems
- By NOT sending them for tuitions.

ASSESSMENT:

20. How do you assess children's learning?

Teachers assess children's learning in multiple ways and in a continuous manner. Some of the methods of assessment in Math include:

Ongoing

- Mental Math exercises (tracking understanding twice/week for various concepts)
- Drill sheets (for computational fluency and accuracy)
- Mixed bag exercises (once/week for various concepts)
- Classroom discussions
- Assignments

End of unit

- Performance task at the end of a unit
- Unit-end Assessment / Cycle Test - Class 3 onwards

End of semester

- Exams – Class 5 onwards

21. What kind of questions on tests/exams can we expect?

The tests/exams will focus on questions from all the content strands. The questions will be framed to test children's ability to think conceptually and compute fluently. For specific type of questions, you may discuss with the respective Math teacher.

22. How can my child better prepare for Math tests/exams?

The design of the worksheets and the fluency of administering them are already preparing the children for taking a snap test at any point of time. In addition, if required, solving sums/problems which are conceptual and application based will add to this readiness.

23. What kind of assignments/performance tasks can we expect?

The assignments or performance tasks will pose real-life situations and problems to children, which can help them to practically apply and showcase their understanding of the concepts learnt.

24. How do we get feedback on the child's progress?

- Formally – through PTM, Performance Tasks/Assignment feedbacks, Mid-semester Report, End of Semester Report Card
- Informally – through evidences of understanding in child's writing and verbal communication

25. Will my child be able to cope up in external exams like ASSET, Olympiads, etc.?

Most external exams test children's ability to think conceptually and apply their understanding. With such a program, we expect children to become better at thinking and applying concepts. Therefore, their performance should improve on such tests.

26. Will my child be able to perform in CISCE/CIE board exams?

CISCE and CIE boards place an emphasis on procedural learning and application based assessments. Therefore, with such a program, children should be able to perform better on such board exams.

27. Are you experimenting on our children with such an approach?

An experiment is adopted as an approach to try a 'new untested' method. What we are following is NOT 'untested', but there is enough research and practical evidence to support the effectiveness of this Maths pedagogy. In fact, all educational boards in India and internationally are now promoting this approach in their outlined curriculum guidelines. This program adopts a tried and tested approach and is carefully planned for *coherence, consistency* and *effectiveness.* The ultimate goal is to maximize student learning and equip them with the required understandings and skills for long-term success.

For any further clarifications or questions, you may please contact the Principal.

Executive Summary

Principles and Standards for School Mathematics

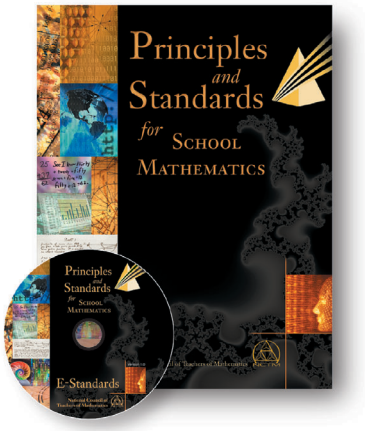
Overview

We live in a time of extraordinary and accelerating change. New knowledge, tools, and ways of doing and communicating mathematics continue to emerge and evolve. The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase.

In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed. The National Council of Teachers of Mathematics (NCTM) challenges the notion that mathematics is for only the select few. On the contrary, everyone needs to understand mathematics. All students should have the opportunity and the support necessary to learn significant mathematics with depth and understanding. There is no conflict between equity and excellence.

A Foundation for All Students

Principles and Standards for School Mathematics, published by NCTM in 2000, outlines the essential components of a high-quality school mathematics program. It calls for and presents a common foundation of mathematics to be learned by all students. It emphasizes the need for well-prepared and well-supported teachers and administrators. It acknowledges the importance of a carefully organized system for assessing students' learning and a program's effectiveness. It also underscores the need for all partners—students, teachers, administrators, community leaders, and parents—to contribute to building a high-quality program for all students.



What Is *Principles and Standards for School Mathematics?*

Principles and Standards for School Mathematics is a guide for focused, sustained efforts to improve students' school mathematics. It aims to do the following:

- **Set forth a comprehensive and coherent set of learning goals** for mathematics for all students from prekindergarten through grade 12 that will orient curricular, teaching, and assessment efforts during the next decades.
- **Serve as a resource for teachers,** education leaders, and policymakers to use in examining and improving the quality of mathematics instructional programs.
- **Guide the development** of curriculum frameworks, assessments, and instructional materials.
- **Stimulate ideas and ongoing conversations** at the national, state or provincial, and local levels about how best to help students gain a deep understanding of important mathematics.

Educational research shaped many of the proposals and claims made throughout *Principles and Standards.* The document contains references to research on what it is possible for students to learn about certain content areas, at certain levels, and under certain pedagogical conditions. The content and processes emphasized also reflect society's needs for mathematical literacy, past practice in mathematics education, and the values and expectations held by teachers, mathematics educators, mathematicians, and the general public.

Principles and Standards for School Mathematics is organized into four main parts:

- **Principles** for school mathematics
- **An Overview** of the Standards in prekindergarten through grade 12
- **Standards outlining in detail both the content and the processes of school mathematics,** accompanied by corresponding expectations, for four separate grade bands: prekindergarten through grade 2, grades 3–5, grades 6–8, and grades 9–12
- **A discussion** of steps needed to move toward the vision

NCTM
NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

The **Principles** are statements reflecting basic precepts that are fundamental to a high-quality mathematics education. The document elaborates the underlying assumptions, values, and evidence on which these Principles are founded. The **Standards** are descriptions of what mathematics instruction should enable students to know and do. Together, the **Principles** and **Standards** constitute a vision to guide educators as they strive for the continual improvement of mathematics education in classrooms, schools, and educational systems. The document includes, as an additional resource, an appendix, "Table of Standards and Expectations," that details the grade-band expectations for each Standard.

Six Principles for School Mathematics

Equity. *Excellence in mathematics education requires equity—high expectations and strong support for all students.*

All students, regardless of their personal characteristics, backgrounds, or physical challenges, can learn mathematics when they have access to high-quality mathematics instruction. Equity does not mean that every student should receive identical instruction. Rather, it demands that reasonable and appropriate accommodations be made and appropriately challenging content be included to promote access and attainment for *all* students.

Curriculum. *A curriculum is more than a collection of activities; it must be coherent, focused on important mathematics, and well articulated across the grades.*

In a coherent curriculum, mathematical ideas are linked to and build on one another so that students' understanding and knowledge deepen and their ability to apply mathematics expands. An effective mathematics curriculum focuses on important mathematics that will prepare students for continued study and for solving problems in a variety of school, home, and work settings. A well-articulated curriculum challenges students to learn increasingly more sophisticated mathematical ideas as they continue their studies.

Teaching. *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*

Students' understanding of mathematics, their ability to use it to solve problems, and their confidence in doing mathematics are all shaped by the teaching they encounter in school. To be effective, teachers must understand and be committed to students as learners of mathematics. They must know and understand deeply the mathematics they are teaching and be able to draw on that knowledge with flexibility in their teaching tasks. Teachers must be supported with ample opportunities and resources to enhance and refresh their knowledge.

Learning. *Students must learn mathematics with understanding, actively building new knowledge from experience and previous knowledge.*

Research has solidly established the important role of conceptual understanding in the learning of mathematics. By aligning factual knowledge and procedural proficiency with conceptual knowledge, students can become effective learners. They will be able to recognize the importance of reflecting on their thinking and learning from their mistakes. Students become competent and confident in their ability to tackle difficult problems and willing to persevere when tasks are challenging.

Assessment. *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*

When assessment is an integral part of mathematics instruction, it contributes significantly to students' mathematics learning. Assessment should inform and guide teachers as they make instructional decisions. The tasks teachers select for assessment convey a message to students about what kinds of mathematical knowledge and performance are valued. Feedback from assessment tasks helps students in setting goals, assuming responsibility for their own learning, and becoming more independent learners.

Technology. ***Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.***

Students can develop deeper understanding of mathematics with the appropriate use of technology. Technology can help support investigation by students in every area of mathematics and allow them to focus on decision making, reflection, reasoning, and problem solving. The existence, versatility, and power of technology make it possible and necessary to reexamine what mathematics students should learn as well as how they can best learn it.

Standards for Pre-K–12 Mathematics

What mathematical content and processes should students know and be able to use as they progress through school? *Principles and Standards for School Mathematics* presents an outline of the focus of school mathematics. High but attainable curriculum standards are required to produce a society that has both the capability to think and reason mathematically and a useful base of mathematical knowledge and skills needed in any walk of life.

The five **Content Standards** explicitly describe the five strands of content that students should learn, whereas the five **Process Standards** highlight ways of acquiring and applying content knowledge. The Standards, which span the entire range from prekindergarten through grade 12, are revisited at each of the four grade bands. Expectations for these grade bands are indicated, discussed, and illustrated with examples. A complete table of the Standards and Expectations by grade is included as an appendix in *Principles and Standards*.

Content Standards

Number and Operations. The Number and Operations Standard deals with understanding numbers, developing meanings of operations, and computing fluently. Young children focus on whole numbers with which they count, compare quantities, and develop an understanding of the structure of the base-ten number system. In higher grades, fractions and integers become more prominent. An understanding of numbers allows computational procedures to be learned and recalled with ease. Students should be able to perform computations in different ways. They should use mental methods and estimations in addition to doing paper-and-pencil calculations. Having computational fluency allows students to make good decisions about the use of calculators. Regardless of the method used to compute, students should be able to explain their method, understand that many methods exist, and see the usefulness of methods that are efficient, accurate, and general.

Algebra. Algebraic symbols and procedures for working with them are a towering mathematical accomplishment in the history of mathematics and are critical in mathematical work. Algebra is best learned as a set of concepts and techniques tied to the representation of quantitative relations and as a style of mathematical thinking for formalizing patterns, functions, and generalizations. Although many adults think that algebra is an area of mathematics more suited to middle school or high school students, even young children can be encouraged to use algebraic reasoning as they study numbers and operations and as they investigate patterns and relations among sets of numbers. In the Algebra Standard, the connections of algebra to number and everyday situations are extended in the later grade bands to include geometric ideas.

Geometry. Geometry has long been regarded as the place in high school where students learn to prove geometric theorems. The Geometry Standard takes a broader view of the power of geometry by calling on students to analyze characteristics of geometric shapes and make mathematical arguments about the geometric relationship, as well as to use visualization, spatial reasoning, and geometric modeling to solve problems. Geometry is a natural area of mathematics for the development of students' reasoning and justification skills.

Measurement. The study of measurement is crucial in the school mathematics curriculum because of its practicality and pervasiveness in so many aspects of life. The Measurement Standard includes understanding the attributes, units, systems, and processes of measurement as well as applying the techniques, tools, and formulas to determine measurements. Measurement can serve as a way to

integrate the different strands of mathematics because it offers opportunities to learn about and apply other areas of mathematics such as number, geometry, functions, and statistical ideas.

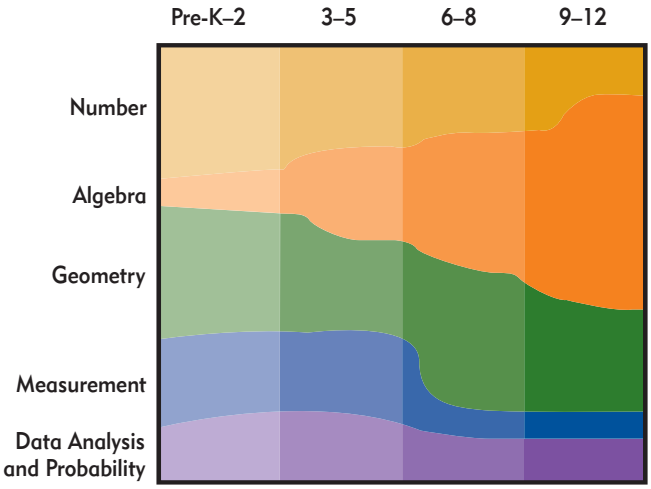
Data Analysis and Probability. Reasoning statistically is essential to being an informed citizen and consumer. The Data Analysis and Probability Standard calls for students to formulate questions and collect, organize, and display relevant data to answer these questions. Additionally, it emphasizes learning appropriate statistical methods to analyze data, making inferences and predictions based on data, and understanding and using the basic concepts of probability.

Process Standards

Problem Solving. Solving problems is not only a goal of learning mathematics but also a major means of doing so. It is an integral part of mathematics, not an isolated piece of the mathematics program. Students require frequent opportunities to formulate, grapple with, and solve complex problems that involve a significant amount of effort. They are to be encouraged to reflect on their thinking during the problem-solving process so that they can apply and adapt the strategies they develop to other problems and in other contexts. By solving mathematical problems, students acquire ways of thinking, habits of persistence and curiosity, and confidence in unfamiliar situations that serve them well outside the mathematics classroom.

Reasoning and Proof. Mathematical reasoning and proof offer powerful ways of developing and expressing insights about a wide range of phenomena. People who reason and think analytically tend to note patterns, structure, or regularities in both real-world and mathematical situations. They ask if those patterns are accidental or if they occur for a reason. They make and investigate mathematical conjectures. They develop and evaluate mathematical arguments and proofs, which are formal ways of expressing particular kinds of reasoning and justification. By exploring phenomena, justifying results, and using mathematical conjectures in all content areas and—with different expectations of sophistication—at all grade levels, students should see and expect that mathematics makes sense.

Communication. Mathematical communication is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment. When students are challenged to communicate the results of their thinking to others orally or in writing, they learn to be clear, convincing, and precise in their use of mathematical language.



The Content Standards should receive different emphases across the grade bands.

Explanations should include mathematical arguments and rationales, not just procedural descriptions or summaries. Listening to others' explanations gives students opportunities to develop their own understandings. Conversations in which mathematical ideas are explored from multiple perspectives help the participants sharpen their thinking and make connections.

Connections. Mathematics is not a collection of separate strands or standards, even though it is often partitioned and presented in this manner. Rather, mathematics is an integrated field of study. When students connect mathematical ideas, their understanding is deeper and more lasting, and they come to view mathematics as a coherent whole. They see mathematical connections in the rich interplay among mathematical topics, in contexts that relate mathematics to other subjects, and in their own interests and experience. Through instruction that emphasizes the interrelatedness of mathematical ideas, students learn not only mathematics but also about the utility of mathematics.

Representations. Mathematical ideas can be represented in a variety of ways: pictures, concrete materials, tables, graphs, number and letter symbols, spreadsheet displays, and so on. The ways in which mathematical ideas are represented is fundamental to how people understand and use those ideas. Many of the representations we now take for granted are the result of a process of cultural refinement that took place over many years. When students gain access to mathematical representations and the ideas they express and when they can create representations to capture mathematical concepts or relationships, they acquire a set of tools that significantly expand their capacity to model and interpret physical, social, and mathematical phenomena.

Ensuring a High-Quality Mathematics Education for All Students

Principles and Standards provides a catalyst for the continued improvement of mathematics education. It represents the best current understanding of mathematics teaching and learning and the contextual factors that shape it. *Principles and Standards* articulates principles to guide decisions about school mathematics and high, but attainable, standards.

Realizing the vision of mathematics education that is described in *Principles and Standards* requires the continued creation of high-quality instructional materials and technology. It requires enhanced preparation for teachers and increased opportunities for professional growth. It requires the creation of assessments aligned with curricular goals. Realizing the vision depends on the active participation of teachers, students, school administrators, teacher-leaders, policymakers, parents and other caregivers, mathematicians, mathematics educators, and the local community. It will require that the vision be shared and understood and that everyone concerned be committed to improving the future of all children.

Learning with Understanding. Imagine a classroom, a school, or a school district where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodations for those who need them and challenges for those who stand to benefit from them. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding. Technology is an essential component of the environment.

Students confidently engage in complex mathematical tasks chosen carefully by teachers. They draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress. Teachers help students make, refine, and explore conjectures on the basis of evidence and use a variety of reasoning and proof techniques to confirm or disprove those conjectures. Students are flexible and resourceful problem solvers. Alone or in groups and with access to technology, they work productively and reflectively, with the skilled guidance of their teachers. Orally and in writing, students communicate their ideas and results effectively. They value mathematics and engage actively in learning it.

Resources

The National Council of Teachers of Mathematics (NCTM) has also produced supporting resources for *Principles and Standards for School Mathematics*. Among them are a set of Frequently Asked Questions about *Principles and Standards,* a Quick Reference Guide that outlines Standards and Expectations by grade band, and an outreach CD to assist those making presentations about *Principles and Standards* or interested in exploring the ten Standards and learning more about them. The Navigations book series translates the *Principles and Standards* into action in the classroom and highlights major mathematics content areas in grade-band-specific volumes. Most recently, the Council published the *Administrator's Guide: How to Support and Improve Mathematics Education in Your School* for school administrators and others responsible for implementing standards, as well as *A Research Companion to "Principles and Standards for School Mathematics."* All are available for sale from NCTM Customer Service (800-235-7566) or the NCTM Web site (www.nctm.org/catalog).

National Council of Teachers of Mathematics

Since 1920, the National Council of Teachers of Mathematics has been dedicated to the improvement of school mathematics at all levels. Through its publications, conferences, Web site offerings, and other services, this professional organization of more than 90,000 members provides a forum for discussing new developments, sharing innovative classroom experiences, and evaluating trends in the teaching of mathematics. NCTM and its 250 Affiliates in the United States and Canada form a network that serves as a clearinghouse of information and resources for all topics related to mathematics education.

A searchable electronic version of *Principles and Standards,* as well as print copies, can be purchased through the NCTM Web site, www.nctm.org, or by contacting

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