

The IMACS Mathematics Enrichment classes are a unique sequence of classes that combine games, logic puzzles, mathematical problem-solving, and other interesting mathematical activities in the development of logical and critical thinking skills and the ability to deal with abstractions.

Background

Each lesson in the IMACS Mathematics Enrichment program has been carefully and individually crafted by the IMACS Curriculum Development Group (CDG). During the 1960's, 70's and 80's, with federal funding and support from national educational laboratories, the developers in the IMACS CDG created an entire mathematics curriculum for elementary schools. Called the Comprehensive School Mathematics Program (CSMP), this curriculum is now published by McRel and is taught throughout the USA. The team also developed a program for talented elementary school students called *Challenge*, published by Addison-Wesley. Other curricula were developed by this group for talented middle and high school students.



In each case, the team always faced the problem that the curriculum had to be designed in such a way that school teachers could teach the new material without significant retraining. Retraining teachers is expensive, and is invariably the biggest barrier to the introduction of new curricula. Working under this restriction had frustrated the team on many occasions. One solution was to approach the task from a different angle. Rather than attempt to replace the traditional curriculum, the team decided to augment the standard material. With the establishment of the IMACS after-school and weekend enrichment school in



Plantation, FL, the team embarked on the development of a new curriculum aimed directly and solely at young students with an interest in or talent for mathematics, but which did not compromise the high expectations of those who would teach it. The unique and incomparable IMACS Curriculum was born!

Traditional teaching generally focuses on the mastery of arithmetic algorithms, usually of the paper-and-pencil kind. On the other hand, IMACS students become involved with real mathematical activities from which they develop a fundamental mathematical understanding. In fact, in IMACS lessons little or no attention is given to arithmetic

manipulations. Instead, the focus is maintained almost exclusively on problem solving and logical reasoning, using standard mathematical abstractions such as sets, relations and functions, but with an approach geared to bright, young students.

The systematic use of these abstractions allows IMACS instructors to introduce certain concepts much earlier than usual. For example, concepts in arithmetic (including negative, rational, and decimal numbers), geometry, measurement, probability, statistics, and combinatorics are introduced in the IMACS Mathematics Enrichment curriculum at a much earlier age than traditional curricula allow.

Thanks to a pedagogy of situations, IMACS students participate in a learning process which leads to the development of skills not by rote memorization but by constructing their own understanding. Faced with challenging situations, the students are led by their own reactions to important ideas in mathematics—they begin to mathematize situations. As this process unfolds, the IMACS student develops a profound and far-reaching mastery of the logical basis on which true mathematical knowledge is based.

Spiral Approach

Students learn through many interrelated experiences. But no experience is an end in itself, particularly a mathematics lesson. With this in mind, IMACS Mathematics Enrichment introduces an idea in one lesson, then another in the next lesson, then another. Later, the first idea reappears in a slightly new setting, or in a slightly expanded version, perhaps with connections to other concepts; then a second topic reappears; and so on. Each of the many times a particular idea or area of study reappears, it is treated in a different manner, and at a slightly higher level than the last time. This is called spiral development.

Spiral development allows students to learn at different times and at different rates. Moreover, only part of the learning of a given topic actually takes place during the classroom lesson. In between the times the topic occurs on the learning spiral, the student is mentally digesting the idea, sometimes consciously, usually unconsciously. In this way the spiral development gives each student a new chance to catch on at each stage. IMACS developers have found it highly effective to follow this kind of development rather than continuing on and on with a topic until so-called mastery has occurred.

The spiral approach implies that some lessons may be stopped before some (or even a majority of) students appear to have caught on. It involves knowing that the topic will reappear again and again, and that varying degrees of understanding will come at varying rates and times for each student. It includes the belief that an idea planted now may not sprout until much later, and that it is best not to force its development.

Is it Really Mathematics?

Yes. Mathematics is much more than calculation with numbers, and its methods include more than paper-and-pencil algorithms. The IMACS Mathematics Enrichment curriculum is filled with experiences that directly and indirectly relate to a wide world of numbers, their interrelationships, and the kinds of logical reasoning about these relationships that make mathematics an activity of interest and concern.

The IMACS Mathematics Enrichment curriculum uses several special teaching tools to achieve its aims. The *Language of Strings* provides a very natural method for collecting and classifying data. It visualizes the fundamentally useful and important mathematical notion of sets. The *Language of Arrows* provides a colorful method for recording and investigating the relationships between mathematical objects. It visualizes the mathematical notions of relations (such as the ordering relations) and functions (including arithmetical operations such as adding, subtracting, multiplying, and sharing equally), and makes possible the consideration at a young age of abstract concepts such as the composition of relations. The *Papy Minicomputer*, a mixed-base binary/decimal abacus invented by the world-renowned Belgian mathematician Georges Papy, allows the in-depth study of a positional numeration system. Besides this, it lends itself to a multitude of numerical algorithms, including the standard algorithms for the basic arithmetical operations, doubling and halving, the manipulation of decimals, and a wide variety of strategic numerical games. It allows very young students to become familiar with and operate upon large numbers long before they are able to work with them on paper. The *Calculator* serves as an instructional tool to help students develop mental arithmetic skills and number sense as well as to focus their attention on understanding and problem-solving.

Benefits for Students

IMACS students are exposed to a great deal of mathematics that is not taught in traditional programs. Moreover, each IMACS student develops a deep intuitive understanding of the fundamental concepts of mathematics, including concepts in arithmetic, in the theory of sets, relations, and functions, and in mathematical logic.

This advantage is quantitatively apparent when IMACS students participate in math competitions, for example. And even though the focus of IMACS Mathematics Enrichment lessons is exclusively on understanding of mathematical concepts and not the mastery of an objectively measurable skill, many IMACS students show significant improvements in standardized test scores.

But the true benefit of the IMACS Mathematics Enrichment program goes far beyond the obvious benefit of a deep understanding of advanced mathematical concepts. Parents and teachers may expect IMACS students to exhibit an increase in self-confidence, and a significant improvement in thinking and reasoning and in the ability to approach and solve non-routine problems of all kinds. To paraphrase an often-heard comment from parents, IMACS students simply have an unfair advantage over their peers.

IMPORTANT NOTE: Prior to registering in the IMACS Mathematics Enrichment program, students and their parents must attend a Demonstration Class. These classes are free, and are scheduled prior to the start of each quarter. Demonstration Classes provide parents with an opportunity to see the unique IMACS curriculum and teaching methods in action, and allow IMACS instructors to assess the mathematics enrichment level that best suits each individual student. Please contact IMACS to reserve a place in a Demonstration Class.