

Institute for Advanced Study/Park City Mathematics Institute
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Mathematical Literacy for All Students

In today's world, a world driven by technology and information, mathematics is emerging as a critical filter for students; mathematics can prepare individuals to become productive citizens and provide them with a foundation for what they do to earn a living. Mathematically literate citizens can make meaningful contributions to their own welfare, to the welfare of the society in which they live, and to the business/industry/workplace in which they earn their living. The Program of International Student Assessment (PISA) defines mathematical literacy "as an individual's capacity to identify and understand the role that mathematics plays in the world, to make well founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive concerned and reflective citizen." [www.pisa.oecd.org/pages/0,2996]. But preparing students to be mathematically literate implies that teachers must be prepared to teach the mathematics necessary for mathematical literacy. The Institute for Advanced Study/Park City Mathematics Institute (PCMI) 2005 International Seminar: Bridging Policy and Practice, in considering the mathematical preparation of teachers, used the notion of mathematical literacy for all students to ground their cross-country discussion of teacher preparation and development: what do teachers need to know in order to prepare students to be mathematically literate. The participants began by accepting the PISA definition of mathematical literacy as a working definition and built upon it in developing common beliefs and recommendations.

Certain common beliefs emerged:

- Everyone needs mathematics. Mathematics is important for informed and responsible citizenship.
- Not all students have the same mathematical needs for their entire academic careers.
- Every child should have access to the same mathematics up to age 14.
- Mathematics courses should be available to all students up to the end of schooling at the pre-collegiate level. These courses should include options for all types of careers.
- Students need to realize that it is only through mathematics that some important problems of the society in which they live can be solved. This means the curriculum must be designed to ensure that students have the opportunity to investigate such problems.

To prepare mathematically literate students, the curricula should include:

- a study of continuous and discrete mathematics;
- explicit connections to other fields including social science, arts, literature and science fields, as well as mathematical fields;
- an emphasis on mathematical modeling;
- experiences with probability, decision-making, and predicting;
- a focus on basic Euclidean geometric concepts, spatial visualization, and geometry as a unifying tool for access to algebraic;

- an emphasis on numeracy, the ability to reason sensibly with and about numbers and their use in a variety of contexts;
- a study of functions with different representations;
- an emphasis on reasoning, conjectures, and proof;
- experiences with data analysis and fundamental statistical concepts.

To achieve mathematical literacy, teachers must recognize that

- a fundamental level of literacy is independent of the level of students and the type of applications to be studied;
- solutions to modeling problems depend on the level of mathematical understanding students bring to problems;
- their expectations as teachers can be heavily influenced by their beliefs about students, which set norms for student achievement and frame how the mathematics is taught.
- technology can be a vehicle for allowing access to mathematics. Although technology is not available to all in many parts of the world, whenever possible it should be acknowledged that technology, (i.e., graphing calculators, computer laboratories and Internet access) facilitates mathematical literacy.

Implications for Teachers: Teaching for mathematical literacy

- means giving students problems at different levels, in different contexts, and finding different solutions. This includes a reflection process that allows students to ask and expect answers to “Why am I doing this”.
- includes practicing and using logical thinking in a variety of mathematical settings and at a variety of levels.
- involves using a variety of approaches not only a theoretical basis;
- requires that teachers use a variety of methods to allow students to experience construction of mathematics and mathematization
- demands pedagogical and mathematical content knowledge.