Reasoning and Problem Solving: Mathematics Thrust in the 2000s

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*T*he "back to the basics" movement in mathematics is the return to what mathematics is all about -- *thinking* and *problem-solving*. Mathematics is rooted in man's earliest endeavors as an aid to human activity in every area that requires reasoning. It is a process often applied by man in his efforts to seek solutions to problems in and around his environment. Mathematics in its origin is reasoning and problem solving.

Reasoning in mathematics and problem-solving often go hand-in-hand. The art of reasoning is used in the process of problem-solving. George Polya, the Polish-born mathematician, is a trailblazer in putting reasoning and problem-solving ability in their right place -- the very basis and essence of mathematics. Polya defines problem-solving as "finding a way out of a difficulty, a way around an obstacle, attaining an aim which was not immediately attainable." Problem-solving involves intelligence. Although lower animals oftentimes show some forms of problem-solving ability in overcoming obstacles encountered along their way, these forms come from instinct and not from real intelligence. Intelligence is a special gift to mankind that characterizes man over all other animals.

What is a problem? Polya says that "to have problem means -- to search consciously for some appropriate action to attain a clearly conceived but not immediately attainable aim." Solving a problem means "finding such action." The degree of difficulty of a problem is mistakenly used to gauge the existence or non-

existence of the problem. We often hear people say that "There is no problem" when they mean that the solution and answer to the problem is easy to find. On the other hand, people say "There is a problem!" when the solution and answer is hard to attain. Nevertheless, the problem exists in both situations.

Every record in human history includes accounts of man doing some form of mathematics. When man started thinking of finding ways and actions in solving his problem he was doing mathematics. Perhaps at the beginning more conscious efforts were made. Most of these activities later were clearly established and became routinary. Many of them ceased to be problems but common exercises and done unconsciously as habits. However, these situations are to man's advantage. Now, he is free to focus his conscious efforts in meeting and solving new problems.

Problem-solving will always be one of man's continuing activities. There are always problems to solve -- old ones and now ones. Many solutions and processes in solving these problems are already established, but many more still needed to be found. some tools and devices in getting these answers are also made, but still new ones are needed. There is no end to man doing mathematics using reasoning and problem-solving.

We are seeing in the decade of the 90's the coming into full bloom of the computer and high technology. Almost every area of human activity will be pervaded by high-tech electronic gadgetry. The "chips" are becoming the ever-present components in almost everything we use. These things range from the simple toys our children play, to the ubiquitous digitals found in timepieces, read-outs, registers and others, and to the complex and sophisticated entertainment sets and mass-media instruments at home, in the community, and in the business world. Surprisingly, the schools which spawned these knowledge in high technology are timid and even reluctant to embrace and utilize these modern-day helps and convenience.

The computer is revolutionizing every facet of our lives today. The industrial revolution about a century ago changed our society from a solely fixed agrarian to a mechanized-assembly lined-fast phased mobile society. The computer revolution is shrinking our society and our world into a tiny electronic chip ushering us into the information and space age. We see right in our own living room what happens and when it happens with the news in and around our world. The saying goes that "Everything you want to know is at the tip of your finger."

The advent of the computer and the new technology necessitated a *shift of emphasis* from computational exercise to critical thinking and analysis. What used to be laborious and long computational processes in mathematics in the past can be

done routinely today ny high-speed calculators and computers. Thus, the shift of focus to reasoning in problem-solving and in finding *algorithms*, (i.e., ways in solving) and in being able to program these algorithms into instructions for computers to execute.

Even without the computer hardware, mathematics is still basically "an exercise of the minds." The emphasis is on the reasoning and in the understanding of the processes in mathematics rather than in the manipulative and computational skill.

The ability to think will carry anyone a long, long way to go in whatever endeavor and pursuit he has in life. *If you can think, then you can do many, many things!* To be able to go ahead into the year 2000 and be in the cutting edge will require one to discipline and train his mind to think, to reason, and to act accordingly in the best manner possible. One has to sharpen his thinking ability more than his computational skill and to learn to be analytical and critical rather than mechanical. Computers and robot machines are more efficient and faster in computation and repeated processes.

High technology and machines will do many of the chores and the routines in the year 2000. But high-tech gadgetry and machines require human minds to develop, to invent, to run, and to maintain. The human mind is still far better than any computer ever built and in existence today. The human mind is still far more flexible and adaptable and able to analyze, to reason, and to think than any machine and technology that man will ever try to develop and build.

There is always room at the top for anyone who has learned to *think* and to *reason* creatively and productively. The problems in the years 2000 and beyond need people who can produce solutions through creative and logical thinking.

As mathematics educators, we owe it to our students today and in the next generations to come to help them understand and learn reasoning in mathematics and problem-solving. Even if our schools do not have computers, the teaching of reasoning and problem-solving in mathematics will help the students to become critical and analytical thinkers allowing them to find their way in doing things in our complex and demanding society in the year 2000 and beyond.

The thrust of mathematics in the years to come is *rationalization through problem-solving.*