Forum

Vitality of Some Very Old Ideas

Arnold E. Ross

Arnold E. Ross was born in Chicago in 1906 and spent part of his youth in Odessa. In 1921 he returned to Chicago and studied with E. H. Moore and L. E. Dickson, obtaining his Ph.D. in 1931. In the 1950s, while on the faculty of Notre Dame University, Ross initiated a summer program for mathematically talented high school students. The program, now called the Ross Young Scholars program, moved with him to The Ohio State University in 1963, and he has continued to run it ever since. The program has had a large impact: Many mathematicians currently active today found early inspiration in Ross's program. In addition, it has been used as a model for a number of successful summer programs on other college and university campuses. In the Ross Young Scholars Program, students work intensively on challenging problem sets which explore complex mathematical situations and encourage students to develop their own conjectures. The fact that many past participants return in later years to serve as counselors has provided the program with continuity and a sense of tradition. Further information on the Ross Young Scholars Program may be found in the article "A Conference Honoring Arnold Ross on His 90th Birthday", by Daniel B. Shapiro, Notices, *October 1996, pages 1151–1154. The URL for the program's Web site is* `http://www.math.ohio-state.edu/ross/index.html`. *The following article, which presents some of Ross's reflections on education today, is informed by his more than forty years of experience working with and inspiring young people in mathematics.*

—Allyn Jackson

Arnold E. Ross is professor emeritus of mathematics at The Ohio State University. His e-mail address is `aer@math.ohio-state.edu`. *This article was written with the assistance of Allyn Jackson.*

Our Background

In its award citation for our program [1], the AMS award committee pointed up the commitment to "inspiring generations of young people." This warm approbation creates the impression that strong and affectionate dedication creates the needed magic regardless of detail. The students are supposedly "talented", and this alone, apart from the nature of student involvement, guarantees success.

What are, in fact, the realities which govern our exercise of affection [2]?

I feel that much of what we have learned from our experience in the Ross Young Scholars (RYS) program has significance for the broad concerns of our mathematical community. It is time to speak up with the accent on the inspired and inspiring ideas so well represented by Eliakim Hastings Moore at Chicago and continued with extraordinary vigor by his student Robert Lee Moore [3].

In this paper we describe as clearly and as vividly as we can how we work with our young charges, and illustrate our progress through examples of reactions of our pupils as they face the transition from passive listeners to deeply involved participants.

The Environment

We face our educational challenges against the background of an unprecedented tempo of economic development. We must be able to help our young charges learn to cope with the flow of innovation and the pressures of the associated competitiveness in their professional lives.

The economically and socially destabilizing effect of the dramatic deficiencies in our nation's precollege education has engendered strong concern from leading political figures of many national centers. In Chicago, where problems were considered to be intractable, Mayor Richard Daley achieved a turnaround in the quality of performance of his public school system.

As mathematics teachers at the collegiate level we are confronted by a growing dissatisfaction with our practices by our colleagues in science and engineering. This is becoming more and more critical.

The growing gap between the quality of performance of our American students and students coming from abroad should be of serious concern. Its economic and social implications are deeply disturbing.

Taking Responsibility

The unhappy practice of systematic evaluation of teachers by their students raises passivity to the status of virtue. The student does not ask himself, "What have I contributed to my progress?" but instead analyzes his teacher's shortcomings—a task for which the student is really not qualified.

This practice inculcates attitudes which Bertrand Russell characterized in another context as intellectual provincialism: If the student is happy today, why should we worry about his tomorrow?

In the RYS program we try to make our young charges aware of their own role in building for the future [4]. Let them speak for themselves:

"I believe that what I will get out of this time spent here this summer fully depends on my own desire for self-improvement and enlightenment in topics of math. Deriving conjectures on problem sets and working out a language useful in communicating these conjectures to others is a very important lesson. I've learned about how to approach problems and topics of exploration."

Durable Skills

In mathematics we make progress by acquiring new, more sophisticated skills grounded in the skills already mastered. All of us have been disturbed by the fact that too often skills acquired in a prerequisite class are no longer available when needed in more advanced studies in mathematics, engineering, or science.

The student's passivity is again a culprit. He is very shortsighted in his view of the significance of learning. His view of life does not reach out beyond the coming classroom test. His environment encourages the development of only short-range or at best middle-range memory. Our limited expectations of the student are a partner in this conspiracy.

The student's strong involvement is essential for the development of long-range memory. Also, deep involvement provides for the student a comforting sense of personal achievement and, when shared, enriches the esprit de corps of the whole group of student participants.

Let them provide a view of their working with us:

"The program here is a total immersion in mathematics. At nearly any hour of the day one can find someone to discuss an interesting topic with. But it is much more than that. It is impossible to describe the emotion that fills one after proving an interesting theorem or making a conjecture and discovering it true. Often it is a thrill even just to conjecture based on experience and understanding, without being able to prove decisively.…As I advance on the [problem] sets I am able to consolidate my knowledge further, drawing connections between ideas believed to be unrelated or unimportant. There is a unity in mathematics difficult to find elsewhere in life.…But this summer has only left me longing for more, to see what else lies within my reach, as every discovery just adds more questions, and no concept is ever fully exhausted of ideas. I look forward to a life filled with mathematics."

Our Future

In order to avoid an accusation by Russell of being provincial, we should look beyond the accepted secure period of learning and out into the less friendly and sharply competitive society. What kind of student involvement is called for to prepare him for the challenges he will face?

At the turn of this century our scientific and technological progress occurred from time to time in dramatic spurts. The tempo allowed for periods of adjustment. At present the tempo of progress has become almost continuous.

Discovery is a vital ingredient of progress. Today the capacity for imaginative initiative is critically important for professional success. Student involvement must anticipate forthcoming professional demands, and this involvement must therefore provide experience of exploration and discovery as an important component of learning.

This is what we attempt to accomplish in our program. Our young charges respond with enthusiasm. Let us observe them at work:

"The system here promotes discovery by one's self of the principles of mathematics. Wrong guesses and false conjectures are a way of life here. This self-discovery promotes communication and

verification of one's ideas. This is an integral part of the real world today, but most schools do not adequately prepare students for this environment."

Language

It has been observed that in every human activity experience comes first, and as this experience grows the need for communication motivates development of language.

Sadly enough, in our classroom practice we place language first and experience second. We worry about what we should say to help the student "understand". By this we mean to provide the effect of experience through the use of suitably chosen words. Not unexpectedly, the effect is at best only a very pale image of the real thing.

Often classroom presentations sound like the common-parlance English accessible to the classroom audience. Precise and concise mathematical language is often totally incomprehensible to this audience.

Even in pure research there are very few loners. In any professional group, quality of communication is important. It is particularly important in academic pursuits. In our program we try to put together a community of young (very young indeed) scholars by encouraging in every possible way the development of language skills.

Our young audience readily responds:

"I have enhanced my language greatly. I am now able to convey my ideas much more precisely. I have learned how to make interesting conjectures and then to test them to see if they hold true. I have learned how to formalize my results into a product that is understandable to others."

Epilogue

We are aware in a rather diffuse manner that quality of life is related to the quality of education. Today we have experienced science fiction advances in communication arts and in international work force mobility. The skills needed in many of our workplaces are knowledge based. Sadly enough, our unwieldy educational system, through forbearance of nonprogress in the secondary school and through subsequent tolerance of easy academic credit, is moving us into a certificate-based society.

It is very likely that our upcoming generation will begin to question the value of certificates on offer as a badge of economic security. Some may select available occupations not requiring strict certification. Some who are unusually ambitious (and possibly more affluent) will seek our more prestigious certificates. Sadly enough, most will be adequately prepared neither for their chosen occupations nor for meeting intense worldwide competition in our knowledge-based economy.

Remembering what we do each summer is always heartwarming. Our aim is to add to the quality of life of our young charges and of our talented and dedicated counselors (our counselors contribute immensely to the success of our program). We hope that programs such as ours may play the role of pathfinders [5] in the labyrinth of challenges confronting us today.

References

[1] 1998 Citations for Public Service, *Notices* (April 1998), 513–516.

[2] The Ross Young Scholars Program at OSU, by Naomi D. Fisher, *MER Newsletter* **2** (1998).

[3] *A Century of Mathematics in America, Volume 2* (Peter Duren, ed.), Amer. Math. Soc., Providence, RI, 1989, p. 173.

[4] Windmills or Stepping Stones? by Arnold E. Ross, in *A Century of Mathematical Meetings*, Amer. Math. Soc., Providence, RI, 1996. This paper contains a description of our program for master teachers. Our teacher program utilizes the RYS program as a laboratory and as an opportunity for participating teachers to observe at close quarters the potential for achievement of our very young charges in the RYS program.

[5] The Demise of the Young Scholars Program, by Allyn Jackson, *Notices* (March 1998), 381–387. This paper contains a fine description of our sister program PROMYS, directed at Boston University by Glenn Stevens and David Fried.