The Benefits of Mathematics Competitions

By Thomas N. Thrasher

Since the inception of the annual Alabama Statewide Mathematics Contest in 1981, ACTM and AACTM have been co-sponsors. Articles on this competition have appeared regularly in this journal. Since a major investment of resources (e.g., manpower, time, and expense) is involved in planning and conducting such competitions, it is apparent that many mathematics educators, school leaders, parents, and community sponsors believe that mathematical competition is beneficial (Howell, 1981).

A substantial amount of research has been conducted since the 1920's in an effort to determine the effects of cooperative and competitive approaches to learning. Considerable disagreement has existed concerning the conclusions to be drawn from such studies (Reid, 1992). For example, Michaels and Forsyth (1977) conclude that competitive approaches result in higher achievement than cooperative approaches, whereas Sharan, Hertz-Lazarowitz, and Ackerman (1980) reach the opposite conclusion. Furthermore, Slavin (1977, 1980) contends that intergroup competition is needed to facilitate effective cooperation, whereas Johnson and Johnson (1974, 1975) found intergroup competition to be irrelevant to the effectiveness of cooperative approaches. Despite the existence of differing conclusions related to the relationship of cooperation and competition to learning, there is evidence that competition provides benefits in at least some instances (Michaels & Forsyth, 1977; Slavin, 1977, 1980). Consequently, a consideration of benefits is in order.

One benefit of mathematical competition is that it provides a challenge to teachers and students. *The College Mathematics Journal,* an official publication of the Mathematical Association of America (MAA), included a "Problems" section, edited by Roger B. Nelsen and a team of assistants. A stated purpose was to "challenge teachers of the first two years of college mathematics"

(Nelsen, 1989, p. 163). The following problem is an example: "In the decimal addition SAGE + SUAVE + SAGE = 46933 the addend digits have been replaced unambiguously by letters. Restore the digits and identify who is described" (p. 163).

Second, competition stimulates student curiosity and activity. *The Alabama Journal of Mathematics* sponsors a "Problem Section." The original intention for the problems was to "help the teacher stimulate curiosity and activity by students" (Casazza, 1977, pp. 82-83). An example problem is: "In a barn there are both horses and men. In all, there are 22 heads and 72 feet. How many horses and how many men are in the barn?" (Casazza, 1980).

Third, competition provides opportunities to recognize problem solvers. *The MATYC* Journal included a "Problem Department," edited by Martin J. Brown, that proposed problems and published solutions submitted by readers (Brown, 1978). Problems are those "which may arise in connection with the content of mathematics courses offered in the first two years of college" (p. 64). The following problem is one of those posed in that issue: "Find all real values of k such that the zeros of $P(x) = x^4 - 2x^3 + (1-2k)x^2 + 2kx$ are real, distinct, and form an arithmetic progression" (p. 65). The *Journal* also sponsors an annual High School Student Mathematics Contest for students in grades 10-12. Solutions to 10 problems are submitted by mail (Miller, 1979).

Fourth, competitions provide opportunities for many students to participate actively. For example, Mathcounts is a national middle school contest in which more than 6000 schools and 500,000 students participated during 2003 (Mathcounts, 2004). Competition is held on chapter, state, and national levels. More than 100 corporate and professional sponsors underwrite the expenses of the contest (Xhajanka, 1994).

Fifth, preparation for competitions provides opportunities for students to explore non-routine problems, types of problems not usually encountered as a part of the regular mathematics curriculum. Schaaf (1978) compiled *A Bibliography of Recreational Mathematics* in which he categorized more than 2600 references to recreational mathematics. Schaaf summarized the types of problems encountered:

> Although considerable interest still exists in number pleasantries, mazes, paperfolding, geometrical and topological problems, magic squares, Pythagorean triples, board games, and many other "classical" recreations, certain areas have achieved prominence in recent years: alphametics, paper-and-pencil games, tiling, combinatorial problems, game strategy, simulation, and computer recreations. (pp. vii-viii)

Sixth, competition encourages students to explore alterative solutions to problems. Barry (1992) presents fourteen distinct methods for solving a particular problem involving the sine of an angle. Nine of these methods were found by students preparing for mathematics competitions. In addition, the Discovery Program provides a range of activities, including competitions and math projects, which focus on creating learning experiences to foster lifelong learning for all students (Schulthes & Wolosky, 1998).

Seventh, competition is beneficial in that it promotes teamwork and enthusiasm. Parker, Zullo, and Preyer (1999) report on the Mathematical Contest in Modeling in which teams of undergraduate students compete internationally. The authors conclude that the competitive program promotes teamwork and generates enthusiasm in students. As part of a longitudinal study, 40 high-achieving German scientists were identified and compared with a nationally representative sample. Among predictor variables the researchers report are an inclination toward intellectual problems and participation in academic competitions (Sieglen & Trost, 1998).

Eighth, mathematics competitions are useful for strengthening the education of gifted students (Kalman, 2002). Riley and Karnes (1998) report on how teachers of the gifted can provide mathematics study that is dynamic, innovative, and creative. They describe how mathematics competitions for elementary, middle, and high school students are used to explore problem-solving and real-life applications. Based upon a survey of 230 gifted students, Olszewski-Kubilius and Lee (2004) found that gifted students are more likely to participate in competitions, clubs, or other extracurricular activities in mathematics than non-gifted students.

Ninth, students with disabilities are not deprived of opportunities for mathematics competition. Palka (1994) describes a successful competitive Math Bowl for hearing disabled junior high students. Six schools for the deaf participated. Mathematics tournament organizers in Alabama seek to accommodate students with disabilities.

Wahl and Besag (1986) researched the types of attributions, including experience in competitive activities, which students make for their algebra performance. The data indicate that competition teaches students to rely on their own efforts and to attribute their achievement to their efforts. Their study did not corroborate previous research findings that indicated differences between girls and boys. However, a study by Li and Adamson (1992) of 169 gifted high school students shows that boys prefer competitive styles more than girls do. By studying the experiences of sixth graders who participated in Math Olympiads, Volpe (1999) concluded that this type of competition is one way of providing mathematical experiences that encourage the personal and mathematical growth of young women.

In view of conflicting conclusions in the research about the benefits of competition, achieving a balance between competitive and cooperative approaches in the mathematics curriculum seems to be a worthwhile aim. Brain-based research by Gurian, Henley, and Trueman (2001) supports the conclusion that "the ultimate classroom" should include both cooperative and competitive learning experiences.

References

[1] Barry, D. (1992), An Abundance of Solutions, *Mathematics Teacher,* 85(5), 384-387.

[2] Brown, M. J. (1978), Problem Department, *The MATYC Journal,* 12, 253-256.

[3] Casazza, P. (Ed.). (1977), Problem Section, *Alabama Journal of Mathematics,* 1(1), 82-83.

[4] Casazza, P. (Ed.). (1980), Problems, *Alabama Journal of Mathematics,* 4(2), 39.

[5] Gurian, M., Henley, P., & Trueman, T. (2001), *Boys and Girls Learn Differently!* San Francisco: Jossey-Bass.

[6] Howell, M. (1981, Spring), Sponsoring teams in mathematics tournaments, *Alabama Journal of Mathematics,* 5(1), 35-37.

[7] Kalman, R. (2002), Challenging Gifted Students: The Math Olympiads, *Understanding Our Gifted,* 14(4), 13-14.

[8] Li, A. K., & Adamson, G. (1992). Gifted secondary students' preferred learning style: Cooperative, Competitive, or Individualistic? *Journal for the Education of the Gifted,* 16(1), 46-54.

[9] Mathcounts. (2004), President Bush Congratulates Mathcounts National Champions, *Mathcounts News,* 19(2), 1.

[10] Michaels, L. A., & Forsyth, R. A. (1977), Construction and Validation of an Instrument Measuring Certain Attitudes Toward Mathematics, *Educational and Psychological Measurement,* 37(4), 1043-1049.

[11] Nelsen, R. (Ed.). (1989), Problems, *The College Mathematics Journal,* 20(2), 163-173.

[12] Olszewski-Kubilius, P., & Lee, S. (2004), The Role of Participation in In-School and Outside-of-School Activities

in the Talent Development of Gifted Students, *Journal of Secondary Gifted Education,* 15(3), 107-123.

[13] Palka, D. (1994), Going for the Gold—in Math! *Perspectives in Education and Deafness,* 13(1), 16-18.

[14] Parker, M., Zullo, H., & Preyer, N. (1999), The Mathematical Contest in Modeling: Success at a Small Regional University, *Primus,* 9(4), 289-300.

[15] Riley, T. L., & Karnes, F. A. (1998), Mathematics + Competitions = a Winning Formula! *Gifted Child Today Magazine,* 21(4), 42-22, 48.

[16] Schaaf, W. L. (Ed.). (1978), *A Bibliography of Recreational Mathematics,* Washington, DC: National Council of Teachers of Mathematics.

[17] Schulthes, D., & Wolosky, J. (1998), Developing Each Child's Potential: The Discovery Program, *Gifted Child Today Magazine,* 21(6), 42-45.

[18] Sharan, S., Hertz-Lazarowitz, R., & Ackerman, Z. (1980), Academic Achievement of Elementary School Children in Small-Group vs. Whole-Class Instruction, *Journal of Experimental Education,* 48, 125-129.

[19] Sieglen, J., & Trost, G. (1998), Prediction of Outstanding Achievement in the Natural Sciences, *Gifted Education International,* 13(2), 106-112.

[20] Slavin, R. E. (1977), *A New Model of Classroom Motivation,* Paper presented at the Annual Convention of the American Educational Research Association, New York, April 1977.

[21] Slavin, R. E. (1980), Effects of Individual Learning Expectations on Student Achievement, *Journal of Educational Psychology,* 72, 520-524.

[22] Volpe, B. J. (1999), A Girls' Math Olympiad Team, *Mathematics Teaching in the Middle School,* 4(5), 290-293.

[23] Wahl, M., & Besag, F. (1986), *Gender, Attribution, and Math Performance,* Paper presented at the 67th annual meeting of the American Educational Research Association, San Francisco, CA. (ERIC Document Reproduction Service No. 276620)

[24] Xhajanka, B. (Ed.), (1994), *Mathcounts News,* 10(1), 6, 8.

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