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Let's Popularize Mathematics

O P Ahuja

Introduction

About three decades ago when I started my teaching career, I was quite amazed to notice that the image of mathematics teachers in the classroom was not good. Many students used to feel that mathematics could be learnt only by memorization and by having a mathematical mind. The public image of mathematics was quite bad. Many students and, in particular, girls used to avoid mathematics because of their false impressions about the nature of mathematics. Though some of my students used to take an interest in mathematics for its own sake and could enjoy and appreciate the beauty of mathematics, yet many were not taking an interest (in mathematics) because they could not find it relevant, exciting and useful in their daily lives.

During these years of my teaching mathematics at several universities in four continents, I have witnessed that many countries could raise their literacy and numeracy rates and brought revolutionary changes in their mathematics curriculum. In fact, some countries such as Singapore, USA and Australia are now making serious attempts to redefine mathematics curriculum in the context of new demand created by a technology-pervasive society.

But when I look back now, I feel that the negative image of mathematics has not changed much. I still hear comments like "Math is boring", "When will I ever use this stuff?", "My son is not gifted and so how can he learn mathematics?", "Why should my daughter study mathematics?", "Mathematics may be important to other people, not to me", etc. During my school visits, I generally ask for opinions of teenage students on their favorite subject. But, I feel sad that many students still think that mathematics is not their favorite subject. Many of the school children are frightened by mathematics. Many teenagers and adults want to avoid mathematics, if at all possible, in the future. Talking to mathematics teachers and our preservice teachers, I find that many of them also experience fear about mathematics. The image of mathematicians is also not that good. Many university departments of Economics and Engineering do not wish to hire mathematicians for teaching mathematics because these departments believe that the experts from their own fields can do a better job of teaching mathematics to their students. The public image of mathematics is also not that good. Most people and even many

mathematics teachers in primary and high schools think that math is a collection of rules, formulas, rituals, and routines.

Incidentally, similar such views were also expressed by the participants from twenty different countries who attended the international conference on Popularization of Mathematics held in Leeds, England, from 17-22 September, 1989. *See* Howson and Kahane (1990a, 1990b). Interestingly, such views were also supported by the South Pacific Conference on Mathematics and Mathematics Education which was held in Papua New Guinea in June 1992. *See* Ahuja (1992). Besides, there is enough literature which indicates that many students, parents, and teachers have negative attitudes, myths and phobia about mathematics. For example, *see* Ahuja (1995b), Foong (1987), Buxton (1981).

Is it possible to change people's negative attitudes and myths about mathematics? Can anything be done to arrest a feeling of discouragement and boredom in doing mathematics? Can we turn some math phobic into math fans? Can we provide more fun with mathematics and where? How do students learn that mathematicians have interests beyond mathematics as well? How do we make teaching and learning of mathematics more meaningful, exciting and effective? In brief, what can teachers do to popularize mathematics and combat mathematics anxiety among their students?
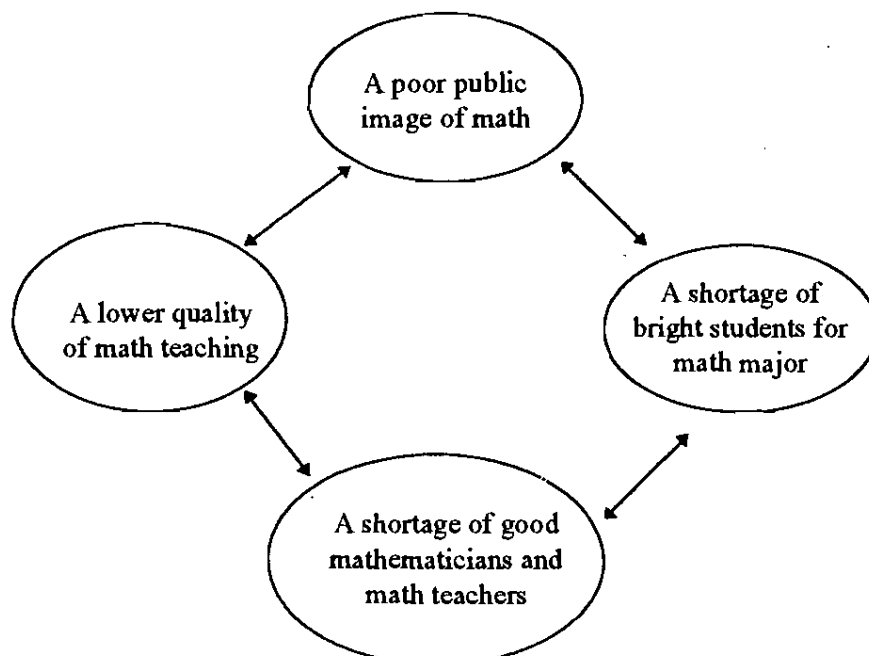
The purpose of this article is two-fold: (a) to discuss the need for popularization of mathematics in every nation, and (b) to describe how mathematics can be popularized before, during and after school education so as to develop a culture of mathematics in every nation.

Why Do We Need To Popularize Mathematics?

The above-mentioned conference in Leeds identified four components of 'mathematical culture' (or of a 'mathematically cultured' person): (a) knowledge of elementary facts and methods, (b) the development of a certain way of thinking and of approaching problems, (c) some knowledge of the history of mathematical concepts and theories, and (d) some knowledge of recent developments in mathematical sciences. Unfortunately, most schools make attempts to prepare their students for only (a). Thus other objectives, essential for developing a mathematical culture, have to be developed elsewhere. (Howson and Kahane, 1990b).

Before we establish a need to popularize mathematics, let's first acknowledge some well-established facts. First, everybody should be mathematically literate in this information era and compete in the "New World Order" marketplace. This means a meaningful, effective and relevant mathematics education for all. Second, mathematics should be considered as a way of thinking (more than just a collection of formulas); that is, how to formulate a problem, how to look for a solution, how to convince or demonstrate. Third, mathematics incubates among people the values which are essential for the development of the personality and attributes which form the basis of a strong nation. Fourth, all countries - developed or developing - need more students in mathematics as well as in science. Fifth, children will enjoy mathematics if their parents appreciate the power and importance of mathematics. Sixth, students will enjoy mathematics if their teachers also enjoy the subject and help them to understand the power and value of mathematics and develop in them positive attitudes towards mathematics. Finally, the teachers will enjoy teaching mathematics if they are familiar with current developments in mathematics because otherwise it may be difficult for them to popularize the subject in the schools.

A negative public image of mathematics has serious implications on teaching and learning of mathematics. It discourages many bright students to take up mathematics major and further advanced mathematics at the college or university level. This results in a shortage of high quality mathematics teachers and mathematicians which ultimately affect the standard of mathematics teaching at every level. Thus a bad public image sets a kind of vicious cycle as shown in the following diagram.

The purpose of popularization of mathematics (PoM) is to break this vicious circle. That is, we need PoM to change attitudes, beliefs and provide motivation for learning mathematics. More precisely, the aim of PoM is to raise awareness, not to educate, and the criterion of success is not an increase of knowledge, but a change in attitudes (Steen, 1990). In fact, the objectives of PoM should include the following:

1. Public should be made aware that to be functionally literate in the 21st century, everybody must be able to read, write, and do basic mathematics up to a certain level of competency.

2. Public should be made aware of the everyday usefulness of mathematics.

3. Public should be made aware of the fact that every child can and must master basic mathematics.

4. Students should be helped to reduce maths anxiety, maths phobia, and maths avoidance.

5. Students should be provided with new positive mathematics experience.

6. Mathematics teachers should be helped to appreciate the value and power of mathematics.

7. Mathematics teachers should be made aware of recent developments in mathematical sciences.

How Do We Popularize Mathematics?

The most important key elements who have the power and ability to break the vicious cycle as described above are university mathematics lecturers, mathematics educators, mathematics teachers, mathematics students, scientists, journalists, and in particular, scientific journalists. For example, a biologist or an economist can greatly help in PoM if he/she is able to explain why he/she thinks that mathematics would be valuable and in what situations mathematics approach would prove useful in his/her subject.

The South Pacific Conference on Mathematics and Mathematics Education in 1992 held a panel discussion on PoM and agreed that:

"If the students are involved with mathematics, get excited by what they find out, enjoy themselves in pursuing their study and communicate mathematics to others, then it will follow that mathematics will be

popularized. Also, if the students go home excited, talking about what they are doing in their schools, then so on, the image of mathematics will improve". (Ahuja, 1992).

Pyne, Bates and Turner (1995) have found that it is possible to change people's negative attitudes to mathematics if the teacher uses an investigative approach as teaching style, organizes continuous assessment, and provides support to students in groups or individually. Also, *see* Ahuja (1995b). However, in a formal classroom, most teachers feel that they are often under pressure to cover the syllabus and cannot follow up the stimulating side issues which are otherwise so essential for achieving excellence in mathematics education. The teacher hardly gets any time to deal with the historical and biographical material of the subject, nor does the teacher have sufficient time to link the history and development of mathematics to that of other scientific and humanistic disciplines.

The above said conference held in Leeds recommended several means through which teachers can popularize mathematics: the pop math Roadshow, mathematics awareness week, mathematical trails, radio, TV, videos and films, exhibitions, games and puzzles, competitions, newspapers, and magazines. (Howson and Kahane 1990a). We now briefly describe some of these well-known successful means for PoM in any nation.

Popularize mathematics through math competitions and related contests

Popular mathematics competitions, mathematics games tournaments, mathematics trails, and other mathematics contests are some of the most efficient means of PoM. They can provide a strong motivational mathematical power to children and adults. They can also serve as an encouragement for a deeper study of mathematics and/or reading mathematical (popular) literature.

'Popular Mathematics Competitions' for PoM should be targeted at all sections of students with an aim to raise their interest in mathematics (Burjan and Vrba: 1990); for example:

- A wide range of various competitions should be created to cover different age groups and different types of students' interests (problem solving/project, multiple-choice/essay type, team/individual, relay,...) so that every student can choose the competition best attuned to his/her character.

- The rules of a mathematical competition have to be interesting, i.e. it has to allow the contestants to choose various strategies to proceed.
- The problems proposed should be attractive and not too hard.
- Give attractive prizes and provide the competitions with adequate publicity among schools, local educational authorities and media.

A 'Math Games Tournament' is a mathematics contest which makes use of educational games. The major goal of a mathematics games tournament should be to bring parents, teachers, administrators, and students together in a social event that prompts the development of mathematical concepts and skills. For further details, see Regato (1982).

A Mathematics Trail is another powerful means of popularizing mathematics. It is considered as an adventurous journey in discovering mathematics around us. In our School of Science Open Day at the Bukit Timah Campus of the Nanyang Technological University (Singapore) on 20th January 1996, the Division of Mathematics organized a very successful mini mathematics trail for the students of schools and colleges and the general public. Most of the participants were quite impressed to discover that learning and using mathematics is interesting and related to environment.

Popularize mathematics through math fairs and math exhibitions

A Mathematical Fair may popularize mathematics if it is enjoyed by the students, public and by mathematics teachers. A mathematical fair will provide opportunities to students in doing mathematics, manipulating objects, discussing, writing, thinking, and solving problems as well as learning skills with which to communicate to their peers and families the information they gather. For more details about a mathematics fair, see Day, McNichols and Robb (1982).

A Mathematical Exhibition is also a very effective means of popularizing mathematics. But, most of the exhibits in the exhibition should be "stand-alone" types which means that they are self-explanatory, and do not require an explanation to be obtained later in the lecture. Furthermore, a mathematical exhibition should:

- Present exhibits which tell their stories mainly through the eye and not through the text. While designing exhibits, we must use simple

and clear words and phrases which mean something to the general public.

- Present each item with a purpose and context and not just because it was something that could be shown or demonstrated.
- Convey an impression of some of the key methods by which mathematics works.
- Show mathematics in the context of science, history, art, technology, and other applications.

Most commercial slide shows or videos are available and could be shown with or without lectures in the exhibition. Various exhibits on applications of mathematics could be designed in a variety of ways to catch the imagination of many people. For example, knotted orbits in weather systems, knotting in DNA, computer games, and animated material could be designed which would provide both entertainment and PoM. Refer to Brown and Porter (1990).

Popularize mathematics through Internet and media

Fortunately, we are rapidly approaching an age in which almost all schools, colleges, and universities will have access to the Internet. The educational institutions can use World Wide Web (WWW) browsers to electronically send and obtain information about popularization of mathematics from all over the world. For example, the University of Minnesota's Center in USA is using the WWW as a part of its on-going effort to make mathematics more accessible and understandable to non-mathematicians. Its hypertext documents are designed to present mathematics to the masses, using a combination of expository prose, computer-generated graphics, and animation. The center has used the unique capabilities of Web to produce interactive documents that allow users to explore and discover mathematics for themselves. For example, using their home page on URL at "http://www.geom.umn.edu", students and teachers of colleges all over the world can investigate and visualize the mathematics of quasiperiodic tiling of the plane, wall-paper groups, geodesics on manifolds, Riemann surfaces, and symmetries of the hyperbolic plane.

Through the Internet, CD-ROM, films, videos, television, radio and other media every nation can popularize mathematics among millions of people from all walks of life. The Internet facilities can be provided for every school, college and university. The educational institutions will then have

access to this powerful medium to communicate mathematics. Like Mathematics Newsletter (Singapore) for teachers and the US *Family Math* publications, there is a need to publish many more math magazines and books for primary school children to play with mathematics. Newspapers are also a powerful medium which must be used in popularizing mathematics. In fact, good newspapers must consider providing a regular space for mathematics written by mathematics teachers and mathematicians.

Popularize mathematics through 'Mathematics Awareness Week'

"Mathematics is easy. Mathematics is fun!" This was the theme of the Mathematics Fun Day celebrated on March 11, 1995 by the Merlimau Primary School in Singapore. This 'Maths Fun Day' was held by the school with the aim of stimulating interest in mathematics and helping pupils to discover that mathematics, besides being easy and interesting is also practical. As per a report by Agnes (1995), the children enjoyed many interesting mathematical activities such as "Tic-tac-toe", "Cover me up", "Make me whole", "Fill me up", and hands-on activities such as drawing, cutting, and pasting.

Likewise there are many primary and secondary schools in Singapore and other countries which celebrate their math fun days or math fun nights every year. Such activities are very helpful in PoM and every school should celebrate such days.

The schools and colleges in USA generally celebrate their math fun days and math fun nights as part of their 'Mathematics Awareness Week' (MAW) which is celebrated in late April each year to increase public understanding and appreciation of mathematics. MAW in USA concentrates on mathematical activities at the local, regional, state, and national levels. It provides an opportunity to schedule local events celebrating the excitement, versatility, and importance of mathematics. It began in 1986 with a proclamation by President Ronald Reagan, who said in part:

> "*Despite the increasing importance of mathematics to the progress of our economy and society, enrollment in mathematics programs has been declining at all levels of the American educational system. Yet the application of mathematics is indispensable in such diverse fields as medicine, computer sciences, space exploration, the skilled trades, business, defense, and government,. To help*

> *encourage the study and utilization of mathematics, it is appropriate that all Americans be reminded of the importance of this basic branch of science to our daily lives.*"

The activities for MAW (USA) each year includes a wide variety of workshops, math fun days/nights, competitions, exhibits, festivals, lectures, and symposia. They are generally organized by the college and university departments, institutional public information offices, student groups, and related associations and interest groups. Each year, numerous proclamations for MAW are issued by elected officials, frequently in connection with special meetings and local/regional/state/national events arranged to observe the week. Most importantly, MAW (USA) gets consistent and positive coverage by television, radio, newspapers, and magazines.

Each year (in USA) a national theme is selected and theme materials are developed and distributed using electronic vehicles. The 1996 theme of MAW is 'Mathematics and Decision Making'. Such information and visual on PoM are made available by the Joint Policy Board for Mathematics (Washington, DC) which includes the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. For example, information about various activities for 'Mathematics Awareness Week - April 21 - 27, 1996' is being made available on the World Wide Web at: Uniform Resource Location (URL) "http://www.maa.org" and the Math Forum "webmaster@forum.swarthmore.edu". Further information about various activities of MAW in April 1996 or previous years can be obtained from the Joint Policy Board of Mathematics (USA) or MAW gopher or web sites.

The results of MAW (USA) indicate that celebrating MAW each year is perhaps the best way not only to popularize mathematics but also to develop a culture of mathematics in the whole nation. Other countries can, therefore, learn a lot from the experiences gained by USA in celebrating its MAW each year. Also, *see* Rogish (1991).

Popularize mathematics through math clubs

Clubs, academic or social, have always held an attraction for adults as well as children. They give everyone the sense of belonging to a group, build confidence in a specific area, and add to self-esteem. (Rogish, 1991). Though

most schools, colleges and universities do have several clubs, such as 'Drama club', "Chinese club', 'French club', 'Music club' and even 'Science club', yet many do not have mathematics clubs.

As the founder advisor of a math club - named after the famous mathematician known as Ramanujan - for four years in a college, I discovered that many of the activities necessary for PoM could be successfully organized by our students under the auspices of the math club. Our club could prove to be an excellent forum to popularize mathematics and offer out-of-college mathematical activities. The club could turn some math phobic into math fans. It could provide an opportunity for students to broaden their views of mathematics. It could help to prevent a dislike being generated through school and college mathematics.

Mathematics clubs do exist in a large number of high schools, junior colleges and undergraduate institutions in many countries including Singapore. The club which impressed me most is '*Mu Alpha Theta*'. Charters are granted to schools by the governing council of *Mu Alpha Theta*, and the schools certify their students for membership. *Mu Alpha Theta* has several hundred chapters and thousand of members in many National High Schools and Junior Colleges in USA. This club was founded by the National Council of Teachers of Mathematics and the Mathematical Association of America in 1958 (Huneke, 1980).

Mathematics clubs have proved successful, where they exist, in popularizing mathematics from primary schools to the institutions of higher education. They can help all types of students. They can benefit weak students to convince themselves of the importance of acquiring basic skills for their everyday life as well as for jobs in which mathematics can play some role. They can help average and bright students because they will profit by learning more about mathematics and its role for their future careers. Also, *see* Jacqueline (1991) and Rogish (1985).

The mathematics club in a primary school is considered as most useful because the children's attitude towards mathematics is largely formed in grades 3-8. Moreover, at this stage of development, children need out-of-class opportunities to communicate mathematics with one another. Also, it is found that wherever mathematics clubs in teacher-training colleges do exist, their influence upon students, teacher-educators and the community is considerable (Srinivasan, 1984).

Mathematics clubs can help to create the environment and avenues for cross discipline and inquiry-based learning. This can encourage co-operation of mathematics, science and other teachers in schools and colleges; see Ahuja (1995a). The clubs can provide opportunities for students to broaden their views of mathematics. The clubs in primary and high schools can also give children opportunities to experiment with mathematics, to interact verbally with others about mathematical ideas, and to express their own ideas and thoughts.

A senior and enthusiastic mathematics teacher/lecturer in the Institution should be the Chief Adviser. The office bearers of the club should be elected annually from the active members (the mathematics students). The Executive Committee of the club may comprise Chief Adviser, President, Vice-President, Secretary, Treasurer, and Publicity Secretary. Senior students should be encouraged to contest for the presidency and vice-presidency. For further details, see Ahuja (1996).

The club must aim to cater for all students and not only for the above average students. In this regard, the South Pacific Conference on Mathematics and Mathematics Education which was held in June 1992 warned that if mathematics clubs and competitions only stress activities for the most able students, there is a real danger of making the (public) image worse than ever because we will polarize the students who can and the students who can't. (Ahuja, 1992).

The activities of a mathematics club in an educational institution will depend on: (a) the level of institution, (b) the interests and abilities of its members, and (c) the resources and facilities available to the club. There are many books and journals where the club may find interesting topics. For example, the National Council of Teachers of Mathematics (USA) has published a booklet, *Topics for Mathematics Clubs*, which can be very useful (Coffield, 1980).

Some suggested activities which may be undertaken by a mathematics club, depending on the level of institution, are as follows :-

1. Organizing inter-class or inter-institutional debates and symposia on some interesting mathematical topics.
2. Organizing lectures of the mathematicians, professionals, and users of mathematics on useful topics in mathematics.

3. Organizing mathematics awareness week (Rogish, 1991), mathematics exhibitions (Brown and Porter, 1990) or mathematics fairs, open days, and mathematical camps (Rabijewska and Trad, 1987).

4. Organizing mathematical contests and Olympiads. (Greitzer, 1987).

5. Helping in making charts, pictures, models, improvised apparatus and a collection of useful material related to learning and teaching of mathematics. (Cathcart, 1977).

6. Organizing seminars, career-lectures, film shows, CD-ROM, and videos on interesting topics in mathematics.

7. Celebrating days and events of the history and men of mathematics.

8. Showing relevant and exciting films and videos dealing with popularizing of mathematics.

9. Making and solving mathematical models of situations in their daily activities - both personal and social - as well as in other school subjects.

10. Organizing small-scale research and brainstorming sessions for non-routine problem-solving.

11. Arranging wall magazines, and publishing the club's newsletters and bulletins.

12. Organizing a small library of books and magazines in mathematics as distinct from the usual range of school textbooks.

13. Investigating and studying topics that are not normally covered in the classrooms. For example, topics such as topology, Fibonacci sequences, symmetry, and many topics from number theory and geometry can be made accessible to the students of senior secondary and training colleges. Similarly, activities involving calculators and computers could be exciting and useful for students of any age.

14. Making up new mathematics cartoons or having fun writing a short poem or acting a role in a mathematics play written by students.

15. Investigating the mathematics of the local (indigenous) culture, its language, arts (weaving, carving, etc.), games and puzzles.

16. Arranging help and guidance for the weaker children in mathematics.

17. Helping the regional educational administration and NGO's in conducting their adult numeracy programs. (Nembou and Ahuja, 1995).

18. Organizing peer tutoring after-school one or two days a week.

19. Organizing field trips to local places of interest in mathematics and science (Rogish, 1991).

20. Reporting investigations and projects (Hatch, 1995); for instance, projects on activities that integrate mathematics and science (Ahuja, 1995 a).

A mathematics club in a primary school can also undertake many of the above activities. Some additional activities for primary schools are listed as follows:

1. Organizing inter-primary school mathematics contests.
2. Sponsoring a Family Night of Math Fun. (Rogish, 1991, Peterson, 1989).
3. Organizing lectures of mathematics teachers from training colleges or secondary schools.
4. Various mathematical games, problems, and puzzles suited to the background and ability of the children.
5. Arranging wall magazines and maintaining a bulletin board.
6. Discovering patterns in numbers and geometry.
7. Making magic squares, magic triangles, magic circles, etc.
8. Various mathematical activities based on the curriculum.
9. Making a story or a poem that could give rise to a mathematical sentence.
10. Make and take home models workshop.

For some other activities for primary school mathematics clubs, one may also refer to Srinivasan (1984) and Rogish (1991).

The primary/high school mathematics club should involve parents and others in some of its activities through workshops, Family Night of Math Fun, Mathematics Awareness Week, Pop Math Roadshow, exhibitions, guided tours, puzzle solving, and competitions.

There is no magic formula by which mathematics can be more effectively popularized through a mathematics club. The secret is a dedicated teacher advisor who stays in the background, but also encourages the students in their activities and indirectly says to them "I care" (Huneke, 1980).

Thus, it is hoped that math clubs will not only popularize mathematics but may also improve the general quality of mathematical thinking, mathematical activity and make the students believe that mathematics is alive and exciting, and create confidence among them about their ability to learn it.

Concluding Comments

A strong rationale exists for popularizing mathematics in every nation whether developed or developing. Many of the educational institutions in USA, UK, Singapore, Canada, Australia, India and other countries are rigorously popularizing mathematics by many successful means, such as math fun days, math awareness weeks, math competitions, math fairs, mathematics associations, Internet, multi-media, and others. Through such means and activities, every nation can thus convey to its students, teachers, and the general public that mathematics is alive, essential for the society, most important for the economic development of the nation, and that it can be highly rewarding for every individual in this technological age.

The lecturers of the universities and teacher-training colleges and mathematics associations can make contributions in popularizing mathematics in the junior colleges and high schools. In a similar way, the junior college teachers can help in high schools and they in turn should provide assistance in popularizing mathematics in primary schools. People from medicine, banks, insurance, business, industry, shipping, airlines, and others can be invited to speak on 'how they use mathematics in their jobs and everyday lives?'

Finally, once mathematics is successfully popularized in a nation, then teaching and learning of mathematics, appreciating the subject and more importantly the culture of mathematics will greatly develop in the nation.

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