

A REPORT ON PREPARING MATHEMATICS TEACHERS TO TEACH STATISTICS IN HIGH SCHOOL

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In order to meet the goal of popularizing statistical concepts in Iranian society at large, the Iranian Statistical Society (IRSS), in cooperation with the Iranian Association of Mathematics Teachers' Societies (IAMTS), have convinced the Ministry of Education to include one statistics course in the national school curriculum. Unfortunately, due to the lack of statistics specialists in the school system, this course has been usually taught by teachers of mathematics, who often confuse statistical thinking with statistical methods, and do not realize that there is a difference between mathematical and statistical reasoning. Hence we have started preparing these teachers to teach statistics using proper teaching methods. In this paper, we present the activities of the Isfahan Mathematics House (IMH) on the professional development of mathematics teachers, and their impact on improvement of statistics education.

INTRODUCTION

As mentioned in Steen (1997), a large proportion of the general population does not have a developed sense of quantitative and statistical reasoning, and this is also true of the population in Iran. In their every-day life, they see figures and real data in newspapers, magazines, and talk about statistics, but they do not really understand and appreciate the concepts that they use or observe. The teachers and school system in Iran do not encourage talented students to continue their studies in the field of statistics, and, like in many other countries, the government does not use statistical tools properly; hence, in general, there is no awareness of the usefulness of statistical reasoning and methods. With lack of encouragement and because of their ignorance of the importance of statistics in all walks of life, very few talented students choose it as their field of study at the university, and very often statistical projects are carried out by non-specialists.

Despite attempts to popularize statistics through the activities of the Iranian Statistical Society (IRSS), which publishes expository journals and books on the subject, the process of enhancing statistical literacy for functioning in the information-based society failed and hence other organizations were asked to help. Many statisticians and institutes responded enthusiastically, with the following results:

- Today, the Isfahan Mathematics House (IMH) and Isfahan University of Technology (IUT), as well as almost all other Iranian universities, celebrate the annual National Statistics Day by organizing talks, exhibitions and presentations of statistical projects that have been completed that year.
- Throughout the year, some students gather together regularly at the IMH to discuss the application of statistical methods and thinking using real life data.
- The national university entrance examinations (which are very popular among students and their families) now include questions in statistics.
- An annual statistics competition is held, as well as an annual Olympiad for university students.

Nonetheless, since the awareness of a subject should start in schools, we were still worried about the quality of statistics education in schools (Meletiou, 2003; Jordan & Haines, 2006). Although some statistical concepts have been taught in Iranian schools for the last thirty years, they were mostly spread out through the years of schooling and either taught as a part of mathematics courses, with emphasis only on theoretical aspects or in a statistical methods course in other curricula, such as social sciences (Parsian & Rejali, 1998). The Ministry of Education has designed a new course in statistics (Rejali, 1997), which is taught to all students

in the second or third year of high school, but the problem of the lack of specialists in statistics in the school system remains. Mathematics teachers still teach this course, without being equipped for it although it is well known that, as with any other subject, statistics comprehension is very sensitive to the method of teaching and presentation of the subject.

To overcome the problem, IMH in cooperation with IRSS, started to prepare mathematics teachers to teach statistics in high schools. First of all, we agreed that the teachers who want to teach statistics should satisfy the following requirements:

- They should be familiar with statistical concepts and methods and have some experience with statistical problems (Larsen, 2006; Jordan, 2007).
- They should know the difference between statistical thinking and statistical methods (Garfield, 2002).
- They should know the difference between statistical reasoning and mathematical reasoning; of course, both types of reasoning are necessary in modern society, especially for understanding probability and the concept of chance (Meletiou, 2003; Batanero, Godino & Roa, 2004).
- They should firmly believe that teaching statistics without the involvement of students in various projects does not help students to learn the art of statistical thinking (Melton, 2004; Kahn, 2005).
- They should know that their students may know the importance of mathematics but are usually not aware of the importance of statistics; hence it is crucial to raise awareness of the importance of the subject (Gattuso, 2006).
- They should know the importance of using statistical software to do real statistical analysis and hence be familiar with at least one software package.

Having agreed on the above items, we started to organize lectures throughout the country and published papers in expository journals accessible to mathematics teachers, in which statistical reasoning and statistics education in general are explained carefully. In these articles and public lectures, we illustrated the usefulness of statistics by explaining real life examples as well as discussing the abuse of statistics and the difference between statistical thinking and statistical methods. Also, books such as *Statistics: A Guide to the Unknown* by Tanur, Mosteller, Kruskal, Lehmann, Link, Pieters and Rising (1989) were translated into Farsi, on the occasion of the World Mathematical Year 2000.

IMH, in cooperation with the IRSS and the Mathematics Teachers' Society of Isfahan (MTSI), started an annual statistical competition among high school students of Isfahan in 2006. This is a team competition, and the questions and projects require a good understanding of statistical concepts. Moreover, IMH, with the help of the Iranian Statistics Research and Training Center (ISRTC), has developed an electronic site in Farsi for the popularization and the education of statistics (www.mathhouse.org).

We believe that all of these activities, however necessary for our society, are far from sufficient and are aware that the professional development of teachers in teaching statistics is the task that needs the greatest attention.

CHALLENGES FOR THE PRE AND IN-SERVICE TRAINING OF TEACHERS

As mentioned earlier, most of the teachers of the statistics course in our school system have a mathematical background and are unfamiliar with statistical concepts, methods and reasoning. We attempted to change this situation with the following recommendations, some of which have been accepted.

- We recommended that the ministry of education employ statistics (rather than mathematics) graduates to teach statistics courses in high schools.
- We asked the Ministry of Higher Education to include statistics questions in the national university entrance examination, each year. These examinations are very popular among students and teachers, and this may encourage students to pay more

attention to their statistics courses and hence have an impact on statistical education, leading to an improvement in the teaching methods for statistics courses.

- We recommended including some statistics courses in all teacher training programs. We have to set standards and encourage teacher training centers to use trained statisticians for teaching these courses. IRSS and IAMTS have still not succeeded in fulfilling this aim but are working on it. Unfortunately we do not have a teacher certificate system in our country, so there are many teachers who have not studied at teacher training centers. Naturally this makes our work much more difficult!
- We have devised a course in statistical methods to be taught to undergraduate mathematics students. The undergraduate mathematics curriculum always had theoretical courses in probability and statistics, but these did not provide students with enough knowledge about statistical methods or statistical reasoning. We hope that this compulsory course may help them understand both these concepts. However, our most important activity is still to design programs in continuing education for the present teachers of statistics courses in schools.
- The national biennial statistics conference organized by IRSS has a session on Statistics Education that aims to increase the awareness of statisticians of the problems of teaching and learning of statistics in schools. We also invite mathematics teachers to participate in these conferences to increase their awareness of the importance of the subject.
- Each mathematics education conference has presentations and workshops in statistics. This was especially true of the 8th Iranian Mathematics Education Conference (IMEC-8), when we had a special program on Statistics Education as well as a discussion group on the subject (Parsian & Rejali, 2006).
- IMH has developed lecture notes for mathematics teachers to help them understand the concepts of statistics and learn the methods of teaching them at the high school level. These notes have been distributed among many mathematics teachers throughout the country. In these notes we have included real life examples relevant to Iranian society, and often selected from current newspapers and magazines (see for example Bond, 2006). We have several lectures on the importance of statistics in real life (Sowey, 1995).
- IMH developed a program in continuing education for mathematics teachers who want to teach statistics in schools or are already doing so. This program was first developed for mathematics teachers of Isfahan in cooperation with MTSI and implemented in the summer of 2004 at IMH as a workshop.
- The workshop introduces basic concepts of statistical methods and the use of statistical software for both inferential and descriptive data analysis.
- Participants also discussed the difference between statistical and mathematical reasoning (Johnson & Dasgupta, 2005) supplemented with discussions on completed school projects as well as suitable choices of projects for students as part of the workshop. This workshop also includes lectures on sampling methods, a topic not discussed in enough detail in high school text books.
- There is special emphasis on topics such as variability, graphical techniques, survey and experimental designs, some simple statistical inference and judgment the validity of statistical arguments based on data, in this six day workshop.
- The ways in which teaching statistics differs from teaching mathematics are explained carefully during the workshop. Less emphasis on probability and more attention on statistical methods are the major aims of the workshop.
- During the workshop, the volunteer teachers, who take part in the program without being paid or promoted, operate in teams, since teamwork is known to be very suitable for learning statistics (Garfield, 1993; Rumsey, 1998).
- The curriculum for the workshop, 20% of which is devoted to the use of statistical packages, has been developed in cooperation with teachers and statisticians as in the case of the Insight into Statistical Practice, Instruction and Reasoning Project (Gould & Peck, 2004).

- After observing the effect of the first workshop, IMH in cooperation with the IRSS and the IAMTS ran this workshop for volunteer mathematics teachers in eight other provinces of Iran in the summer of 2005 and has announced its readiness to run it anywhere else.

FOLLOW UP OBSERVATIONS:

A follow-up study in Isfahan province shows some success among Isfahan students, as well as teachers. Some conclusions of these observations are described below:

- Every year, teams of high school students present about five statistical projects at the IMH yearly festivals, which is a quantitative improvement.
- High school students are getting interested in enrolling in undergraduate statistics programs, although we still have to check the entrance examination results to justify this improvement.
- High school teachers are participating actively in increasing numbers in the annual IMECs, where they expound on how to teach statistical concepts and methods or talk of research in their field that is based on statistical methods.
- Many mathematics teachers, who, because of lack of enough statistical knowledge, preferred to use any extra time to solve mathematics problems in their statistics classes, today organize discussions on statistical methods and reasoning instead.
- Teachers from schools throughout the province have developed enough confidence to volunteer to coach 63 teams of high school students for the first statistics competition in 2006 and 72 teams for the second in 2007.

As a result of this new awareness, teachers are also more willing to deliver talks on statistical concepts and methods and probability ideas at the mathematics education conferences and the weekly colloquiums of IMTS. This year five out of 25 lectures were devoted to statistics and probability in these colloquiums. This shows a significant improvement in teachers' attitude and bodes a promising future for statistics education in our country. These observations motivate the other mathematics teachers' societies to invite IMH to run the workshop in their provinces.

Future plans include a complete follow-up study on the impact of these workshops, observations on the impact of the workshops on students and general public, publishing new resources for teachers and students and developing a forum for the teachers to continue their discussions on statistical teaching methods. We also intend to foster more involvement of teachers in our national statistics conferences, training motivated statistics educators, constructing a suitable internet site for teachers and students in Farsi, and learning from other projects to expand our efforts in enhancing statistics education in Iran.

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