A CONTINUED EDUCATION PROGRAM IN STATISTICS AND RESEARCH METHODOLOGY FOR SCIENCE TEACHERS IN PUERTO RICO, USA

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This paper presents the design and results of a Teacher Enhancement Program in Statistics/Research Methodology for Science Teachers in the Mayaguez Region of Puerto Rico, a Caribbean island. The program trained science teachers to teach effectively a new course of Scientific Investigation. The project is ***comprehensive*** *with emphasis on* ***the role of Statistics as a research tool. Experts in pedagogy/research*** *gave workshops. One important feature is the* ***follow up program*** *in schools with* ***visits*** *for mentoring of teachers individually. The program is also* ***multiplicative in nature****. The participant teachers dis****seminated*** *their statistical knowledge through* ***workshops*** *and* ***Statistics Fairs****.*

INTRODUCTION

As per the communication of the Department of Education dated June 1995, the new course of "Scientific Research" was made a full one year *requisite course* for all students to graduate from high school. This course, consists of research methodology and statistics. Many units of instruction, at all levels, need the science teacher to have a very good knowledge of Statistics. The teachers needed to be trained/retrained in statistics

A Teacher Enhancement Program was sponsored by the Council of Higher Education of Puerto Rico, to meet the needs of the Education Department. This paper is a report of the design and experiences in this project, during the period of July 96-97. This project is based on the modern statistical philosophy that statistics becomes more meaningful to students at all levels when they design a research project, execute, and interpret the results rather than simply learning a set of formulas, techniques and theory.

The *project site* was the *Mayagüez Campus* of the University of Puerto Rico in the city of Mayagüez which is centrally located in the western region of Puerto Rico. Puerto Rico is an island- territory of USA, in the Caribbean where more than 3 million American citizens of Hispanic origin live. *Educational System* is highly centralized and hierarchical.

PROJECT DESIGN AND DESCRIPTION

The project's *goal* was to prepare *lead science teachers* in statistics and research methodology at the secondary level in the Mayagüez Region, and disseminate the developed program in the Region in cooperation with the regional Education Department.

The *program included* preparation of teachers in the areas of probability, statistics, computers, the basics of research methodology and modern methods of teaching science and research courses so as to enable them to effectively teach the revised curriculum.

The *project design* was *comprehensive* and was really a combination of seven sub-programs which are: (i) Research methodology, (ii) Descriptive statistics, (iii) Probability concepts, (iv) Introduction to inferential statistics (v) Use of computer and statistical software, (vi) Methods of teaching science and motivation of students, and assessment in science, and (vii) Use of statistics in research and science projects. Both academic content and *pedagogy* were taught. *Hands-on experience with research* was emphasized. The project was also *multiplicative* in nature. It prepared lead teachers at the primary level who in their turn disseminated the knowledge to colleagues through workshops.

The project had an *extensive follow up* during the academic year to integrate the knowledge gained in the program into the classroom activities. Each teacher was *monitored and mentored* individually through a dialogue/(visits) as needed. The *duration* of the project was from July, 96 to July, 97. The summer program trained the teachers for 108 hours. Teachers participated during the academic year for 48 hours. The project trained the teachers in the above seven sub-programs for a total of 156 hours approximately. The academic year follow up program included a round table conference, workshops, weekend classes, interaction meetings and visits with individual teachers.

Academic Content included the material of a basic course in statistics, covering descriptive statistics and probability concepts. Parts of David Moore's text (Moore and McCabe, 1989) as well as the Quantitative Literacy Booklets on Measurement, Data Analysis and Probability (Kepner and Scheaffer, 1994; Landwher and Watkins, 1987; Newman, Obremski, and Scheaffer, 1987) were used. Excerpts from *videos* of "Against All Odds: Inside Statistics" (1989), a 26-program telecourse, were used to enrich class lectures. For imparting *computer literacy***,** teachers were introduced to computers during the summer and taught the use of statistical software packages.

Teacher participants themselves used secondary data from the library and did *research projects* in pairs or individually. They gave a proposal, collected data, analyzed the data and submitted a final report. They choose themes such as: Life expectancy in Puerto Rico (PR) ; Chronic Respiratory Infections in Americas; Earthquake data in the area of PR; Mortality due to Cirrhosis in PR; Growth of plants; Yield of plantains, Infant mortality rate by sex in PR; Live births in municipalities in PR; Electricity consumption

and per capita income in countries, etc. The performance of teachers in their projects helped the project personnel assess their learning of statistics. The report was discussed with each group by a special appointment. Thus the teachers had a *hands-on- experience* with research methods and use of statistics in research.

Workshops by experts were also given to teachers, which covered a number of topics such as: Creative thinking and research; Lying with statistics and ethics; Motivating high school students to do research projects in the physical/natural sciences; Basics concepts of evaluating research projects; Styles of learning about how to do scientific research; Total Quality Management in teaching and learning, etc.

Follow up program during the academic year was designed to strengthen the summer program and integrate the knowledge into the mathematics curriculum of the school system. It involved Saturday meetings, workshops, mentoring the individual teachers, visits to schools, celebration of Statistics day/fair, and a Round table conference. Seven follow up Saturday meetings were organized during the year. These meetings were used for workshops, problem solving, supplemental training in data analysis, review of probability concepts, and computer practice. This phase strengthened the academic content of the summer and provided an opportunity for interchange of ideas between teachers. *School visits* by the Project Director were to evaluate the implementation of the program. Each teacher was visited at the school at least once. The project director had also *conferences* with each teacher to discuss the summer research projects and to assess the integration of the summer academic content into the classroom teaching. She *dialogued and mentored* about the problems of integration, dissemination and reaction of students. *Workshops by teacher participants* helped to disseminate the curriculum materials and the knowledge and skills gained during the summer to fellow teachers. Some school districts arranged more training sessions by the teachers. Teachers from the same school district, in general, gave workshops together.

The project director, participated in all the workshops and explained the philosophy behind the project. The teachers were requested to celebrate a *Statistics day or Statistics fair* in the school and invite the neighboring schools. Many interesting student projects were exhibited at the fairs. A *round table conference* of administrators and teachers was held at the end of the program to form teams in each school district for integration and dissemination of the statistical education given in summer.

RESULTS

The *impact* of the project was measured in different ways. Evaluation of the project was done through: (a) testing the differences between scores in Pre-tests and Post-tests given to teachers; (b) the evaluation of the project by the teacher participants; (c) evaluations by external evaluators and (d) the impact of the knowledge on the students of the teacher participants as evidenced in the of students' projects at Statistics fairs.

The *academic content* was covered as planned. *Pre-tests and post-tests* given showed that the teachers learnt Statistics. Statistical tests evidenced highly significant improvement in the knowledge of the teachers, although all of them did not have individually high absolute scores. The teachers required many more *visits* than proposed. A few teachers had resistance to schedule the visits. All teachers were requested to give *workshops* to colleagues but only a fraction of the enrolled teachers trained their colleagues. Dissemination and integration put a very substantial demand on the time of the teachers and some were unable to comply. Some teachers did not celebrate Statistical fairs.

Evaluation, through questionnaires to teachers, provided evidence of the mainly positive effect of the project on the teachers. The *questionnaires* asked them about the various aspects of the project and the impact of the project. Almost all mentioned the significant improvement in their knowledge of statistics. Some liked the conferences by experts/the organization of the project/computer training. They liked doing the research projects and having a hands-on experience with writing a proposal and research report. They said that they felt more confident about doing research projects after this training. Some stated that by using data from real life situations, their classes have become attractive and the classroom participation of their students was more active than before. Some said that the project changed the way they prepared for the class to reach the students and made them realize the importance of doing research projects. When asked about the *aspects* of the project which are *not appealing*, they mentioned that the program's academic content was very long and accelerated. They rated the program overall as excellent/very good for their professional development and very useful. They were all well convinced about the importance of experiential method of teaching through real data and research projects.

The *impact* of the project was also measured by how the teachers *took the knowledge to their classrooms*. Some of the teachers, celebrated a *statistic fair/exhibition*

of their students' projects. The student-research reports presented the results professionally. When compared with the previous projects of training mathematics teachers at all levels (Gandhi, 1993; Gandhi, 1996), the science teachers seemed to be less enthusiastic about learning statistics. The *external evaluators* rated the project as very good and effective.

DISCLAIMER

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