INTERNATIONAL STATISTICAL INSTITUTE

Newsletter

International Statistical Institute

IASE

International Association for Statistical Education

IASE NEWS: At the *First Scientific Meeting of IASE*, to be held in Perugia, Italy August 23-24, 1993, the main topics that will be addressed are: University and college level statistical education and training, Statistical education in developing countries, Training statistical staff in government offices, Research into teaching probability and statistics at the school level, and Computers and video tools in teaching and learning statistics. An impressive list of invited speakers has been drawn up to help focus the sessions. You are invited to submit abstracts for contributed papers, posters or other exhibits for presentation at the meeting to: The Secretariat of the 1st IASE Scientific Meeting, Dipartimento di Scienze Statistiche, Università di Perugia, Via A. Pascoli, C.P. 1315, Succ. 1, 06100, Perugia, Italy (Fax: +39-75-43242, E-mail: STATLI@IPGUNIV.EARN).

In Italy, the new IASE Executive Committee will take over, with David Moore of Purdue University, Indiana, USA, as President, and Anne Hawkins of University College London, UK, as President Elect. Voting has just taken place to elect four Vice-presidents from among eight nominations. Those elected are: Guiseppi Cicchitelli (Italy), Annie Morin (France), Brian Phillips (Australia) and Richard Scheaffer (USA).

ICOTS-4 NEWS: The preliminary version of the programme for the Fourth International Conference on Teaching Statistics, to be held in Marrakech, Morocco 25-30 July, 1994, has now been circulated to session organisers. The First Announcement and Call for Papers is available from Yves Escoufier, Programme Committee Chairperson, Université Montpellier II, Science et Technique du Languedoc, Place E Bataillon-34095, Montpellier Cédex 5, France (Tel: +67-14-3030, Fax: +67-14-3558, E-mail: yes@montpellier.inra.fr).

JOURNAL OF STATISTICS EDUCATION: (News just in - more details next issue) JSE is a new electronic journal on postsecondary statistics education, supported by the Statistics Department at North Carolina State University. The Guidelines for Authors may be obtained by sending e-mail to: archive@jse.stat.ncsu.edu with the one-line message (no subject is needed): send jse/author.guide

There are two levels of subscription: receiving announcements only and as a full discussion participant. For either level, send e-mail to: listserv@jse.stat.ncsu.edu with the appropriate one-line message from below:
subscribe jse-announce FirstName LastName   subscribe jse-talk FirstName LastName

The following summaries outline two recent empirical projects in the teaching and learning of statistics. The *IASE Newsletter* is intended to provide a forum for discussing the methodologies employed as well as the results obtained and the implications of the inferences drawn. Readers are therefore invited to respond to these summary reports with comments in an appropriate form for publication in future issues. Further information on the individual projects may be obtained from the original authors.

Another function of the *IASE Newsletter* is to promote research. Only by building up a significant research literature can Statistical Education become recognised as an academic discipline in its own right, and one which is worthy of study at the highest levels. A discipline cannot depend on anecdotal evidence and speculation alone.

ENRICHING A PROBABILITY UNIT WITH LABORATORY INSTRUCTION

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It is widely accepted that statistics is a practical subject and that therefore its study should take a different form from the study of mathematics. However, because statistics and probability are often taught within the context of mathematics, students receive tuition in which too much emphasis is placed on the technique of computing statistics, rather than on the collection of data, and on the discussion and interpretation of results obtained.

Several studies have indicated that students may learn better if they are encouraged to explore, to discover, and to have real experience with the real world. In the teaching of probability, the nature of randomness can be taught through experiments. Hence, the purpose of this study was to provide empirical data related to the question: Does achievement in a probability unit differ when the teaching is enriched with laboratory experiments?

Subjects: 82 eighth grade students were randomly allocated to one of two groups, which had been randomly assigned to two "treatments". It was decided previously that anyone who could not participate in at least two activities or classes (two 40-minute sessions) during the treatment would not be included in the statistical analysis of the study. This resulted in an overall sample size of 73 students, divided into the experimental group (19 girls, 18 boys) and the control group (22 girls, 14 boys).

Instrument: The Probability Achievement Test (PAT) was developed by the researchers. The test included 39 items covering the following five dimensions:

BPC - *Basic Probability Concepts:* sample space; sample point; event; probability of an event; boundaries of a probability ratio; probability of an event and its complement.

APC - *Advanced Probability Concepts:* classical and conditional probability; mutually exclusive, dependent and independent events.

BCS - *Basic Computational Skills in Probability:* determining the probability ratio of a given problem; converting a probability ratio into percentage.

ACS - *Advanced Computational Skills in Probability:* finding the mathematical probability of 'A or B' (where A and B are two events); finding the mathematical probability of 'A and B' (for independent events); solving problems based on combined events; drawing a graph by using a set of data.

PPC - *Probability Involving Permutations and Combinations:* finding the number of elements of a sample space by using permutations and combinations; solving problems by using permutations and combinations; solving problems by using permutations, combinations, union and intersection formulae simultaneously.

Procedure: The students in the experimental and control groups studied the probability unit in twelve 40-minute sessions. The control group were taught by a traditional lecture method, whereas the experimental group had seven lecture sessions and five sessions devoted to laboratory experiments. In the laboratory sessions, students worked individually or in groups of two or three. They received programmed materials to aid them in the learning process. There were no teacher presentations during these laboratory sessions, although the teacher was available to help individual or groups of students if required.

The five experiments for the laboratory sessions were prepared to include the major goal, objectives, materials and procedures. In each laboratory session there were student handouts explaining how the experiment was to be performed, with exercises to follow the activities. The topics for the experiments were: basketball, rock stars, blindfolds, names and numbers, and Ankara. At the beginning and at the end of the treatment, the PAT was administered to all students in both groups.

Results and Discussion: Because there was no significant difference between the pre-test mean scores for the two groups of students, it was assumed that the groups were equivalent with respect to their initial grasp of the probability concepts to be investigated. Both the total and the part post-test scores for the two groups were subjected to t-test analyses. The results revealed a significant difference between the total achievement scores for the two groups, with those students who had had laboratory classes scoring better. The mean scores were 19.68 and 17.08 ($t_{71} = 2.05$, $p = 0.05$).

When the difference between the group means was tested for the sub-scores corresponding to the five dimensions shown above, significant differences between the two groups' means were observed for the *ACS* and *PPC* dimensions, in favour of the students who had had practical laboratory experience. No significant differences were observed for the other three dimensions.

Hence, within the limitations of this study, it could be concluded that instruction enriched with laboratory activities in teaching more complex concepts and skills related to probability produced greater achievement than conventional lecture sessions only.

CONTEXT AND CONTENT OF STATISTICAL PROBLEMS

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Basic statistics is important for everyone. It must therefore be taught in a way that makes it equally accessible to all students, so that they can achieve the confidence and competence necessary to be fully contributing citizens. In New Zealand we have some indications that the context and content of the problems that we set for assignments have an effect on the ease of assimilation of the material for different subgroups of students.

At Victoria University, there are two first year statistics courses; *STAT131, Data and Probability* - the course recommended for students majoring in mathematics, physics, chemistry, computer science and engineering; and *STAT193, Statistics for the Natural and Social Sciences* - the course suggested for those majoring in biological sciences, social sciences, commerce and medicine. These two courses are essentially equivalent with respect to level of difficulty and statistical content.

In 1991, 40% of seventh form (year 12) female high school students took biology, while only 13% studied physics. Perhaps not unexpectedly, therefore, the proportion of females in *STAT193* is always higher than the proportion of females in *STAT131*. Less predictable, however, is that it seems to be easier for them to succeed in the *STAT193* course than in the *STAT131* course. As shown in Table 1, they consistently take a larger proportion of the A grades than their proportion of the class membership would lead one to expect, while the converse is sometimes true for *STAT131*.

Table 1: Female Participation % and Female Success (% of A grades awarded to females) for students in First Year statistics courses.

Year	**Course**	
	STAT131	*STAT193*
1987	20 (26)	44 (62)
1988	30 (27)	36 (48)
1989	21 (25)	41 (59)
1990	37 (37)	52 (57)
1991	28 (38)	54 (60)

The Final Examinations: Over the three year investigation period (1990-92) some patterns in examination outcomes have emerged. In the *STAT131* final examination, male students often performed better overall than their female counterparts. The examination as a whole is usually somewhat abstract. Any non-abstract questions usually involve machinery, manufacturing or money, and it was on these latter questions that males, in general, performed better. They were also more likely to choose to attempt these questions.

In the *STAT193* examination, female overall scores were either equivalent to, or better than, those of the males. There are always two or three very abstract questions, usually about finite populations, the central limit theorem, power, etc., but these questions were not popular choices. In this examination, males and females tended to attempt the same questions. The most popular questions were: analysis of variance questions based on scores in psychology tests or sales, and contingency table analyses on spouse abuse *versus* family type, and on vaccination levels and ethnicity. The most frequently attempted questions were those involving people and the environment, and these were the questions on which the female students did particularly well.

In general, male students in *STAT193* are not doing standard mathematics courses. The majority are doing no other mathematics at university and may not even have done mathematics as far as the end of secondary school. They are not studying in technical or mathematical areas, most having rejected or been unsuccessful in mainstream mathematics. The problems that appeal to the females in the class are, by and large, the problems that appeal to the males in the same group. Work with secondary school pupils in New Zealand has confirmed this liking for problems in which the students can see a connection between the statistics and their lives.

Coursework: The nature of the assigned problems in STAT131 and STAT193 differs. All assignment problems for three years were categorised into 3 groups; firstly, abstract or traditional problems [urns, dice, ...]; secondly, problems about people or animals [blood pressure, bacteria, ...]; and lastly, a category of problems based on contexts *"from the boys' world"* [Football matches, stock market, ...]. The breakdown is shown in Table 2. Clearly, there is far more emphasis throughout the course on "people or animal problems" in STAT193.

This difference in content suggests some reasons why female students might prefer *STAT193*, because there is much research to show that "the most influential factor in girls' attitudes to study is whether the subject is perceived as a 'male' or 'female' subject". Another possibility is that differential staffing of these courses was an influential factor. *STAT131* has three male lecturers while *STAT193* has two male lecturers and one female lecturer. Perhaps we should make an effort to offset this imbalance in the gender of staff by taking particular care with assignment questions.

In 1991 and 1992 further work was done with the *STAT193 - Statistics for Natural and Social Sciences* group. In one assignment a question was set with two options, from which they were to choose one. The alternatives presented were structurally the same, (an analysis of variance problem with the same numerical data, the same method of solution, and the same answer in terms of the numbers involved), but one was couched in terms of scores on a psychological test of hostility after different treatments and the other was worded in terms of a comparison of strengths of different concrete mixes. Half the class had the question printed in one way and the other half received it with the order of the alternatives reversed. In 1992, a similar choice was offered to the students in a question involving the cost of operation of truck types alternated with the same question couched in terms of provision of emergency health care services.

In both years the results were very similar. Few of the students appeared to notice that these were essentially the same question and most (about 75%) answered the first option available. However, women were more likely to take the second option if the first was about concrete (or trucks). Overall, 73% of the females and only 53% of the males took the psychology option. This result supports the idea that "people problems" are most effective for female students. Given the problem in terms of people, animals and everyday reality, female students and non-technical males appear to achieve better than they do when attempting the same material couched in the abstract or in terms traditionally associated with industry and manufacturing.

Table 2: Percentage of different types of problems in First Year statistics

	Percentage of Problems					
Courses	*STAT131*			*STAT193*		
	1990	1991	1992	1990	1991	1992
abstract or traditional problems	60	53	53	41	13	26
problems "from the boys' world"	9	19	23	6	7	12
people or animal problems	31	28	24	53	80	62