

ISSUES IN THE TEACHING
OF PROBABILITY AND STATISTICS

Contributed papers

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From Brunelli, Lina & Cicchitelli, Giuseppe (editors). **Proceedings of the First Scientific Meeting (of the IASE)**. Università di Perugia (Italy), 1994. Pages 345-354. Copyright holder: University of Perugia. Permission granted by Dipartimento di Scienze Statistiche to the IASE to make this book freely available on the Internet. This pdf file is from the IASE website at <http://www.stat.auckland.nz/~iase/publications/proc1993>. Copies of the complete Proceedings are available for 10 Euros from the ISI (International Statistical Institute). See <http://isi.cbs.nl/sale-iase.htm> for details.

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STUDENT VIEWS ON EFFECTIVE AND INEFFECTIVE LEARNING IN GRADUATE LEVEL APPLIED STATISTICS COURSES

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1. Introduction

Applied or service statistics courses are often viewed by students with something less than enthusiasm. Instructors of such courses have argued for the need to alter attitudes and provide more emphasis on real-world problems and issues using real data and computers (e.g., Blalock, 1987; Roberts, 1987; Singer and Willett, 1990). In a recent article, Snee (1993) reiterated this plea and stipulated that people process information in different ways. Therefore, having different learning styles, they need to be taught with different methods. He concluded by stating that this would result in more favorable attitudes, as well as in greater use of statistical thinking.

Graduate students are adult learners in school by choice, with definite goals for their education, and often motivated by specific job demands. Unfortunately, my 10 years of experience teaching such students is that many of them are enrolled in graduate level statistics courses only because it is a requirement for the degree. For many there is little or no motivation or desire to learn the content or utilize statistical tools. Once students overcome negative attitudes toward statistics, begin to see its value and to think in statistical terms, they do tend to approach the subject differently and some go on to advanced courses, managing to do so even in the face of poor prior background.

What is it that makes the difference for students? What is their perspective on what benefitted or hindered their learning in a first statistics class? Additionally, can students' reasons be categorized based on different student characteristics or learning styles? To answer these questions, the present investigation is a qualitative follow-up to a quantitative analysis that was aimed at determining relationships among learning styles, academic programs, background variables and attitude toward statistics (Belli, 1993). Findings from that study of 155 graduate students indicated that they tended to differ in preferences for how they function cognitively, as well as to differ widely in their readiness for

statistics. These differences were found to be somewhat related to mathematics and computer background, attitude and gender.

At the end of the structured questionnaire used for those analyses, students were asked two open-ended questions: (1) What was it that allowed you to learn as effectively as you could? (2) What was it that prevented you from learning as effectively as you could? A content analysis of their written responses was conducted to allow for several comparisons: (1) among students with different learning style preferences, (2) across different disciplines and (3) between males and females.

2. Learning styles

People's preferences or type may be characterized in four bi-polar dimensions based on Jung's theory of psychological type (Myers and Myers, 1980). Two dimensions identify different preferences for using the mind. These preferences relate to: (1) the perceptive process people use to gather information and (2) the decision-making or judgement process people use to reach conclusions. Perceiving may be either a sensing (S) or intuitive (N) process. S relates to practical facts and experience and N deals with possibilities and relationships. Decision-making may be either an objective thinking (T) or a subjective feeling (F) process. These latter terms do not refer to a cognitive-emotional distinction, but merely to a preference for reaching conclusions through impersonal analysis or based on subjective or personal involvement (Lawrence, 1982). By crossing the two dimensions, four basic mental functions that relate to learning style are identified (ST, SF, NT and NF). These were measured using the Kiersey Temperament Sorter (Kiersey and Bates, 1974).

Two additional dimensions in type identification relate to how one uses the perception or judgement process. The extroversion-introversion (EI) dimension indicates a preference for these processes to be outwardly or inwardly directed. The judgement-perception (JP) dimension indicates a preference for dealing with the outer world and dictates whether the SN (perception) or TF (judgement) dimension is the dominant process. J-types, with a proclivity to decision-making, prefer closure and are outcome oriented. P-types, in keeping with an interest toward gathering information, prefer to keep options open and are more process oriented.

3. Student characteristics

The data were collected from students in required entry level statistics

courses in education, business and engineering at VPI & SU. The classes were conducted at Virginia Tech's Graduate Center located near Washington, D.C. and were taught by either a resident faculty member (myself) or one of five adjunct statistics faculty during the past three years. Almost all were employed full time and were in either a masters or a doctoral program. Of the original 155 students, 134 responded to at least one of the open-ended questions.

As may be seen in Table 1, most were from education (63%) and over half were female (57%). While over two thirds of the education students were females (69%), males were in the majority in engineering (64%) and business (59%). Students were about evenly split in the SN perception dimension (53% Ss). The majority of education students, however, were Ns. With respect to the TF decision-making dimension, 66% were Ts, as were almost all the engineers (82%). Additionally, students were equally likely to be an E or an I, but almost all were J-types.

Considering the joint distribution of the two personality type dimensions, Table 2 indicates that almost half the students were STs and only 7% were SFs. Males were predominantly STs, while females were split across three categories (excluding SF). Overall, males were predominantly S-types (76%), while females tended to be N-types (64%). Three quarters of the males were Ts as were 58% of the females. This sample differs from the general population where the TF dimension is the only one that is gender related, with 60% of males being Ts and 60% of females being Fs (Lawrence, 1982). The distributions across mental functions by discipline seems to be primarily a reflection of the gender distribution.

4. Aids to effective learning

Responses to the first question were amazingly diverse, from a mere listing of single items to a full page of writing with multiple comments. In the subsequent discussion, percentages for categories of responses are based on the student as the unit of analysis and not the total number of individual comments. Most of the reasons for effective learning fell into four broad categories relating to the instructor, the student, practical applications, and outside assistance. Ten percent of the students provided no response and four said that nothing helped them, as they did not learn effectively. There was much commonality among the comments of students, irrespective of learning style, academic area, or gender. When combined with the skewed nature of the sample and the under representation in some cells, it was difficult to accurately assess group

differences. Therefore, the discussion will be more general and only provide comparisons where appropriate.

Table 1. *Gender and personality characteristics of the sample by academic discipline*

Column % within pairs	Education 84 (63%)		Engineering 28 (21%)		Business 22 (16%)		TOTAL 134	
GENDER								
Male	24	29%	18	64%	13	59%	55	41%
Female	58	69%	10	36%	9	41%	77	58%
unknown	2	2%					2	1%
PERSONALITY TYPE								
Sensing (S)	39	46%	18	64%	14	64%	71	53%
iNtuition (N)	45	54%	10	36%	8	36%	63	47%
Thinking (T)	50	60%	23	82%	15	68%	88	66%
Feeling (F)	34	40%	5	18%	7	32%	46	34%

Table 2. *Distribution of gender and discipline according to mental function*

Row percents	ST 61 46%		SF 10 7%		NT 27 20%		NF 36 27%		TOTAL 134
GENDER									
Male	38	69%	4	7%	4	7%	9	17%	55
Female	22	28%	6	8%	23	30%	26	34%	77
unknown	1						1		2
DISCIPLINE									
Education	32	38%	7	8%	18	22%	27	32%	84
Engineering	17	61%	1	4%	6	21%	4	14%	28
Business	12	54%	2	9%	3	14%	5	23%	22

Instructor

Over half of the students either cited the instructor specifically or mentioned instructor generated or selected materials. About half of the instructor comments specified his or her clarity of explanations. For example, that the instructor "wrote information on the board and clarified as we went along" and that "important areas were highlighted". Most of the remaining comments were about the instructor's concern and understanding, apparently very important for some students.

A typical characteristic for S-types, who are linear learners, is a

preference for beginning with the known and going systematically, tying new facts to past experiences. They tend to like organized instruction with a detailing of all the steps involved (Lawrence, 1982). One S typified this by saying "the teacher categorized and explained the information in an organized way". However, three other comments about the instructor breaking down material "from simplest to complex" were given by N-type students. Such people, theoretically, are global learners whose intuition provides insight into complexity and who are impatient with details (Lawrence, 1982).

About one quarter of the comments dealt with the instructor's course materials. In particular, students valued handouts that "reinforced the material" and "went thoroughly through each step of the problem". Only nine people mentioned the text.

Students

Of the 41% who said they were a major reason for their own success, three quarters cited effort, doing homework, and extensive study. As typified by one student, the acknowledgement that "spending adequate time on weekly assignments was absolutely essential" was deemed as a very important aspect of effective learning.

Only three students gave the reason for their success as being their aptitude or mathematical bent, another three cited a predisposition or interest in the subject, and seven stated a strong mathematical background. Of interest is the fact that 10 of these 13 statements came from females (mostly in education). This goes counter to expectation, particularly given the prior analysis of 155 students that indicated both a stronger background and more positive attitudes for males, particularly for males in engineering (Belli, 1993).

Practical applications

Although, as mentioned earlier, the literature is rife with the importance of real world examples and practical applications, less than one quarter of the students claimed this was a benefit to their learning. Comments took two forms. The first related to the utility and interest of real-life examples and problems, particularly as they applied to "real, day to day work" and were "immediately applicable in my job assignment". It is typical for S-types to like practical applications and these comments came entirely from STs, most of whom were male engineers. The second aspect related to use of computer software for problem solving so that "we did not have to crunch numbers". This was viewed as providing "freedom to experiment and see various ways to test the same numbers on my own without feeling inadequate". Both aspects

were also mentioned together, indicating the utility of the "practical application of statistical software to real world problems".

Outside assistance

The final area, cited by less than one fifth of the students, was outside assistance from a combination of sources. Working with a group was highly valued by these students. One comment confirmed anecdotal reports from students in many classes, i.e., that "we had one member of our group who understood the material and we felt comfortable asking her questions". Although the instructor was the most frequently cited reason for effective learning, there seems to be an apparent pervasive fear of appearing dumb and of not being willing to ask questions in class or of the instructor. As one student put it, in response to the second question, "An uncomfortableness with my confusion prevented me from going to the instructor for help". Hence, the added value of group interaction. Other sources of aid came from families, both in terms of actual tutoring in statistics or computer utilization and of support and understanding. The latter coming, in part, due to the fact that "there are many lost weekends" for families. Although spouses were a source of both types of support, many computer novices benefitted from help provided by their computer-literate children.

5. Impediments to effective learning

Student responses to what prevented them from learning dealt predominantly with time related issues, the instructor, themselves, or course difficulty.

Time related constraints

One third of the students cited various interrelated reasons for lack of time as a primary deterrent to learning. Over half of the reasons consisted of job and family constraints, which were often cited together. Job requirements sometimes caused students to miss class or simply to be too exhausted to concentrate. Family and other responsibilities and commitments also placed a heavy burden on them. As one student said, "generally time to study affected my grade and learning ability".

A quarter of the time related comments focused on the pace of the course and the belief that there was "too much material in too short a time span". A real sense of frustration was evident due to the "necessity of being exposed to different concepts on a weekly basis and not having enough time to fully understand one topic before being exposed to a new one".

Time related complaints were voiced by students in all three disciplines and learning style preference categories.

Instructor

Although the instructor ranked high for half the students, about one quarter felt that he or she was the reason for their inability to learn effectively. This was primarily due to a lack of good communication skills and to not providing good structure and organization for the class. An additional 11% of the students blamed the text and instructor's handouts and materials as being confusing and of little benefit. One student captured what others were saying: "Lack of structure - we should have had: (1) objectives stated, (2) definition of terms, (3) when and why a specified test was used, (4) examples, (5) closure". This comment, which would be typical of an S-type person, came from an NF. The remaining such comments cut across all types. This may reflect the preponderance of J-types, who like to have a plan and know where they are headed. The desire for organization, structure, and handouts that provide step-by-step detail is also likely related to students' time demands as they do not have the time to deal with trying to sort out concepts and information. Hence, they may expect that to a greater degree from the instructor.

It should be noted that fully two-thirds of these complaints were aimed at one adjunct professor in an educational statistics class. In fairness to the instructor, six female students had positive comments in response to the first question. Two, in particular, felt she "worked to reduce anxiety ... was very affirming" and "was not a drill sergeant; did not teach by intimidation".

Students

Eighteen percent of the students blamed themselves for their lack of learning. Over half of these comments dealt with anxiety and fear of the subject, sometimes tied to a poor math background. Comments were both general ("Unfamiliarity with the subject at onset and lack of background") and specific ("Fear and insecurity with the subject matter, which I believe is due to an incredibly bad ninth grade algebra experience"). A few students simply blamed their "own lameness" and "lack of adequate preparation".

Given the fact that these students, on average, have not had a math course in 13 years (10 years with a sd of 7.7 for males, and 15 years with a sd of 10.4 for females), it is interesting to note that only four education students mentioned this specifically. Another education student, however, noted that "the make-up of the class was diverse - from knowing little about math/stat to 'experts'" and claimed that this made it "difficult to

ask any but the most essential questions”.

Course difficulty and relevance

About 10% of the students found the use of computers to be an added difficulty that was detrimental to their learning. In part, lack of time to learn how to use the computer and software was the problem. But, apparently more important was the lack of adequate instruction and lab assistance and the need to learn both course material and software simultaneously, which “created anxiety and frustration”.

A few students felt the course was too difficult or not relevant and that “there was too much emphasis on mathematical techniques and language of a technical nature”. Yet, only six students felt a need for more practical applications and interpretation of printouts and articles and one who “would have preferred information to be explained in more psychological/behavioral terms”.

6. Discussion

Although the hoped for results of categorizing students’ comments about effective and ineffective learning by student characteristics and learning styles did not attain, the information provided by the students dramatizes the problems and adversity faced by working adults in a rigorous graduate program. Responses to both questions showed an incredible amount of consistency among these students. The underlying reason for this may be that the common denominator of being older and already involved in a full-time job (often a long-term career), with many responsibilities beyond schooling, overrides any differences that might otherwise prevail. A similar study conducted with undergraduate, full-time students would assist in determining the viability of this hypothesis and provide an interesting comparison.

An alternative perspective, based on the fact that there are different approaches to measuring learning style, would be to undertake more comprehensive studies using various instruments. Smith (1982) provides 17 such inventories and tests. It is possible that, with a different instrument, students would be classified in ways that would be more consistent with their comments and that patterns would be evident.

Finally, different educational settings may require different learning theories (Dubin and Okin, 1973). A service statistics class populated by at least some non-mathematical adults who have, of necessity, only a part-time investment in their education is a different environment, particularly in an off-campus setting (Belli and Seaver, 1989). Although the field of

adult education is primarily aimed at informal education, the focus is the adult learner and some of their work should be applicable. Merriam (1988) proposed a framework for organizing and considering the vast body of adult education literature. Areas such as cognitive style, motivation, and experience seem particularly relevant to understanding and improving the experience in graduate applied statistics classes. Situational characteristics such as part-time v. full-time study and voluntary v. compulsory participation considered in Cross' (1981) Characteristics of Adults as Learners (CAL) theory of adult education could also provide some fruitful directions for further inquiry.

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