TEACHING OF STATISTICS IN THE HEALTH SCIENCES

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A Note from the Editor

This month our newsletter is featuring an article written by Dr. H.B. Slotnick. Dr. Slotnick is the Director of the Office of Medical Education and Evaluation and Professor of Neuroscience at the University of North Dakota School of Medicine.

This is an article which I think will be of great interest to many of you. Moreover, I also think that many of you may wish to respond to the paper. If so, I encourage your response in the form of a letter to the editor or a new article.

This newsletter depends upon the support of our subscribers, in terms of the submission of papers. I would like to encourage you to respond to any articles published in this newsletter. I would also invite submission of new articles. If you have any article which you would like to submit, please send to:

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Feature Article

Statistical Quality Control and Teaching Satistics

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Manufacturing and Teaching

Our friend Ruth had just finished her doctoral program in education, and she was interviewing for an elementary school principalship. When she met with the school board, one member said, "I am a manufacturer--I make baby carriages. And I guarantee every baby carriage that comes out of my plant. Will you guarantee the quality of the students who leave your elementary school?"

Appalled that anyone would think that educating a human being was like manufacturing an inanimate object, the superintendent of schools tried to change the subject. But Ruth insisted on answering the question. "Yes," she told the manufacturer. "I'll guarantee the product if you'll guarantee the raw materials."

This should sound a little like Deming's approach to statistical quality control (SQC); being concerned about students entering and leaving our classes does sound like being concerned about raw materials and finished products. And even though the metaphor is flawed (the school superintendent is right about the differences between educating

people and manufacturing baby carriages), there is nevertheless something more to be learned from it.

Learning about Teaching and Learning

Specifically, when statistical quality control is successful in manufacturing, the people responsible learn a lot about the process they're studying. In the course of bringing the manufacturing process into statistical control and improving quality, they learn about the nature and attributes of the raw materials, the ways in which each step in the process works, and the places in the process where tractable and intractable problems are found. The same thing happens in education.

What I mean is that in the process of bringing statistics teaching "into control", we'll become increasingly knowledgeable about students' needs and abilities, the ways in which our activities as teachers impact on the students, and the limitations we and our students have as far as teaching and learning are concerned. In fact, some of our colleagues have begun to do this.

Applying SQC Methods in Statistical Education

I'm thinking, for example, about Doug Zahn from Florida State who uses Mosteller's minute papers (1988) to do quality control in his large (n = 250) undergraduate statistics class (Zahn, 1991). He can point to control charts, for example, showing that the percentages of students who find his presentations un-muddied (his terminology) has increased with efforts he has taken for improving instruction. It sure sounds like statistical quality control.

The SQC question remaining is why did his efforts work? I'd like to suggest two different hypotheses, one of which has been implied already--that his efforts at improving instruction have been successful. The second is that simply by involving students in the feedback process, he communicates a definitely Demingesque message, that students and their views are important in the class. Our studies of adult and young adult learners (Slotnick,et al., In press) shows that this is important for all undergraduates (18- and 19-year-olds in particular) because they are at points in their professional lives where they are unsure of themselves ("Can I really make it through statistics?", "Will I be able to succeed as an accountant/engineer/psychologist...?"), and so asking for their views and then making use of those views communicates an important message about how their statistics professor feels about them: They are good people (otherwise the teacher wouldn't bother with them) and their efforts at learning are recognized and appreciated.

Are these kinds of messages important? They are for the reason teaching is unlike manufacturing: While manufacturing involves people working on inanimate objects (the only way in which the raw materials can change), teaching involves an interaction between the people responsible for the process (the teachers) and the people who anticipate being changed by the process (the students). In fact, it can be argued that while students learn (i.e., they actively internalize the material presented to them), all a teacher can do is arrange the learning environment so that students' efforts are maximized (Fenstermacher & Soltis, 1986). In a way, while teachers are responsible for the process, students are responsible for the product.

This can be seen intuitively (did you ever attend a lecture where no one learned even though the lecturer covered the material?) and quantitatively (in analyzing data from a course evaluation questionnaire, a colleague and I found that out-of-class activities such as readings and laboratory exercises increased in importance as students' reports of the teacher's teaching effectiveness decreased [Slotnick & Durkovic, 1973]).

And so Doug Zahn's collecting and acting upon minute reports provides students with an opportunity to interact with him, and this interaction resulted in improved student satisfaction with his course. At a minimum, this is an example of the Hawthorne effect where simply attending to the needs of workers caused the workers to be more productive. But more than helping students to be productive, Doug helps students both with developmental needs they have (he helps them to be more confident in the professional decision resulting in their enrolling in his class) and the need for

self-esteem all people have (see Gage & Berliner, 1988, pp. 336-37). Do his students feel good about themselves because their teacher listens to what they've expressed in their minute papers? I'd be surprised if they didn't. Do these kinds of feelings facilitate learning? Again, I'd be surprised if they didn't.

In other words, Doug has shown that as if we bring teaching statistics more under control, we will become increasingly aware that our students are trying to address multiple needs simultaneously. To think they are in our classes simply to learn statistics is to understand inadequately students' motivations. They also want to feel good about themselves because of what happens in classes.

In fact, they have needs beyond the two just described, needs which they seek to address even though they are not listed in our syllabi and may not be addressed by our instruction. Some of these needs are developmental in nature (needs varying with the students' ages), and others concern motivational issues (such as affiliation). What is more, identifying these needs and knowing how instructional strategies impact on them requires our understanding areas other than statistics--in this case, developmental and motivational psychology.

A Fishbone Diagram for Teaching and Learning

If we pursue these issues as a problem in statistical quality control, we can use a fishbone (cause and effect) diagram (Walton, 1986)--though with some modifications--to represent the ideas in the preceding paragraph. The modifications are necessary because, as noted earlier, the interaction between teacher and student is qualitatively different from the relationship between an assembly line worker and raw materials.

And so we can use a fishbone diagram knowing it represents an educational and not an industrial process. If it's horizontal line represents teaching and learning at a given time, the ribs touching the line correspond to the issues bearing on the interaction taking place. Though industrial diagrams commonly consider four ribs (materials, methods, manpower, and machines), I'll posit three ribs here: Students (corresponding roughly to materials), teachers (considering both methods and manpower, and curriculum (which considers machines, methods, and materials issues).

Students. The student (S) rib has two sub-ribs, one dealing with students generally, the other concerning individual differences among students. Individual differences, in turn, consider both ways of understanding such differences among students, and ways of working with students showing them. The topic of individual differences is important because the generalizations considered in the other student sub-rib can take a teacher only so far; to be successful with individual students, teachers must be able to appreciate them and relate to them as individuals.

Now this does not mean Doug Zahn has to know personally each of the 250 students in his class; but it does mean he has to stand ready to deal individually with students wanting his counsel on handling the occasional problem that stumps them, with others needing help with more systematic difficulties, and with those wanting to talk about majoring in mathematics or statistics. The common feature in all these instances is that Doug will deal with each student individually by understanding their needs, deciding how best to help them approach their needs, and then working with each to ensure they succeed.

While it is true that each student is unique, it is also true that students share attributes with one another, attributes which can be expressed as generalizations. These generalizations are helpful to teachers like Doug who use them in planning curriculum, designing instruction, producing evaluation instruments, and working with students individually (e.g., Doug uses the generalizations as starting points, departing from them as each student's needs and abilities become clear to him). These generalizations make up the second student sub-rib.

Both sub-ribs include students' beliefs about how teaching and learning take place, the activities students are prepared/willing to attempt, and the other demands made on them. In one sub-rib, these are described as generalizations, in the other, they're considered as individual differences. An example from the generalization sub-rib is the fact

that young students (those in introductory undergraduate classes, for example) tend to see college as the place to learn from experts who have the answers students seek. More mature students, however, have learned these answers don't exist (e.g., see Perry, 1970), and that collegiate learning is more a matter of learning to learn (i.e., education) rather than learning things (i.e., training). The message for teachers is that less mature students will have problems (why bother with approximations? can't you figure out exactly what the value will be?) more mature ones have already resolved, and so we can do things with and for the latter group that will simply result in frustration and unhappiness for the former group.

In addition, some students are never able to deal with the lack of absolutes, while others develop those abilities only after they arrive on campus (see Papalia, et al., 1989). And having these abilities is necessary for more than a superficial appreciation of statistics. This is important because, like motivational issues, cognitive ability is part of the S rib and thus contributes to the success of teaching that takes place in the statistics classroom.

Teachers. The statistics teacher (T) rib includes the teacher's beliefs about how teaching and learning take place, her capabilities as both a communicator of information and an observer of her students' performances, the tasks she identifies for each student, and the other demands made on her--demands including the needs of other students in the class as well as her other responsibilities as a faculty member. In other words, working with the teacher at issues like how she sees teaching and learning taking place, instructional activities she expects students to participate in, and the demands made on her are all potential arenas in which improvement might be realized.

Like the students, teachers find that personal and professional demands made on them change with age. Thus a teacher might work with beginning classes when she is young (because all assistant professors are assigned beginning classes) and, as she matures as a scholar, she is given more advanced courses to teach. It is not unusual, though, for her to find that, after working with more advanced students, she's attracted back to the basic classes. Because of her increased experience and increased maturity, she can offer these students instruction they'll find valuable and she'll find satisfying.

The points I wish to make are that, because of changes that come with age and experience, the teacher interacts differently with her students, and these changes can be reflected in a fishbone diagram.

Curriculum. What the teacher teaches and the students learn is the last rib in the diagram. This is the curriculum (C) rib which I've visualized as reflecting Tyler's notion of curriculum (1949). Thus there are four interrelated sub-ribs considering the goals to be addressed by instruction, the resources available to address those goals (e.g., teachers, instructional materials), the manner in which the instruction is organized, and the manner in which instruction is evaluated. Since I've considered these issues elsewhere (Slotnick, 1990), I'll not pursue them here.

In Summary

Indeed, the discussion of T, S, and C ribs is beyond the scope of the brief comments I want to make here. I simply hope that these comments carry messages for us as teachers of statistics. These messages are: (i) using SQC methodology holds promise as a way for increasing how much students learn in our classes, (ii) interaction between students and teachers is the critical feature of teaching, making the teaching/learning process qualitatively different from manufacturing, and, probably most importantly, (iii) there is much to be learned about how we teach by examining attributes of ourselves and our students as those attributes impact on the interactions taking place in our classrooms. I hope you agree.

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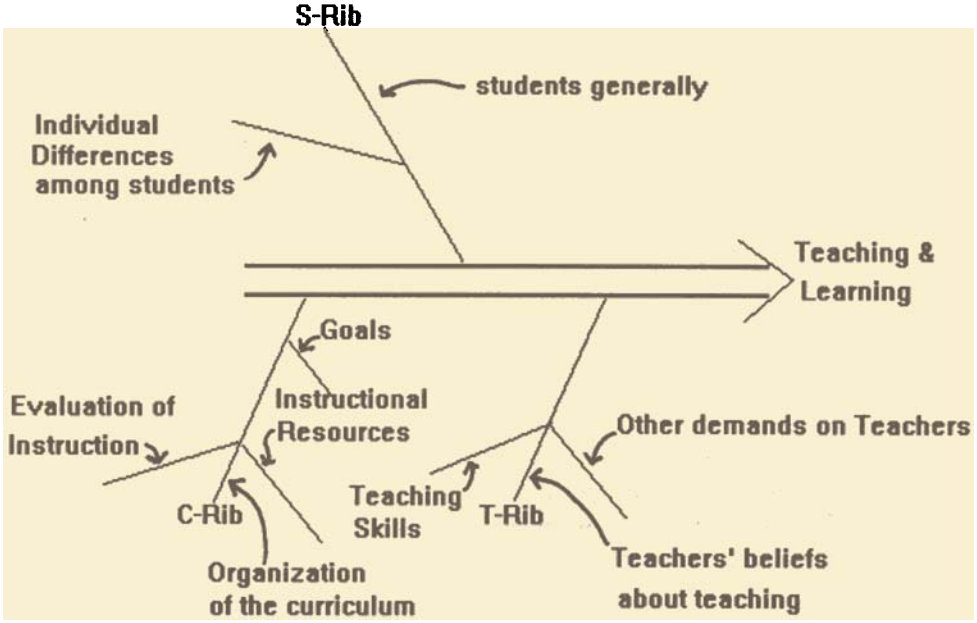
Fishbone Diagram for Teaching and Learning



Note that the S-Rib changes with students' ages, and the T-Rib changes with teachers' experiences.

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This newsletter will publish official notices, articles, book reviews, descriptions of research in progress, reviews of research, letters, and announcements judged to be of interest to members of the section. Materials and manuscripts should be submitted to:

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