Quality Management Journal, *6*(2), 9-21 (1999).

HOW TO IMPROVE TEACHING QUALITY

Richard M. Felder
Department of Chemical Engineering
North Carolina State University

Rebecca Brent
College of Engineering
North Carolina State University

An announcement goes out to the faculty that from now on the university will operate as a total quality management campus. All academic, business, and service functions will be assessed regularly, and quality teams will plan ways to improve them. A campus quality director and a steering team are named, with the director reporting to the Provost. All university departments appoint quality coordinators, who attend a one-day workshop on quality management principles and return to their departments to facilitate faculty and/or staff meetings at which quality improvement is discussed.

Many faculty members are irate. They argue that TQM was developed by and for industry to improve profits, industry and the university are totally different, and talking of students as "customers" is offensive and makes no sense. They make it clear that they will have nothing to do with this scheme and will view any attempt to compel them to participate as a violation of their academic freedom.

What happens then is…practically nothing. Some changes are made in business and service departments, some curricula are revised, and a few

instructors make changes in what they do in their classrooms but most go on teaching the way they have always taught. After two or three years the steering committee writes its final report declaring the program an unqualified success and disbands, and life goes on.

Higher education discovered total quality management in the 1980s and quickly became enamored of it. Books like *TQM for Professors and Students* (Bateman and Roberts 1992) and *Total Quality Management in Higher Education* (Sherr and Teeter 1991) declared that TQM could serve as a paradigm for improving every aspect of collegiate functioning from fiscal administration to classroom instruction. Terms like "customer focus," "employee empowerment," "continuous assessment," and "Deming's 14 principles" started appearing with regularity in education journals and in administrative pronouncements on campuses all over the country. Deming himself suggested the linkage between quality management principles and education, claiming that "…improvement of education, and the management of education, require application of the same principles that must be used for the improvement of any process, manufacturing or service" (Deming, 1994).

Some academic programs and many individual faculty members have tried applying quality principles in their work. Recent papers in engineering education describe quality-based models for classroom instruction (Jensen and Robinson 1995; Shuman et al. 1996; Stedinger 1996; Latzgo 1997; Karapetrovic and Rajamani 1998), curriculum reform and revision (Bellamy et al. 1994; Litwhiler and Kiemele 1994; Summers 1995; Houshmand et al. 1996; Shelnutt and Buch 1996), and department program planning and administration (Diller and Barnes 1994). Nevertheless, after more than a decade of such efforts, TQM has not

established itself as the way many universities operate, especially in matters related to classroom instruction.

Our concern in this paper is specifically with teaching, as opposed to academic or research program structure and administration. We first consider how an instructor can improve the quality of instruction in an individual course, and then the more difficult question of how an academic organization (a university, college, or academic department) can improve the quality of its instructional program. In both cases, we examine the potential contribution of quality management principles to teaching improvement programs in light of the cultural differences between industry and the university.

IMPROVING TEACHING QUALITY IN AN INDIVIDUAL CLASS

We may define good teaching as instruction that leads to effective learning, which in turn means thorough and lasting acquisition of the knowledge, skills, and values the instructor or the institution has set out to impart. The education literature presents a variety of good teaching strategies and research studies that validate them (Campbell and Smith 1997; Johnson et al. 1998; McKeachie 1999). In the sections that follow, we describe several strategies known to be particularly effective.

Write instructional objectives

Instructional objectives are statements of specific observable actions that students should be able to perform if they have mastered the content and skills the instructor has attempted to teach (Gronlund 1991; Brent and Felder 1997). An instructional objective has one of the following stems:

- *At the end of this [course, chapter, week, lecture], the student should be able to ****
- *To do well on the next exam, the student should be able to ****

where *** is a phrase that begins with an action verb (e.g., *list, calculate, solve, estimate, describe, explain, paraphrase, interpret, predict, model, design, optimize,*…). The outcome of the specified action must be directly observable by the instructor: words like "learn," "know," "understand," and "appreciate," while important, do not qualify.

Following are illustrative phrases that might be attached to the stem of an instructional objective, grouped in six categories according to the levels of thinking they require.

1. **Knowledge** (repeating verbatim): *list* [the first five books of the Old Testament]; *state* [the steps in the procedure for calibrating a gas chromatograph].
2. **Comprehension** (demonstrating understanding of terms and concepts): *explain* [in your own words the concept of phototropism]; *paraphrase* [Section 3.8 of the text].
3. **Application** (solving problems): *calculate* [the probability that two sample means will differ by more than 5%]; *solve* [Problem 17 in Chapter 5 of the text].
4. **Analysis** (breaking things down into their elements, formulating theoretical explanations or mathematical or logical models for observed phenomena): *derive* [Poiseuille's law for laminar Newtonian flow from a force balance]; *simulate* [a sewage treatment plant for a city, given population demographics and waste emission data from local manufacturing plants].

5. **Synthesis** (creating something, combining elements in novel ways)**:** *design* [an elementary school playground given demographic information about the school and budget constraints]; *make up* [a homework problem involving material covered in class this week].
6. **Evaluation** (choosing from among alternatives): *determine* [which of several versions of an essay is better, and explain your reasoning]; *select* [from among available options for expanding production capacity, and justify your choice].

The six given categories are the cognitive domain levels of *Bloom's Taxonomy of Educational Objectives* (Bloom 1984). The last three categories--synthesis, analysis, and evaluation--are often referred to as the "higher level thinking skills."

Well-formulated instructional objectives can help instructors prepare lecture and assignment schedules and facilitate construction of in-class activities, out-of-class assignments, and tests. Perhaps the greatest benefit comes when the objectives cover all of the content and skills the instructor wishes to teach and they are handed out as study guides prior to examinations. The more explicitly students know what is expected of them, the more likely they will be to meet the expectations.

Use active learning in class

Most students cannot stay focused throughout a lecture. After about 10 minutes their attention begins to drift, first for brief moments and then for longer intervals, and by the end of the lecture they are taking in very little and retaining less. A classroom research study showed that immediately after a lecture students recalled 70% of the information presented in the

first ten minutes and only 20% of that from the last ten minutes (McKeachie 1999).

Students' attention can be maintained throughout a class session by periodically giving them something to do. Many different activities can serve this purpose (Bonwell and Eison 1991; Brent and Felder 1992; Felder 1994a; Johnson et al. 1998; Meyers and Jones 1993), of which the most common is the small-group exercise. At some point during a class period, the instructor tells the students to get into groups of two or three and arbitrarily designates a recorder (the second student from the left, the student born closest to the university, any student who has not yet been a recorder that week). When the groups are in place, the instructor asks a question or poses a short problem and instructs the groups to come up with a response, telling them that only the recorder is allowed to write but any team member may be called on to give the response. After a suitable period has elapsed (which may be as short as 30 seconds or as long as 5 minutes—shorter is generally better), the instructor randomly calls on one or more students or teams to present their solutions. Calling on students rather than asking for volunteers is essential. If the students know that someone else will eventually supply the answer, many will not even bother to think about the question.

Active learning exercises may address a variety of objectives. Some examples follow.

- *Recalling prior material.* The students may be given one minute to list as many points as they can recall about the previous lecture or about a specific topic covered in an assigned reading.

- *Responding to questions***.** Any questions an instructor would normally ask in class can be directed to groups. In most classes—especially large ones—very few students are willing to volunteer answers to questions, even if they know the answers. When the questions are directed to small groups, most students will attempt to come up with answers and the instructor will get as many responses as he or she wants.
- *Problem solving*. A large problem can always be broken into a series of steps, such as paraphrasing the problem statement, sketching a schematic or flow chart, predicting a solution, writing the relevant equations, solving them or outlining a solution procedure, and checking and/or interpreting the solution. When working through a problem in class, the instructor may complete some steps and ask the student groups to attempt others. The groups should generally be given enough time to think about what they have been asked to do and begin formulating a response but not necessarily enough to reach closure.
- *Explaining written material*. TAPPS (thinking-aloud pair problem solving) is a powerful activity for helping students understand a body of material. The students are put in pairs and given a text passage or a worked-out derivation or problem solution. An arbitrarily designated member of each pair explains each statement or calculation, and the explainer's partner asks for clarification if anything is unclear, giving hints if necessary. After about five minutes, the instructor calls on one or two pairs to summarize their explanations up to a point in the text, and the students reverse roles within their pairs and continue from that point.

- *Analytical, critical, and creative thinking*. The students may be asked to list assumptions, problems, errors, or ethical dilemmas in a case study or design; explain a technical concept in jargon-free terms; find the logical flaw in an argument; predict the outcome of an experiment or explain an observed outcome in terms of course concepts; or choose from among alternative answers or designs or models or strategies and justify the choice made. The more practice and feedback the students get in the types of thinking the instructor wants them to master, the more likely they are to develop the requisite skills.
- *Generating questions and summarizing.* The students may be given a minute to come up with two good questions about the preceding lecture segment or to summarize the major points in the lecture just concluded.

Use cooperative learning

Cooperative learning (CL) is instruction that involves students working in teams to accomplish an assigned task and produce a final product (e.g., a problem solution, critical analysis, laboratory report, or process or product design), under conditions that include the following elements (Johnson et al. 1998):

1. *Positive interdependence*. Team members are obliged to rely on one another to achieve the goal. If any team members fail to do their part, everyone on the team suffers consequences.

2. *Individual accountability*. All team members are held accountable both for doing their share of the work and for

understanding everything in the final product (not just the parts for which they were primarily responsible).

3. *Face-to-face promotive interaction.* Although some of the group work may be done individually, some must be done interactively, with team members providing mutual feedback and guidance, challenging one another, and working toward consensus.

4. *Appropriate use of teamwork skills.* Students are encouraged and helped to develop and exercise leadership, communication, conflict management, and decision-making skills.

5. *Regular self-assessment of team functioning.* Team members set goals, periodically assess how well they are working together, and identify changes they will make to function more effectively in the future.

An extensive body of research confirms the effectiveness of cooperative learning in higher education. Relative to students taught conventionally, cooperatively-taught students tend to exhibit better grades on common tests, greater persistence through graduation, better analytical, creative, and critical thinking skills, deeper understanding of learned material, greater intrinsic motivation to learn and achieve, better relationships with peers, more positive attitudes toward subject areas, lower levels of anxiety and stress, and higher self-esteem (Johnson *et al.* 1998; McKeachie 1999).

Formal cooperative learning is not trivial to implement, and instructors who simply put students to work in teams without addressing the five defining conditions of cooperative learning could be doing more harm than good. In particular, if team projects are carried out under conditions

that do not ensure individual accountability, some students will inevitably get credit for work done by their more industrious and responsible teammates. The slackers learn little or nothing in the process, and the students who actually do the work justifiably resent both their teammates and the instructor.

The following guidelines suggest ways to realize the benefits and avoid the pitfalls of cooperative learning (Felder and Brent 1994; Johnson et al. 1998; Millis and Cottell 1998; NISE 1997).