Why do we need science education?

In a democratic society, the strong support of the general public is needed in order to maintain a strong base in scientific research and science education. It is essential, therefore, to show the public why their support is important. Quality in education and skill in thinking are perceived to be in decline. The public's current levels of scientific understanding are perceived to be inadequate for life in the 21st century. Continuing causes of general educational decline are routinely noted. Educational fixes are profligate. More of the three R's are demanded. What should be done next (Hackerman 1992)?

Because 99% of the national population is not involved in science, nor do they want to be, it is in the scientists' and science instructors' best interest, as well as for the society as a whole, that we should put our best creative efforts into solving the problem of how to fan the interest of nonscience majors in natural phenomena (Hackerman 1992). The science courses that are taught in community colleges will probably be the last formal education most students not majoring in science will take. Therefore, we should provide students with positive and quality scientific experiences. We should not further alienate them from science and from supporting science education and research.

This means current motivational forces applicable to science education must be modified to accommodate this pressing need instead of maintaining the status quo or making the problem of science illiteracy worse (AAAS 1989). It is important that such modifying actions are not at the expense of the non-science major students and science educators at community colleges.

Today's average college student is virtually scientifically illiterate. Many of these students who enroll in science classes are at-risk and under represented students—that is they need more attention for learning to understand phenomena than science majors (AAAS 1989).

How should science be taught?

Science must fulfill an essential role as one of the liberal arts. The teaching of science to all college students must be imbued with a dynamic philosophy. The ideal science education revolves around students and teachers thinking together (AAAS 1990).

Science should be taught as science is practiced at its best and not as it is told about. When students are told about science, it is difficult for students to appreciate and understand scientific endeavors and science anxiety frequently develops (AAAS 1990).

As Fall (1992) points out, in ideal situations the students and teacher would act as a research team, generating ideas, setting up experimental designs, gathering and interpreting data, and writing up the final results. When they get involved in doing science they are more likely to retain their interest in science and be successful students and supporters of scientific programs.

Science educators should be developing higher-level cognitive skills where scientific con-
cepts and methodologies are used to analyze, synthesize, and evaluate problems (AAAS 1989; Raimondo et al. 1990).

Science should start with questions about nature, engage students actively, concentrate on the collection and use of evidence, insist on clear expression, use a team approach, and de-emphasize the memorization of technical vocabulary. Science should welcome curiosity, reward creativity, encourage the spirit of healthy questioning, avoid dogmatism, promote aesthetic response, and build on success (AAAS 1989; Litecky 1988).

Learning to think ensues from students investing time in thinking. To engage students in depth over their written and spoken products requires much instructor time and energy. Reading and analyzing student papers requires a great deal of instructor time and effort. These efforts can be accomplished and sustained when class sizes and teaching loads are not physically and pedagogically prohibitive (Holliday 1992).

When class sizes and teaching loads physically and psychologically are not overtaxing science teachers, they will give written tests and assignments. Work load will not drive the educational process. There will be no override on teaching quality. Instead of teaching students to memorize, thinking will prevail. We should teach students those things that are worth learning. We will not waste our energy, resources and students when we do these things. Teaching then becomes productive, in the long term more efficient, and enhances student learning (Holliday 1992).

One alternative idea to educational steerage instead of educational first class was suggested by E. F. Schumacher in his book on the economics, "Small is Beautiful: Economics as if People Mattered." Schumacher essentially said that a philosophy of "smallness" is the reverse of current trends throughout society. Perhaps a similar "small" philosophy should guide educational practice.

Fall (1992) is convinced that in education, small philosophy guides us toward simplicity, streamlined infrastructure, student diversity, interconnected study, small schools—and, to go with our small schools, small classes. Small classes, of 15 students, mean teachers guide a family, rather than a mob, of students through a curriculum.

"Small" means teachers could more easily be guides, co-students, co-teachers, and co-inquirers with their charges. It means students learning to write because the teacher has time to read, critique, and offer suggestions to students to improve their writing. It means students learning to read because they have the unhurried time to enjoy the story and to cogitate on what it might feel like to one day have people read their own works. It means teachers enjoying teaching because they have the time and encouragement to create. It means small-school social problems, more of the kind that families experience rather than the kind that cities do.

Small education might be expensive initially, but the payoff in the long term could be an educated people that cares for their environment, reads with their children, writes to their representatives, votes wisely, and pays taxes rather then spends them (Fall 1992). The opposite to small education is what we have now—mediocrity or less than optimum learning environments. The alternative may lead to a much more enlightened society tomorrow.

**Rationale for not increasing science class sizes**

1. *Today's average college student is virtually scientifically illiterate.* At-risk students often suffer from science anxiety and making classes larger continues to perpetuate their problems. When science class sizes are increased, there is a corresponding change in
teaching methods to accommodate the increase in teaching load. We should be reversing the trend of alienating students in science classes instead of increasing alienation.

2. **Teachers must recognize the economic compromises, but not compromises that are educationally damaging to our clientele—our students.** Frequently, attempts to increase science class sizes have been capricious, unilateral and not thoughtful. Local administrators need to take the lead when justifying recommendations for class size increases. Other factors besides state mandates for increased efficiency, staffing ratios and edicts of supervisory committees must be taken into consideration. Science faculty are unable to accept class size changes when the only reason for doing so is in the name of efficiency and economics. The burden of proof for justifying these increased class size changes should be on the proposers of the change.

3. **Some teachers of science have crushing teaching loads that make it nearly impossible for them to perform well, no matter how excellent their preparation may have been** (AAAS 1989). Some science teachers have normally taught at the maximum load and usually with the most number of preparations of any faculty over the past 25 years. We have spent needless hours putting up and taking down laboratory equipment that we could not leave out because we had to share lab space. Students have lost access to the laboratory and to the quality they deserved for the past 25 years. We have often spent hours in the labs without compensation in order to make programs go. We have provided field experience way outside of our required time without compensation in order to provide students with quality experiences. We have not asked to lower class sizes in major classes in order to maintain an effective student-faculty ratio overall. We have compromised the times low enrollment classes are offered in order to offer more classes with higher enrollments. And now we are being asked to take on even more students which will further compound our load and quality problems.

4. **Teaching must provide more for students than listening to authoritarian presentations of scientific information.** When students are only told about science it is difficult for students to appreciate and understand scientific endeavors. When class sizes are increased in nonscience majors classes we will not be able to effectively teach science as it is practiced. This further insures that our students at risk will get less attention.

Larger classes represent a movement toward more efficient production for an institution, but it will generally mean a reduction in the development of cognitive skills because teaching styles and behaviors will change as class sizes increase (Holliday 1992; Odden 1990; Raimondo et al. 1990).

5. **Extra teacher time, energy, and effort required with writing- and thinking-intensive courses can not be accomplished, yet alone sustained when class sizes and teaching loads are physically and pedagogically prohibitive.** Writing intensive classes are those defined where writing is the sole or major vehicle for student grading. If other courses with recognized lower class sizes and students at risk are allowed to exist, why are administrators interested in raising science class sizes where students without science backgrounds are definitely at risk in writing- and thinking- intensive classes? The learning process for students should be improved not denigrated. Our students do not deserve that type of education.

When class sizes and teaching loads physically and psychologically overtax science teachers they will be forced to go to non-writing tests and assignments. Work load then drives the educational processes which are not in the best interests of the students. There is usually a subsequent override on teaching quality. Instead of teaching students to think, memorization prevails. When memorization prevails we begin to teach students those things that are not worth teaching. We waste our energy, resources and students' potential when we do these things. It becomes counterproductive and in the long term less efficient and more damaging to stu-

6. Why do the students and the faculty have to take the brunt of higher class sizes in the name of economic efficiency when funding deferrals have gone to cover the cost of excessive administrative growth instead of keeping up with student growth? Colleges should achieve the desired learner outcomes, namely writing, computing, and thinking across the curriculum. These initiatives are not achieved by raising class sizes beyond that which is counter-productive (AAAS 1989, 1990).

7. The expansion of teacher work weeks to include night classes where more than two laboratory sections must be offered, may not be in the students' overall best interests. It is already very difficult to offer a lecture and laboratory experience over a five hour period during one night a week.

8. Increasing class sizes does not necessarily increase access for students. Offering a second section with a reasonable class size and with different times does. When students get the personal attention they deserve they will learn more. Putting more students into a class which drives the teacher to use less effective teaching, assessment, and guidance methods is hardly in the best interest of student access.

9. With many colleges finally seeing future development of remodeled laboratory facilities, science faculty and students will get to use those laboratories in a timely fashion without sharing inadequate and crowded rooms. Just when we get to a reasonable situation administrators have proposed larger class sizes that would perpetuate the problems of the past 25 years.

10. Class size increases should be concomitant with increases in funding for the science program and library and learning resources.

11. Will increases in class sizes be accommodated by contractual language and with the current staff? Does increasing class size mean that we will have to eliminate some offerings we currently have?

**Literature Cited**


