MATHEMATICS FOR THE SAKE OF SCIENCE AND/OR ITSELF[1]

MARY LAYCOCK,
Oak Ridge High School, Oak Ridge, Tennessee

Since I am a mathematics teacher, I want to use sets and Venn diagrams to make my points.

Let M be the set of mathematical concepts and skills which are important to a sequentially developed program in high school mathematics. Let set S be the concepts and skills which are essential for a meaningful program in high school science. (Someone may challenge the well definedness of my sets because there is much doubt and argument these days about "important skills and concepts," so I will limit the sets to a particular school where the program is well defined.)

There are three subsets so described: (1) the set $M \cap S$, (2) the set $M' \cap S$, and (3) the set $M \cap S'$. The first one should receive our most careful attention. It is the set of concepts and skills important to both.

The mathematics program needs the motivation that application to science allows; science needs the careful, meaningful development of concepts that modern mathematics does best.

The planning needed to arrive at the best treatment of those common concepts and skills must be preceeded by each group's separate description of its own scope and sequence. Many of the concepts are important to both groups, but science needs the skill before the mathematics sequence presents it. For example, seventh grade science teachers in our system experienced difficulty because the seventh grade mathematics program presented the Metric System near the end of the year. As a result of their suggestion, a summer writing committee proposed an introductory unit. This year seventh grade mathematics classes began with this unit on the Metric System.

Sophomores who take chemistry need to compute with the slide rule. I maintain that such training is the job of the science class. In an advanced Algebra II class, we cannot present a meaningful study of logarithms until February, and only then is teaching the slide rule a meaningful mathematical activity.

After each department has outlined its own scope and sequence, there should be a cooperative effort in determining the content common to both and then opportunity for the mathematics department to acquire a listing of mathematical problems students are asked to solve in science. Time for the departments to work out many of these problems together would promote an understanding of the language and techniques used by both. On one occasion, when the chemistry classes were working on pH factors, one of our students insisted that the science teacher had found the logarithm of a negative number which we had said was undefined. When we worked out the problem together, we were able to explain what was happening in a language of both science and mathematics so the student gained a better appreciation of both subjects. It was a great help in motivation for my students because the study of logarithms as a function is unique to the advanced classes, and here was a real need for it if the students hoped to really understand the chemical problem.

The scientific community is aware of the need for collaboration. Titles such as Kline's *Mathematics and the Physical World* and George Owen's *Fundamentals of Scientific Mathematics* do a fine job of making mathematics more exciting because of the scientific setting.

School Mathematics Study Group (SMSG) has been aware of a need in their program for student-real problems from the world of science that need mathematical interpretation. Some of their recent titles have been: *Radioactive Decay, Mathematics of Living Things, Applied Math in High School,* and *Math Methods in Science.*

The Life Science series on *Mathematics* and the November, 1964, issue of *Scientific American* both give a beautiful introduction to mathematics and at the same time relate it to science.

In a number of science oriented curriculum development programs there are lengthy units on mathematical concepts needed in science.

There are two other sets of which we have not spoken. They are $M' \cap S$ which might be described as the scientific concepts not mathematically oriented. The other set is $M \cap S'$ or the mathematical concepts not connected with science.

Much of the most interesting project work of a mathematics class arises from finding a relationship between the data gathered regarding some interesting scientific phenomena and the interpretation of this data.

When my analytics students begin to add mathematical vectors, they want to do their problems by drawing angles and measuring lines, but the understanding they have developed in physics class makes the component addition of vectors plausible. To define a vector product without the definition of work from physics would make vector products a rather abstract, meaningless mathematical activity.

Many schools are introducing a senior course called senior mathematics and science which encourages students to do research using both tools.

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When the biology classes talk about genetics, a mathematics teacher welcomes the opportunity to bring in Pascal's triangle and the elementary probability necessary to compute the probability of four boys and one girl in a family of five, for example. Means and standard deviations are not difficult to present and make the work in Biology II more meaningful.

This notion of mathematics for the sake of science and/or itself is a hotly debated topic; so as I have the opportunity to visit outstanding schools, I question people about their views. Burt Kaufman, the head of the twelve year mathematics program in Nova School near Fort Lauderdale, Florida, said he began by listening to the cries of the science people whose only wish was to make technicians and senseless automatic answer finders of mathematics students; so he has told them to teach their own mathematics, and he will plan and carry out a meaningful development of mathematics for its own sake.

I fear I disagree to the extent that the two disciplines may be of help to each other. One of the questions I prod my aspiring engineering students to ask of the colleges they visit is, "Who teaches your engineers mathematics?" I suggest they choose the college where the mathematics department teaches it.

I have watched the engineering department at the University of Tennessee listen attentively and with an awareness of the need for more study as they heard about the mathematics taught in a modern high school program. At the undergraduate level "cook book" mathematics may be sufficient and probably gets the job done faster; but as a student advances into research engineering, the theoretical foundations of mathematics become important as well as the "answer getting" techniques.

So back to the Venn diagrams, Mathematics for its own Sake AND (not or) the Sake of science is my plea since "and" means the intersection set of concepts common to both subjects.