important that the staff involved are well known by the students and that the setting is informal. It would be impracticable to implement this system for large classes because it is quite time-consuming, but it is a good place for problems to be aired which the student may not wish to discuss in a more public setting.

**CONCLUSIONS**

Obviously, no system is going to solve all possible problems. However, these three innovations – the staff-student liaison committee, lecture evaluation and individual interviews – have been of great use in improving staff-student communication, giving students some element of control over the ways in which they are taught and the feeling that their views are important, and helping in staff development. The students have certainly grown in confidence about approaching staff. The evaluation summaries could also be useful to course organisers in maintaining their overall view of course structures. Many teaching departments do include some of these elements to a greater or lesser extent but those that do not should seriously consider introducing them. They do not take up much staff time and are very beneficial. ※

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# Alligation Revisited

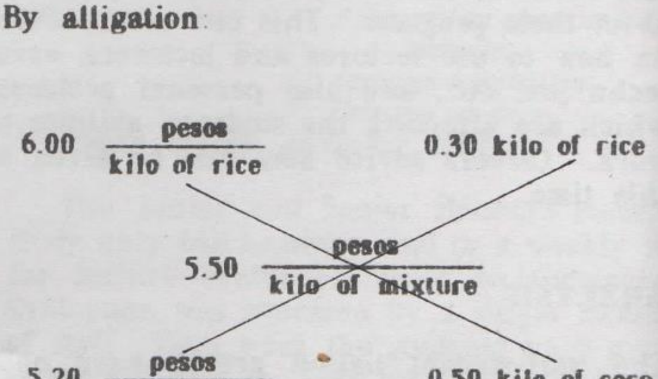
Moises S. Soriaga

*Problem solving is an integral part of chemistry and of its instruction. The correct solutions to various quantitative problems have corresponding steps or methods which, if simple, are preferred. Is a direct, algebraic approach always the best way? Or are alternative approaches better sometimes?*

Alligation is algebraically derived and designed to facilitate the solving of certain problems on mixtures. I have used it profitably over a wide range of problems involving dilution, isotopic mixtures, alpha-beta anomer equilibria, monomer-dimer systems, analytical constants of oil blends, dissociation effects on gas densities and average molecular weights. To illustrate its use better, some sample problems are presented here.

Example 1 If corn is ₱5.20 a kilo and rice is ₱6.00, how much of each is needed to make a mixture costing ₱5.50 a kilo?

By alligation:




The author is a Professorial Lecturer of the Department of Chemistry, University of San Carlos, Cebu City.

Answers are found on the right side of the diagram, obtained by simple subtraction. Their units are in kilos because the unit cost of the component cereals is in pesos per kilo; if it were in kilos per peso (which it is not), answers would be in pesos.

It is the weight ratio of rice to corn that is paramount. For as long as this ratio is kept at 0.6 or 0.3/0.5, the unit cost of the mix will be ₱5.50 per kilo, regardless of quantity. If, for example, 90 tons of corn are used, 54 tons of rice would be required.

When do we alligate? Evidently, not all problems may be alligated. A problem has to satisfy the following conditions to qualify:

a. A mixture of only two components is involved, or one that may be simplified into a two-component system.

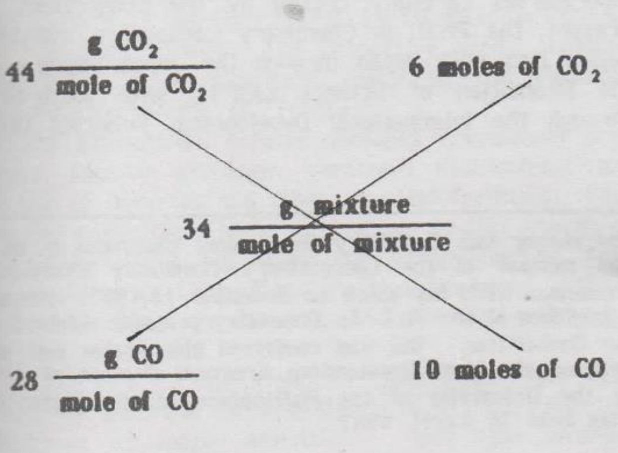
b. A special property (unit cost in example 1) of the system must be known, with different values for each component and for the mixture.

c. The special property must be an "averaging" property.

Is the unit cost in example 1 "averaging"? Yes, because if equal weights of the rice and corn above are mixed, the resulting unit cost of the mix equals ₱5.60, the exact AVERAGE of ₱6.00 and ₱5.20, which are the unit costs of these cereals respectively.

Because all the requirements set forth in a, b, and c are fulfilled in sample problem no.1, alligating it is a profitable exercise.

Example 2. A mixture of CO and $CO_2$ has an average molecular weight of 34. Calculate the volume % of CO.




And, since for a gas, mole % = volume %,

$$\frac{10}{10 + 6} \times 100 = 62.5 \text{ volume \% of CO}$$

However, if the mixture in problem no. 2 also contained $CH_4$, there would be more than two components, and the problem attains a new status, for it acquires an infinite number of solutions. It is impossible to determine the % composition of a mix from its average molecular weight if the mix contains more than two components.

Example 3. What will be the saponification number of a mixture containing 100 g of coconut oil, S. No.= 250, and 200 grams of butterfat, S. No. = 225?

The "averaging" property here is saponification number. Only two are given, that of the mixture is unknown. For this type of problem a direct algebraic approach is the first choice. Alligation retreats to a poor second. Try it.

Example 4. How many grams of oil A, $I_2$ No. = 65, must be added to 200 grams of oil B, $I_2$ No. = 45 to get a mix whose $I_2$ No. = 67?

Many students and a few teachers have been observed to alligate this kind of problem in all seriousness. Unfortunately, this problem is unsolvable. Certainly, no infinite number of 65s can ever raise 45 to 67.

Allow me to retell an interesting incident.

I had been analyzing fish meal then for protein content. One of my clients was having some difficulty formulating a 50%-protein fish meal, of which he had none. Instead he had one with 35% protein content and another with 60%. His question: How many sacks (50 kilos) of each must go into the 50%-protein fish meal he wanted to market? I think my client was highly impressed. And why not? I had the answers to his problem even before he had finished wording it. I forgot to tell him, though, that under certain conditions mental alligation can be faster than an electronic calculator.