The Importance of Asking Questions – in Different Ways!

Uday Maitra
Organic Chemistry Department
Indian Institute of Science
Bangalore 560 012, India.
Email:
maitra@orgchem.iisc.ernet.in.

Most students spend a big fraction of their study time preparing themselves for answering questions – for examinations. This becomes all the more important when a student writes a competitive examination such as the IIT entrance. In such a situation, the busy student tries to consult as many question banks from as many sources as possible, ensuring that (s)he has created his/her own database with (almost) all possible variations in questions from a certain theme! Does this time-consuming exercise lead to a better understanding of the subject? The simple answer is no! Answering question after question with all possible variations does not really enable the student to think deeply, which is required to understand and master the subject. While it is almost obligatory to do well in competitive examinations, it is also important that the subject is understood well. This just does not happen by answering questions. In fact, the student should ask more questions than (s)he answers!

This writeup was meant for school students, but I felt that it may be important to share some of these thoughts with a larger audience.

Let me quote a statement made recently by Professor Richard Zare, Professor of Chemistry at Stanford University, USA. He said: *"The question is a central aspect of both learning and knowledge creation. Yet students often seem to value more the answer than the question. I think quite the opposite. The quest to answer a question is where the learning takes place, not the answer itself"*. Here is a quote from another scientist, who said: "*My mother made me a scientist without ever intending to. Every other Jewish mother in Brooklyn would ask her child after school: So? Did you learn anything today? But not my mother. "Izzy," she would say, "did you ask a good question today?" That difference — asking good questions — made me become a scientist*." And what kind of scientist did he become? He was Isidor Isaac Rabi, who worked in the Physics department in Columbia University, USA. Rabi won the Nobel Prize in Physics 1944 '*for his resonance method for recording the magnetic properties of atomic nuclei*'. This technique became known as NMR, and has considerable applications in Chemistry, and in Medicine (MRI).

This article is reprinted with permission from *Accelerating Science*, Eds Dharanidhar Das and Surajit Choudhuri, published by the Principal, Jamuguri Higher Secondary School, Shonitpur 784180, ©2013.

Keywords
Questions, answers, creativity, classroom teaching.

Figure 1. Isidor Isaac Rabi.

Let me briefly discuss a few strategies I have been using in my course at IISc Bangalore which allow me to judge the creative abilities of students. In this course, I do not give routine homework to the students. Instead, I ask them to submit on a single page, every 2-3 weeks, a question and its probable answer. Probable, because the answer to the question may not even be known! My conditions are that the question cannot be from any textbook, or from any school/college/competitive examination. Ideally, I say, that the answer should not be obvious from a text book, and for answering the question one will have to **think**. Over the years, my students have told me that they very much enjoyed this type of homework, since it made them read books, research papers, and most importantly, think! From the teacher's point of view, this has an additional advantage that every student comes up with a different question, and thus there is no question of copying the homework from one another!

I have attempted another variation of this in my examination papers. In addition to standard questions, I usually have a question in which I produce a drawing (relevant to the topic I teach), and ask them to write two questions which one may ask by looking at the drawing (it can be a plot, or a chemical structure, or a photograph, depending on the subject). This also allows me to judge the creative abilities of the students.

A third 'trick' that I frequently employ is to provide a question with answers, with the caveat that the answers can be correct, partially correct, or completely wrong! The student's job is to 'evaluate' the answers, and give marks! I eventually give marks to the student based on how accurately (s)he has evaluated the answers. My students liked this as well, since it allowed them to use their judgments in a creative way.

I realize that all these cannot possibly be done at the school level because of many constraints. However, the message I would like to pass on to all the teachers is that they should encourage their students to ask questions!

Will the students reading this article send me two questions which they can think of by looking at *Figure* 1? Please email your questions to: maitra@orgchem.iisc.ernet.in.

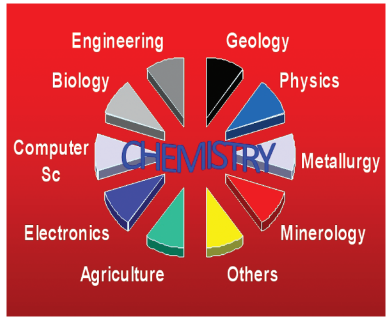

Figure 1.

Suggested Reading

[1] Richard Zare, *Resonance*, 2009, page 818-819.

[2] http://www.organicdivision.org/ama/orig/EminentOrganic Chemists/link/breslow.html (watch the third video on 'Interesting questions').

[3] http://hepg.org/hel-home/issues/27_5/helarticle/teaching-students-to-ask-their-own-questions_507

A Short Proof of Euler's Inequality $R \geq 2r$

Theorem. *Let* Δ ABC *be an arbitrary triangle with circumradius* R *and inradius* r. *Then* $R \geq 2r$ *with equality holding if and only if* ΔABC *is equilateral.*

This was first published by Euler in 1765. Since then several proofs have followed, some geometric and some algebraic. We will use relations between inradius and exradii (r_a, r_b, r_c) to prove the inequality. The following are standard identities, and their proofs can be obtained from any book on trigonometry.

$$\frac{1}{r_a} + \frac{1}{r_b} + \frac{1}{r_c} = \frac{1}{r}; \tag{1}$$

$$r_a + r_b + r_c - r = 4R. \tag{2}$$

It is known that for any three positive real numbers x, y, z, one has

$$(x + y + z)\left(\frac{1}{x} + \frac{1}{y} + \frac{1}{z}\right) \geq 9,$$

with equality holding if and only if $x = y = z$.

Hence one has from (1) and (2) above

$$\frac{4R + r}{r} = (r_a + r_b + r_c)\left(\frac{1}{r_a} + \frac{1}{r_b} + \frac{1}{r_c}\right) \geq 9,$$

which gives the desired inequality $R \geq 2r$. Equality holds if and only if $r_a = r_b = r_c$, that is, if and only if

$$\frac{\Delta}{s - a} = \frac{\Delta}{s - b} = \frac{\Delta}{s - c} \Leftrightarrow a = b = c.$$

(Here Δ is the area and s is the semiperimeter of the triangle.)

Samer Seraj, samer.seraj@mail.utoronto.ca