Spreading the Good News of Chemistry: Macroscale Appreciation for a Microscale Approach

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In this International Year of Chemistry, I feel enthusiastic about this opportunity for sharing several individual and group experiences related to the joy of doing chemistry.

It all started when I was 10 years old, as my parents gave me a most wonderful Christmas present: a chemistry set! That simple fact over four decades ago motivated my entire professional career, which has brought me an incredible amount of positive experiences and growth. I would have never dreamt that I would be designing new experiments, writing books, visiting dozens of countries, reaching so many people, knowing their cultures, and exchanging ideas and friendship.

How Did I Get into All This?

I was attending an ACS meeting over 20 years ago and I heard a talk that captivated me on how to downscale the amounts of reagents and products in the teaching laboratories (by Ron Pike, Zvi Szafran, and Mohan Singh: see ref *1*). I envisioned that this idea of microscale chemistry could spread like wildfire especially in places with limited financial and material resources. And it did! From that moment on, we invited these innovative chemists to give workshops at Universidad Iberoamericana (UIA) and they got us started. My colleagues, especially our chairman Arturo Fregoso *(2)*, also became very keen about the idea and it did not take much to persuade them and UIA of the benefits of initiating a program focusing on the development and dissemination of microscale lab experiences. More recently, one of our colleagues at UIA, Carmen Doria *(3)*, convinced us of "going green", which has prompted us to advance even further, aided at every stage by Ken Doxsee from the University of Oregon *(4)*.

At UIA we have established the Centro Mexicano de Química Verde y Microescala (Mexican Center for Green and Microscale Chemistry), which endeavors to promote the use of small-scale techniques (microscale) in the teaching laboratories at all levels, and to spread the concepts of green chemistry. Now I would like to share some specific ideas on how my group and I have gone about these objectives in the hopes that some readers of this *Journal* may be encouraged by our experiences.

Recommendations for Adopting Microscale and Green Chemistry Approaches

Form a Group

We formed this group of a dozen or so greatly motivated teachers *(5)*. This is very helpful because together we have been able to organize major events, to attend outreach invitations virtually in any season of the year, and to write our experiences in the form of summaries, papers, or books.

Develop New Experiments

There is nothing wrong with old experiments, yet as new materials and concepts develop, it is imperative to include them in lab experiences. This is a great teaching and learning experience and lots of fun.

Go Green

Modern society is very aware of environmental issues. Minimization in the use of resources (including energy), generation of waste, and exposure to dangerous substances has a positive impact not only on our students, but also for every person that hears about what we do. Incorporation of the principles of green chemistry also challenges us to use catalysts rather than stoichiometric reagents, looking for a greater atomic usage (atom economy), replacing toxic, dangerous, and nonrenewable materials, and the like. Not only this is very effective and ethical, but it also yields a positive public image.

Give Talks, Workshops, and Demonstrations

When we found the richness in these approaches, we spread the good news by going out to do outreach activities that have spurred interest in our host institutions at science fairs, commemorative events, or simply in regular classes or laboratory sessions where we are invited *(6)*.

Organize Events

Local. Once you get started, it is relatively easy to organize local events by putting together a brief program that may interest teachers from local schools comprising demonstrations, workshops, contests, and the like. For example, we have organized two very successful contests for developing a specific experiment (i.e., reproduce the colors of our national banner by simple chemical means), or for developing a universal piece of equipment at low cost (i.e., a magnetic stirring unit). Contests spark even more interest when offering wide publicity to the winners and by finding sponsors to give cash or material awards.

National. As soon as we became known in our field, we received several invitations to organize national conferences and symposia *(7)*. These are perfect opportunities to develop networks and to exchange ideas and resources.

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International. When feasible, international interaction brings several benefits, not the least being the development of personal and professional relationships that go well beyond everyday tasks.

Disseminate Knowledge and Findings

For this, we have focused on presenting papers at specialized meetings, writing journal articles, and writing books *(8)*. This has given us the opportunity to put together ideas, to repeat experiences to ensure their reproducibility, and to condense large bodies of knowledge into manageable syntheses more apt for broader audiences.

Visit Local Schools

High school students usually love to get visitors to give shows, even chemistry ones! Not only are these visits fun and give students a different prospective, but the students also get to know you and your institution, and thus, you have made contact with that school, its teachers, and administrators.

Appeal to Prospective Students

In addition to visiting local schools, consider inviting students to visit you. Every year our university organizes a welcoming event that attracts several thousand students in a single day. Each department organizes a booth and activities. Academic events are presented together with social events, including music bands, games, and other "relaxed activities" that set an atmosphere where prospective students are open to attend, for example, our "magic chemistry" demonstration shows.

Involve Your Own Students

Our students have participated in myriad activities: developing new experiments (as part of their course requirements), writing them up for different journals (including, of course, this *Journal*!) *(9)*, presenting them at specialized meetings, accompanying professors to give demonstrations in the neighboring schools, and similar activities.

Contact the News Media

Media coverage gives a boost to organized activities while school administrators see these activities with pleasant eyes. Journalists are normally open to conducting interviews and providing media coverage of special programs when events outside of the ordinary are taking place.

Connect to Other Key Organizations

American Chemical Society. By building connections with the ACS, we formed an International Chapter of its Green Chemistry Institute *(10)*. This fact opened many doors, including the co-organization of a Pan American Summer Institute on Green Chemistry *(11)* as well as the co-organization of a Microscale Chemistry Symposium *(12)* at a joint North American meeting. We are in continuous collaboration with ACS administrators and members and this has greatly expanded our horizons.

IUPAC. This very lively organization has so much to offer, it is a matter of opening one's eyes to the possibilities! Congresses, symposia, publications, projects, cooperation, interaction, and networking are just some of the opportunities available *(13)*.

Local and National Chemical Societies. This is the most tangible door to everyday growth and collaboration. Get drawn in, as these societies are phantom entities unless *each* of us becomes involved.

Bring Key People

Nobody is a prophet in his own land. Whenever we have wanted to have a new idea accepted, we have invited a colleague from another institution to present it. It works! The better the reputation of your guest or of your guest's school, the more the chances that your administrators and colleagues will buy into the ideas presented. We have brought key people from some 20 countries, what a fantastic experience!

Participate in Calls for Awards and Recognition

Humbleness is not an enemy of truth. Participating in calls for special recognition is a way of believing in what you do and the way you do it. We would have never imagined that we were going to receive the National Chemistry Award in 1998 *(14)*, and that the ACS was to give us a 2010 award through its Committee on Environmental Improvement *(15)*. These awards not only raised our spirits, but also caught the attention of our school administration and of our National Chemical Society... and got them interested in what we do!

Get Funding

Even though decent funding is of paramount importance, you can start with very little and do very much. In fact, we started purchasing 10 microscale glass sets the first year; then we did the same for the following few years, and within a short time, we were completely labware equipped. The same is true for other lab supplies and equipment. Knock on many doors if you want at least one to open. And do not despair if things start slow!

Epilogue

I hope that through this brief summary I have transmitted a message of enthusiasm and a sense of a noble objective...for us and for humanity at large in this very special year, 2011, the International Year of Chemistry.

Literature Cited

1. Pike, R. M.; Szafran, Z.; Singh, M. M.; Mayo, D. W. **1989**. Integration of Microscale Inorganic and Organic Chemistry Laboratories. Presented at the 197th National Meeting of the American Chemical Society, April 1989, Dallas, TX.
2. Web Page of Arturo Fregoso at the Universidad Iberoamericana Department of Engineering and Chemical Sciences. http://www.icq.uia.mx/webicq/plantadocingquim/arturofregoso.htm (accessed Nov 2010).
3. Web Page of Carmen Doria Serrano at the Universidad Iberoamericana Department of Engineering and Chemical Sciences. http://www.icq.uia.mx/webicq/plantadocmaestingquim/carmendoria.htm (accessed Nov 2010).
4. Web Page of Kenneth M. Doxsee at the University of Oregon Department of Chemistry. http://chemistry.uoregon.edu/fac.html?doxsee (accessed Nov 2010).
5. Home Page of the Centro Mexicano de Química Verde y Microescala. http://www.uia.mx/investigacion/cmqvm/index.html (accessed Nov 2010).
6. Web Site of the IUPAC project: Towards an Improved Teaching and Learning of Chemistry at the Tertiary Level in the Philippines.

http://www.iupac.org/objID/Institution/2007-018-1-050 (accessed Nov 2010).
7. Web Site of the First National Congress on Sustainable Chemistry and Second National Congress on Microscale Chemistry, Mexico. http://www.educacion.yucatan.gob.mx/shownoticia.php?id=1774 (accessed Nov 2010).
8. (a) Ibanez, J. G.; Hernandez-Esparza, M.; Doria-Serrano, C.; Fregoso-Infante, A.; Singh, M. M. *Environmental Chemistry: Fundamentals*; Springer: New York, 2007. http://www.springer.com/west/home/generic/search/results?SGWID=4-40109-22-90284071-0 (accessed Nov 2010). (b) Ibanez, J. G.; Hernandez-Esparza, M.; Doria-Serrano, C.; Fregoso-Infante, A.; Singh, M. M. *Environmental Chemistry: Microscale Laboratory Experiments*; Springer: New York, 2008. http://www.springer.com/west/home/generic/search/results?SGWID=4-40109-22-173705138-0 (accessed Nov 2010).
9. (a) Ibanez, J. G.; Mena-Brito, R.; Fregoso-Infante, A. Laboratory Experiments on the Electrochemical Remediation of the Environment. Part 8. Microscale Simultaneous Photocatalysis. *J. Chem. Educ.* **2005**, *82*, 1549–1551. (b) Ibanez, J. G.; Gomez, F.; Konik, I.; Lozano, D. E.; Mugica, A.; Gonzalez-Mesa, C.; Singh, M. M.; Szafran, Z.; Pike, R. Preparation of Semiconducting Materials in the Laboratory. Part 2. Microscale Chemical Bath Deposition of Materials with Band Gap Energies in the UV, Vis, and IR. *J. Chem. Educ.* **1997**, *74*, 1205–1207.
10. Web Site of the ACS Green Chemistry Institute International Chapter Affiliates. http://portal.acs.org/portal/PublicWebSite/greenchemistry/about/chapters/ (accessed Nov 2010).
11. Kirchhoff, M. Green Chemistry South of the Border. *Chem. Eng. News* **2007**, *85* (32, Aug. 6), 40; http://pubs.acs.org/isubscribe/journals/cen/85/i32/html/8532meetings.html (accessed Nov 2010).
12. Microscale Chemistry Symposium, 5th Chemical Congress of North America. Cancun, Mexico. November 11−15, **1997**.
13. Home Page of IUPAC. http://www.iupac.org/ (accessed Nov 2010).
14. Web Page of the Sociedad Química de México, Awards. http://www.sqm.org.mx/award/amdelrio/Premiados.pdf (accessed Nov 2010).
15. ACS−Committee on Environmental Improvement Recognition of Exemplary Work in the Incorporation of Sustainability into Chemistry Education. http://portal.acs.org/portal/PublicWebSite/about/governance/committees/cei/index.htm (accessed Nov 2010).

