NSDL Reflections Project

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Reflections on the NSDL

David Yaron
Department of Chemistry
Carnegie Mellon University
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Introduction

This essay is a reflection on my involvement in the NSDL, which I was lucky enough to be involved with from the beginning. My interests are in using online resources to improve chemical education at both the college and high school level, and this work has led to our current NSDL project, the ChemCollective (www.chemcollective.org).

The NSDL has provided an inspiring home for me as a developer. The structure, including especially in-person meetings and workshops, has created a community of like-minded individuals who have educated me and helped guide my work for the past eight years. In this sense, I believe the NSDL project is an unusually successful NSF research program. Working together on a grand challenge, that of creating a national library, provides a structure that encourages engagement among the participants that is far more substantive than the interactions arising in programs built only around a competitive funding model. These interactions have strongly benefited me as a developer. But this is not the only way to perceive the NSDL. At the NSDL kickoff meeting, an attendee who had spent time in the software industry commented "this is an Internet startup company without a CEO or CIO". This comment highlights the nature of the NSDL as a coalition of projects. The benefits of the NSDL arise primarily from the value added to those projects, and for me, the added benefit has stemmed primarily from interactions with the NSDL community.

Transformation of Learning and Speed of Change

I firmly believe that the Internet will radically transform the way people learn. I also firmly believe that I do not know how this transformation will occur or what education will look like in ten or twenty years. It is especially difficult to predict which technologies and constructs will have the most lasting impact, beyond saying that the current choices will at most be forerunners to what eventually succeeds. The technological artifacts created by the NSDL may indeed end up being important forerunners. However, the most lasting impact will likely be through the people it inspired. Years from now, when I download the best-selling book "How the Internet transformed education" onto my digital book reader, my involvement in the NSDL will mean that I know some of the main characters in that history book. For me, meeting these dedicated and talented people is by far the largest impact that involvement in the NSDL has had on me and my work. The cross-disciplinary of the project was key to this impact. I have been involved in many cross-disciplinary projects, but the NSDL is unique in bringing me into substantive dialogue with a diverse group of people interested specifically in using network technology to advance education.

A supportive developer community is especially helpful given the challenges facing the NSDL. Many of these challenges arise from juxtaposing the formal education system, which is shockingly resistant to change, with the Internet, which is shockingly able to undergo radical transformations on a moments notice. Life at the interface of these differently-paced worlds can instill a professional version of manic depression. Ideas intended to radically improve education most often end up having incremental impacts. Our hopes to change the world hit against stark realities and end up pushing the boundaries by only a fraction of our initial hopes. An idealistic community, such as the NSDL, is what is needed to inspire individual projects to continue to throw themselves against the wall in hopes of pushing it back further and further. Such an incremental pace is to be expected in research. When it comes to curing cancer or developing nanotechnology, the research enterprise is structured around the anticipation that ultimate success will mostly come as the culmination of small advances. But the rapid transformations we sometimes see on the Internet, with sites growing from initial concept to household words in a few years, builds up hope for similarly rapid advances in education.

An equally challenging aspect of life at the interface of education and technology is the speed at which the Internet transforms. The shared experience provided by involvement in the NSDL has helped me learn how to focus my own efforts on projects that are likely to have impact when they are completed in two or three years, and the Internet landscape has once again been redrawn. In particular, some user needs appear to be education specific on the surface, but turn out to be specific instances of broader issues such as the need for improved communication, search, or rapid software application development. Attempting to meet such broad needs will likely lead to a race with much larger entities, such as the for-profit sector. To avoiding such counterproductive races, I try to put all my ideas through a litmus test for educational specificity. This has shifted my development efforts to projects with a strong focus on the chemical education community.

Transforming Introductory Chemistry Courses

Fortunately, restricting focus to chemical education is not very limiting since, in my opinion, introductory chemistry courses need a complete overhaul. The traditional course teaches the wrong stuff, in the wrong way.

The "wrong stuff" comment is especially relevant for high school courses, where I believe the emphasis should be on scientific literacy. After all, why should almost every student be required to take a chemistry course? The most common response is that chemistry is necessary to understand many important issues in modern society. We did a thorough analysis of the way chemistry appears in sources such as the New York Times, Scientific American, and the Nobel Prize citations, as a concrete instance of what scientific literacy means in chemistry. Our results show that the current course does almost nothing to advance scientific literacy. [1] Based on these sources, we created a domain map which, if used as a basis for instruction, would give students a useful perspective of how chemists *explain* phenomena by generating and testing hypotheses; *analyze* substances to determine their chemical makeup, and *synthesize* new chemicals such as drugs or plastics. The current course covers fundamental tools and conceptual frameworks of chemistry without giving any hint as to how they are actually used to explain, analyze or synthesize anything. Even students destined to be future scientists and engineers would be better served by a course that conveyed the big-picture of the domain, with detailed information on the tools and frameworks embedded appropriately in the overall structure of the domain.

By "wrong way", I mean that the current course focuses on teaching students how to carry out a set of tasks that are instantiated either as mathematical problem solving or as manipulation of graphical notations. Inquiry may be held up as a value in middle school education, but inquiry falls to the wayside as high school teachers struggle to cover the laundry list of topics that make up introductory chemistry. The end result is that students learn a large set of disconnected tasks without gaining insight into the actual chemistry concepts the tasks were intended to convey.

So if I could transform chemistry at a Google-like pace, I would immediately have all classrooms start teaching the "right" stuff in the "right" way. But such broad sweeping change is not possible, or even desirable, in educational systems. When it comes to social systems, evolution is better than revolution. The goal of our ChemCollective project is to provide educational resources that help promote this evolution. The need for improved instructional approaches is becoming increasingly well appreciated among chemical educators and so teaching in the "right" way is our current focus, via virtual labs and other interactive activities that help students go beyond mathematical procedures and develop a conceptual understanding of chemistry. Teaching the "right" stuff for scientific literacy will be a much more difficult evolution. Our current approach is to embed the traditional course content in scenarios that highlight how this knowledge is used to explain, analyze and synthesize. These scenarios include a murder mystery, arsenic poisoning in the groundwater of Bangladesh, ozone depletion, and human respiration.

Conclusion

Our hope is that the Internet will provide a means to help build a community of educators that can, collectively, evolve current chemistry courses to a structure that better engages students and improves their ability to reason about chemistry in their lives. I believe my involvement in the NSDL has helped me better craft goals that are ambitious but compatible with life at the interface of the disjoint worlds of education and technology, and improved my ability to work towards and monitor progress towards those goals. I am hoping that my hopes for this effort are not symptoms of a manic phase. But, in any case, the friends I have made through the NSDL make it rewarding to join in and continue pushing against the wall. As one of my favorite colleagues in the NSDL said to me, while I was in a somewhat depressive phase, "You have to keep fighting the good fight".

References

[1] Karen L. Evans, Michael Karabinos, Gaea Leinhardt, and David Yaron, "Chemistry in the field and chemistry in the classroom: A cognitive disconnect?", Journal of Chemical Education, Vol 83 No. 4. April, 2006.