The UC Davis STEMWiki Hyperlibrary consists of seven pseudo-independently operating and interconnected “STEMWikis” that focus on augmenting post-secondary education in STEM (Science, Technology, Engineering and Mathematics) fields. The primary goal of the project is to develop and disseminate viable online textbook alternatives within a central environment that is both vertically (from advance to basic level) and horizontally (across different fields) integrated and provides students with high quality cost-free textbooks. The Hyperlibrary project is empowered by Mindtouch’s cloud-delivered web platform and is a powerful mechanism for disseminating new educational approaches, especially those that capitalize on advanced computation resources and visualization. The project is developed by a consortium of students and faculty across multiple campuses and countries and grows monthly. Contact Delmar Larsen (dlarsen@ucdavis.edu) for more details about contributing or using the Hyperlibrary.

INTEGRATING NEW PHYSICAL CONTENT

While General and Organic chemistry content has been a major focus for the ChemWiki Development team recently, other fields have not been ignored. New physical chemistry content has been added to the ChemWiki including Advanced Thermodynamics from Martin Gruebele (U. Illinois Urbana Champaign), Advanced Theoretical Chemistry from Jack Simons (U. Utah), Advanced Statistical Mechanics from Mark Tuckerman (New York U.) and Quantum Mechanics from Seymore Blind (U. Michigan). This complements the physical chemistry text “Quantum States of Atoms and Molecules” by David M. Hanson, Erica Harvey, Robert Sweeney, and Theresa Julia Zielinski. For the Physwiki, General Physics content from Benjamin Crowell (Fullerton College) and Advanced Quantum Mechanics from Michael Fowler (University of Virginia) have been added. Complementing these physical additions, the Analytical Chemistry 2.0 text by David Harvey (DePauw University) was introduced. Pursue these substantial contributions as they are linked within the growing Hyperlibrary network.

PILOT RESULTS: CHEMWIKI AS GOOD AS CONVENTIONAL TEXTBOOK

The preliminary results of a three-quarter pilot to test the efficacy of the ChemWiki, as a representative of the greater Hyperlibrary project, are positive. The pilot is part of a data-driven quantitative effort to evaluate the viability of the ChemWiki to supplant conventional textbooks. The first quarter of the pilot involved 926 students that were enrolled in two sections of Chemistry 2C (Spring ‘14). Both sections were taught by Prof. Larsen and had identical lectures, TAs (each TA taught in each class), and exams, but differed in using either the ChemWiki or the conventional textbook (Petrucci et al. 10th). The assessment protocols were established in collaboration with Marco Molinaro (UCD iamSTEMHub) and Gregory Allen (Chemistry).

While a full report of the pilot is forthcoming, the initial analysis indicate that students using the ChemWiki performed as well as students in the Petrucci et al. control course, after controlling for all the covariates in the model. Multiple linear regression was used to model individual student characteristics on the outcome variables of choice including exam performance, normalized learning gains from pre/post exams, COPUS classroom observations, weekly “time-on-task” surveys, and course evaluations. To our knowledge, this is the largest quantitative assessment of an online textbook and demonstrates that with suitable development, the Hyperlibrary is a viable alternative to conventional textbooks.
Advancing the ChemWiki into the Classroom

The exponential growth of the Hyperlibrary visitor traffic, with approximately 4.5 million visitors per month expected by mid-December, was enabled by the many student and faculty developers/contributors that have participated in its construction. Despite this impressive traffic, the goal of the Hyperlibrary project is not just supplement conventional textbooks, but to supplant them. This requires extending the ChemWiki from an online resource into functioning textbook.

Moreover, the Hyperlibrary must be optimized to address a range of classes from Community Colleges, Four-year Colleges, and Universities. Since March 2014, the ChemWiki has been used as the exclusive textbook in seven different classes involving six different instructors over four campuses in two states. These seven classes alone have saved students approximately $500,000.

We are looking forward to working with forward-thinking faculty in scaling up this effort in the next few years. Central to this expansion is the adoption of the ChemWiki in large enrollment classes like those at UC Davis. The ChemWiki was used as the exclusive textbook for two classes of Chem 2C (3rd quarter General Chemistry) by Prof. Delmar Larsen and is currently being used by Dr. Tomoyuki Hayashi for Chem 2A (the first quarter in the sequence) with an enrollment of 500 students.

Contributions from developers Tim Soderberg (UM Morris) and Steven Bennett from Sacramento City College are using the project for her GOB (General, Organic and Biological chemistry) class, which targets health and nursing students. As Prof. Bennett explains, the reliability and flexibility of the ChemWiki was particularly instrumental this semester. “The ChemWiki saved the day this fall. Delivery of the traditional text was delayed until the 2nd week of the semester.”

The Diablo Valley College team has been carefully crafting an expansive homework Question and Solution database to supplement the existing Modules. Lead by Prof. Ron Rusay, their homework database, containing thousands of problems, is being used currently by Dr. Hayashi’s Chem 2A (UCD). Each problem has associated metadata including organization, question type, hints (with links to ChemWiki pages) and a fully vetted solution. The next stage of this effort is to expand the database to include organic chemistry questions and to integrate the database within the Qoll Q&A system as a self-grading, self correcting OER online platform similar to commercial systems like Aleks, Sapling, MasteringChemistry, WebAssign, OWL, etc.

The results of these initial efforts are strongly encouraging and hint at the potential of the approaches underlying the ChemWiki and the greater Hyperlibrary.

<table>
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<tr>
<th>Instructor</th>
<th>When</th>
<th>Course</th>
<th>Campus</th>
<th>Enrollment</th>
<th>Text Cost</th>
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<td>UC Davis</td>
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</table>

In Washington D.C., Prof. Joshua Halpern from Howard University is using the ChemWiki to design a new “Atoms First” online textbook for his first semester General Chemistry class. Prof. Halpern argues that “[the ChemWiki] expands my options. I have only scratched the surface with respect to including additional material. This is the strength of the ChemWiki, not one textbook for the class, but many.”

Purdue University has taken the lead in using the ChemWiki for organic chemistry courses, based in part on new material and existing Farmer (Sonoma SU). Both Profs. Mark Lipton and Paul Wenthold use the ChemWiki as the primary reading resource for students in their classes. While their experiment with the ChemWiki started Fall semester, both are optimistic of its potential as Prof. Lipton emphasizes, “[the ChemWiki was] easy to set up. I was usually able to find articles relevant to my class and I was able to write articles quite easily to supplement the existing material.”

As an example of the flexibility of the ChemWiki to address a wide spectrum of classes, Prof. Dianne Hayashi (UC Davis) is using the ChemWiki as textbooks in their chemistry classes.


Profs. Paul Wenthold (Purdue), Mark Lipton (Purdue), Dianne Bennett (Sacramento City College), Joshua Halpern (Howard University), and Dr. Tomoyuki Hayashi (UC Davis) are using the ChemWiki as textbooks in their chemistry classes.
Integration Scheme of Hyperlibrary (top). Monthly visitor traffic profiles for the ChemWiki (middle) and five other STEMWikis (bottom) since project initiation. Dotted line is projection of traffic to December 2014

A common question that often arises concerns which aspects distinguish the STEMWiki Hyperlibrary from other Open Education Research (OER) projects like OpenSTAX that focus on textbooks? Two principle factors eventually surface to address this question.

The first factor is that the Hyperlibrary’s intrinsic collaborative developmental approach introduces a potent combination of flexibility, adaptability, and applicability capable of addressing a range of different classes. This enables faculty to adopt and adapt Hyperlibrary materials to suit their specific purposes. As demonstrated by the initial classroom efforts discussed in page two of this newsletter, this approach is successful in addressing students at community colleges, four year colleges, and even university honors classes. This coupled with the constantly evolving nature of the collaborative development approach empowered a vibrant project with widespread usage (based on traffic statistics at right) and ensures that it “never goes stale.” Moreover, this diversified approach is efficient requiring fewer financial resources for its development than many other OER projects.

The second factor is the “greater than the sum” aspect of the hyperlibrary. Once properly integrated, all content added into the Hyperlibrary is “wired” into a dynamic network that extends both horizontally (across multiple fields) and vertically (across multiple levels of complexity). This offers students and faculty, not just a single hypertextbook, but an infinitely large Hyperlibrary of interconnected hypertextbooks. This provides a comprehensive picture of how concepts interrelate – a central goal in education.

The goal of STEM education is not to master the concepts taught in individual classes, but to master the concepts across multiple classes that extend across differing fields and construct the connections that integrate those concepts to create a “whole that is greater than the sum of its parts” education. For example, students learning “enzymology” from the BioWiki cannot fully master the concepts of this field without understanding “chemical kinetics” from the ChemWiki. This correspondingly requires understanding “separable differential equations” from the Mathwiki. Many such connections exist in STEM fields and Hyperlibrary is constructed with the philosophy that textbooks should emphasize such interconnections, not obscure them in separate textbooks.

The strongly integrated and collaborative nature of the STEMWiki Hyperlibrary enables the project with the flexibility necessary to address both current and future STEM education needs. Building a project of this complexity requires greater effort than building textbook repositories. To accomplish this, we need your help (page four of newsletter).
Help us to help you: Consider contributing, adopting or facilitating the construction of course Hypertexts

Our construction approach follows a “bottom-up” modular development scheme involving faculty and students with faculty contributing content and organization, while students contribute through supporting tasks like content integration and evaluation. Our project goals are sweeping in scope and many avenues exist to support to the Hyperlibrary project. Please consider contributing to the construction of the STEMWiki Hyperlibrary or publicizing its utility.

People are talking: Search “ChemWiki” in your favorite social media platform for an overview of project’s impact

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Please link, like, g+, or tweet about the UCD Hyperlibrary.

Contact Prof. Delmar Larsen for more details on how to contribute (dlarsen@ucdavis.edu)

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