分析科学デジタルライブラリー（ASDL）

本会名誉会員でASDL責任者のT. Kuwana教授とASDL編集委員長C. K. Larive教授から，分析科学に関するウェブ図書館であるAnalytical Sciences Digital Library（ASDL）について原稿をいただいた。その概要を紹介すると次のようである。

“Active Learning with the Analytical Sciences Digital Library”のタイトルが示すように，ASDLを分析科学の教育に活かしてほしいという視点で執筆されている。記事は，ASDL設立に至るまでの背景，Analytical Sciences Digital Libraryのジャーナル（JASDL）について，能動学習の教材について，ASDLコミュニティについて，から構成されている。それらの要点は，四つの表にまとめられている。1996年と1997年に全米科学財団（NSF）後援のワークショップで作成された分析科学のカリキュラム作成への大切な提言（表1），問題解決型学習すなわち，能動学習とは（表2），ウェブサイトの内容（表3），ASDLの蔵書カテゴリーの概略（表4）である。

まずは会員の皆さまには，www.asdlib.orgにアクセスしていただきたい。NSFの資金提供を得ながら分析科学に特化した領域で，しかも査読を経たウェブサイトを精選した蔵書は次の五つのカテゴリーにまとめられている。

分析技術：計量化学，電気化学，計測機器，質量分析，NMRとEPR，分離分析，分光分析，表面/ナノ材料などの各種分析法につき，基本から応用に至る講座が充実している。ビデオによる講義例もある。

分析の応用例：データベース，生物分析，環境分析，法医学分析，定量分析，研究室マニュアル，実験，研究の実践，科学者ガイドラインなど，分析の応用分野を視野においた講座である。

各種フォーマットを使ったリソース：アニメーション，パワーポイント，e-テキスト，チュートリアル，ビデオ，仮想研究室等を活用して，効果的に分析科学の学習が進められる教材である。

教育のためのリソース：能動学習，ケーススタディ，協力学習，問題解決型・情報探求型の学習，参照リンク/データベース等が提供されている。

JASDL： コースウェア，実験ウェア，教育実践などの内容が含まれる。

これらの450を超える査読を経たウェブサイトの蔵書ばかりでなく，能動的e-ラーニングのモジュール，e-テキストブックも充実している。それらはウェブを使った問題解決型学習に適するばかりでなく，我々日本人にとっては英語による分析科学講義にも最適の教材といえよう。JASDLにおいて，著者は，教育や研究プロジェクトおよびe-ラーニングのモデュールに関する原著記事を投稿してJASDL出版物として提供できる。また，Scientist’s Guidelineとして，クリエイティブ・コモンズの著作権方針（http://creativecommons.org/about/licenses/），アメリカ化学会の著作権方針（http://pubs.acs.org/page/copyright/index.html）にも触れて，これらの点の教育にも役立つ。掲載サイトの記事の執筆者には，著作権が保持されている。さらに，ASDLネットコミュニティとして，ASDLにソーシャル・ネットワーキングを作って，ユーザーのグループがドキュメントファイルを共有し互いに分析科学教育の活性化できるコミュニティを建設している。

記事を読むより先に，www.asdlib.orgをクリックするのもお奨めである。教育に腐心されている会員は，その内容に感激するはずだから。

なお，両教授の原文は，本会ホームページ上の「ぶんせき」（http://www.jsac.or.jp/bunseki/bunseki.html）に本稿とともに掲載されているので，ぜひ参照されたい。

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Active Learning with the Analytical Sciences Digital Library

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There has been a revolution in the amount of information that is readily accessible with the advent of the Internet and the development of electronic devices, particularly those that are hand-held and wireless. This revolution also has changed the way in which we interact and communicate. For those in the educational field, the changes are profound. As we will show with the Analytical Sciences Digital Library (ASDL), there is a wide variety of resources, both online and self-embedded, to deliver instructional material for ***active learning*** and classroom instruction. Because information is readily available electronically, it is no longer necessary to retain data and facts through memorization. What is important is to learn how to access, assimilate and utilize such information as a basis for a working knowledge to solve problems and live a fuller productive life.

Background to ASDL - Two workshops, sponsored by the National Science Foundation (NSF) in 1996/97, produced a report ***Curricular Developments in the Analytical Sciences*** (http://www.asdlib.org/files/CurricularDevelopment_Report.pdf). This report was subsequently translated to Japanese text by Prof. Yano and published in Japan year 2001. Of the 13 recommendations in the Report, six dealing with educational approaches are listed in Table 1. Questions arose at meetings and workshops regarding the need for materials to support instructors in implementing these recommendations, particularly problem-based learning (PBL). The answer was to develop a digital library that provided links to the needed resources like PBL, which is a student-centered rather than teacher-centered active learning approach. That is, students ask and define real-world problems to be solved and work as a team to solve the problems. The teacher acts more as a guide and a consultant. Table 2 provides the essentials of PBL with URL links to reference websites that provide guidance for implementation including an example of a PBL-based laboratory course.

With the support of NSF through its National Sciences Digital Library (NSDL) program, a grant provided support to develop the Analytical Sciences Digital Library (ASDL) which went online in November 2002 (www.asdlib.org). The Internet contains millions of websites that potentially could serve this need. The difficulty is in finding those sites that contain accurate and appropriate material in the context of serving the educational community. With a cadre of dedicated editors, the Internet was searched for such material and subjected to *peer-review* to ascertain quality and merit for inclusion in asdlib.

Table 3 summarizes the contents of asdlib. We will discuss each of these in the order listed. The **Collection** refers to the compilation of URL-linked, peer-reviewed websites that are organized and categorized under five main headings as shown in the Table: Techniques, Applications, Resources by Format, Teaching Resources and the journal of ASDL(JASDL). These main categories are each followed by a list of subcategories, further delineating the subjects to facilitate searching and browsing the Collection. The Collection can also be searched by entry of

search priority words into the search box. Websites contained in the Techniques and Applications categories primarily deal with the basics and applications of instrumental methods of chemical analysis such as mass spectrometry and NMR. Many come formatted as animations, videos and powerpoint slides as delineated in the Resources by Format category. Many of these are taken directly from lectures and meeting presentations, easily adapted to classroom instruction or supplemental learning material for students.

An example website, that may be familiar to readers, may be the one titled *Integrated Spectral Database System for Organic Compounds* (http://riodbol.ibase.aist.go.jp/sdbs/Lines/introduction_eng.html as maintained by the National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba/Japan. It contains an extensive spectral database for various spectroscopies (i.e. IR, Raman, optical, NMR, etc.). These spectra can serve as standards for comparison to experimental results.

ASDL/asdlib recently expanded its scope of interest to include guidelines for professional activities and conduct. Clicking the cursor over Scientist's Guideline yields subcategories of copyright and patents, ethics and mentoring, poster guidelines, safety and compliance, and writing practices, notebook and authorship. The copyright policies of Creative Commons, http://creativecommons.org/about/licenses/, and that of the American Chemical Society, http://pubs.acs.org/page/copyright/index.html, are two websites that everyone should become familiar with. Fraud and plagiarism in the conduct of research and writing papers are ongoing concerns for the scientific community (see *Online Ethics Center* by the National Academy of Engineering for role-playing examples of conduct to understand ethics compliance issues, http://www.onlineethics.org/). We hope that compiling these types of websites in ASDL/asdlib serves to promote professional awareness, skills and conduct within the analytical community.

Teaching Resources contain websites in subcategories of active learning (12), case studies (4), cooperative learning (6), problem/inquiry-based learning (22), reference links/databases (4). These websites are resources to foster effective teaching and learning for classroom and laboratory courses. Some like PBL have been widely adopted as indicated by the data in The Problem-based Learning Directory by U. Brighton (UK) (http://feedback.bton.ac.uk/pbl/pbldirectory/index.php). It contains information for 104 courses at 90 institutions across 29 countries. These student-centered rather than teacher-centered methods are now being widely adopted globally.

The Journal of the Analytical Sciences Digital Library (JASDL) - While the ASDL collection primarily annotates and links to external websites, JASDL serves as the publishing arm of ASDL. Authors can submit original items such as essays on teaching and learning, laboratory projects and eLearning Modules, providing a concise tutorial on analytical science topics and even electronic textbooks for JASDL publication. JASDL removes the burden to authors of maintaining their own web content, permitting publication under the Creative Commons copyright which allows others free use of the material, providing attribution is given to the author. All JASDL materials are subjected to peer-review prior to publication. JASDL materials are categorized under Courseware, Labware and Educational Practices.

The e-Learning Modules give a comprehensive overview of the tools in the analytical chemist's toolbox. A good example of an eLearning Module in the JASDL courseware is the tutorial on Analytical Electrochemistry. This module covers the complete scope of electrochemical measurements from the foundational underpinnings of voltammetric measurements to practical applications and includes a comprehensive list of 7 experiments. JASDL eLearning Modules are also available on Affinity Chromatography, Atomic Emission Spectroscopy, Kinetic Capillary Electrophoresis, Lasers, Potentiometry, Scanning Probe Microscopy, Signals and Noise, Statistical Analysis of Data, X-ray Diffraction and X-ray Fluorescence, with additional topics currently under development.

Active Learning Materials

With funding from the National Science Foundation TUES (Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics) a group of NSF principles led by Tom Wenzel, Bates College, have begun to develop active learning materials for instruction in analytical science. This project involves more than 20 chemistry faculty from around the United States and from a wide variety of universities (public, private, primarily undergraduate, Ph.D. granting, and including 2 minority-serving institutions). These materials will be disseminated through ASDL for adoption and adaptation by others, and are currently available at http://www.asdlib.org/ActiveLearning.php. These materials are being developed in a modular format that is intended to allow instructors to use all or a portion of a given module as appropriate for their course and students.

A good example of the type of materials being developed is the Lake Nakuru module which questions why flamingoes are dying at this alkaline lake in Kenya. One hypothesis is that organochlorine pesticides such as DDT are responsible for the flamingo deaths. The module explores fundamental aspects of analytical chemistry in addressing this question with GC-MS. This module contains units for Identifying the Problem, Sampling, Sample Preparation, Gas Chromatography, Mass Spectrometry, and Method Validation. In addition the module contains an Instructor's Guide that provides guidance on implementation and answers to questions. Finally, the module gives a link to the EPA method 525.2 which serves as a resource. The Lake Nakuru module has been tested by Heather Bullen (Northern Kentucky University), Anna Cavinato (Eastern Oregon University), Alanah Fitch (Loyola University – Chicago), Richard Kelly (East Stroudsburg University), Cynthia Larive (University of California – Riverside), David Thompson (Sam Houston State University) and Tom Wenzel (Bates College), and their experiences are posted as Instructor Vignettes in the Guide for Instructors. Each of the instructors used the materials in different ways as driven by their courses and curricula. Several have used the Lake Nakuru materials to teach GC-MS in their instrumental analysis courses. Others found components of the module, particularly the section on sampling, to be helpful in teaching Environmental Chemistry. Anna Cavinato, used a portion of the Lake Nakuru module to introduce sampling into her analytical chemistry lecture and laboratory courses. She assigned the sampling module as an exercise, and then challenged the students to design and implement a random sampling plan for a local lake. Using a random number generator, a GPS and a canoe, students collected water samples for the analysis of calcium and magnesium by EDTA titration and atomic absorption, and pesticides by GC-MS.

JASDL Courseware also provides a venue for publications of e-Texts. For example *Analytical Chemistry 2.0* is a comprehensive electronic text written by David Harvey and downloadable through JASDL. This book includes 15 Chapters (over 1000 pages) written and formatted similarly to commercially produced textbooks, but available for free download as a pdf document. The text includes topics normally covered in undergraduate analytical chemistry courses: statistical treatment of data, standardization/calibration, equilibrium chemistry, gravimetric and titrimetric methods, spectroscopy and chromatography. In addition, Analytical Chemistry 2.0 also discusses important topics that are less commonly covered in depth in commercial textbooks such as, collecting and preparing samples, kinetic methods, developing a standard method and quality assurance. Each chapter includes detailed graphics that can be downloaded separately for use in lectures, practice exercises with solutions and embedded hyperlinks that provide functionality not available in a printed text.

Stanley Manahan's popular book *Green Chemistry, 2nd Ed.* is also available for downloading as a pdf document, along with powerpoint slides that can be used for lectures based on each chapter. In addition to their inclusion in JASDL, both books are cross-listed in the e-Text category of the ASDL collection, wherein links to 37 resources covering a wide range of topics can be found.

The ASDL Community

Under development is an effort to build an interactive community around ASDL. This effort, led by David Harvey, Depauw University and funded by the National Science Foundation, will bring social networking to ASDL and allow groups of users to share documents, such as problem sets, exams and curricular materials under development, and to post questions to the ASDL community through blogs. ASDL users will have the option of signing up for an RSS feed that can alert them when new content is posted on ASDL. We hope that this effort will expand both the users and the utility of the ASDL project on a global scale.

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Table 1. Selected Recommendations from Curricular Development Report

- That the academic community develop context-based analytical science curricular that incorporates problem-based learning
- That more students be offered hands-on learning opportunities
- That teaching styles accommodate students' different learning needs
- That faculty strive to incorporate today's technology into classrooms and laboratories and use such technology to promote real-world learning
- That analytical faculty drive the revisions to undergraduate analytical curricula and help spread he word about the need for these revisions.
- That everyone involved in undergraduate education look for ways to share information about curricular reform

Table 2. What is Problem-based Learning (i.e., Active Learning)

- Student-centered pedagogy, pioneered in the health sciences, McMaster University 1960's
- Learning driven by challenging, ill-defined, real-world related problems
- Instructor acts as a facilitator; i.e., consultant and guide
- Students work in teams, develop communication, teamwork, sharing and problem-solving skill

http://en/wikipedia.org/wiki/Problem-based_learning
http://www.udel.edu/inst/
http://ku.edu/groups/wilson_grp/chem636/index.shtml
Wilson, Anderson & Lunte, Anal. Chem. (1999) 677A-681A
ACS Symposium Series 970: ***Active Learning***: Models from the Analytical Sciences, Ed. Patricia Ann Mabrouk, 2007

Table 3. The Contents of www.asdlib.org

- The Collection – over 450 meritorious, peer-reviewed websites (see Table 4)
- JASDL the journal is the publishing arm of ASDL – publishes Coursewares, Labwares and Educational Best Practices
- Active eLearning Modules in JASDL - consider these as "tools" for the analytical toolbox; example is the Lake Nakuru module, a self-contained, comprehensive module for adoption in analytical and environmental courses
- eTextbook – example is David Harvey's textbook, *Analytical Chemistry 2.0*, freely available with downloadable PDF files, comprehensive in content
- ASDL Community – a recent offering in asdlib for bloggers and builders of collaboratives among faculty, students and practitioners

Table 4: Summary of the main categories and subcategories of the asdlib Collection

TECHNIQUES: chemometrics, electrochemistry, instrumentation, mass spectrometry, NMR and EPR, Separations, spectroscopy, surface/nanomaterials

APPLICATIONS: applications, databases, bioanalytical, environmental, forensic, quantitative analysis, lab manuals, experiments, research practices, scientists guidelines

RESOURCES BY FORMAT: animations, PowerPoints, eTexts, tutorials, videos, virtual labs

TEACHING RESOURCES: active learning, case studies, cooperative learning, problem/inquiry-based learning, reference links/databases

JASDL: courseware, labware, educational practices, undergraduate research