The 21st Century Physics Flexbook

A science flexbook initiative provides an open educational resource model for delivery of current, customizable, teacher-generated content.

By Jim Batterson and Lan Nugent

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Two panels of practicing chemists and physicists met in summer 2007 to review Virginia's content standards in the high school capstone courses of chemistry and physics. Those panels were sponsored by the Virginia secretary of education and NASA, and the findings and recommendations were meant to help inform the 2010 septennial review of Virginia's science standards by the state board of education. Panel members were drawn from practicing scientists at universities, government research laboratories, and industry to span the full range of research, technology, and development perspectives: basic and applied research at universities; applied research and development at government labs; and development, manufacturing, and operations in industry. The scientists were complemented by a few K–12 physics and chemistry teachers for "ground truth."

Each of the panels met for two days in a facilitated workshop to answer the question, "What chemistry (physics) should a Virginia citizen know in order to participate in the political, economic, social, and technological world of the 21st century?" In other words, this was not about advanced science, but rather about what science knowledge a high school graduate should have to be an informed citizen. It was assumed that advanced science would be well-handled by AP courses, IB programs, and such special programs as Virginia's Governor's Schools. But those advanced programs serve only 16% of Virginia's high school population, and thus the panels' findings and recommendations were aimed at supporting the education of the remaining 84% of high school students.

Among the panels' findings and recommendations were the following:

- Although the Virginia standards were very well-written and easy to understand, they were out of date and reflected the mid-20th century
- Some dated material should be excised and replaced with contemporary and emerging physics and chemistry (e.g., cathode ray tubes should be eliminated; transistors, integrated circuits, LEDs, LCDs, plasmas, quarks, gluons, nanostructures, organic chemistry, and biochemistry should be added)
- Laboratories should include state-of-the-practice instrumentation and methodologies, such as lab-on-a-chip and modeling and simulation
- An open-content software resource, such as a wiki, should be created and maintained for teachers to post curricula they develop on contemporary and emerging content.

The last point resulted from concerns of the K–12 teachers on the panel and was the genesis of the physics flexbook project. It was the teachers' belief that although 10%–20% of their colleagues could easily and competently access the Web and journals to create new curricula to address newly posted content standards involving contemporary and emerging science, it was likely that another 40% to 50% would need to be given resources from which to teach this new material.

The panel contended that many teachers do not stay current in their fields. For example, a 2003 survey of Kentucky middle and high school science teachers found that only

60% were aware of the concept of nanotechnology; 33% were familiar with it; and 18% understood it (Kentucky Science and Technology Corporation, 2004).

The teachers on the panel were concerned that it could be years before traditional textbooks containing the new material would be in the hands of all teachers. A wiki seemed to be a 21st century approach that would disseminate the best thinking of the top teachers so that it is readily available to their colleagues. Accessing it would not require great knowledge of the Web or even key search words, but simply linking to the single URL of the wiki itself, where they would find material written by colleagues.

The Physics Flexbook Project

Under the leadership of the then–Virginia Secretary of Technology Aneesh P. Chopra, several wikis were examined but found lacking in their transparency to teachers—many required some knowledge of a markup language, which was considered to be a potential barrier to broad teacher participation. The CK–12 Foundation (www.ck12.org), however, had recently developed the "flexbook" concept, a flexible or adaptable textbook that is implemented as a freely available software product on the Web. The flexbook, although more formal than a simple wiki, would allow teachers to develop curricula as book chapters using either a simple markup language or Microsoft Word. All material in the flexbook would be licensed as Creative Commons (www.CreativeCommons.org) and thus be generally available to use by all teachers. The flexbook met all of the panel's requirements.

The Commonwealth of Virginia and the CK-12 Foundation formed a partnership in which CK-12 would provide the software platform and technical support and Virginia would provide the content of the physics flexbook. In response to a request for collaborators, some 25 potential contributors volunteered to participate, and 13 were selected to write 10 chapters of the pilot edition.

The pilot flexbook was titled *21st Century Physics Flexbook: A Compilation of Contemporary and Emerging Technologies*. The title reflects the flexbook's purpose as a supplement to the standard high school physics text that focuses on only contemporary and emerging physics and methodologies that might be added by the board of education as a result of its 2010 review.

The schedule was aggressive: the official project kickoff was October 29, 2008, and all chapter drafts were completed by authors by January 15, 2009. Because most of the authors were high school teachers who were carrying out this task in addition to their regular teaching duties, much of their work was accomplished during their winter break. After the draft chapters were completed, the editorial process had three components:

- Technical review of the physics content of each chapter by a university research physicist
- Editorial review of each chapter by three other authors (much like a journal peer review)
- Editorial review for readability by several high school students and college freshmen.

The technical and editorial reviews took place simultaneously over four weeks, and authors made their final revisions during the last two weeks of February. The official public release of

version 1.0 of the book was March 15, 2009. The first release contained 10 chapters:

- Toward Understanding Gravitation
- Nuclear Energy
- The Standard Model (of Particle Physics)
- Beyond the Standard Model
- Modern Physics
- Nanoscience
- Biophysics (Medical Imaging)
- Kinematics (Laboratory)
- Laboratory Activities With Technology
- Modeling and Simulation.

Unique Attributes of Flexbooks

A flexbook differs from a traditional textbook in several ways:

- It is licensed as CC-BY-SA so that all content is freely available to the reader.
- Teachers can use chapters as they are or modify them by adding material from other

Web resources or removing material—rip, mash, and burn!

- Its chapters are not in a single voice or style, but rather they reflect the unique voice of each author—focusing on technical editing rather than homogeneity of form allows for rapid publication.
- Its chapters are not all written at a uniform reading level—this reflects the broad make-up of the contributors: high school teachers, college professors, and working physicists.
- It can be updated with additional or corrected material quickly, and the newly updated version is freely and immediately available to all. For example, new discoveries can be inserted as they occur.
- It supports diverse pedagogy and learning styles.
- It is structured to provide such things as student readings of basic materials, writing assignments, discussion groups, Internet research, virtual laboratories, simulations and games, collaborative team projects and presentations, audiovisual clips, interactive graphs, question-and-answer sessions, virtual field trips, meetings online with noted content experts, group problem-solving exercises, and more.

Summary

The physics flexbook platform allows teachers to become a real community of learners by sharing their original ideas for new curricula. It is widely, freely, and globally accessible. Teachers can create chapters during the academic year, during the summer, or while on sabbatical. Chapters can be customized by individual readers or used as published. The vetting process was designed to balance adequate assurance of technical veracity with speed of publication. In the future, the plan is to create a full version of a physics textbook and other textbooks. PL

REFERENCE

- Kentucky Science & Technology Corporation. (2004). Kentucky survey of critical technologies: Highlights. Retrieved from www.kstc.com/TeacherSurveySummaryw.pdf?CFID=512907&CFTOKEN=66761147