

## **The Need for Open Source Textbooks for Nuclear Workforce Training -11384**

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### **ABSTRACT**

There is a concern for the lack of trained workforce for when future nuclear power plants begin to be built in the United States (US). One way to reduce this concern is with the adoption of open source textbooks within current and future organizations. Open source textbooks can be used to increase the training materials available for a diverse workforce, significantly decreasing the cost of using textbooks for training, and mitigating problems with current copyright laws in respect to textbook utilization. Multiple organizations have made it easier for people to develop open source textbooks, two of which, Wikibooks and Connexions, can be valuable tools for any type of organization.

### **INTRODUCTION**

With both political and scientific concern for anthropological global warming, politicians and government agencies are seeing a need for the development and construction of all types of green energy, including nuclear power. However, there is concern that when new nuclear power plants are built in the US there will not be enough trained nuclear work force to support a large insurgence of nuclear power [1]. There have been many ideas presented on how to decrease the concerns associated with future nuclear workforce development. For example, in one paper from Savanna River Site the author discussed the need for better collaborating within government, industry, and universities to find the specific areas of limitation and then try to increase the workforce through avenues such as internships, scholarships, fellowships, and training grants. [2] New organizations, programs, or structures for improving the workforce development do not need to be developed, but instead small changes in policies that promote open source textbooks would provide significant improvements in current and future organization's methods for workforce development.

### **PROBLEM DESCRIPTION**

There are three current problems facing nuclear workforce development that can be significantly reduced with the development and adoption of open source textbooks: limited training materials for a diverse workforce, high cost of textbooks, and restrictive copyright laws.

According to the current American Nuclear Society position statement, maintaining a highly educated and skilled nuclear workforce is essential to ensuring the long-term viability of nuclear technology as a major resource for energy, defense, and health care. In addition, the large aging workforce will create severe shortages in qualified workers in the areas of maintaining safe operation of nuclear plants, continuing research in medicine, power, and nuclear manufacturing, constructing new facilities, continuing high-quality nuclear education and the recruitment of students to nuclear education and careers. [3]

When thinking about the aging workforce, it is also important to realize the extensive educational diversity is found within the nuclear industry. The nuclear industry does not only need nuclear engineers, but also other engineers, technicians, managers, skilled labor, health physics, etc. Despite the large diversity in educational backgrounds within the nuclear industry, there are some similarities between each division of labor. For effective communication, each individual in the nuclear workforce needs to be able to use the same terms and jargon associated with the nuclear industry. The depth of knowledge associated with terms can be vastly different. For example, the equations and mathematics needed for engineers will not be useful to a health physics technician, but the health physics technician will need to effectively communicate the dangers of radiation to the engineers in a way that they both understand each other. One major advantage of open source textbooks is their ability to be modified and customized for the specific class being taught. Open source textbooks can also be combined with other textbooks or references improving the usefulness of the textbook in the classroom.

Even in areas of the nuclear industry where there are multiple textbooks written for different skill levels, there are still both economic and legal problems associated with using these textbooks. One of the larger problems with using textbooks for training is the associated cost. The cost of textbooks continues to rise making it harder for academia, industry, or government agencies to justify using textbooks for either training or reference materials. This can be especially noticeable in two-year junior colleges and vocation schools in which the cost of textbooks can be as much the cost of tuition. According to the Washington Post, the price of textbooks can be around \$700 to \$1,100 annually for college students. In addition, the Washington Post stated that between 1986 and 2004, the price of textbooks nearly tripled, rising an average of 6 percent per year while inflation rose only 3 percent per year. [4]

The nuclear industry not exempted from high textbook costs. A simple search on Amazon.com on October 20, 2010 shows the high cost of new nuclear engineering textbooks. As can be seen from Table 1, the prices for these textbooks can be as high as \$200 with the average textbook being around \$130. In addition, the dates of these publications vary with some new releases and one textbook over 30 years old that is still worth \$175. A major advantage of open source textbooks is that they are free to all in electronic version and can cost around \$20 for a printed version using online print on demand services.

Table 1. List of Waste Management Textbooks and Associated Price.

Name	Date Published	Listed Price
Radioactive waste management	Oct 1 2001	\$162.95
Decommissioning and Radioactive waste	Oct 8, 2008	\$52.95
Geological Storage of Highly Radioactive Waste	Nov 2 2010	\$199
Sitting Low Level Radioactive Waste Disposal	1992	\$112.95

Nuclear and Radio-chemistry	Aug 10, 1981	\$175.00
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[5]

The third problem with education in the nuclear workforce that can be reduced with open source textbooks, are complications with the current copyright law. Copyright protection is meant to protect the author's creative works for a limited period while promoting creativity and learning. Copyright law allows the owner multiple exclusive rights such as, reproducing, distributing, and creating derivative works. This means that no other individual may legally reproduce, distribute, or derive copyrighted works such as textbooks without the owner's permission. Fair use is an exemption to the owner's exclusive rights, but typically can only be applied to a portion of the work that has been created. Once the copyright has expired, typically 70 years after the last living author has passed away, the copyrighted materials fall under public domain, allowing everyone the same rights that were initially exclusively given to the owner. [6]

The current copyright law as it applies to textbooks may do more harm to the advancement of education and science than the potential good intended from the copyright law. This is especially true with large time spans before the copyrighted textbook becomes public domain. For example, under current copyright law the textbook Sitting Low Lever Radioactive Waste Disposal by Mary R. English will not become part of the public domain until 70 years after she passes away. Her book would not be released into the public domain until around the year 2100, allowing only the owner of this material the exclusive rights to determine if the textbook can be reproduced, distributed, or modified until the next century. When this textbook is finally released as public domain, most likely the information contained within the book will have limited academic and scientific value to the nuclear industry. However, if this same textbook became public domain as soon as the author passed away, for example, then future updates and releases of this textbook would be much more applicable, making this textbook more useful to the scientific and academic communities.

In some cases, not only are revisions needed to keep the textbooks up-to-date, but also additional copies and distributions of a textbook are drastically needed. For example, in the 1957 textbook Nuclear Chemical Engineer by Benedict and Pigford. Manson Benedict died in Sep 2008 and Robert Pigford died in August 4, 1988, which means that their textbook will not be part of public domain until 2078. It would be very beneficial to make additional changes to this book as the future scientific discoveries and engineering improvements are made. Nevertheless, what is even more of a concern now is that there are only a limited number of used copies that can be purchased. For example, on October 20, 2010 only two used copies were available for purchase from Amazon.com for a cost of over 300 dollars. Another search was done Jan 3, 2010 and three used copies were found with the lowest price being \$600. [5] Even though there are still multiple copies found within libraries and individual possessions, the textbook can no longer be used as a textbook in a nuclear chemistry class until the publishers decide to print more books or the textbook becomes public domain in 2078. With the openness of open source textbooks, any textbook created will be free to the public and can legally be updated as new technology in the nuclear energy and waste management arena become available. .

## **AN EXPLANATION OF OPEN SOURCE TEXTBOOKS**

According to the open source organization, the main purpose for any type of open source project is for peer production by collaboration with the end product being available at no cost to the public. For almost all open source projects, the original work involves large amount of initial time, money, and effort. Reproducing the work is very inexpensive and requires a small amount of time. Open source is a relatively new concept in regards to the textbooks community but has been successfully adopted in other communities such as the computer software community. Successfully open source software programs include Linux, Firefox, Open Office, and Moodle. [6]

Even though most people associate open source projects to software production, open source licensing is not just limited to software and text, but can extend to other forms of media including pictures, movies, animation. In theory, anything that is copyrighted can be licensed under the open source framework. For example, Picasa web album and Flickr have both allowed users to promote the use of their pictures and video clips by licensing them as open source through the creative commons organization.

There currently exist multiple universities, such as Michigan Institute of Technology (MIT), that have started an open source lecture program in which the lectures and accompanying material are licensed under Creative Commons, an open source licensing organization. [7] MIT has developed multiple lecture series on nuclear engineering; however, most of the lectures series do not have open source textbooks available for learning in conjunction with the course lectures. They typically rely on lecture notes and recorded material for the audience to learn about the subject.

Having recorded lectures and homework can be a great way for some people to learn, but does have some limitations such as customizing the lecture series to a class being taught at a different university. One nice feature about MIT and other online source lectures released under the creative commons license is these lectures can be reproduced, distributed, and modified without any copyright infringements making MIT Open source ware a great starting point for developing an open source textbook.

The two most common ways of licensing open source textbooks is with either the Creative Commons organization or the Gnu's Not Unix (GNU) organization. [7-8] Creative Commons was founded in 2001 with the major support from the Center for the Public Domain. It is not an alternative to copyrights, but works alongside them and helps licenses work globally. Recently, Creative Commons has promoted projects to build common based infrastructure for the science projects. Just two years ago, it started focusing also on education projects. The advantage of Creative Commons is it allows the user to customize the limited copyright agreements. There are four different options for Creative Commons: [7]

- Attribution,
- Share alike
- Non-commercialization

- Non-derivative works.

The attribution option requires that the author be recognized for work being performed. The share alike attribution requires that whatever works are produced from the original material needs to be released with the same Creative Commons copyright protection. The non-commercialization requires that the material not be used for financial gain. The non-derivative works require the work remain as it was originally presented. With these four different options available with the Creative Commons license, the authors can customize the type of copyright protection they want for their work.

The other common open source license used for textbooks is the GNU Free documentation license. GNU originally used to license software, started in September of 1983 as the GNU Project. From this project software such as Linux, gcc, and gfortran were developed. Currently there are thousands of games, utilities, and programs that have been developed under the GNU license. One of the thoughts behind the GNU programs was that if the software was free, then the manuals for the software should also be free. That is where GNU project came up with the GNU Free documentation license. [8]

Unlike the Creative Commons license, GNU license is not customizable. All GNU licensed documents allow attribution, coping, modification, and redistribution. Because of the fixed requirement for distribution, a GNU document has to be released as a GNU document. The GNU documentation license is used mostly for software related textbooks, but it is also the license used by Wikipedia.

Multiple organizations and academic institutions have started adopting open source textbooks under the Creative Commons license or the GNU documentation license. Here is a list of the more popular websites that have open source textbooks [9]:

- CK12 Flexbooks
- Connexions
- Community College Open Textbook Collaborative
- Community College Consortium for Open Educational Resources
- Flat World Knowledge
- Global Text Project
- MERLOT
- OER Commons
- Orange Grove Text Plus
- Textbook Revolution
- The Assayer
- USG Share
- Wikibooks

Of the thirteen organizations listed above, the two most popular open source textbook organizations, Connections and Wikibooks will be discussed further in this paper. One major tool that both these organizations provide is that they host open source textbooks and the editing capabilities on their websites as well.

Open source textbooks have not been adopted by the nuclear energy industry yet, but there has been other organizations that have adopted open source textbooks and have started producing some quality textbooks. Some K-12 states programs, such as California and Texas, are adopting the open source textbook in hopes of reducing the total cost of educational material. California is probably leading the open source textbook effort with the California's Open source textbook project (COSTP). One of the goals of the COSTP is to eliminate the \$400 million annually cost for textbooks. In addition, the project hopes to provide a wider range of textbooks to schools such that individual instructors can provide a more custom textbook for the specific class being taught. [10]

Some of the open source textbooks used now in high school include subjects such as chemistry, computer science, history, English, mathematics, electrical engineering, statistics, just to name a few. In addition, these textbooks are available for download directly onto the iPad and ITouch free of charge. [11]

Despite the obvious advantages of open source textbooks, there is still a large resistance to the open source textbook movement; the biggest concern being the quality of the educational material. This concern for the quality product was a similar concern when Linux came out as an open source desktop platform. Linux has now become the standard for scientific computing, even in the nuclear industry. Even with as big a concern as open source textbooks becoming a quality product, there are multiple ways to address this issue. Connexions, along with other organizations are aware of the concerns for the quality of open source textbooks and have developed tools for reviewing, editing, and many provide a rating system for users to make more informed discussions on the quality of the textbook.

### **COMPARISON OF TWO OPEN SOURCE TEXTBOOK HOSTS:**

Two different organizational websites were analyzed for potential location of developing and hosting open source textbook projects for radioactive waste management content: Wikibooks and Connexions.

Wikibooks, hosted by Wikicreations, is used for the creation of textbooks and annotations that anyone can edit. Wikibooks was started in 2003 to host and build free textbooks. All the content on Wikibooks is released under the both Creative Commons Attribute/Share-Alike and GNU Free Document License. The reason the creators of Wikibooks decided to go with both licenses is that this will ensure that books will remain freely distributable forever. However, by having two copyright license agreements, that are both share alike, requires if the works found on Wikibooks are modified that work will need to be released under both license agreements, which can be problematic for some organizations. [12]

One concern with Wikibooks is that anyone can make changes to the books created in Wikibooks. This can create obvious problems with quality control, but Wikibooks has built in tools that will track all changes made, and by whom, making it easier to correct malicious attacks

and prevent them from happening in the future. However, allowing anyone to edit Wikibooks can offer some advantages such as allowing many more people to edit and improve the content of the textbooks all free of charge to the final end user.

Wikibooks can be written with two different markup languages: Wikitext and Hyper Text Markup Language (HTML). Wikitext is the simplest of the two languages to learn and can take a beginner less than an hour before they can begin editing or creating textbooks. In addition, there are some great free resources on how to edit using the Wikitext language. If more advance editing capability is needed in Wikitext, people can add HTML with or without cascade style sheets (CSS). [12]

Textbooks on Wikibooks are generally in a state of construction. Books are never “complete”, because they can always be updated, improved, expanded, reformatted. However, some of the better books found on Wikibooks can be considered well enough that they could be used in a classroom. In addition, Wikibooks has tools available that will allow teachers to “freeze” the textbooks. The Wikibooks also has the option of easily printing the books with the print-on-demand. The Wikibooks uses the publishing partner PediaPress for inexpensive and simplistic printing. However, other print on demand publishers could also be used. [12]

In addition to printing open source textbooks or having a frozen version of the textbook, it is possible to have a working textbook in which students continue to improve as a working project for the class. This allows the knowledge obtained from previous classes to be passed on to the next class.

As a demonstration of the capability of Wikibooks for developing books, a Wikibooks textbook on radioactive waste management has been started. It is recommended that people from academia, industry, and government agencies work together to improve the quality of this textbook. The location of the textbook is found at [http://en.Wikibooks.org/wiki/Radioactive\\_Waste\\_Management](http://en.Wikibooks.org/wiki/Radioactive_Waste_Management)

The second organization that was investigated as a potential location for developing open source textbooks is Connexions. [13] Connexions provides an environment for collaboratively developing, freely sharing, and rapidly publishing scholarly content on the Web. Connexions recommends the use of small modules that are easily connected into larger collections or textbooks that can be used for study aids or coursework. The advantage of developing smaller modules is that ability to link specific subjects together in a nonlinear way. On the Connexions website it states that the following:

“Most textbooks are a mass of information in linear format: one topic follows after another. However, our brains are not linear - we learn by making connections between new concepts and things we already know. Connexions mimics this by breaking down content into smaller chunks, called modules, that can be linked together and arranged in different ways.” [13]

All of the content within Connexions is open source licensed under the Creative Commons “attribution” license. With the modularity of the modules, it can make it much easier to develop textbooks for specific classes without having to “reinvent the wheel”. For example, a textbook

written for a radiation detection class will share a lot of similar information found in a radioactive waste management class like radiation interaction, decay, and an overview of detectors. Instead of an author having to rewrite the repeated information from two similar topics, the author could write specifically on detectors and then link the related information found in the waste management class to the new radiation detection textbook. [13]

The main difference between Connexions and Wikibooks is that textbook development is not available for everyone, but only selected team members. With this difference in mind, Connexions has a lot of beneficial communication tools integrated within the website. Connexions has individual and group workgroups that are used to create, edit, and review textbook information. With the shared workgroup tools, the collaborators can edit each other's content, and give feedback to each other on the draft content. In addition, roles can be assigned to members of the shared workgroup to help with development and publication. Some of the roles include author, maintainer, editor, and translator. People in each of these roles will receive accreditation for the work performed in developing the open source textbook.

One of the difficult parts of projects developed on Connexions is that all projects will need to eventually be in the Connexions Markup Language (CNXML) format. The CNXML is a Connexions specific eXtensible Markup Language (XML) format that has a large amount of flexibility and modularity, but also requires some XML programming knowledge. To help with the complexity of programming in CNXML language, the staff at Connexions has developed built in tools that allow conversions of more familiar formats to CNXML. Currently on Connexions word, open office, and LaTeX formats can all be converted into the CNXML with a little modification of the initial document. Additional information and resource on how to use Connexions for developing textbooks can be found on their website.

To demonstrate the capability of Connexions for developing open source textbooks, a shared workgroup along with content has been started. The initial project is based on a radiation interaction course taught to reactor operators at Department of Energy (DOE) sites, but can be expanded to cover additional areas as needed.

## **RECOMMENDATION AND CONCLUSIONS**

Open source textbooks can be a valuable resource for the nuclear industry. It has the ability to help retain knowledge from the aging workforce, significantly decreases the cost of using textbooks for training, and mitigates problems with the current copyright laws. There are multiple policy changes that could inexpensively be implemented but would still significantly improve the quality and quantity of open source textbooks for the nuclear industry.

One potential policy change should take place with government organizations. For example, the DOE and Nuclear Regulatory Commission (NRC) provide funding for teacher development and course work development for nuclear engineering assistant professors. The DOE and NRC could require or encourage recipients of the grants to also release their results under creative commons making it easier to implement the work into open source textbooks. Another policy change recommendation is within the nuclear industry. The nuclear industry could find areas where the



education sector is missing needed training or skills and develop open source modules in those areas that could be used by academia for better training. In addition, the nuclear operation trainers at utilities could release their general training material under creative commons that then could be used by other trainers in addition to nuclear engineering technical schools and universities.

The third recommended policy change is with nuclear organizations that host conferences. These organizations could change policies that would allow a portion of the preceding at the conferences to be published and released under a creative commons license for easier implementation into open source textbooks. The final recommendation for improving open source textbooks is by encouraging nuclear engineering professors assign assignments to students to update or provide new content for open source textbooks.

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