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Textbook Bling: An Evaluation of Textbook Quality and Usability in Open Educational Resources Versus Traditionally Published Textbooks

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Textbook Bling: An Evaluation of Textbook Quality and Usability

in Open Educational Resources Versus

Traditionally Published Textbooks

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A selected project submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

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August 2012

ABSTRACT

Textbook Bling: An Evaluation of Textbook Quality and Usability in Open Educational
Resources Versus Traditionally Published Textbooks

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This mixed-methods study evaluated quality, usage, and perceptions of open educational resources compared to traditionally published textbooks. Because textbooks and other related materials make up a significant portion of educational costs, open educational resources have been explored for potential cost savings at all levels of education. These resources use public domain or open-licensed materials as the content component of free eTextbooks or low-cost printed textbooks. This evaluation explores how teachers and students use textbook resources both in and out of the classroom and the degree to which the content and design of open textbooks compares in quality and value to traditional textbooks. Data came through evaluating the print media design and content quality of the books in a Utah pilot program, analyzing the actual textbook artifacts from students, and conducting teacher surveys and interviews. The data points to clear differences in quality and use between the two types of books. Although the open textbooks are generally a lower quality product than traditional publisher-produced textbooks, they were used in unique ways. Teachers who participated in the open textbook development tended to value the book as a resource, leading us to conclude that the ability to customize open resources may be an important determinant of textbook use. However, it is also likely that textbooks have only a minor affect on academic outcomes compared to other more problematic pedagogical and educational policy issues. This evaluation points to the need for additional study on the impact these differences between traditionally published and open resource textbooks have on learning outcomes.

ACKNOWLEDGMENTS

I am appreciative to a smart, innovative, and helpful committee. They have been great examples of scholarship and how to mentor a student. I am especially appreciative to my committee chair, Dr. Randy Davies, for his help on the writing and editing. Most of all I am grateful to my patient husband and baby son. They are my joy and greatest happiness. I thank them for sticking by me while I completed this project. Little Lance, Mommy can play now.

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Introduction

Ask any college student what causes them more pain than paying tuition and almost universally the answer is buying textbooks. Although textbook costs as a percent of post secondary education expenses have remained consistent over the past thirty years at about 6% of total expenses (NACS, 2011), the general outrage over perceived price gauging can be seen in numerous college newspaper articles, student avoidance of university bookstores, and the preponderance of textbook pirating websites (NACS Foundation, 2012). Even the U.S. Congress has weighed in on this issue with the Textbook Affordability Act of 2010, which requires publishers and university bookstores to be more transparent with information in an effort to give students more choices. The situation is not much better in K-12 schools. Typically, primary and secondary education students do not buy their textbooks directly; however, in 2011, school districts spent approximately 5.5 billion dollars on textbooks for K-12 classrooms (AAP, 2011). Reduced state budgets often mean that a textbook is used for several years before purchasing new books (NASTA, 2010).

Despite technology innovations that could help reduce textbook prices, the publishing industry trend has been to add additional features to enhance textbooks (Hess, 2010). No longer is the typical textbook a simple black and white printed book. It will more often have expensive full color graphics on every page, supporting websites behind access codes, ancillary CDs and animations, interactive electronic versions of the text, and other innovations. Presumably the purpose of these features is to enhance learning, but they can also have a very real impact on the bottom line for textbook publishers. Not

only are full-color hardback textbooks expensive to produce, often costing more than $100 per book on average (NACS, 2011), but the extra features such as access codes can make the textbook disposable. A publisher only makes money on the sale of a new textbook. Convincing the buyer that the current version of a textbook has somehow been improved, or making the book disposable, helps ensure new sales.

If all of these extras really do improve learning, perhaps the added expense of an elaborate textbook is justified. But the increasing number and complexity of these extras leads to several important questions. Would a simple textbook without all of the extras suffice? Is there a point at which the extras do not contribute significantly to students' learning? If so, can this point be identified? What aspects of the content[1] and print media design might be considered essential, which improvements might be classified as affordable extras, and which additional features are bling— entertaining eye candy, expensive to produce but probably not helpful to learning. Essentially, are those who purchase textbooks getting what they pay for?

Context

With a combined total of over 10 billion dollars per year spent on textbooks in the K-12 and higher education markets, even small improvements in textbook costs would help education affordability (AAP, 2010). Supporters of the open content movement are one group seeking to reduce textbook prices. Open content textbooks are those

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[1] For purposes of this thesis, the term "content" will refer to the typical textbook industry usage of the word content, meaning the intellectual property contained within the book, i.e., its written words, its graphics, tables, etc.

distributed free by the author in a manner similar to the computer concept of freeware. These open content books can be printed or read electronically by anyone without infringing on copyright. Open textbook resources have been identified as one way to reduce costs, but little is known about their efficacy in the classroom. Because these books use open content and do not have the financial backing of a major publisher they typically use a more simple design than a traditional publisher produced textbook without extras such as elaborate graphics, supporting websites, and other add-ons. However, it is their very simplicity that leads some researchers to hypothesis that these books may produce better learning outcomes than the more expensive publisher produced books. Because the cost to print the open textbook is so minimal, students are allowed to interact with them in ways they were previously unable. The book becomes the property of the student and the student is allowed to highlight or write notes in them, which will, it is hypothesize, lead to deeper learner.

Dr. David Wiley, a supporter of open content, has conducted a pilot program involving the learning effectiveness and potential cost savings of three open content secondary education science textbooks versus their nationally produced counterparts (Wiley et al., 2012). Approximately 2,500 students in Utah County used the open content textbooks during the 2011-12 school year. The pilot program is scheduled to continue through the 2012-13 school year. Although this pilot program is being conducted at the high school level, open content textbooks have the potential to significantly impact the entire K-12 and college textbook markets.

Evaluation Purpose

The purpose of this project was to provide evaluation support to the Open Textbook Project (OTP), a project funded by The William and Flora Hewlett Foundation. The grant awarded by the Hewlett Foundation provided funding for the textbooks students used in Dr. Wiley's open content pilot project. The OTP was concerned primarily with determining how using the open content textbooks may have impacted student learning outcomes and the level of cost savings realized by using the open textbooks as an alternative to more expensive publisher created textbooks covering the same material. Because open content textbooks are a relatively new development in course materials there are few empirical studies demonstrating their learning effectiveness relative to traditional course materials.

Although the OTP is primarily concerned with learning outcome impacts and measuring cost savings, this evaluation explores other lines of inquiry described by the OTP. Specifically, this evaluation explores how teachers and students used textbook resources both in and out of the classroom and whether the content and print media design of open textbooks were of similar quality[2]. Of particular interest was gaining an understanding of how the teachers and students interacted with the textbooks, their perceptions of quality, and any differences in use between the OTP books and publisher-produced books.

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[2] For purposes of this thesis the term "quality" will refer to the inherent characteristics and physical appearance present within the book itself, i.e., the quality of its writing, graphics, and photographs, and in terms on how accurate and how readable they are presented.

This evaluation focused on supporting two of the activities described in the OTP grant application: (1) Reviewing samples of the open textbooks used by participating students and samples of traditional textbooks used by comparison students to determine exactly what kinds of unique behavior (like highlighting and annotating) the open textbooks enabled, and (2) Observing, interviewing, and/or surveying teachers and students about their experiences using the open textbooks. (see Wiley, 2008, p. 8)

In particular, this evaluation attempted to describe whether any differences in content and print media design quality may have influenced the way in which textbooks were used in and outside of classrooms. This case study is intended to provide the basis for describing which aspects of textbooks are required for learning, which are helpful, and which might be considered frivolous add-ons.

Evaluation Questions

This evaluation focuses on answering the following four questions:

1. How do the open content textbooks used in this project compare in quality of content (i.e., clarity of writing, accuracy of grammatical mechanics, relevance of examples, etc.) to traditional publisher-produced books?

2. How do these open content textbooks compare in print media design quality to traditional publisher-produced books?

3. How are these OTP textbooks being used (both in and out of the classroom) and is their use any different compared to textbooks used in classrooms with a similar publisher-produced textbook?

4. Do any differences in usage provide the basis for identifying which textbook features are essential, which are helpful, and which simply add unnecessary expense?

Stakeholders

As the funder of the OTP, the William and Flora Hewlett Foundation has an inherent interest in knowing whether the initiative is successful. The Hewlett Foundation, a non-profit organization founded in 1967, awards over 200 million dollars per year in grants to solve social and environment issues (Hewlett, 2012). The foundation has identified open textbook resources as one of its areas of interest because of the potential impact to education affordability. The foundation's *Open Educational Resources* initiative, of which Dr. Wiley's grant was a part, was established to create "a self-sustaining and adaptive open educational resources ecosystem and demonstrating its potential to improve teaching and learning" (Hewlett, 2012, p. 3). The OTP addresses this concern by providing empirical data regarding the efficacy of open educational materials.

The Utah State Office of Education (USOE) is another key stakeholder. The results of the OTP project will provide a basis for decisions they will make regarding the adoption of open resources. Based on early results of Dr. Wiley's study, the USOE recently announced a decision to encourage adoption of open content textbooks in all language arts, math, and science courses for grades 7-12 beginning with fall 2012 (Dickerson, 2012). This evaluation will provide additional evidence of any value or benefit of adopting open content textbooks as well as any unexpected consequences to

pursuing this option. Other stakeholders include textbook users (i.e., students, teachers and professors), parents, school districts, and university and college communities.

Previous Work

The OTP began during the 2010-2011 school year with ten teachers and approximately 1,500 participating students. Dr. Wiley's team conducted an initial analysis of the OTP's impact to learning outcomes by comparing Utah State CRT scores (Criterion-Referenced Test) between students who used the open textbooks and students who did not (Wiley et al., 2012). This preliminary data showed that there were no significant differences in the percent of students who achieved the status of "proficient" on the CRT between those using the open books and those who used traditionally published books. In fact each of the classrooms participating in this study maintained high numbers of students receiving a designation of proficient regardless of the textbook teachers used. These results suggested that open textbooks did not harm student learning outcomes and points to the need for further research on the use and quality of open textbooks. What is not known from this previous analysis is how the textbooks were used and whether any differences in use might affect student achievement.

Evaluand

The evaluand for this evaluation is three open content science textbooks currently being used as part of the OTP and adopted by several Utah County schools within the Nebo School District. The books were developed by the CK12.com organization and then customized at the local level by teachers involved in the study. These books were

compared to their nationally published counterparts in terms of their usage in and out of the classroom, print media design quality, and content quality.

The three textbooks used in the OTP during the 2011-12 school year and their publisher-published counterparts are listed in Table 1. For each of the books, a small group of teachers came together to choose content based on textbooks available at CK12.org. CK12.org is a non-profit organization building an online infrastructure able to host and distribute a growing library of open content resources. The teachers decided which chapters of the CK12 material to include and which to exclude. In this way, textbook content was customized to only include material that would be covered in class and forgo the expense of printing material that would just be skipped anyway.

Table 1

List of OTP and Publisher-produced Textbooks Used in this Study

OTP Book	Course	Traditionally Published Counterpart	Number Participating Students	Number Participating Teachers
Blake's Biology	9th Grade Biology	*Holt Biology* (ISBN 978-0030672149)	1,200	8
Introduction to Chemistry	10th Grade Chemistry	*Holt Chemistry* (ISBN 978-0030391071)	750	5
Earth Science Systems	8th Grade Science	*Glencoe Physical Science w/Earth Science* (ISBN 978-0078802485	740	4

The OTP customization process resulted in books that were much shorter and more targeted towards the Utah State core curriculum than their traditionally published counterparts. For instance, the OTP biology book is 277 pages, whereas *Holt Biology*, its

nationally published counterpart, is 1,154 pages. In all three cases, the textbook committees ended up deferring primarily to one or two teachers for content decisions. In some cases, these teachers also edited the CK12.org content for clarity or added additional content of their own. Over 2,500 OTP textbooks were specifically printed for the study and delivered to participating students. Students were informed that the books were their own individual copy and would be theirs to keep at the end of the year. They were also told they could write and make notes in the books.

Evaluator

I have been in the printing and publishing business for just over 20 years. During this time I have seen textbooks emerge from simple black and white textbooks to textbooks with an excessive amount of bling. During the early part of my career I owned and operated a small printing company in Kaneohe, Hawaii. Although I specialized in printing business forms, I also printed books for BYU-Hawaii. The fresh memory of being a poor college student paying what seemed like outrageous prices for books prompted me to write a business plan for a textbook publishing company I called Robin Hood Books. The plan was to make textbooks cheap or free by including advertising.

Twelve years later I got to implement this idea when I started BYU Academic Publishing. My overarching goal was to produce high-quality textbooks at a fraction of the price of nationally published books. During one semester, we included coupons from campus vendors in the back of our physical science textbook to help offset the price. By doing so, we were able to sell the book for $25. The closest competing book with comparable content was $130. Unfortunately, BYU politics prevented us from selling

advertising to off-campus vendors and so the advertising component got dropped. Instead, we focused on producing high quality books at an affordable price. In one case, we took a book that had been $80 as a simple black and white nationally published textbook and made it full-color with professional design for $29.

With BYU Academic Publishing I participated in all aspects of textbook development and production. I worked with authors, did editing, typesetting, graphic design, illustration, and photography. I managed others on the team who also worked on the books, and I worked closely with BYU Print Services on book production. I ran BYU Academic Publishing for eight years. During that time we won several awards for our textbooks and business model. We also received several offers from national publishers to buy the ownership rights to our books so they could be repurposed for the national market. However, we never sold them because that would have defeated the very purpose of keeping textbook prices low for BYU students.

In April of 2011 I left my position with BYU Academic Publishing to focus on finishing a master's degree in instructional psychology and technology. I have completed several design courses that, along with my experience doing design with Academic Publishing, help qualify me to make judgments on print media design quality. As part of my IP & T program, I have taught the print media design class for two semesters. My bachelor's degree in English helps qualify me to judge the quality of the written content, and my MBA provides me with helpful experience in conducting surveys, focus groups, and observational studies.

Background Information

The 2002 study *Losing Ground* by the National Center for Public Policy and Higher Education came to the conclusion that a perfect storm of rising tuition, housing, and textbook prices has left many academically prepared students unable to participate in higher education. The report noted that in 1980 average tuition at a public higher education institution represented 13% of yearly income for low-income families. By 2000, tuition represented 25% of the income for these families (National Center, 2002). Because the education and skill of the population is central to the continued growth and viability of the American enterprise, programs and solutions to address higher education affordability are urgently needed.

Textbook Pricing

Reducing textbook prices represents one area of possible remediation. Textbooks and other course materials[3] represent approximately 6.4% of the yearly cost of undergraduate higher education at a public institution and 2.6% for private institutions (National Center, 2002). Despite the seemingly low percent of the overall cost of education, textbooks costs are among the most visible. Other educational technologies (whiteboards, projectors, computer labs, etc.) are funded as part of tuition; their costs are invisible or assumed, built into the system. Textbooks, on the other hand, are a cost borne directly by college students and parents—hence the sticker shock and growing outrage

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[3] New technologies are blurring the lines in what constitutes a textbook and what does not. Some textbooks now include printed and electronic components, or only electronic components. For purposes of this narrative, the term "textbook" is used broadly to mean any required course materials, whether delivered in print or digitally.

over skyrocketing textbook prices. Although textbook prices are only one factor in the higher education affordability equation, they represent a real concern for parents and students alike. Even small improvements in affordability could increase access to higher education. Most importantly, these improvements would help low and moderate income families more significantly because textbook expenses for these students represent a disproportionately higher percentage of family income (GAO, 2005). The price of college textbooks has driven Congress and nearly three-dozen states to attempt to curtail price increases and controversial publishing practices (such as making textbooks disposable) through legislation, most noticeably with the textbook provisions of the Higher Education Opportunity Act, which took effect July 1, 2010 (NACS, 2012).

Estimates of how much every higher education student spends annually on textbooks range from $700 to $1,100 (NACS, 2011). The total market for new books is estimated at $4.54 billion a year (Enrollment, 2012). Between 1986 and 2004, the price of textbooks nearly tripled, rising a yealy average of 6 percent while inflation rose only 3 percent (GAO, 2005). Part of the *sticker shock* of textbook prices also seems to come from the differences in who pays for the books. For most of a child's K-12 life, textbooks are provided at no cost by public school systems. In college, that cost suddenly shifts to the student and often by extension their family. The true cost of textbooks had been there all along, but typically changes to individuals at the higher education level.

Recent studies have suggested that structural imperfections in the market are artificially driving up the price of textbooks. That is to say, textbook prices do not reflect the economic realities of the cost to produce the materials. In 2007, an advisory

committee to the U.S. Education Department issued *Turn the Page*, a lengthy analysis of the economic forces that lead to high textbook prices. These factors include inelastic demand in which the market is driven by supply rather than by demand (i.e., students who want to pass their courses have to buy the books), an oligopolistic supply market in which only a handful of publishers dominate, and high production costs that create barriers to entry by possible competitors to the dominant publishers.

The *Turn the Page* report, as well as several other state and national studies on textbook affordability, cite other factors unique to the textbook industry as reasons for the high cost of textbooks. For instance, publishers can only cover costs through the sale of new books. The advent of the internet paved the way for the consolidation and growth of the student-to-student used book market. With more used book sales leading to fewer new book sales, publishers raise prices, leading to something of a textbook price death spiral—as textbooks become more expensive, students become more aggressive in finding less expensive alternatives, thereby leading to fewer new sales, which in turn leads to even higher prices. In 2008, the used book market posted 15% sales increases, compared to average new book sales increases of 4 to 5%, as reported by Simba Information, a market research group (Mickey, 2008).

In response to the growing used book market, publishers change editions frequently or bundle textbooks with disposable products, thereby rendering the book obsolete on the used book market (AAP, 2006; NACS, 2012). Although these studies question the validity of publisher edition changes and other practices, they note that universities and bookstores also play a role in the textbook price problem. For instance,

there has historically been a lack of transparency in textbook pricing information provided to the student, which limits access to the used book market. Further, some universities view the college store as a profit center and require certain margins to be applied to textbook sales.

The Traditional Publishing Process. The impact of textbook industry practices and its artificial market structures is profound and helps account for the steady and sharp rise in textbook prices. Yet, these structures and understanding the traditional publishing process also represent areas of possible innovation and change, hopefully leading to lasting improvement and reductions in textbook prices.

The national K-12 textbook market has come to be dominated by three major publishers controlling approximately 85% of the market (Owen, 3). Those publishers are McGraw Hill, Pearson Learning, and Houghton Mifflin. A competitive and hostile publishing environment, along with significant start-up costs for new major titles, has contributed to a movement towards consolidation. This consolidation has been cited as one of the factors artificially driving up textbook costs (USDE, 2007).

A major textbook title can cost hundreds of thousands, or even millions, of dollars to develop. In the traditional publishing industry, the only place to recoup those costs is in the sale of each new book. A major factor in textbook prices is that start-up costs must be apportioned to the relatively small market for each title, compared to the general trade market where a novel like *Harry Potter* appeals to a wide audience. Textbooks are limited to audiences in specific classes and may only have a total market of thousands or tens of thousands rather than millions. Some general education or standard high school

courses have significant enrollments nationally, and these are generally the courses with the most elaborate textbook productions, although each still has a finite limit on potential market. For instance, the book *Holt Biology*, one of the competing national textbooks examined in this study, is geared specifically for a high school biology class. It is not a product that will appeal to the general consumer on a shelf at WalMart.

The textbook industry can be likened somewhat to the pharmaceutical industry. Drug manufacturers spend millions of dollars, if not billions, researching and developing a new pill. The lay press sometimes describes the situation as that the *first pill* costs a billion dollars whereas each successive pill costs only a few cents. However, as consumers we understand why a pill may cost several dollars each when manufacturing costs are actually only a few cents—those research and development costs must be spread out among all pills sold. The pharmaceuticals also tend to invest most heavily in drugs that target health issues affecting the largest populations. Likewise, publishers will spend more resources on textbooks for big general education courses rather than unique niche courses where economies of scale are unlikely to materialize.

These two industries also share an odd feature within a free enterprise marketplace: the user of the item is generally not the decision maker on purchasing the item. The doctor selects and prescribes pills to a patient and then it is the patient who pays for the pills even though the selection decision was not theirs. Likewise, the selection of a textbook falls to teachers, professors, and school districts, not to the student. At the higher education level, this lack of choice adds to the level of angst in having to pay a high price for something that wasn't a choice.

Both industries rely on their position as owners of intellectual property to recoup research and development costs. Because textbooks are intellectual property protected by copyright laws, those owning the copyright can legally charge any fee they wish for their property. The decision-maker on a textbook adoption may or may not choose based on lowest price. In one study, 74% of higher education professors indicated content was the key factor and not price in selection decisions (AAP, 15). As such, textbook publishers who develop superior content are more able to charge additional premiums for popular textbooks that do not reflect the true costs in developing that specific material.

To determine a textbook price, the publisher adds up total production costs, which includes everything from costs in selecting manuscripts, to editing, proofreading, design, and printing, adds overhead and desired profit margin, and then divides those costs by expected market share to come up with the net price. In a 2006 report submitted to Congress, the Association of American Publishers cited an example of a general high school science textbook that took 27,465 worker hours to produce (AAP, 16). The risks to publishers are significant considering only 20-30% of textbooks are ever reprinted. Just as a pharmaceutical's drug may *flop* because of negative patient outcomes, textbook titles can *flop* for a publisher if teachers are not convinced of a title's usefulness.

The costs for producing a textbook can be broken down into four major categories: pre-production, production, marketing, and administrative. These costs are described in Table 2. At the pre-production level, publishers first begin a manuscript selection process. Editors sift through both solicited and unsolicited manuscripts. This process highlights one of the major roles assumed by a publisher, that of content selector

and validator. The publisher assumes the responsibility to vet the content for accuracy and relevance. Selected manuscripts then begin what can be a long process of editing, fact checking, proofreading, and peer reviewing. Pre-production also includes laying out the textbook using graphic design, photos, illustrations, etc. Once the book is ready for the printing press, an initial print run is determined. This decision is critical because although unit costs go down with higher print runs, too many books can result in expensive waste and negate any profit.

Table 2

Textbook Production Costs

	OTP *Blake's Biology*		*Holt Biology*	
	Cost	%	Cost*	%
Author's Income	Donated	0%	$10.34	15.1%
Pre-production (Includes manuscript acquisition process, editorial, proof-reading, graphic design, layout, photos, etc.)	Donated	0%	$20.00	29.2%
Printing and Binding	$5.16	92.5%	$9.25	13.5%
Publisher Overhead (Includes legal, property plant and equipment, accounting, hr., etc.)	Donated	0%	$8.29	12.1%
Marketing (Includes publisher reps, sample copies, instructor's editions, lesson plans, etc)	Donated	0%	$12.95	18.9%
Shipping	$.42	7.5%	$1.44	2.1%
Publisher Income	None	0%	$6.23	9.1%
Total Net Price	$5.58		$68.50	

* *Costs were extrapolated based on publisher's reported average book production costs.*

New digital technologies are changing the make-up of book printing costs. Printing press set-up is expensive because metal printing plates costing upwards of $80 each must be fabricated and mounted on the press for each group of pages. Digital technology uses a copy machine approach where the first copy is no more work than the last. This technology makes custom books with low run sizes possible.

Digital technology has improved to the point that it is now cost effective to print low-run black and white textbooks. However, the cost per printed full color page in digital environments is still high enough to be prohibitive for short-run books. In the early 1990s when digital color printing was first introduced, cost per printed page side could be more than $1.00 each (Maxwell, 2012). Although this cost is now down to around twenty cents each, a 300-page book would still be $60 in printing costs alone. As technology continues to improve per page costs will decrease and open up additional possibilities for short-run full color textbooks.

Open Educational Resources. One possible avenue for reducing textbook expenses is to increase the adoption of open educational resources (OER), specifically open textbooks. OER are educational materials that are available at no cost under open copyright licenses or in the public domain. They are defined as "high-quality digitized educational materials offered freely and openly for anyone with access to the Internet" (William, 2005, pg. 5). Students, self-learners, and teachers can use, re-use, or re-package the content to suit their needs. OER materials are generally distributed over the internet, but can also be printed and bound like a traditional textbook for a nominal printing fee.

Proponents of OER contend that they have the potential to greatly reduce school expenses and possibly improve educational outcomes (Baker, 2008; Baker, et al. 2009; Koch, 2006, Wiley, 2010). As a result OER have received considerable attention. A bill currently in a congressional education committee proposes to provide funding for the development of a national database of open educational resources on the basis that the open textbooks will create new learning opportunities (Foster, 2009). Researchers are also interested in examining how students respond to open textbooks and how they may impact student learning and the overall educational experience for teachers and students (Frith, 2009).

Some researchers have hypothesized that open textbooks may improve learning outcomes because they can more easily be customized to meet local needs (Wiley, 2010). Faculty can re-use and re-mix content to best fit learning goals[4]. Additionally, because OER are free to the user if accessed online or significantly reduced in cost if printed, higher education students may be more likely to obtain the material rather than choose to go without it because of cost. Approximately 10% of higher education students do not purchase required materials (NACS, 2011). At the high school level, OER may also assist in improving learning outcomes because their negligible expense means each students gets their own copy, and they can interact with the book by highlighting and taking notes in the margins, whereas school policies usually forbids them from doing so

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[4] Many national publishers offer "customization" of textbooks, but these programs are generally limited to customizing content already available and not adding in teacher generated content. Further, in the K-12 market, textbook purchases are often centralized without an opportunity for the teacher to make customizations.

with nationally published texts. Interacting with a textbook by making notes and highlighting has been described as a study method leading to deeper learning (Wiley, 2010).

OER is a relatively new innovation in education, which means these possible benefits are under study and few conclusive studies have yet been reported. Along with these areas of inquiry to demonstrate possible benefits, OER studies have raised areas of possible concern. These include issues of sustainability, quality, and value.

Possibly the biggest issue in OER is how to develop a sustainable environment where high quality content is produced when little or no money is available to pay the producer (Wiley, 2007). Theoretically, OER content and traditionally published materials may only differ in the distribution and use models. The content could be the same. For instance, a biology expert could write an introductory biology text for high school students. That author can send the text to a traditional publisher and receive compensation, on average, of 15% of net sales (NACS, 2011). Or, the author can donate the text to an open content library and forgo compensation. With either option, the content is the same, so the issue becomes one of funding.

The OER model depends upon the generosity of the author or private funding to develop the material and donate it to the public domain and some form of philanthropy to market, host, and distribute the resources. Either way, there are real production, storage, and distribution costs. Although some costs may be reduced or eliminated with OER, such as publisher overhead, most costs do not disappear but are shifted to another party with the OER model. Any cost savings realized by the users are made possible because

of the generosity of the OER community. The funding question remains pivotal in the effort to define a sustainable OER environment (Wiley, 2007).

Although OER materials *can* be identical to traditionally published material, the funding model leads to a situation where they may not be and the quality of the items is put into question. Subject matter experts are not often trained in instructional design, illustration, photography, graphic design, and layout. Content aside, it would be unlikely that teacher produced materials could compete with professionally produced resources by experts in the publication arts. The dependence on a donation style of funding means possibly fewer resources to develop high quality graphics, illustrations, photos, or professional layouts. Few studies exist that demonstrate quality of OER as compared to nationally published textbooks.

Perhaps the bigger issue of whether or not OER are comparable in quality is whether or not it matters that they are, i.e. are nice full-color graphics in a printed book essential to learning outcomes? Or, is the same text in an online format or inexpensively printed black and white book just as effective? The issue of textbook value is particularly challenging. Some studies suggest that textbooks in general provide little over-all value and are used by students primarily as reference items (Pundak, 2010). Textbooks have been characterized as artificial or superficial accumulations of knowledge. Few students fall in love with their textbooks the way they may fall in love with a fictional novel. If the questions of how and to what degree textbooks are actually used by students and which features are most effective is answered, it would provide an effective basis for judging how well OER delivers on necessary features.

The OTP Publishing Process. All aspects of the traditional publishing process previously described can carry-over to open textbooks, but given the possible differences in funding levels some processes are likely to be dropped. The differences in the cost breakdown of the biology book in this study were noted in Table 2. For instance, the publisher of the national textbook spent approximately $20 per book on editing, typesetting, and layout, whereas the OTP book had no pre-production costs. With OTP books, the authors donate content to the open source community. The roles of editing, proofreading, validating, layout and design also rely on volunteers to the community. For the OTP biology book, the layout and design was placed into an automated print-layout. The credits for the OTP biology book indicate one author and one general editor, whereas the national biology book has a credit list of over 56 people for authorship, editing, and pre-production. The pre-production costs for *Holt Biology* likely cost hundreds of thousands of dollars, if not millions, whereas these costs were zero with the open textbook.

The original OTP biology book consists of 26 chapters. It is available free of charge on the internet at CK12.org. At this website, the teachers participating in the OTP were able to evaluate the chapters and choose which specific chapters to include in the book. In this case, 10 of the original 26 chapters were included. One of the website features is for the content to be exported into a press-ready format using a standardized layout via the *Flexbook*. This software enables CK12.org to host textbooks and make them downloadable into a printed format using a general layout common to each book. After choosing the content for the book, the customized Flexbook was exported for

printing. Once this PDF was generated using the Flexbook rendering system, it was not editable. To fix even minor errors a new PDF had to be generated. After a PDF was ready, the books were printed on high-speed black and white copiers. The process was similar for the other two OTP books in this evaluation.

Summary. Open textbooks represent possible savings at all levels of education, including elementary, secondary, and higher education where school districts, students, and parents spend in excess of 10 billion per year on traditionally published textbooks (AAP, 2011; NACS, 2011). Because the same group of publishers control both the high school and higher education markets, and there is little difference in how textbooks are produced and used in these two markets, the findings of this study on high school students and open textbooks may be extrapolated to the higher education market as well. Further, it is hoped that this evaluation of a pilot program involving three high school textbooks can provide some generalizable knowledge on the benefits and drawbacks of open textbooks at all educational levels.

Method

This evaluation was designed as a case study. There were two phases to the evaluation: (1) a qualitative comparison and analysis of the textbooks being used in this study, and (2) a cross case analysis of how students and teachers were using the textbooks.

The first phase of this study involved an analysis of the print media design quality and content quality comparing OTP and traditionally published textbooks. The second

phase of the study involved analyzing textbook artifacts to explore evidence of any difference in how the books were used (i.e. whether there was highlighting, note-taking, etc). This phase also included surveying and interviewing the teachers for their opinions about textbook quality and use.

The first phase addressed the quality issues raised in the first two research questions, whereas the second phase explored how the textbooks were used in order to answer the third research question. The two phases intersect at the last research question that asked which textbook features were essential, which were seen as optional, and which were considered to be bling.

Phase 1: Textbook Comparisons

The OTP textbooks were judged according to two measures that addressed the interests of stakeholders and the issues and concerns noted in the background information section. These measures included:

1. The OTP textbooks' print media design quality as seen in the layout, graphic design, illustration, and photography.

2. The OTP textbooks quality of content and writing, including organization, accuracy, relevance, and instructional design.

The nationally produced textbooks served as the standard and the OTP textbooks were judged on how well they matched or exceeded that standard.

Instrument Development. In order to minimize impacts of personal preference, two rubrics were created to facilitate evaluating the print media design (see Appendix A) and content quality of the textbooks used in this study (see Appendix B).

The print media design rubric is loosely based on the design principles described in the book, *The Non-Designers Design Book* by Williams (2007). This book describes four main principles of design: contrast, repetition, alignment, and proximity. The rubric was also influenced by a design rubric by Bott (2012). Finally, the rubric includes the elements of graphic design I found most effective during my 20 years in the publishing and printing industries. For instance, while at BYU Academic Publishing, I conducted several readability studies to determine effective column width, font style, and font size.

The print media quality rubric focuses on the visual quality and visual impact of the textbooks. In particular, it deals with the layout and graphic design and how well this design helps guide the reader through the page.

The content quality rubric includes general writing style and mechanics components, the appropriateness of the content in terms of readability, the organization and order of the content, as well as content issues relating specifically to textbooks (e.g., the need for an index and a glossary, a table of contents, identifiable section headings, illustrations, vocabulary lists, and application of ideas sections). Although the content rubric is largely based on my experience at Academic Publishing, I was also influenced by several studies on textbook features and their impact on learning outcomes (Carney 2002, Pozzer 2003, Stelzer et al 2008). The analysis of content quality is supplemented by teacher and student perceptions of the appropriateness and accuracy of the content.

Both rubrics are in the form of a table with the factor being rated on a four-point scale to judge each factor from poor to excellent. Each textbook was analyzed in terms of its implementation of a specific component on the rubric. In so doing, each textbook

could be noted for things done well or things done not so well, instead of making broad generalized statements.

Data Collection and Procedure. For the rubric analysis, I collected unused copies of all three OTP books and their three national counterparts. Each of the six books were analyzed using the rubrics to guide the evaluation. I made qualitative judgments on each book against all factors on both the print media design and content rubrics. Results were tabulated for comparison based on an average *quality* score for each book.

For rubric items of general impression, such as typography quality, I thumbed through the books but made sure to get a glimpse of most pages. For more specific rubric items, such as grammar and spelling, I randomly picked 20 pages from each book— reading and evaluating all 3000 plus pages in the six textbooks would not have been feasible— and then read and evaluated all content on each of those pages. I used a random number generator to pick the 20 pages. Since each book was a different length, I generated six different sets of random numbers specific to the page count for each of the books. Appendix C is a table listing the 20 pages evaluated for each book.

After reading all 20 pages and making notes on the content, I made a qualitative judgment about where on the four-point scale the feature being evaluated should be based on the description in the rubric of what constituted each score. On the content rubric, some items were a yes/no question of whether or not the book had a particular feature, such as whether or not the book had a glossary. In those cases I examined the book specifically for those features. Further, there were several questions on the teacher survey

related to content and print media design. The teacher responses helped inform the rubric score decision (see "teacher survey procedures" in following section).

Data Analysis. Using the individual scores on each rubric item, I was able to generate an average print media design quality and average content quality score for each book. The scores were correlated with other data collected by book title to analyze quality in relationship to use. These scores were also compared against other collected data as a check for reliability.

Phase 2: Methods Used to Evaluate Textbook Use

This phase of the evaluation consisted of analyzing the textbook artifacts from students by studying the types and frequency of their markings. It also included surveying and interviewing teachers about how textbooks are used in their classroom and the types of textbook features they consider important. They were asked to evaluate how well the textbook they were currently using delivered on features they perceived as important.

Textbook Artifacts Participants and Setting. Participants for this study came from five schools in the Nebo School District in Utah County, Utah. Approximately 2,500 students used the OTP books during the 2011-12 school year. Just over 10% of the textbooks used by those students were analyzed and 16 of the 17 teachers using the OTP books provided information. Each of the 17 participating OTP teachers were asked via email to participate in the evaluation. They were each asked to do two things: collect student textbooks for review and complete an online survey and/or interview. Nine of the 17 teachers agreed to collect their students' textbooks and have them reviewed. Fifteen

teachers completed the online survey and thirteen participated in interviews. Of the nine teachers who participated in the book collection, five had been involved as the main coordinator on content selection on the particular title used in their class. These five represented all of the teachers who served as primary decision makers on the content.

The collected textbooks represented all three OTP titles and approximately half of the 2,500 books provided in the pilot program. The students using the textbooks were enrolled in either 8th grade science, 8th grade honors biology, high school biology, or high school chemistry. Two non-OTP teachers also allowed me to inspect the books from their students for control purposes.

Textbook Artifact Data Collection and Procedures. Over a two-week period, textbooks were collected for analysis and then returned to the students. Specific pick-up and delivery times were scheduled with teachers separately.

For the textbook artifact analysis I began by doing a simple evaluation on 10 different books. I randomly selected 10 books from an initial lot of the OTP biology books. I assigned them each a score based on a four-point scale of *no apparent use* to *extensive use*. I assigned a score based on a visual thumb-through of the book. Before proceeding, I wanted to validate those scores by going through each book page by page and keeping track of all pages that had writing in them. I then looked at the total number of pages that had writing and compared those totals to the four-point judgment I had made.

Since thumbing-through each book only took a few seconds, I had hoped this would be an accurate enough method to use with all of the books; going through all 1,200

collected books on a page for page basis would have been time prohibitive. For the page-by-page analysis, I created a data file with the page numbers across the top going from page 1 to page 277. For each page I encountered writing, I put either an "h" for highlighting (whether with a highlighter or underlining), an "n" for note (any note or comment relating to the course), an "e" for exercise (the student had written in answers to an exercise or review question), and a "c" for correction (the student marked an apparent typo in the book) in the corresponding page number column.

After doing this coding for the 10 original books, it became apparent that a visual thumb-through would not be adequate. Some of the books I had marked as having minimal use actually had extensive use and vice-versa. Some of the students marked the books with light pencils while others used colorful highlighters. A visual thumb-through could make it seem like the colorful highlighted book had more use, when in fact the other had more extensive use. Further, it was also going through this process that I realized most of the 10 books had identical markings. I had given the ten books a variety of scores, but in the end over 85% of the pages had the same markings. I then determined that rather than thumbing through all 1,200 books I would select a sample and go through the sample on a page-by-page basis. I randomly selected 20 books from each class of textbooks I collected. In addition to coding 20 books from each class, I also picked three classes and went through all of the books in those classes, which ranged from a total of 32 to 38 books per class. The three classes for which I did all books were chosen based on the amount of time I had with the books before the students needed them back.

I did a page-by-page code of a total of 281 books, which represented just over 11% of the total sample. For all books not selected for a page-by-page analysis, I did a cursory thumb-through of those books to see if I saw anything unusual or different and recorded those findings in the data file.

I also took several photographs of pages that were representative of markings found in the books. As I went through the books, I kept track in a comments section of the data file anything unique I encountered in a particular student's book, such as damage to the book, non-academic notes and comments, or any other indicator of how the book was used. I also did a member check during the teacher interviews to better understand patterns that were identified. Based on the analysis, I described patterns in the data and asked for teacher comments on those patterns as a way to verify my analysis of the results.

Textbook Artifact Data Analysis. I recorded the results of the page-by-page analysis in a data file by teacher, class period, and book. I calculated the frequency of different types of markings and the total number of markings in each book. I also analyzed the uniqueness of the markings by comparing the percent of pages that were marked in a similar way to other books within a particular class.

Teacher Survey Procedures. I administered a survey to all 17 OTP teachers and 28 non-OTP teachers using the qualitrics.com online survey platform. All 28 of the non-OTP teachers taught 8th grade or higher science classes in the Nebo School District, just their OTP peers.

After obtaining IRB approval to administer the survey, teachers were asked to complete the 19 question survey. A total of 16 teachers responded to the survey with the first email invitation. Another 10 responded as a result of reminder emails. All but one of the 17 OTP teachers completed the survey. Two of the teacher surveys were disqualified because 18 of the 19 questions were left blank. A total of twenty-four teachers completed the survey, sixteen teachers using the OTP books and eight teachers using the traditional textbooks. All nine OTP teachers who participated in the book collection completed a survey. A copy of this survey is included as Appendix D.

The teacher survey included several general information questions to determine whether the 16 OTP and 9 non-OTP teachers were similar in background. There were no significant differences in the background questions between the OTP and non-OTP teachers. Seventy-six percent of respondents have been teaching for at least seven years, although only fifty-six percent having been teaching the course involved in the study for the same length of time. The teachers came from all three courses involved in this study: eleven from biology, six from chemistry, and five from earth science. Two teachers in the non-OTP group taught physics. Because of the small sample size, few survey items were found to have a statistically significant difference between the OTP and non-OTP teachers. As a result I focused on looking for general trends in the data.

Teacher Survey Data Analysis. I analyzed the data for patterns in teacher opinions on the usability and quality of the textbooks. In particular, I looked for any differences in opinions between those who had used the OTP books and those who had not. Because of the relatively small sample-size, the analysis focused on finding thematic

patterns as a case study rather than finding statistically significant differences. I also looked for patterns in the survey results as compared to the usage found in the textbook artifacts. That is, did they match up? Was there evidence from teacher interviews about their students' use of the textbooks consistent with the use as reported in the survey data? Finally, I looked to the data for any differences in use between those teachers who had participated as taking a primary role on content decisions and those who had not.

Teacher Interviews and Analysis. Based on the initial survey results, I did follow-up interviews with thirteen teachers and one Nebo School District administrator. The textbook artifact analysis and survey responses had triggered specific areas needing additional follow-up. For instance, in some classes, some of the markings in the books were identical. I contacted those teachers and asked them to describe their classroom procedures of how they instructed students to mark in the books. I also asked some of the lead teachers to describe the process that had occurred to make the specific chapter selections. Each of the interviews was different and targeted to specific items of interest that came up during the initial analysis. Interview data was grouped by themes. Particularly insightful quotes from the teachers were noted. Interview results with the survey data were compared as a consistency check of the results.

Combined Data Analysis. After performing each of the three evaluation activities—the rubrics, survey, and interviews—I analyzed the data for themes in how it all related to each other. I analyzed the survey and interview responses in light of the quality scores calculated with the two rubrics. In particular, I looked for any patterns on a teacher's reported usage with the quality and features noted in the book. I also looked

for any indication as to what aspects of quality may have influenced usage. For instance, did the teacher note in the survey something that was missing that changed how they were able to use the textbook? With the combined analysis, I looked for broader patterns that would service as the basis for a useful case discussion on how the OTP books compared in usage to their publisher-produced counterparts and which features impacted that usage.

Results

This evaluation focused on determining whether there were any differences in the quality of the print media design and the quality of the content between the OTP and traditional textbooks and whether there was any difference in how the students used the textbooks. The results of the textbook analysis using the two rubrics showed a substantial difference in the print media design and content quality of the OTP textbooks versus their traditionally published counterparts. In general, the OTP books did not meet basic standards of professional print media design or content quality, whereas the nationally produced textbook did. The teacher survey results indicated the differences in quality were noticeable, but generally not to the point of impacting a teacher's decision on whether or not to choose an OTP book as the adopted textbook. The following sections report specific details of the print media design and content analysis including comparisons between the two groups of textbooks.

Print Media Design Quality Analysis

To make a comparison between these OTP and publisher created textbooks, each book was evaluated using the print media design quality rubric. Additionally, how the

teachers viewed the books, as indicated in the surveys and interviews, was also considered. The teachers responded to four different questions relating to the print media quality of the textbooks. Because of the small sample size, few items were found to have a statistically significant difference between the OTP and non-OTP teachers. However, there were general trends in the survey results.

On the four print media design quality questions in the teacher survey, one was found to have a statistically significant difference using an independent sample t-test. Teachers using the traditional textbooks noted that their books had more useful graphics than those using the OTP books. The means for each print media design question is listed in Table 3. Although only one question had a statistically significant difference in the means, there was a general trend in the data. The traditional books had higher means (i.e., higher quality scores) on all of the design questions. These finding are consistent with the teacher interviews and notes in the survey free-response section and the rubric scores. In these sections and in the interviews 72% of the OTP teachers mentioned that the books did not contain enough high quality graphics.

From the rubric review and with consideration of this teacher survey input, it was determined that the OTP textbooks had an average design quality score of 20, whereas the publisher-produced textbooks had an average score of 45 (see Table 4). With twelve criteria on the rubric and four judgment levels, a perfect score would have been 48 and a minimum score 12. Based on this analysis it is clear that the traditional textbooks were far superior in terms of the quality of layout and design and level of professional impact.

Table 3

Print Media Design Quality Questions by OTP or non-OTP

	OTP n=7	Non-OTP n=16	Sig. (2-tailed)
The textbook was nicely-designed	4.1	4.7	.176
Overall visual quality good	3.9	4.6	.125
The textbook design aided readability	3.3	3.6	.251
The textbook had useful graphics	3.4	4.9	.014*

Results were based on a 6-point scale from strongly disagreed to strongly agree.

* Indicates a statistically significant result at the alpha=.05 level.

Table 4

Print Media Design Rubric Scores

	OTP Biology	OTP Chemistry	OTP Earth Science	Holt Biology	Holt Chemistry	Glencoe Physical w/ Earth Science
Visual Impact	2	1	2	4	4	4
Visual Clarity	2	2	2	3	3	3
Contrast	1	2	2	3	4	3
Consistency	2	3	1	4	4	4
Alignment	2	3	1	4	4	4
Proximity	2	2	2	3	4	4
White Space	1	1	2	3	4	3
Color	1	1	1	3	3	4
Typography	1	1	1	4	4	4
Column Design	1	1	1	4	4	4
Quality of Graphics	1	1	2	4	4	4
Craftsmanship	3	3	3	4	4	4
Overall Score	19	21	20	43	46	45

Because the two groups of books (OTP and non-OTP) were very similar to each other within their own groups, the following report on the results of the print media design analysis will discuss rubric criteria grouped by OTP book or publisher-produced book, rather than for each book individually.

Figures 1 and 2 are photos of typical two-page spreads in the OTP books. Figure 3 is a typical spread from one of the traditional textbooks. These pages are used to describe representative layout and design principles and how they do or do not exhibit those requisite qualities in the print media design analysis.
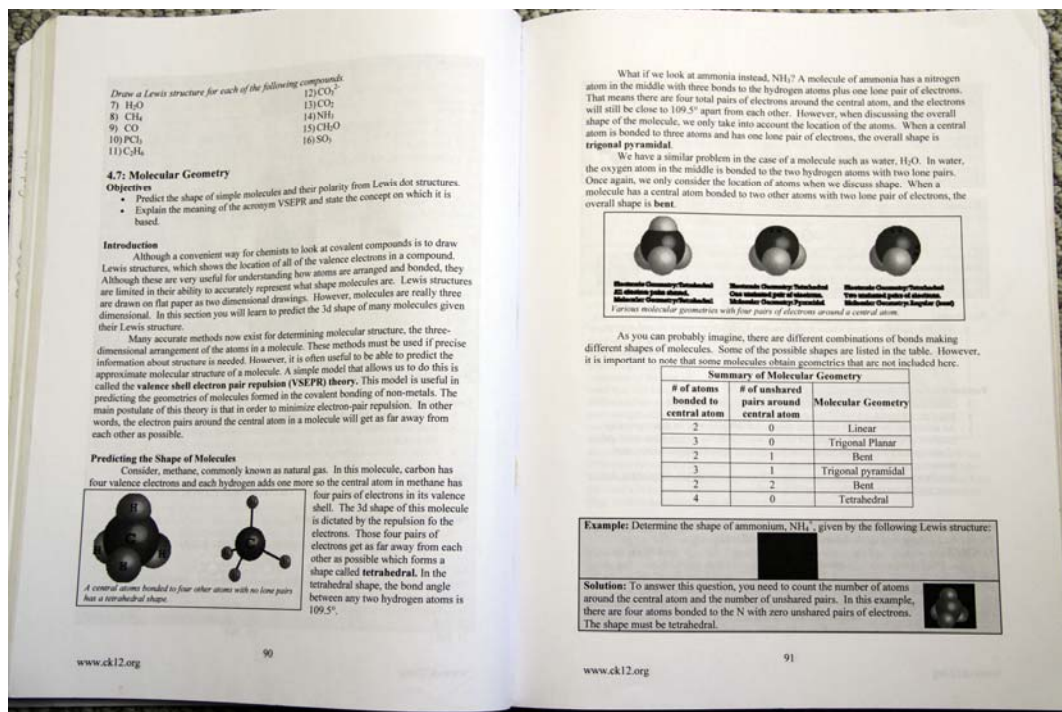
Figure 1. OTP chemistry book pages 90-91.
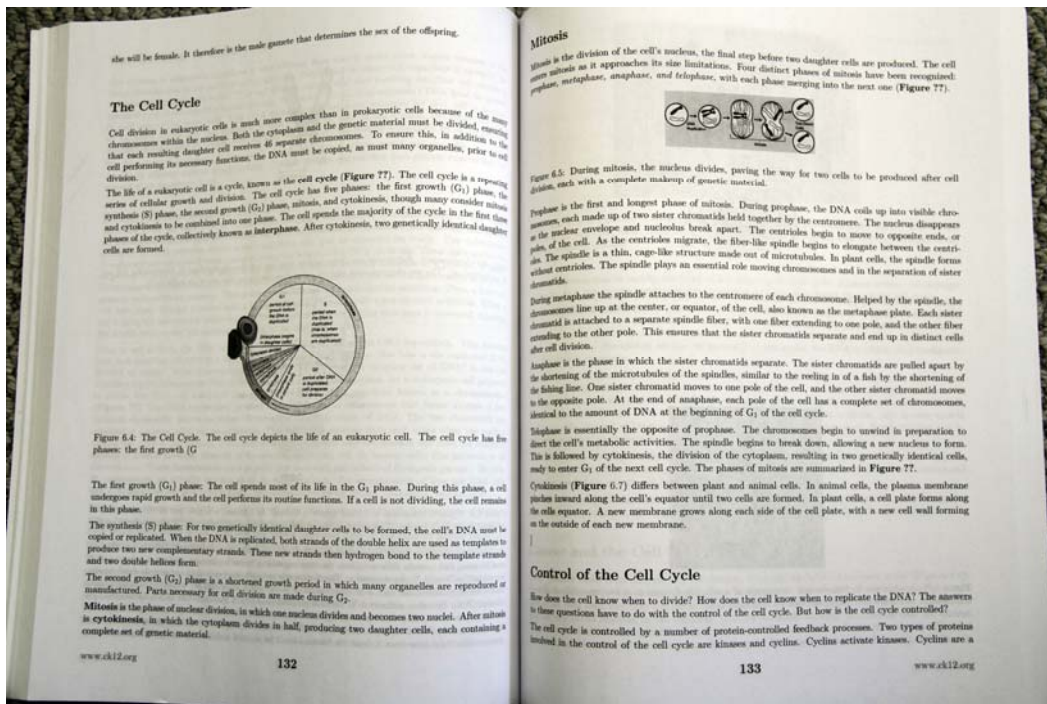
Figure 2. OTP biology book pages 132-33.
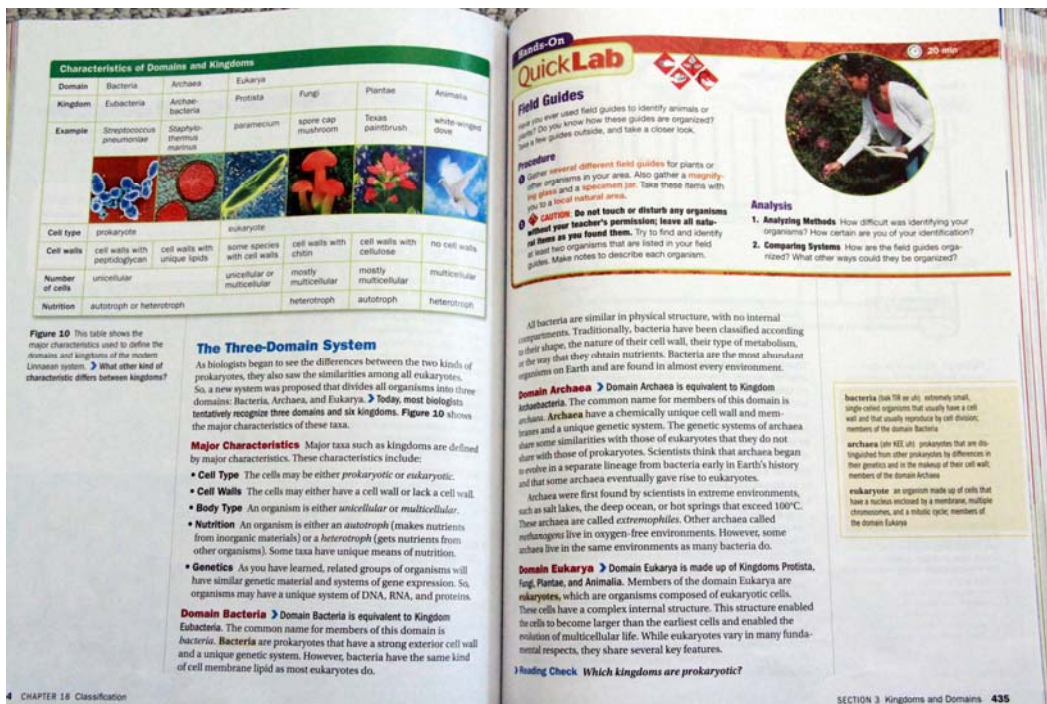
Figure 3. Traditional book, *Holt Biology*, pages 434-35.

Although the difference in overall visual quality and visual impact between the two groups of books should be readily apparent from the three figures above, there are specific principles of design that help explain why.

Visual Impact and Clarity. The OTP textbooks were very similar in their design and features, presumably because they were all auto-generated using the FlexBook print engine. These books each had the feel of being a basic word-processor produced document rather than something typeset in a professional page-layout program. The text flowed from one content area to the next without regard for how the text fell in the document. The text in the book simply proceeds in a single column from one heading and text paragraph to the next with the occasional graphic interrupting the flow. As a result, a table or graphic may appear oddly on the page apart from the text to which it refers.

In contrast, it was obvious that the publisher-produced textbooks used a more sophisticated document layout program. In professional document layout programs, the designers work with text and graphic boxes to get the precise layout they want. They can move boxes around in limitless combination and are not constrained to one main column. There can be a text column, a side-column for highlighted words, graphics that span the entire page, etc. The designer can add text that flows down the page, but still move around call-outs, tables, and illustrations with the text reflowing around it. Although word processors have a definite place for some types of documents, and have features that simulate professional page layout software, they generally do not provide the level of

control and precision needed for sophisticated page layout, especially in an automated process similar to that use to create the OTP textbooks.

Contrast. Contrast is an important design element. It refers to how elements on the page are visually different from each other in their level of boldness. There is a saying, "if everything is bold, nothing is bold." A page with little contrast impedes readability because everything looks the same resulting in the reader not knowing where to look (Williams, 2007). Contrast helps guide the reader's eye from one component to another. Contrast is especially important in pictures so that distinctions are readily apparent. This reduces the cognitive load for the reader to facilitate learning. In Figure 2, the picture on the bottom left-hand corner is so dark there is no contrast between the picture and the letters represented by each molecule. The figure does not convey its intended meaning. The OTP books in general had frequent problems in picture contrast. Teachers using the OTP textbooks consistently commented that students would often complain about the picture quality. The problems with the pictures were most likely caused by low-resolution photos designed for a computer monitors rather than the printed page. In the three traditional textbooks, I did not find any issues with contrast that impeded readability. However, I did find that in some instances the contrast seemed to be too much. Figure 3 is a highly-designed set of pages. For some, the multiple elements on the page may be distracting, even though they produce a lot of contrast.

Consistency. Consistency is how graphic design elements are used and placed on the page in a focused and similar manner to each other. For example, font choices and sizes need to be internally consistent from chapter to chapter. Changing fonts for no

apparent reason or having too many fonts on the page can lead to a cluttered and disorganized look. The OTP books were, for the most part, consistent (i.e., they were just consistently simple). The books generally used one serif font for the body text and a larger version of that font for headings. There were however a few minor consistency problems in how design elements were formatted. For instance, in the OTP earth science book, some of the vocabulary word sections were presented as bullet-point lists. Others were lists of bold words with no bullets.

The major consistency problems were in the illustrations and photos. They did not have consistency of style. Some illustrations looked liked they were scanned from a hard-copy book, while others looked like photos out of stock photo banks. Figure 4 shows two illustrations from the OTP biology book. They are next to each other in the book, but do not share consistency of illustration style, suggesting they came from different sources. For instance, they both use a san serif font, but they are different san serif fonts. The illustration on the left has a finer greyscale dot pattern (the dots can be seen on the right but not on the left graphic), it capitalizes "Cholorplast," whereas the other does not, the lightening bolts representing light are of different styles, the left one uses a box to represent "NADPH" and the other uses a star pattern, it also uses greyscale arrows to point out reactions and the other uses a dotted-line arrow, among other differences.
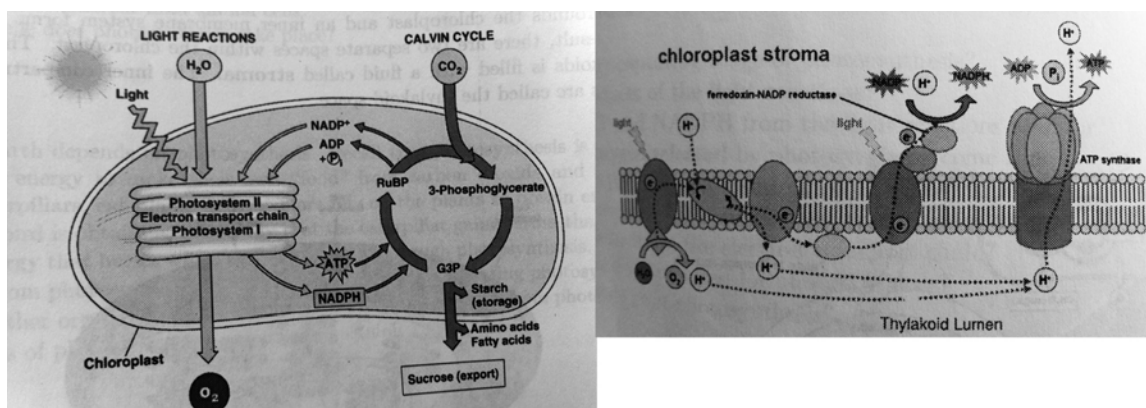
Figure 4. Illustrations from pages 102 and 103 of the OTP biology book.

Few of the figures in the biology or earth science systems books provided a reference citation (an issue to be addressed in the next section), so it is unknown where the figures came from. As a result of different sources, the text included in the figures was of all different fonts and the style of illustration varies from one to the next. The OTP biology book seemed to have the most diverse group of illustrations while the chemistry book had the least. The traditional books did not have a consistency problem and were all stylized in a similar manner.

Alignment. A strong design includes strong lines. This means aligning like material on the same line relative to each other. This does not mean that everything is aligned the same because a lack of contrast would result. Instead, every design should include several consistent lines for like elements in the design. For instance, if I include a list in my book, I would generally indent the list so it does not have the same alignment as the preceding text, for contrast. In order to maintain consistency, every list should be indented in a similar fashion on the same line.

The OTP books generally stuck to one main line for everything, whereas the traditionally published books used different lines for different elements. The one line alignment of the OTP books led to a single "boxy" look for each page. For instance, in Figure 2, the figure caption is aligned left with the rest of the text. Such placement impinges readability because it can be mistaken for part of the text. In Figure 3 from the publisher-produced book, the figure caption is set apart from the main text and aligned to a left margin.

Proximity. Proximity is based on the idea of placing relevant material close together so that the reader can visually understand what is and is not related to each other. The free-flow nature of the FlexBook rendering layout led to many issues with proximity in the OTP books. In free-flow documents, when the text changes, the flow of the entire document changes.

For instance, I might be working on a section in a book about L.E.D. lights. The section includes a table and a graphic. In my text, I might refer to the table as being located at the bottom of the page. If I went back and added in an extra sentence on L.E.D.s, the additional text might cause the table to be pushed over to the next page, which then means my text is incorrect and should refer to the table at the top of the next page. Such issues become hard to manage in word-processed documents with each iteration of the text. In professional design programs, the table is not a part of the main text block and will not move to the next page unless it is specifically selected and moved. Errors in reference to the location of an item were frequent in the OTP books but not in the traditional books. In many cases in the OTP books, the figures were unnecessarily far

away from the corresponding text. The placement of text captions either being too close or too far away from the corresponding graphic was also an issue.

White Space. Although one of the proposed benefits of the OTP was for students to be able to highlight and make notes in them, the OTP design did not facilitate this use. The margins were small and left little white space. Further, the margins were of equal proportions rather than having different left/right page measurements. In book design, the margin next to the gutter, the area of the book closest to the binding, is usually larger than the outside margin so that the text does not flow too closely to the binding. With the OTP books, they had to be pressed very flat in order to see all of the text. Another white-space issue was in the placement of figures. In many cases the body text flowed too closely to the edge of the figure, making the page look crowded. For instance, in Figure 1, there is almost no space between the body text and the "Summary of Molecular Geometry" table.

Color. There were practical financial reasons for excluding color in the OTP books, but it was noticeably missed, particularly because of the nature of these books as science texts. In the chemistry book, for example, on page 43 there is an illustration of the visible light spectrum. There really is no way to illustrate a spectrum from purple to red in a black and white fashion. Figure 5 is presents a photo of that page. In this case, the student wrote in the colors. This figure is also an example of text that is barely readable because of the graphic's low resolution and the student writing in missing information ("microwave" is missing from the chart as a wavelength type.)

energy of all visible light. Even lower in the spectrum, too low in energy to see, are in ays and radio waves.

The light energies that are in the visible range are electromagnetic waves that

[Figure with handwritten annotations showing the electromagnetic spectrum: Gamma Rays, X-Rays, Ultraviolet Rays, Infrared Rays, Radar, FM, TV, shortwave, AM; with wavelength and energy scales, and visible light colors Purple (violet), Blue, green, yellow, orange, red labeled "Visible Light," noting "Too harsh to see," "too low to see," "High Energy," "Low Energy"]

human eye to respond when those frequencies enter the eye. The eye sends signals n and the individual "sees" various colors. The highest energy

Figure 5. Color issues in page 43 of the OTP chemistry book.

In the teacher survey, several teachers noted that color in the OTP textbooks would have been helpful. They commented about how a lack of color rendered some graphics incomprehensible. However, they also reported that their students seemed ambivalent about the necessity of color. The teachers reported that when surveying their own students, students said color would be helpful, but if given the choice between having color or getting to write in the book, they would choose writing in the book. However, teachers also reported that students felt they should be able to have both.

All three publisher-produced texts were printed in full-color. Color schemes were appropriate for the use. In some instances, the possibly excessive use of color added to the problem mentioned earlier of over-design. For instance, the *Holt Biology* book had a

color-coding scheme where certain colors were supposed to signal different types of material.

Typography. The OTP books included, at least a rudimentary level, typography characteristics required for basic readability. The main body font was a standard 12-point serif font—Times New Roman for the biology book and New Century School Book for the other two. The headings were larger and bolder versions of the main text font. Generally speaking, headings should be enough different than the main text so as to draw appropriate contrast. This is usually accomplished by changing to a san-serif font. Since the OTP did not make this change, the single font design weakens the overall visual impact and hinders the ability of the reader to find material on the page. Further, the spacing between lines was too close in all three books. The traditional books utilized a serif font for the main text and san-serif fonts for the headings and sub-headings. Font choices and line spacing were consistent and effective.

Column Design. The single column design of the OTP books led to issues in readability. The columns were so wide that it is hard for the eye to keep track of the line. Usability studies indicate optimal column width is approximately 36 characters (Williams, 2012). The OTP books typically had around 95 characters per line, while the traditional books had around 45. Figure 6 is a page from the OTP chemistry book. Note the solid, dense, and boxy look of the page because of the single page column. There is little room for note taking. The OTP biology book had an odd column issue in that there were several instances where the text went right to the edge and got cut off. Figure 7 is a photo of the bottom of page 93 of that book where text runs off of the edge.
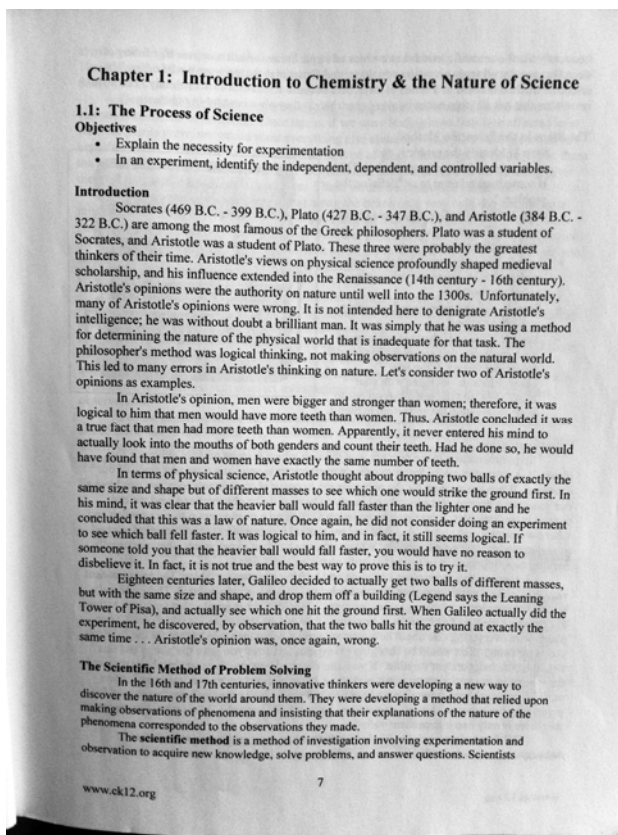
Figure 6. Single column design. Page 7 of OTP chemistry.
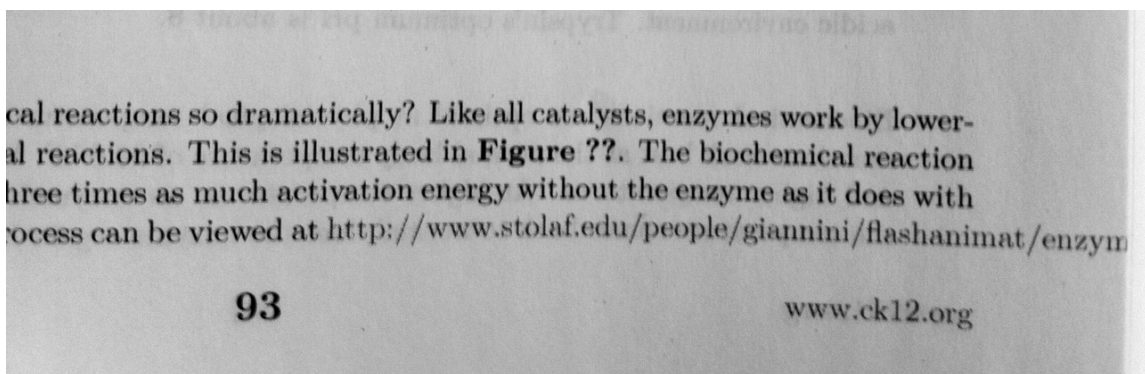
Figure 7. Formatting problems with text running off the page. Page 93 of OTP biology.

Graphics. As noted in previous examples, there were many problems with the OTP graphics. They appeared to come from a variety of sources and often lacked consistency of style and readability. During the interviews, some teachers described the graphics as "useless." A noticeable difference in the quality of graphics was the only statistically significant difference found in the teacher survey out of the four print media quality questions (see Table 3). A lack of quality graphics was the second most frequently mentioned item in the survey's free response section, only behind typo issues.

Readability of the graphics was a major problem in all three OTP books, although the gray-scale graphics generally turned out the best in the earth systems book. The graphics were often too small or too blurry to be readable. Some graphic designers suggest that a useful rule of thumb is that graphics appearing in a book should be readable from three feet away (Williams, 2012). Many of the OTP graphics were not readable at any distance. Some of the OTP chemistry graphics, in particular, appeared as a solid black box instead of the intended picture.

In the 60 pages evaluated from the OTP books, there were 41 graphics, of which 36 (88%) had major issues in readability. The graphics were either too small, too bitmapped, too dark, missing information, or too gray without enough contrast to be readable. In contrast, the professionally-published books included clear and colorful graphics appropriately sized for readability.

The earth systems book also had a problem with the graphic captions for much of the book. The captions were formatted as html links rather than actual words as shown in Figure 8. Apparently, the FlexBook platform pulled the URL link rather than the content.

Figure 2.30: http://localhost/Pluto%20with%20its%20moons:%20Charon,%20Nix%20and%20Hydra.

- Dwarf planets are spherical bodies that orbit the Sun, but that have not cleared their orbit of smaller bodies.
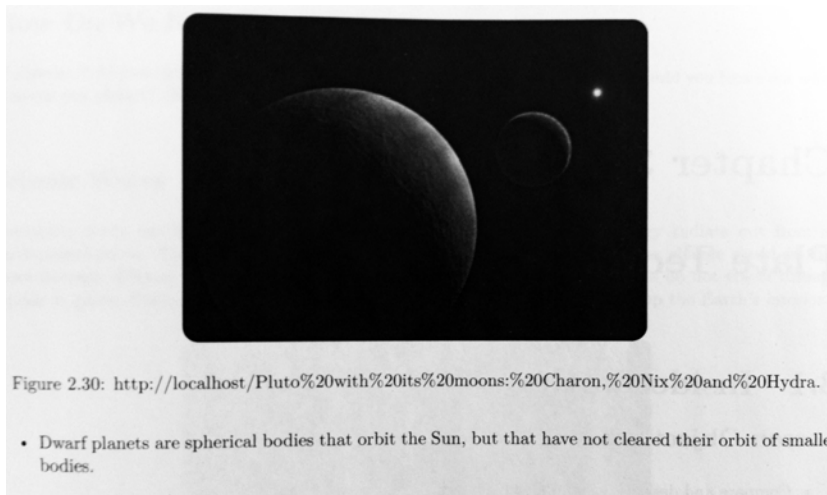
Figure 8. Figure caption problems in the OTP earth systems book.

Craftsmanship. The OTP books held up very well for a year of student use and being lugged around in backpacks. However, most were very worn and probably would not have withstood a second year of use, which fortunately was not needed given the single use design. The softback binding had strong glue and adequately held the pages in place. The covers were laminated and stayed together. The only problem I noted in the materials was that the economy bulk uncoated copy machine paper bled through to the opposite page with highlighters or heavy markings. The traditional books used a coated stock paper and had students been allowed to mark the books this would have been less of an issue. The traditional books were solid in craftsmanship and designed to withstand years of use.

Content Quality Analysis

To make a comparison between the OTP and publisher-created textbooks on the quality of the content as it appeared in the textbook, each of the books was evaluated using the content quality rubric and supplemented with comments made by the teachers

in the interviews and surveys. The content analysis included making judgments on the information that appeared in the text and how well and accurately it was presented, as opposed to how it visually looked as in the print media design analysis. The content analysis included considering information that appeared both in the prose of the text and in the illustrations and photographs. For instance, the content analysis included judging how well a photograph supported the topic being discussed or whether a photograph should have been included and was not.

The teacher survey included six questions related to the quality of the content in the textbooks. Like the print media design questions, the content quality questions were presented on a six-point Likert scale with response options ranging from strongly disagree to strongly agree. Also like the print media design quality questions, with the exception of one item, the average mean scores were higher (indicating a higher quality score) for the non-OTP books on each of the six content quality questions (see Table 5). The exception was that OTP teachers found their books to be slightly easier to read than the teachers using the professionally produced textbooks. During the interviews, several teachers confirmed this finding by saying that the traditional textbooks were not at a reading level appropriate for their students. Of the six questions, only one had a statistically significant difference. The teachers using the OTP books tended to feel the grammar and spelling quality of the OTP books was problematic, rating their books an average of 3.6 out of 6 for grammar and spelling quality. This was not the case for the professionally produced textbooks. Teachers using the professionally produced books rated their books a relatively high 5.6 out of 6 for grammar and spelling quality.

Table 5

Content Quality Questions by OTP or non-OTP

	OTP n=7	Non-OTP n=16	Sig. (2-tailed)
The textbook was well-organized	4.3	4.4	.748
The textbook content was easy to read	4.3	3.6	.270
The textbook included good examples	4.1	4.6	.232
The textbook clearly explained major concepts	4.4	4.7	.502
The textbook had accurate content	5.0	5.3	.496
The textbook had no errors in grammar/spelling	3.6	5.6	.003*

* Indicates a statistically significant result at the alpha=.05 level.

Using the teacher input and the content quality rubric judgments each book received an overall content quality score. As with the print media design analysis, the OTP textbooks did not score as well as the professionally produced textbooks with regards to content quality. On average the content quality score for the OTP textbooks was 19, whereas the traditional textbooks had an average score of 37 (see Table 6). The traditional books had more extensive content, more accurate content, and fewer mechanical errors in content than the OTP books.

One limitation of this analysis was the fact that the scientific accuracy of the content could not be fully considered because I am not a scientist. However, comments from teachers and evidence from markings in the OTP texts where content was corrected suggest the accuracy of the information was at times lacking in the OTP textbooks. The analysis that follows looked primarily at the clarity of writing, effective examples, accurate writing mechanics, and content features typical of successful textbooks.

Table 6

Content Rubric Results

	OTP Biology	OTP Chemistry	OTP Earth Science	Holt Biology	Holt Chemistry	Glencoe Physical w/ Earth Science
Table of Contents	4	4	4	4	4	4
Index	1	1	1	4	4	4
Glossary	1	1	3	4	4	4
Citations	1	2	1	4	4	4
Relevance of Graphics	2	2	2	4	4	4
Audience/Readability	3	3	3	2	2	2
Spelling & Grammar	1	1	1	4	4	4
Content Application	1	1	1	4	3	4
Content Development & Organization	3	3	3	4	4	4
Instructional Design	2	2	2	4	4	3
Score	19	20	21	38	37	37

Extra Matter. In book publishing, items like the preface and table of contents are referred to as *front matter* and items like the index as *end matter*. In terms of these extra features (i.e., *extra matter*), textbooks should have, at minimum, a table of contents, glossary, and index. Each of the OTP books included a table of contents, but none contained an index, and only one, the earth science book, included a glossary. The automated approach of the Flexbook platform was apparently unable to generate an index for the customized version used in the OTP. Several teachers noted this as a problem for students in the surveys and interviews. Specifically, in the survey's free response section,

teachers indicated that they wanted an index and a glossary. Other than an answer key at the end of the OTP chemistry book and the earth science book's glossary, there was no *end matter* in the OTP books. They simply ended with the last chapter.

The traditional textbooks each included a short and expanded table of contents, an extensive index, glossary, photo credits, review question answers, and other extra reference items such as a periodic table and study skills guide.

Citations. The OTP books had few, if any, citations for illustrations or photographs. It is very unlikely that all the photos and illustrations used in the OTP textbooks came from the public domain but were probably found on websites and included as *fair use*. I found evidence of such use by locating some of the exact images on other websites. Although *fair use* would allow a single image or photo to be used in this way, they should be properly credited with a citation. Citing the source of images used in the OTP was rare. The biology book, for instance, included a photo of tortoises from the Galapagos Islands (which, as an aside, was spelled three times incorrectly as the "Galpagos Islands" see page 209). The book also included photos of a jaguar, a humpback whale, and an underwater photo of a clown fish. While the CK12 authors may have license or permission to reproduce these images the failure to cite the source of these content elements is problematic.

The number and simplicity of illustrations and photos in the chemistry book was more limited than the other two books. They are also more consistent in a simple design and look like they could have been produced on a word processor and not a professional vector-based illustration program. As such, there may not have been as much of a

citation problem with the chemistry book. However, the illustrations in the biology and earth systems books were all so very different in style as to indicate different authorship, but they were not cited. In my analysis of the biology book, I encountered one illustration (on page 108) that was exactly the same as an illustration on a private person's website (see drchadedwards.com). This encounter led me to wonder about whether the text was original to the author or borrowed from other sources. On one of the random pages selected for analysis from the biology book (page 99) there was a discussion of ATP (Adenosine triphosphate). I checked several sentences on these pages and found they were word-for-word identical to the ATP content on Wikipedia. The same wording is also used on numerous other websites. As such, it is impossible to tell where it originated. Wikipedia is also an open-licensed content provider, but the CK12 book is presented as being written by six different authors and maintains a copyright claimed without any reference to Wikipedia, a requirement for most open source content.

To be clear, this may not be an indication of copyright infringement (CK12 has purchased rights to some copyrighted material and the use of open content may be appropriate) but failure to cite the source of informational content and supplemental images leaves readers to wonder. The traditional books, on the other hand, included several pages of citations for the illustrations and photos appearing in the books.

Relevance of Graphics.   The graphics in all six books were generally on topic. However, several teachers noted in the survey the need for more graphics and more relevant graphics. In the survey, one of the biology teachers said that the graphics did not have enough content to explain concepts.

Another issue with the OTP graphics is a lack of clarity and readability, as noted in the print media design analysis section. The lack of color also limited the relevance of the graphics to the topic of discussion. For instance, in the chemistry book there is a sequence of two graphics showing a test strip inside of a liquid filled jar. One is supposed to depict the test strip turning red and the other turning blue. However, as shown in Figure 9, without color, both pictures look identical and the value added for including the illustration is minimized.

therwise, you could identify them by their
? Think
taste
is a
that
s an
lor
. If blue

property
heir
a bad

Acids cause blue litmus paper to turn red

nave nad the opportunity to taste: milk of
nagnesium hydroxide. This substance is
ded
ter
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nave
s
f the

Bases cause red litmus paper to turn blue
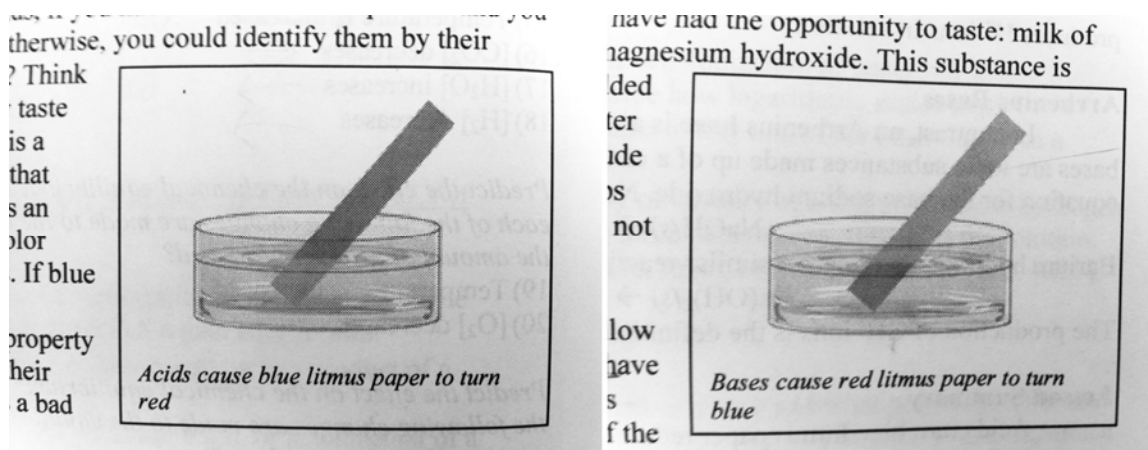
Figure 9. Illustrations from pages 170 and 171 of the OTP chemistry book.

Audience/Readability. On this criteria, scores were based on information from the teacher surveys and interviews. Although all of the books seemed to have understandable writing, I do not remember what it is like to be a high-school level reader. The teachers however reported that the publisher-produced textbooks were often at a reading level too high for many students. The OTP teachers did not express this complaint about the OTP books, and so this was the only criteria on which the OTP books scored higher on the rubric than the traditional books.

Spelling and Grammar. Unfortunately, the OTP books contained an excessive number of typos, spelling errors, and grammar problems. Even the cover of the chemistry book was misspelled as "chemisty." On the 60-page detailed examination, I found typos on all but four pages. The typos were so excessive that one teacher commented he felt he was teaching an English class and gave the students extra credit for each typo they found. On the teacher survey, the question regarding grammar and spelling showed a statistically significant difference between the OTP and publisher produced textbooks. The OTP teachers rated their books a 3.63 on the six-point scale for grammar and spelling accuracy while the non-OTP teachers rated their books 5.57 (see Table 5).

In most cases the typos were distracting, but not necessarily misleading. Some particularly serious errors, however, could have harmed learning outcomes because they presented incorrect information likely leading a misconception on the part of the student. For instance, on page 84 in an exercise section of the chemistry book, students are asked to write out the name of $Mg_3(PO_4)$. The answer should be magnesium phosphate but instead is listed as sodium acetate. Figure 10 shows a section from page 42 of the OTP chemistry book highlighted by a student. The second sentence of the *Light Energy* section should read, "The low point is called the trough." Instead of trough it reads, *crest*. Note that in this case, the student continued the error by writing in "crest" on the part of the figure that should have been labeled the trough.

Light, also called **electromagnetic radiation**, is a special typ[e]
wave.

Light Energy

Before we talk about the different forms of light or electromagnetic radiation (EMR), it is important to understand some of the general characteristics that waves share.

The high point of a wave is called the crest. The low point is called t[he] The distance from one point on a wave to the same point on the next wave is called the **wavelength** of the wavelength by measuring the distance from one trough t[o] of one wave to the crest of the next wave. The symbol used letter lambda, λ.

Figure 10. Typo in "Light Energy" section (circle added for emphasis).

The textbook analysis also revealed severe limitations with the automated FlexBook rendering approach that led to errors in the text. Because the books were customized versions of a larger book, the figure numbering was often either off or missing all together. For instance, Figure 11 showing page 13 of OTP biology shows question marks used in place of the correct figure number. This was a consistent problem throughout the OTP textbooks.

Further, any references from one chapter to another section of the text were lost if one of those chapters was not included in the book. For instance, on page 248 of the OTP biology book, readers are directed to refer to chapter 14 for additional information. However, chapter 14 was not included in this edition of the OTP book. Apparently the FlexBook software makes it impossible to correct this type of error once the book has been rendered for the customized content.

> Some of the very best early optical microscopes were made four hundred years ago by Antoine van Leeuwen-hoek (**Figure ??**), a man who taught himself to make his own microscopes (**Figure ??**). When he looked at a sample of scum from his own teeth, Leeuwenhoek discovered bacteria. In rainwater, he saw tiny protozoa. Imagine his excitement when he looked through the microscope and saw this lively microscopic world. Leeuwenhoek discovered the first one-celled organisms (protists), the first bacteria, and the first sperm. Robert Hooke, an English natural scientist of the same period of history, used a microscope to see and name the first "cells" (**Figure ??**), which he discovered in plants.
>
> Some modern microscopes use light, as Hooke's and van Leeuwenhoek's did, but others may use electron beams or sound waves.

Figure 11. Problems in figure numbering in the OTP biology book.

Content Application. A frequent problem in designing learning materials is including a rationale for why the student should care about that material (Pundak, 2010). Textbooks are often criticized for being a collection of facts to memorize rather than logical and interesting material relevant to every-day life. Newer textbooks are increasingly addressing this concern by including application boxes within the text. These boxes highlight examples from everyday life that help students relate to the materials. For instance, a section describing pH might have a call-out box about how pH levels relate to a swimming pool's water quality. The *Holt Biology* book includes many application features. It begins each unit with a spotlight on a real-life person employed in a field that uses the principles to be discussed in that unit, as shown in Figure 12. The traditional books also included lab sections with activities the students could do to learn the material. These labs were simple in design so as to not need any special equipment. Students could do them on their own at home.

Figure 12. *Holt Biology* career application pages.

Some teachers mentioned that the students complained the OTP books had few sections devoted to real-world examples. According to the teachers, many students commented that the books needed to include relevant examples and information on why they should learn the material. During the 60-page detailed examination, I did find some examples within the text of applying the principles to everyday life, but they were generally limited to a simple sentence or two rather than a well-developed applications.

Content Development and Organization. The OTP books generally follow a traditional textbook pattern for each chapter. They follow an order of lesson objectives, vocabulary, introduction, main text, review questions, and chapter summaries. The traditional textbooks also have a basic structure which each chapter followed. They had

the same sections as the OTP books as well as several other features, such as standardized test preparation, references, a reading toolbox, and chapter outlines.

Some sections of the OTP books seem short and abrupt, particularly in the earth systems book. In this case, the paragraphs are short and move quickly from one topic to another without transitions. This is likely due to the nature of the books as being put together specifically for customized use. The more a book is designed to be one integrated whole with transitions and references to other sections, the more difficult it would be to pick and choose chapters for a custom book.

Instructional Design. Textbooks usually contain instructionally designed features that are geared toward facilitating learning outcomes, such as key words, stated learning objectives, introductions, chapter outlines, exercise questions, and other related resources. The most frequently used instructional design item in a textbook is probably the vocabulary call-out box or side definition. For instance, on the right-hand side of the page in Figure 3 from the *Holt Biology* book, there is a list of three vocabulary words along with their definition. The OTP books had no call-out vocabulary boxes, but did have stated learning objections, vocabulary lists, and exercise questions.

The publisher-produced books take instructional design to the next level with the electronic versions of the texts. Further, many supporting items are available from the publisher specifically for each textbook, such as a teacher's edition, a Spanish edition, workbooks, assessment tools, study guides, lab videos, computer simulation CDs, etc. Each has a supporting online website with interactive material, quizzes, instructional

games, and additional resources. The OTP books also had an electronic version, but it was simply a static duplication of the text as a PDF.

Textbook Use Analysis

In order to answer the evaluation question regarding textbook use, an analysis was made of the specific textbook artifacts in terms of how they were marked up by students. Additionally, evidence from the teacher surveys and interviews was used to determine how the teachers used the books both in and out their classrooms and the degree to which they valued different features of the textbooks. The teacher survey included seven questions related to how the teachers used the books and their general satisfaction with them. Although none of the questions had a statistically significant difference in the mean responses of OTP and non-OTP teachers, there were interesting trends in the data analysis.

This analysis of the teacher survey and teacher interviews together signaled that the two types of books were generally used in two different ways. Both books were *used* but neither were used in the sense of a traditional textbook as an instructional resource for individual study. Instead, the professionally produced books were used mainly as reference items and the OTP books were mainly used as workbooks during joint in-class reading.

Assignments from the Textbook. On the issue of use, teachers were asked how often they assigned the book to be used in preparation for class, for completing homework, and for reading in class. There was a statistically significant difference on the question of using the book in preparation for class. The non-OTP teachers assigned

reading at home more often than OTP teachers. It was determined that the OTP teachers made textbook reading assignments an average of 1.1 times per week, while the non-OTP teachers made readings on average 2.6 times per week. The results were significant at the alpha=.05 level, $t(20)$=2.57, p=.018, two-tailed. Teacher responses regarding how often they assigned homework from the text were similar. However, the non-OTP teachers reported that students came to class having read assignments more often than students using the OTP books (30 % to 24%, respectively), although this difference was not statistically significant.

On total book use, the OTP teachers reported covering slightly more of the textbook than the non-OTP teachers. Several OTP teachers noted during the interviews that a primary benefit of the OTP books was that they were shorter and more focused on the content they were required to teach. The survey results were consistent with this idea. The OTP teachers indicated they covered an average of 63% of the content of the book, while non-OTP teachers covered 50% of their books. These results however fell outside of the range of statistical significance.

Interestingly, the results of the textbook artifact analysis suggest many fewer pages may have been used by students than reported by teachers (as indicated by evidence of students marking pages). Teachers may have covered the subject matter in class (reading the material as a group, having it assigned for reading, or having the teacher explain the material), but there was little indication that student used the textbooks to the extent teachers indicated for personal learning. Table 7 lists the nine classes in the analysis and the percent of individual pages that had writing, e.g. at least

one student had written on page 1, or page 2, etc. For instance, in one of the biology classes, based on an analysis of the 277 pages, 78% of pages did not have even one student writing anything on any of those particular pages. Overall, 36% of the individual pages had something written on them by students in a particular class. Only two classes, both from the chemistry group, came close to the teacher survey results indicating 63% of the book was covered with 62% and 59% of pages having writing by at least one student.

Table 7

Percent of Individual Pages Having Writing, Grouped by Subject and Class

	Percent pages with at least one student writing on a particular page grouped by class
Earth Science, 193 pages	24.9%
	30.1%
Biology, 277 pages	22.0%
	41.9%
	20.6%
	26.7%
Chemistry, 223 pages	61.8%
	41.3%
	58.8%

In the survey, teachers were asked how much value they perceived from different types of textbook uses. For instance, they were asked how valuable their textbook was as a resource for students to study for tests and quizzes. The results for all five questions relating to value based on different types of use indicated that scores, while marginally higher for non-OTP textbooks, were very similar (see Table 8).

Table 8

Results of Survey Value in Use Questions by OTP or non-OTP

	OTP n=8	Non-OTP N=16	Sig. (2-tailed)
Value-Assigned reading before (in preparation for) class	2.3	2.8	.125
Value-Student resource to study for tests and quizzes	2.9	3.0	.350
Value-In-class reading resource	3.4	3.5	.525
Value-Resource to complete homework assignments	2.8	2.9	.748
Value-Optional out-of-class resource to supplement what was taught in class	3.0	3.1	.176

Three teachers reported using the electronic version of the textbook along with the printed text. However, during the interviews, these teachers confirmed that the electronic books got little use and that students primarily used the print book. All students actually had access to an electronic version at CK12.org. According to the teachers during the interviews, the electronic versions were not perceived as useful by students. The students reported that since they had a print version they did not see a need for the electronic versions. Because so little data was available on the use of the electronic versions, differences in use between electronic and print version are not addressed in this study.

One of these teachers said, "if someone gave me the choice to buy textbooks or something else, I'd take the money for something else." He said he would use the money to make "workbooks" for each student and purchase apps for iPads he already had in his classroom. He added that simply buying a lot of apps would not work because students

still needed direction on what to look at. He said there is too much information to simply turn the students loose with apps and web content. He wanted money to make workbooks instructing students on what to look at, places to make notes, and complete review questions.

Markings in Textbooks. Use patterns for the OTP books were checked in the textbook artifact analysis through an analysis of how students marked up their textbooks. The page-by-page analysis of 281 OTP textbooks used by the students revealed clear differences in use when compared to the publisher-produced textbooks (62 textbooks were analyzed from the traditional group). Those results are simple to report– there was no writing inside the publisher-produced textbooks. Students seemed to generally follow school policies that prohibit them from writing in the school's textbooks. There was writing on the outside of the textbooks on the spine and book's edges. This writing could best be described as *graffiti*. It was not academically related, but instead included random student comments about life in high school or daydream doodling. The OTP books also had a fair bit of graffiti and doodling in them, but often they also contained extensive highlighting, comments, written in vocabulary definitions, and answers to exercise problems. Many students also wrote in corrections to typos. Different classes showed evidence of different types of use. Table 9 is a summary of the various types of markings found in the student books. The table is grouped by how they were categorized for this study.

Table 9

Types of Markings Found in the OTP books

	Types of markings and uses
Highlighting	Highlighting or underlining various passages.
	Highlighting individual words with the note, " on test."
	Several students color-coded highlights; pink for vocabulary words, yellow for concepts, etc.
	One class added in color-coded tabs to all of the chapter starts
Notes	Students wrote in lists of additional vocabulary words and their definitions.
	One class had a group of chapters where each student wrote in one question on each page of the chapter.
	Some classes had assignments given where students were given a list of concepts and they had to find those concepts in the book and mark them by number.
	Many books had additional notes written around the figures.
Exercises	A few students wrote in answers to various exercise or review questions appearing in the books.
Corrections	Students crossed out typos and wrote in the correct information
	Many students wrote in corrections to figure text that was either missing or too small to read.
	One of the chemistry classes put a sticker over the misspelled "chemisty" on the cover.
Graffiti	Most of the Earth Systems books had highly decorated covers.
	Notes written to other students.
	Lots of "I love so-and-so" type notes
	Doodles and pictures.
	Several chemistry students made flip-art scene, including one of a murder scene.

The main four types of academic markings found in the textbook artifact analysis–highlights, notes, exercises, and corrections. Table 10 indicates the type and frequency of markings in the OTP books. There is overlap in these numbers, meaning some students had both highlighted and made notes on the same page.

Table 10

Frequencies of OTP Markings

	Number pages in book	Percent pages with highlights	Percent pages with notes	Percent pages with exercise questions answered	Number unique typos corrected by students
Biology	277	6.5%	4.3%	0%	33
Chemistry	223	12.9%	2.8%	1.2%	26
Earth Systems	193	6.3%	0.6%	0.1%	14

The percent of total pages marked in each particular book ranged from 0% to 56%, with most books averaging 12% of pages with at least one marking. These figures are for the total pages marked by the student regardless of the type or number of markings on a particular page. The standard deviation from the mean was 9 points, meaning most students wrote on 3% and 21% of the pages in their books. Figure 13 is a graph of the data and visually depicts a skewed distribution of student marking data towards the lower end of the scale.
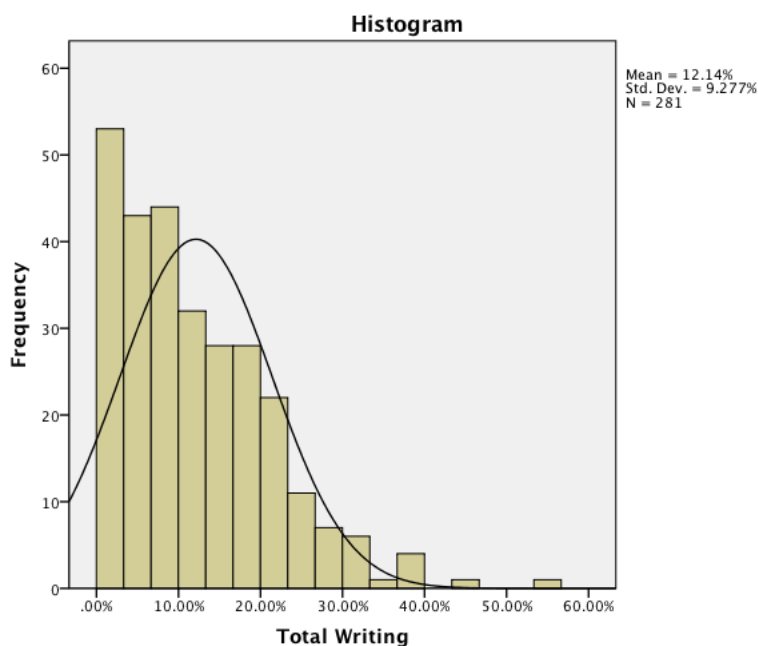
Figure 13. Total percent of pages written on in student OTP books.

I encountered 14 books, or 5%, that did not have any writing at all. Only thirteen books, or 4.6%, had more than 30% of pages with writing on them. These thirteen books also had the most noticeably unique markings. Only two students had more than 40% of pages with writing and in these two cases the markings were almost exclusively highlights. Both of these students were in the chemistry class.

The analysis included books from nine different teachers: 2 earth systems, 4 biology, and 3 chemistry teachers. In general, the earth systems books were the least marked. Only 7% of pages had any writing on them. The chemistry books had the most markings with 15% of pages with writing. The books from one biology teacher had 5% of pages marked while another had 19%. The standard deviation by teacher was lower than the overall standard deviation for eight of the nine teachers, suggesting the books were

marked similarly within their own teacher group. Table 11 indicates use by teacher group and subject matter.

Table 11

Textbook Usage Reported by Teacher

	n	Mean	Std. Deviation
Earth Science	19	7.4%	8.7%
	21	7.1%	7.6%
Biology	28	5.5%	5.3%
	36	19.4%	6.4%
	32	5.1%	3.9%
	27	9.0%	4.5%
Chemistry	66	16.5%	8.3%
	31	11.7%	7.3%
	21	19.8%	14.1%
Total	281	12.1%	9.3%

Identical Marking Patterns. As part of this analysis, the disaggregated textbook marking results by teacher and class were used to determine whether any patterns in the markings might be dependent on the class context. This was done through visual inspection. Based on this analysis some patterns in textbook uses were identified, including some classes where books were used as in-class note-taking devices.

Figure 14 is a screenshot of the data file from one of the OTP biology classes. A use pattern is apparent just by visual inspection. The page numbers are across the top by column and for each cell that had markings the corresponding cell is filled in with a black box. The analysis revealed strong patterns in every class. Sometimes the markings on the same page were different, indicating the student had decided what to write. In most cases, the markings were identical, indicating they were directed by the teacher to make a

particular marking. Interviews with the teachers confirmed this interpretation indicating that in many cases they directed the students to mark their textbooks in a specific way.

Figure 14. Screenshot of markings by page of 35 OTP biology students in the same class. Each black box represents a marking on a page.

In Figure 14, the strong vertical lines indicate markings made on the same page. For instance, in this group of students, 33 of the 35 students had made the same marking on page 29. That marking was to write in the words, "20% of the world's population is hungry" next to the graphic at the top of the page. In this particular class, there were 69 pages where most students had identical markings. A table summarizing these markings is included in Appendix G as a representative example of the types of specific teacher-directed markings found in the books. There were a total of 9,952 pages studied from books in this class and 2,083 total markings found. When the identical markings from those 69 pages are excluded from the study, there were a total of only 305 unique markings left on the 9,952 pages reviewed. These results indicate approximately 85% of the markings were made at the direction of the teacher. These kinds of patterns are repeated in the other classes. During the teacher surveys and interviews, several teachers confirmed that the primary use of the textbook was for reading together during which

time the teachers would make comments instructing students to make various notes or highlight specific material.

Marking for Assignments. Several of the teachers used the books for assignments. In one case, the student left in the assignment page as given by the teacher. The assignment had a list of twenty concepts and instructed the student to find each concept in the textbook then highlight and number it. As a result, many books had what might have appeared to be random numbers next to different paragraphs, but were actually part of an assignment. Other teachers assigned students to complete the review questions. Students would write their answers in the textbook. The books were later turned in to the teacher, graded, and then returned to the student.

Doodling. Many of the books contained random doodles and markings unrelated to anything academic. There were lots of "I love [insert name here]" type of notes. Some books contained very elaborate and decorative drawings. Figure 15 shows three such examples, including the one in the middle with decoration and highlighting.
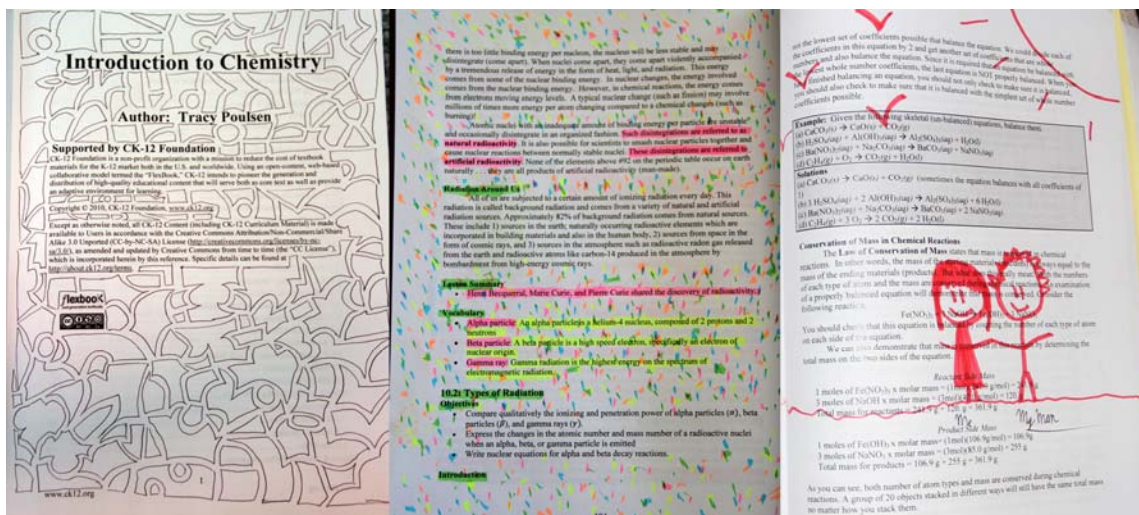

Figure 15. Three different doodling artwork samples.

Several books contained running conversations between students indicating the books were used as a way to pass notes to each other. I did not keep track of these kinds of markings in all of the books, but looked at 20 books specifically for such markings to get an idea of prevalence. Of those 20 books, selected randomly across all three books, there were 187 instances of doodling in 19 of the books. Most of the doodling was innocuous, but some could be a concern because of foul language, inappropriate remarks to other students, and as a way to pass notes to each other.

Some of the doodling could be construed as bullying. In several of the classes, students turned in the books to their teachers to show completed assignments and they would be placed on a shelf for the students to retrieve. It appears that some students would take the books of other students and write notes to the owner of the book. In most cases the notes were friendly, but in at least seven cases that I observed, the notes were very cruel, including obscene sexual references and foul language. In one case, as I was in a classroom picking up the books, an obese young lady walked in late. Her teacher asked for her book and she added it to the top of the stack. As I glanced at the book, I noted that on the cover there were several comments like "Anne is fat!" and "Anne is sooooo freaking annoying!" and "I hate Anne" (Anne was not her actual name). These comments were in several different handwritings. It appears this young lady had to spend the year working with a textbook containing cruel remarks directed at her.

Student Attitudes and Book Ownership. The biggest difference on the teacher survey, although not statistically different, was on the question involving student attitudes. On a six-point Likert scale, the OTP teachers gave an average rating of 4.2 for

how using the books improved student attitudes versus an average rating of 2.7 from the non-OTP teachers. There are many factors that might have influenced this result but one of the teachers said the improvement in student attitudes was enough to make any problems with the books worth it. This teacher indicated student attitudes improved because of the ownership issue, students being able to write in their books.

Several of the OTP teachers also conducted their own informal surveys of their students on what they did or did not like about the books. These teachers suggested the two primary benefits reported by the students were the ability to write in the books and the fact that they were lightweight and didn't have to be "lugged around" like traditional books. Interestingly, when the teachers probed further about the ability to write in the books, some students commented that in the end, the textbook didn't really matter since they got most of their information from their teachers and didn't study from the book anyway. These data point to the problem that students are not using the textbooks to read and study, but are mostly using them as in-class resources.

During the teacher interviews the two non-OTP teachers both commented that the traditional books were at reading levels too difficult for many students and so they did not use the books as much as they might have otherwise, as previously noted in Table 5 with survey data indicating the non-OTP books were not as easy to read as the OTP books. They also said the books were too big and had too much content to possibly cover in one year. They both liked the quality of the books and said they were useful as a reference item, but that they rarely assigned reading from them. They said most of class

was focused around the classroom lecture and the purpose of the book was to provide a reference for students if they need extra help.

Use differences between lead teachers and regular teachers. I checked the data for any differences in survey opinions between the OTP teachers who participated in the book collection and those who did not. Those who participated in the book collection generally seemed to have more of a vested interest in the project than those who only participated by receiving the OTP books but had little say in their creation. As noted previously, of the nine teachers who had participated in the book collection, five had participated as lead teachers (i.e., teachers who were instrumental in choosing the content). During the interviews they seemed more positive about the project in general than the other teachers. Although the sample size is too small to make claims of statistical significance, there were trends in the data that those who participated in the book collection and had assumed the role as lead teacher in choosing content used the books more frequently and thoroughly than those who did not. However, this group also rated the value of the books lower for each of the five value questions. On the design quality questions, the averages were very close on three of the four questions. The only question that was noticeably different was the question on spelling errors. The group participating in the book collection rated the quality lower in terms of spelling and grammar errors. This finding is consistent with the idea that this group used the books more and thus found more of the errors. On the general satisfaction questions, the only noticeable difference was on the question of student attitudes. This group felt there was more of a positive impact on student attitudes than the other group.

I also interviewed all nine of the teachers involved in the book collection, two other OTP teachers, and two non-OTP teachers. As previously noted, five of the nine teachers involved in the book collection took the lead in making content selection decisions. These five teachers were the most enthusiastic about the process and the quality level of the finished books. They exhibited a level of ownership and excitement. They recognized the limitations with the graphics and spelling and grammar errors, but felt those problems could be fixed. All five of the lead teachers said they wanted to continue using the books.

The teachers who did not participate as lead teachers were generally not as positive. Some indicated they would not be using the books again. Several were embarrassed at the level of errors in the books. One said he felt like he was "teaching an English class." He said he couldn't "bear to see chemistry misspelled on the cover all year long" and so he put stickers on all of the books to cover the mistake.

Discussion and Conclusions

In terms of print media design and content quality the OTP books and the professionally published textbooks used in this study are in completely different leagues. The OTP books are a mini compact car while the publisher-produced books are a Cadillac Escalade. Both get a person from point A to point B, but do so in dramatically different fashions. The publisher-produced textbooks were extensive, colorful, professionally designed instructional devices. They contained all of the basics–and a lot of the bling. The OTP books also covered the basics, but with little extra. On one hand, students appreciated having a less heavy book, but on the other, important elements

needed for study were missing, such as an index or glossary. The OPT books also contained many errors and imperfections which the professionally produced textbooks did not.

What remains, however, is the question of whether these quality issues matter. Wiley et al. (2012) found that average achievement as measured by state assessments was similar regardless of whether students used OTP textbooks or the more expensive publisher-produced textbooks. An analysis of these data however suggests that while the OTP books did get used slightly more in the classroom for group reading and note taking, neither group of books was used extensively as a resource for individual study in or outside of class. The professionally produced books were used primarily as reference material. They were used in a limited way as an in-class resource and assigned sparingly for individual study at home. For the OTP books, students did write in them indicating some use, however, many of the markings were teacher directed and involved classroom note taking during group reading or corrections/additions to the content being presented. Additionally, many of the markings seemed to be extraneous daydream doodles; although there was some evidence that the OTP textbooks were used to complete assignments from time to time.

If the primary benefit of the OTP textbooks is that it can be written in, then the textbooks should show more evidence of unique markings made by the students as they read and studied. Instead, it appears that teachers directed the majority of markings students made. These tended to be during class time (e.g., teachers having students read together in class and then stopping to have students highlight or correct something in the

book). Still, several teachers commented that simply getting to write in the books improved student attitudes. One teacher said, "I don't think it [the OTP books] helped any with the learning, but the attitudes of my students were better with being able to write in them and that alone makes it worth it to do again."

Interpretation of these data suggests a problem with textbook use in general. Teachers from both groups reported that they make few assignments to read from the books for independent study or for completing homework because they were frustrated when students didn't do the readings. The survey data shows that across both groups teachers assigned reading from the text was low, an average of only 1.7 times per week, but also estimated that students only completed that reading an average of 26% of the time. During the interviews, many teachers referred to the traditional textbooks as *reference items*, and refrained from assigning reading either because the level of reading was a bit high for the students or they believed the students simply would not do the readings. In eleven of the thirteen interviews, teachers said they had "given-up" assigning students to read at home since they "don't do it anyway." Still, in the survey, only one teacher indicated giving no home reading assignments. During a follow-up interview, one teacher said they marked on the survey the number of times they gave reading assignments, but that it was more of a "suggestion" to students than a requirement. Students seemed to feel the reading was not necessary as the teacher would tell them in class what the reading was about. Why read if the teacher will tell you what you need to know?

These results indicate the traditional use of textbooks may no longer be a factor in education. That is, textbook use in general is no longer about books being an instructional resource for individual study. If textbooks in general are seen and used by students only as reference material and not a primary instructional resource then this would have implications for how textbooks dollars should be used. Although the traditional textbooks examined in this study had the potential to provide numerous quality learning opportunities, they ended up being an unnecessary expenses because they were under utilized as a pedagogically sound instructional resource. Other, less expensive resources like open textbooks could easily fulfill this same purpose. As an instructional tool the professionally produced books were high quality, but if they are not used for the purpose and in the ways they were designed to be used, their value as a learning tool is diminished.

The most significant complaint about the professionally produced textbooks was that they were too big and covered too much material. Textbook publishing companies have taken the one-size fits all approach of making thousand page plus textbooks covering far too much material than could be covered in one year rather than limiting the scope of their books. Publishers can be rightly criticized for not being more innovative and using recent technological advances to provide the ability for schools to have shorter and more customized content for a lower price.

An analysis of these data indicates the OTP books played a different role in the classroom than that of a publisher-produced textbook. That is, the OTP books were more of a workbook than a reference item. The students used these workbooks in class but

rarely used them on their own for study. The OTP books were missing key features needed for use as a reference item, namely an index and glossary. As a workbook, the OTP were also deficient in many respects since they were designed as if they were to be used like a traditional textbook. They were missing workbook design features such as space for taking notes, practice exercise pages, and useful graphics.

Because the teachers who invested the most in the process got the most out of the books, teacher involvement in the customization process must be noted as critical in the OTP process. As a straight traditional textbook replacement, teachers did not find much value in the OTP books. However, they seemed to find more value when they were involved in the process of choosing content. This finding suggests that simply providing OTP books is not adequate. Instead, teachers need resources for choosing content and customizing it to their own preferences. Whether they have the time and inclination to do so is another matter. However, implementing such resources leads to an additional conundrum. That is, teachers end up needing to take on some of the role publishers have traditionally taken of validating and choosing content. Unfortunately, often these teachers do not have the expertise, time and resources to produce a quality textbook. Limitations in the automated processes used to create the OTP textbooks also resulted in reduced quality.

The premise of open content is that by using material in the public domain, books can be very inexpensive. However, many aspects involved in textbook development simply do not get done in the open content environment. Some of these processes (e.g., typesetting, design, illustration, editing and proofreading) can greatly affect the quality of

the book. Open content relies on volunteers or philanthropic donations to pay for those processes. In the case of the books involved in this study, these processes did not take place at a professional level. This problem points to the economic concept of specialization. Our society is generally geared around the concept that people specialize in a profession and can charge a premium for their training. Specialization has grown as society has gotten more technical. Traditional textbooks are developed in a specialized environment. Those trained in typesetting do the typesetting and those in proofreading do the proofreading. OTP textbooks are generally not developed in a specialized environment. Instead, an author is also the typesetter and the editor and the illustrator. It is unlikely they are as trained as a professional in all of those areas. The OTP environment pushes some of the specialized work of textbook production onto teachers as they customize the content. They are trained as teachers–not proofreaders, editors, or illustrators, but must take on those roles if they want a high quality OTP book.

A major role textbook publishers play is that of content validator. They evaluate content for relevance and vet it for accuracy. In the OTP environment, this role is usually left to the author. As a result, a potential problem with OTP books is that they often contain content that is inaccurate, low quality, or not appropriate as a learning resource.

Aside from the quality issues, the results also pointed to another concern with the value the OTP books as an instructional tool. The value of being able to write in the books may be overrated if the highlighting and markings are simply things the teacher tells them to mark. If students and teachers are not using the textbooks in a more

pedagogically sound way, it may not really matter whether they can be written in the book or not.

Study Limitations

This research pointed to clear differences in quality between the OTP and traditional textbooks. However, the six-title sample size may be too small to make sweeping statements about open textbooks in general. Any textbook, OTP or traditional, can be high quality if adequate resources of time and manpower are put into it. Quality comes at a cost.

The difference in quality noted in this study could be skewed by the three particular courses in the study. As noted in the background section, textbook investment and development is based on expected market share. The six titles served core high school subjects. As such, they are among the titles with the largest possible market share. Publishers are able to spend more on development costs for a core title than for books covering niche topics. Had this study included six books from more obscure courses, it is likely the publisher-produced books would not have been so elaborate. The spread of difference in quality might not have been as extreme, although OTP content for obscure courses might also have also been proportionately lower quality. There may also have been differences if this had been an independent study course rather than a traditional classroom based course set in a public school setting.

Implications for Practitioners

Despite the print media and content quality problems with the OTP books, the two most promising benefits of the OTP approach are the ability for the students to write in

the books and the ability for the teachers to customize content at the chapter level to include only that which they intend to cover during the year. Both students and teachers seem to take more ownership over the course materials with such an approach. The book becomes theirs, rather than a stale, almost overwhelming monstrosity to lug around.

Based on what I have learned in this study, if I were able to implement my version of an ideal course materials program in the state of Utah using the benefits noted above, it would be to do the following. I would suggest the state bid out to purchase publication rights to the content and design of finished, high quality textbook chapters in the core subjects. Content should be comparable in quality to that of the traditionally published textbooks, including relevant, accurate, visually appealing, proofread, and peer-reviewed content targeted to specific courses and the state core. The content should be developed as individual chapters. Guides suggesting which chapters to include for a particular course should also be developed.

Why not make just one biology book or one chemistry book? By taking the chapter approach used in the OTP, teachers will have more ownership over the book by being able to customize the book content to their own needs. Further, much content overlaps. For instance, all three OTP books began with a chapter on the scientific method and how science works. Such a chapter only needs to be developed once, and then it can be included in chemistry, biology, or physical science books.

One problem identified in this research from the chapter approach is missing or wrong references because the chapters changed numbers or were not included. This issue

could be handled by referring to any content outside of a particular chapter to a website containing all content. In so doing there would not be any non-existent references.

Each chapter should be typeset in a way to facilitate note taking. The workbook like nature of the OTP books helped student attitudes, according to several teachers, but teachers noted they were not designed effectively as workbooks. The traditional books were set-up ideally for writing, but unfortunately it was against policy for students to do so. Utilizing a traditional high-quality design with adequate space for writing in an OTP approach would be the best of both worlds.

The state education office could also hire the people to develop the content in-house rather than bidding it out, but should understand that to do so requires more than just a few authors, but also editors, proofreaders, graphic designers, and instructional designers. Otherwise, graphic design and content quality issues will likely plague the material just like it did with the OTP books.

As chapters are prepared, a procedure should be put in place for teachers to be able to modify the content, add new content, or attach ancillary items such as study guides, labs, video resources, etc. Many of the teachers relied on handouts as their primary instructional material rather than the textbooks. Teachers should be able to attach relevant handouts to chapters in the database. All content should be accessible from an online database. However, modifying the content should not be a "free-for-all," as such an approach leads to errors. A procedure needs to be in place for changes to be vetted.

This online accessible database of chapters should then be made available for teachers to select and put together their own textbook for their class, including being able to add in their own handouts. A PDF of their customized content is generated and sent for printing. Right now, that printing would still most likely need to be done in black and white for cost reasons. Eventually, it should be able to be done in color. Most production printers also should be able to handle putting in color inserts for pages that need to be in color, such as one on the color spectrum. With the PDF, students will have access to an electronic copy of the book.

The process described above is not that dissimilar to the OTP pilot project. The major difference is the recognition that quality content costs money to develop. Although significant money has been spent by CK12 and similar organizational to develop and design a platform for hosting and delivering open content, more resources need to go to ensuring the quality of the content itself. Educational departments can still save money by making a one-time payment for the rights to quality content and then making the content available to schools and teachers. Although the savings might not be as great as with the completely free open content, as the old saying goes, "you get what you pay for."

Implications for Future Research

While this study identified the differences in quality and use between these types of textbooks, there remains a need to study the question of impact. It is obvious that if teachers and students do not use a textbook in a pedagogically sound manner, there will likely be little impact to learning, in which case it does not matter which book you adopt,

and the cheapest alternative should be adequate. There is also the possibility that the instructional approach which seems to be used in the classroom (i.e., the teacher as textbook) works fairly well for many students. This study suggests that the specific intervention and the implementation fidelity of that intervention is important. What this study does not tell us is whether a high quality, low cost textbook, used in a pedagogically sound way would make any difference in learning outcomes.

Additional research should be done to find ways of providing students the type of quality content found in the traditional textbooks, but in a manner that is more focused on what is actually covered during a school year. The traditional publishers, while producing superior content, end up producing far too much content for each particular book. In attempting to cast the widest net possible for market share, the books end up containing extensive and expensive content that is never used.

The research also points to the need for studies on textbook utilization in general. Are textbooks even necessary if they are not going to be effectively utilized both in and out of the classroom? My analysis of these data indicates that textbooks are a tiny issue compared to the more systemic educational issues found in today's schools. Most students are not using textbooks as a standalone instructional piece for personal study, but only as directed as an optional resource or as a notebook during classroom reading.

Conclusion

This evaluation focused on answering four research questions. The first two questions related to the quality of the open textbooks versus their traditionally published counterparts. The data strongly suggests that the open textbooks were of inferior quality.

The third research question looked at textbook use. There was little evidence to suggest that either group of books were used by students as study tools for independent learning. The traditional books were used mostly as reference items, while the OTP books were used more as workbooks. Both types of textbooks were use in limited ways during class. The final question focused on whether differences in use could help clarify which aspects of textbooks are essential, which are nice, and which are "bling." This study found that essential textbook features included: content that is written at the intended grade level, useful graphics, an index and glossary, and accurate content. Features that, though not essential, were found to be very helpful to teachers and students included: color graphics, real-world examples and application boxes, the ability for student to write in the book, and for teachers to be able customize content. Some features that might be described as bling included: content coverage that far exceeds what can be covered in one year, expensive paper and binding choices, full-color graphics on every page, and extra ancillary content.

Open textbooks have the potential to disrupt the traditional textbook publishing business because they are low-cost alternative to the expensive nature of traditional publisher produced textbooks. However, quality and sustainability issues have yet to be solved. Open books *can* be high quality and include essential textbook features, but often do not because of a lack of resources most notably the time and expertise necessary to accomplish that task. Furthermore, the role of the textbook in the classroom can take on different forms (i.e., being a workbook, reference item, or personal study tool). An analysis of these data indicates textbooks are rarely utilized as individual instructional

study tools. They are most often used only for reference or to jot down notes during classroom, or for in class group reading. Both the OTP books and publisher-produced books can fill either role, but given this limited use, the very role of textbooks in education is called into question.

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APPENDIX A

Design Rubric

	1 Poor	2 Fair	3 Good	4 Excellent
Visual Impact	Boring design. Few design elements and not very attractive.	Design has beginnings of visual appeal though it may be disorganized or shows little understanding of layout.	Design is interesting and well-organized. Demonstrates a use of layout principles.	Exceptionally attractive layout and design. It is exciting, clever, or just plain cool.
Visual Clarity	Placement of design elements ambiguous or contradictory. Design fails to convey meaning, is cluttered and unattractive.	Slightly confusing. It may be a bit disorganized.	Readers can follow the content easily. Text and graphics flow naturally together.	Text and graphics are readable, bold and clear. Design is simple (yet elegant) and to the point.
Contrast	Little difference in light/dark weakens overall impact and leads to a cluttered look.	Use of contrast could be improved.	Contrast is evident.	Use of light/dark elements provides appropriate prominence.
Consistency	Little internal consistency, different fonts, layout styles etc. Content elements seem unrelated to each other.	Repeated elements may not be evident or may be overdone.	Most design elements are repeated throughout.	Repeated use of elements creates a unified work.
Alignment	Lacks clear entry points and sightlines, resulting in a chaotic look.	Edges and lines can vary from one page to the next.	Elements are orderly lined up centered, left, or right as appropriate.	Bold and clear lines lead to a clean, crisp look.
Proximity	Problems with placement lead to confusion over what is and is not connected to each other.	Design elements are close together but some placement problems lead to connection confusion.	Design elements are strategically placed to indicate clear connections.	Design elements are precisely placed to guide the reader to know what is important and connected.
White Space	Crowded and heavily-looking design with little or no white space.	Some white space but not enough to direct the reader through the content.	Adequate white space.	White space effectively helps the eye move through the content.

Appendix A (cont)

Color	Color choices weaken the work in dramatic ways. Type is difficult to read because of color choices.	Color choices clash at times and clutter the work.	Colors are mostly effective although there may be some minor clashing.	Effective colors choices enhance the meaning and readability of the work.
Typography	No apparent typography choices. Default system fonts or too many fonts used. Font usage impacts readability in a negative way.	Font choices and/or sizes create distractions.	Typography is generally effective but may create minor distractions.	Font choices and sizes are consistent and help create a strong visual-verbal connection. Strong readability.
Column Design	Text in columns that are too wide or too narrow or not enough margin space for readability.	Columns and margins somewhat impair readability.	Columns and margins generally effective and consistent but may need some improvement.	Column width and features aid in overall readability.
Quality of Graphics	Graphics are illegible, poorly placed, or otherwise hard to read. They fail to convey meaning.	Graphics may have poor placement or sizing, but generally can be viewed and identified from 3 ft. away.	Graphics are generally in focus but some improvement in size or location could have been made.	Graphics are clear and visually appealing. Graphics add to overall design impact.
Craftsmanship	Imperfections in production or materials are highly distracting and take away from overall effectiveness.	Work has imperfections that create minor distractions.	Work may have slight imperfections.	Work has no evident imperfections.

APPENDIX B

Content Rubric

	1 Poor	2 Fair	3 Good	4 Excellent
Table of Contents	No table of contents.			Contains a usable table of contents.
Index	No index.			Contains a usable index.
Glossary	No glossary.			Contains a usable glossary.
Citations	No references.	Incomplete references.	Most citations included.	References were properly cited.
Relevance of Graphics	Graphics are either missing or unclear to the point they do not help convey intended meaning.	Graphics often "miss the point."	Most graphics are on topic.	Graphics clearly convey the learning concepts and relate to the topics in the main text.
Audience / Readability	Sentence structures and vocabulary choices cause confusion for the typical target audience.	Audience is poorly defined. Sentence structures convey basic meaning but can be difficult to follow.	Sentence structures effective few errors.	The writing is clear, balanced, and appropriate for the intended audience. The tone is professional.
Spelling and Grammar	Writing contains numerous errors in spelling and grammar that interfere with readability.	Frequent errors in spelling and grammar distract the reader.	Minor errors, but the writing follows normal conventions and has been carefully proofread.	The content is essentially error free.
Content Application	The material is essentially a collection of facts.	Many ideas need further exploration.	Examples and applications point a clear direction and meaning.	There are frequent and meaningful applications of the concepts.
Content Development and Organization	Content is presented haphazardly. Presentation of ideas is incomplete.	Ideas are organized in paragraphs not necessarily connected.	Most ideas are developed and unified.	The content is presented in a logical, cogent manner with effective transitions.
Instructional Design	Only text is essentially just basic text and graphics. Little to no extra instructional features.	The text includes rudimentary elements of graphic design, such as stated learning objective at the beginning of a chapter.	The text includes many in instructional design elements.	The content includes helpful learning tools beyond the text, such review questions, vocabulary lists, and sidebar definitions.

APPENDIX C

Random Pages Examined

OTP Biology	OTP Chemistry	OTP Earth Science Systems	Holt Biology	Holt Chemistry	Glencoe Physical w/ Earth Science
109	165	139	512	363	443
108	192	116	287	750	852
99	108	130	295	708	802
77	111	47	134	614	542
150	195	79	97	618	301
59	13	98	331	809	665
226	46	39	911	567	251
151	179	146	828	885	74
51	34	145	437	758	868
76	183	36	997	540	760
141	72	106	618	415	157
193	164	149	139	798	595
199	190	19	484	845	519
15	30	81	428	263	132
181	54	167	886	219	798
34	77	29	50	527	181
172	140	22	312	741	13
231	69	72	109	532	19
52	58	144	571	473	111
273	150	168	115	345	885

APPENDIX D

OTP Faculty Survey as Administered on Qualtrics.com

THANK YOU! for being willing to participate in this research about open educational texts. Please read the following Consent Information before proceeding with the survey. The purpose of the study is to explore the potential value of using open textbooks for this course. You are being asked to participate because you used an open textbook in your class or are teaching a class using a traditional textbook on the same subject.

Risks/Discomforts: There are minimal risks for participation in this study. If you feel uncomfortable answering a particular question, you may choose to not answer that question, or discontinue the survey altogether.

Benefits and Compensation: There are no direct benefits to you for participating in this study and you will receive no compensation for participating. It is hoped that through your participation researchers will learn more about the open textbooks in education and be able to assist others in their decision on whether they should use such textbooks.

Confidentiality: Your answers will not be disclosed as an individual, but summed with all other responses. All individual data will be kept confidential. Survey results will be presented as a group with no identifiable responses being reported.   Participation: Your participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate entirely. Filling out the attached survey indicates that you have read and understood the above consent and agree to participate in this study.

If you have questions regarding this study, you may contact Jennifer Price by email at provojenn@me.com or Randy Davies by email at Randy.Davies@byu.edu or by phone at 801-422-5229.

Questions about your Rights as Research Participants If you have questions regarding your rights as a research participant, you may contact IRB Administrator, (801) 422-4636, A-285 ASB Campus Drive, Brigham Young University, Provo, UT 84602

Q2 How many years have you been teaching?
- 0-3 (1)
- 4-6 (2)
- 7-10 (3)
- 11-15 (4)
- More than 15 years (5)

Q3 How many years have you been teaching this course?
- 0-3 (1)
- 4-6 (2)
- 7-10 (3)
- 11-15 (4)
- More than 15 years (5)

Q4 Which open textbook did you use? (If you did not use one of the open textbooks, please indicate which textbook you used)
- Blake's Biology (1)
- Introduction to Chemistry (2)
- Earth Science (3)
- Other, please indicate the main textbook used (4) _____

* If answer in Q4 was "Blake's Biology" survey gave question Q7 and then skipped to Q5.
* If answer in Q4 was "Introduction to Chemistry" survey gave question Q8 and then skipped to Q5.
* If answer in Q4 was "Earth Science" survey gave question Q9 and then skipped to Q5.
* If answer in Q4 "Other" was selected survey skipped to Q10.

Q7 Please mark which units in Blake's Biology that were covered by your students (as homework, in-class reading, assignments, etc). Select all that apply.
- Introduction to Science (1)
- Ecological Levels of Organization (2)
- Chemistry of Life (3)
- Energy Production in Cells (4)
- Cell Theory (5)
- Cell Growth (6)
- The Father of Genetics (7)
- The Story of DNA (8)
- Human Genetics (9)
- Evidence of Evolution (10)
- Biological Classification (11)
- Animal and Plant Anatomy (12)

Q8 Please mark which units in Introduction to Chemistry that were covered by your students (as homework, in-class reading, assignments etc). Select all that apply.
- Introduction to Chemistry (1)
- The Structure of the Atom (2)
- The Organization of the Elements (3)
- Describing Compounds (4)
- Problem Solving & the Mole (5)
- Mixtures & Their Properties (6)
- Describing Chemical Reactions (7)
- Describing Acids and Bases (8)
- Energy of Chemical Change (9)
- Nuclear Changes (10)

Q9 Please mark which units in Earth Systems that were covered by your students (as homework, in-class reading, assignments etc). Select all that apply.
- Nature of Science (1)
- The Universe (2)
- Plate Tectonics (3)
- Fresh Water (4)
- Oceans (5)
- The Atmosphere (6)
- Weather (7)
- Climate (8)
- Ecology (9)

Q5 Which version of the textbook did your class use?
- Printed (1)
- Electronic (2)
- Both (3)

* If answer in Q5 "Electronic" or "Both" Survey gave question Q6, otherwise skipped to Q10.

Q6 Please describe your experience using the electronic version of the textbook versus a traditionally printed textbook: what did you like about it? What did you NOT like about it?
- Free Response Box

Q10 Please rate the value of the textbook in terms of the following potential uses.

	Very Poor (1)	Poor (2)	Good (3)	Very Good (4)	Don't Know / Did not use the Textbook for this purpose (5)
Assigned reading before (in preparation for) class (1)					
Student resource to study for tests and quizzes (2)					
In-class reading resource (3)					
Resource to complete homework assignments (4)					
Optional out-of-class resource to supplement what was taught in class (5)					

Q20 What percent of the total pages of the textbook were covered (through assignments, in-class reading, etc) by your students both in and out of class?
- None of the textbook (1)
- 10% (2)
- 20% (3)
- 30% (4)
- 40% (5)
- 50% (6)
- 60% (7)
- 70% (8)
- 80% (9)
- 90% (10)
- All of the textbook (11)

Q21 If there were portions of the textbook that you did not use, please describe why they were not used and what was used in their place:
- Free response box

Q11 For this course, how many scheduled classes per week did you have?
- every day (5 times) (1)
- 4 times per week (2)
- 3 times per week (3)
- twice per week (4)
- one day each week (5)

Q12 Please use the sliders to estimate how often you assigned the textbook to be used for the following purposes (average times per week).

      _____ Reading in class (times/week) (1)
      _____ Reading at home in preparation for class (times/week) (2)
      _____ Completing homework assignments (times/week) (3)

Q13 What percent of the time do you feel students came to class prepared having read the textbook chapters you assigned for reading?

- 0% (1) • 10% (2) • 20% (3)
- 30% (4) • 40% (5) • 50% (6)
- 60% (7) • 70% (8) • 80% (9)
- 90% (10) • 100% (11)

Q14 Please indicate your level of agreement or disagreement with the following statements:

	Strongly DISAGREE (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly AGREE (6)
The overall quality of this textbook is excellent. (1)						
Reading from this textbook was essential to students getting a good grade in this class. (2)						
This textbook improved learning outcomes for my students. (3)						
Getting to highlight and write in this textbook was a major benefit to my students. (4)						
My students came better prepared for class using this textbook than they have in the past using other textbooks. (5)						
The attitudes of my students improved because we used this textbook. (6)						
I strongly recommend other teachers use this textbook. (7)						
I plan to use this textbook again next year. (8)						

Q15 Design issues: Rate this textbook for each of the following. The textbook:

	Strongly DISAGREE (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly AGREE (6)
was well-organized (1)						
was nicely-designed (2)						

was easy to read (3)						
had useful graphics (4)						
included good examples (5)						
clearly explained major concepts (6)						
had accurate content (7)						
had no errors in grammar/spelling (8)						

Q16 Please describe the BEST part of this textbook:
    Free Response Box

Q17 Please describe the WORST part of this textbook:
    Free Response Box

Q18 Please describe anything this textbook NEEDS that it doesn't have:
    Free Response Box

Q19 What else can you tell us about the textbook (how it was used or the quality of the book) that we did not ask?
    Free Response Box

APPENDIX E

Table Summarizing Identical Markings in OTP Biology

Page	Marking
19	Definition of Ecology
20	Highlighting of "Abiotic" and "Biotic"
22	Fill-in table 2.2 with additional vocabulary words
26	Addition of graph labels to population growth chart
29	Human population growth graph notes - "20% of the world is hungry"
32	Additional definition - "predator-pray relations mirror one another"
34	Highlighting and extra notes of "symbiotic relationships" table
39	Additional vocabulary words relating to habitats
41	Highlight of biome definition
43	Seven additional vocabulary words and definitions relating to types of climate zones
47	Food chain notes
60	Highlighting of succession
61	Additional notes on cars and CO_2 emissions
66	Definitions of types of chemical bonds
67	Notes on elements and atomic structure
68	Vocabulary word
82-89	Highlighting and numbering of certain passages according to an assignment (copy of the assignment left in one of the books)
87	Acids and bases additional notes
94	Inserting additional captions on figure 3.24
95	Adding additional labels on graphs
98	Highlighting of "atp"
99	Highlighting areas of photosynthesis paragraph
100	Highlighting or underlining of photosynthesis passages
101	Adding additional labels on figure 4.2
103	Adding additional labels and vocabulary words to figure 4.4
106	Chemical equations
112	Highlighting or underlining of cell theory definition
121	Adding additional vocabulary words to figure 5.14
122	Highlighting figure 5.15
123	Highlighting table 5.2, adding in label
128	Drawing a cell division diagram
133	Additional explanation on figure 6.5
134	Adding an equation