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A Shoestring Grassroots Approach to Publishing an Open Educational Resource Engineering Textbook

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Abstract

The lack of affordable and accessible education is one of the major obstacles inhibiting the upward social mobility of New Yorkers from low to middle socioeconomic classes. Students from lower income, underrepresented and first-generation college households in an urban setting, are particularly affected by the rise of higher education costs, which further marginalizes the members of these communities. The availability and adoption of good quality Open Educational Resource (OER) textbooks, has the ability to significantly ease the economic burden on the student population; however, upper level engineering text books, available as OERs, are scarce and vary in quality. This case study presents a grassroots approach for the creation of a Soil Mechanics Engineering Textbook on a shoe string budget. This ongoing work is being done by putting into play an array of interdisciplinary resources, available within the New York City College of Technology and the City University of New York. These include library collaborations, communication design professionals, students, undergraduate research programs, surplus technician funds and professional community goodwill. The result is a well-rounded, visually engaging and appealing, peer reviewed OER textbook, which when published will become available free to any student and faculty member worldwide. This translates to direct savings of approximately $112 per student, at local and/or national higher education institutions that adopt the textbook for their entry level soil mechanics course. The author estimates that when adopted at the New York City College of Technology, the entire cost of publication of the textbook will be recovered through student savings within three semesters, by conservative estimates.

1. Background and Context

The lack of affordable and accessible education is one of the major obstacles inhibiting upward social mobility of New Yorkers from low to middle socioeconomic classes. Students from lower income, underrepresented and first-generation college households in an urban setting, are particularly affected by the rise of higher education costs, which further marginalizes the members of these communities. With a limited amount of family discretionary funds, students

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from underrepresented households often rely on affordable education to break through socioeconomic barriers. As stated by Cooney [1], "*Convenient access to course materials is an issue of particular gravity among underserved populations and urban commuter students who typically balance many commitments in addition to their studies"*.

The pole bearers of affordable education have traditionally been state and locally sponsored educational institutions. Unfortunately, the costs in higher learning public educational institutions including, tuition, textbooks and supplies, and room and board, have dramatically risen in the last couple of decades. According to the National Center for Education Statistics (NCES), between 2008-2009 and 2018-2019, the cost for tuition, fees, and room and board at public and private non-for-profit institutions rose by 28% and 19%, respectively, after adjustment for inflation. While the cost at for-profit private institutions decreased by 6% [2]. Additionally, the cost of textbooks has increased by 63% from 2006 to 2016, according to the U.S. Bureau of Labor Statistics [3].

The availability and adoption of good quality Open Educational Resource (OER) textbooks, has the ability of significantly easing the economic burden on student populations. The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines OER's as "*teaching, learning and research materials in any medium – digital or otherwise – that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions*.", [4]. However, in 2016 a study by Seaman & Seaman [5] found that only 9% of the overall textbook market was represented by OER textbooks. Furthermore, these resources usually were found for introductory multi section courses such as math and physics [6], while the availability of engineering upper level OER titles is scarce [7]. Finally, a survey by Moore and Reinsfelder [6] of engineering faculty, related to available engineering mechanics OER's, found a lack of quality, in-depth resources as a detractor to adoption by faculty members.

From the student perspective, a literature review by Cooney [1], scanned published reports based on student interviews and focus groups to gage student perception and satisfaction with courses that had employed OER materials. The review found that students were satisfied with the cost savings afforded [8-10]. Also that the majority of the end users found OER content to be comparable [8, 11] or preferred to traditional textbooks [10, 12, 13]. In contrast to a minority of students who found the OER content to be inferior.

This case study presents a grassroots approach to the creation of a Soil Mechanics Engineering textbook [14] which will be published under a Creative Common (CC) license. This work is being completed by putting into play an array of available interdisciplinary resources within the New York City College of Technology (City Tech) and the City University of New York

(CUNY). These include library collaborations, communication design professionals, students, undergraduate research programs, surplus technician funds and professional community goodwill. The result will be a well-rounded, visually engaging and appealing, peer reviewed OER textbook for a mid-career soil mechanics course.

Motivation of the First Author

It would be misleading to assume that the motivation to start along the path towards completion of an OER textbook was entirely altruistic. It is also a personal quest. As former students and now educators, we have seen the cost of textbooks spiral out of control. We have also observed how textbooks that were used as part of the education of the first author in the 1990's, are still marketed several editions later with very little change in content, while still rising in cost. With that said, I immersed myself in this project to create an OER textbook with a sense of duty, as something that needed to be done in order to help ease the burden of my students. What started as a humble approach to publishing an OER soil mechanics laboratory manuscript, has flourished into a much more engaging and complete textbook by using commonly available resources, partnerships and professional goodwill that can best be described as a grassroots approach.

2. Grassroots Approach to Creating a Good Quality OER Manuscript

The following sections describe the resources that the author of the OER manuscript (1st author of this case study) employed to create a high quality, well rounded, and visually engaging textbook which can be used in undergraduate soil mechanics courses and commercial laboratories.

OER Movement Across University Libraries

The need for awareness, development, and adoption of OER has become one of the goals of many higher education libraries. In particular the library at City Tech offers multiple programs that seek to disseminate the development and adoption of open content. The City Tech library offers guides, mentorship for creation and adoption of content, and fellowship programs to foster the dissemination of OERs. Some of these programs are the Faculty OER Fellowship, Environmental Scan Working Groups, and authorship projects [15]. Thus, a prospective author can start their search for available resources and support at their institution library.

In particular the author of the OER textbook discussed herein received support from the City Tech library in the form of an institutional grant named *2019-2020 New York State Scale Up Initiative*. As part of this grant the author received monetary compensation in the form of faculty summer hours, and collaborated with two library faculty members on an environmental scan, scope and outline development for a nine-chapter manuscript.

A Visually Engaging Interdisciplinary Engagement

To help in adoption and dissemination of the textbook the author strived to create not only a technically sound, in-depth manuscript, but one that is also visually appealing, thus fostering engagement with the end users, mid-career civil engineering students. To help in this effort the author looked to other departments within the university. This resulted in collaboration with the second author of this case study, a faculty member from the Communication Design department (COMD), to commission students from COMD to create visually appealing imagery for the manuscript.

To attract COMD students to the project the author took advantage of two existing programs. The first was an undergraduate research grant program, *Emerging Scholars Program* [16], which offers stipends to students to engage in research under the guidance of faculty mentors. The second program was the NYC Department of Youth and Community Development (DYCD) *Work Force Connect Summer Youth Employment Program* [17], which was used to support student artists throughout the summer. Interested students from COMD were identified and interviewed for the position of illustrators. After students were selected, a Designer-Director-Client model was used to complete the work. In this model, students assumed the role of artistic designers, the faculty member from COMD offered creative direction, and the author of the manuscript assumed the role of a "client" with a product in need of illustration.

The students selected for this novel approach to undergraduate research, Jenny Zhupan, Evelyn Ng, and Edward Alston, were specifically tasked with building interest, engagement and understanding of a STEM subject. As students coming from a NON STEM discipline, the illustration team was challenged to consider what it would take to get students like themselves more involved with the subject matter. They were asked to reflect and then propose methods of making the text appealing and understandable to different kinds of learners.

The methodology of the program, pairing student *designers*, with a researcher in the role of *client* and communication design faculty as *creative director* was specifically chosen to facilitate collaboration and to reflect a real-world work experience for the student design team. As part of this method, student illustrators met with the creative director and the client initially to assess project scope, and analyze the client's needs, before proposing their own creative solution. Taking cues from science based comics strip, *The Far Side* by Gary Larson [18], students chose to use cartooning and humor as a method of making a STEM subject more universally palatable. The student designers built their knowledge base through research, which informed their character designs, resulting in the creative solution of animals who live underground as the cast of creatures explaining soil mechanics, Figures 1 & 2.

Figure 1. Sample of the work produced through the collaboration of student artists, creative director and client (author). This particular draft illustration will be part of the title page. Illustration by Jenny Zhupan, Evelyn Ng. Borrowed from [14].

Figure 2. Sample of the work produced through the collaboration of student artists, creative director and client (author). This particular illustration will be the cover of the chapter on moisture content determination. Illustration by Jenny Zhupan and Evelyn Ng. Borrowed from [14].

An incidental benefit of this methodology was that student designers experienced a common occurrence within their profession. In a real world professional setting an illustrator often has to familiarize themselves with a subject outside of their knowledge realm, to be able to deliver visual content that is artistically appealing, has depth, and is factually correct. In this case, student designers learned within a short period of time some of the general principles of soil mechanics behavior which helped enhance their general education experience at the university.

Use of Surplus Laboratory Technician Budget

While content created by student artists serves to create visually engaging content, there was also a need to create high quality photography related to the content of the textbook. To accomplish this the author took advantage of a surplus in College Laboratory Technician (CLT) hours within the Construction Management and Civil Engineering Technology department. The surplus was due to suspension of in person laboratory courses during the COVID-19 pandemic from Spring 2020 to Summer 2021. A CLT with previous experience producing editorial photography, Kelly

Wu, was employed to produce imagery relevant to the manuscript. The results were the images that will be used to illustrate the equipment, supplies and procedures needed to complete laboratory experiments in each chapter (Figure 3).

Figure 3. Sample photographs of laboratory equipment for the OER textbook. Photographs by Kelly Wu. Borrowed from [14]

The surplus budget was also used to employ two CLTs to review the manuscript. Specifically, CLTs which had taken the course in which the final textbook will be employed and have laboratory experience as a CLT for the course, were hired to do a “hands on” practical review of the manuscript. During this “hands on” practical review the selected CLT’s used the draft manuscript as a guide to complete the laboratory experiments without supervision. This review process yielded early feedback on the practicality of the written procedures and equipment necessary to complete the laboratory experiments.

Peer Review and End User Review Process

From the early stages of the development of this project it was agreed that the manuscript would go through a comprehensive peer review process. By tapping into professional goodwill the manuscript will be subject to the scrutiny of scholars and industry professionals within the field of soil mechanics and Geotechnical Engineering. This level of review will also serve as an additional quality control measure following the "hands on" practical review of laboratory technicians mentioned above. In general the peer review process will help assure quality of the textbook as well as providing legitimacy to the technical writings presented in the manuscript, something that is sometimes missing in OER content.

After the peer review process is complete the manuscript in BETA version will be used as the textbook for the laboratory portion of the soil mechanics course at City Tech for one semester. During the semester students will be encouraged to reflect, seek out and highlight errors, omissions, and provide general feedback on the manuscript before the final version is released to the general public.

3. Budget

The effort to produce a high quality textbook was made possible by the passion and goodwill of professionals from varied fields such as Library Faculty members, Art Directors, Geotechnical Engineering professionals, and college administrative support. Monetary support included tapping into several resources offered by City Tech and CUNY. These included library managed grants (*2019-2020 New York State Scale Up Initiative Grant*), undergraduate research grant programs (*Emerging Scholars Program*), unused department funds (College Laboratory Technicians), and city wide summer work programs (*NYC DYCD Youth Employment Program*). These resources were leveraged to support the project by employing artists, photographers, laboratory technician reviewers, and faculty. The breakdown of these costs can be seen in Table 1. The cost of one of the required textbooks for the Soil Mechanics Laboratory course at City Tech has a price tag of approximately $112 dollars including shipping. Considering that when published this textbook will replace this textbook and that the course is offered approximately to 96 students a year (6 sections of 16 students each), the project should break even, in student savings, within 3 semesters (1.5 years), Figure 4. It is expected that at 5 years after publication, the textbook will bring savings to City Tech students of about $35,000. If other universities adopt the textbook in their soil mechanics courses the savings then become exponential. This analysis takes into account the cost of printing and binding the textbook if the student chooses to do so.

Table 1. Breakdown of Project Costs

Source	Quantity	$ per item	Total
2019-2020 New York State Scale Up Initiative Grant	1	$4,866	$4,866
Emerging Scholars Undergraduate Research Grants	5	$500	$2,500
Surplus Department Budget (CLT hours)	24	$15	$360
NYC DYCD Youth Employment Program (hours)	125	$15	$1,875
	Total Investment		**$9,601**

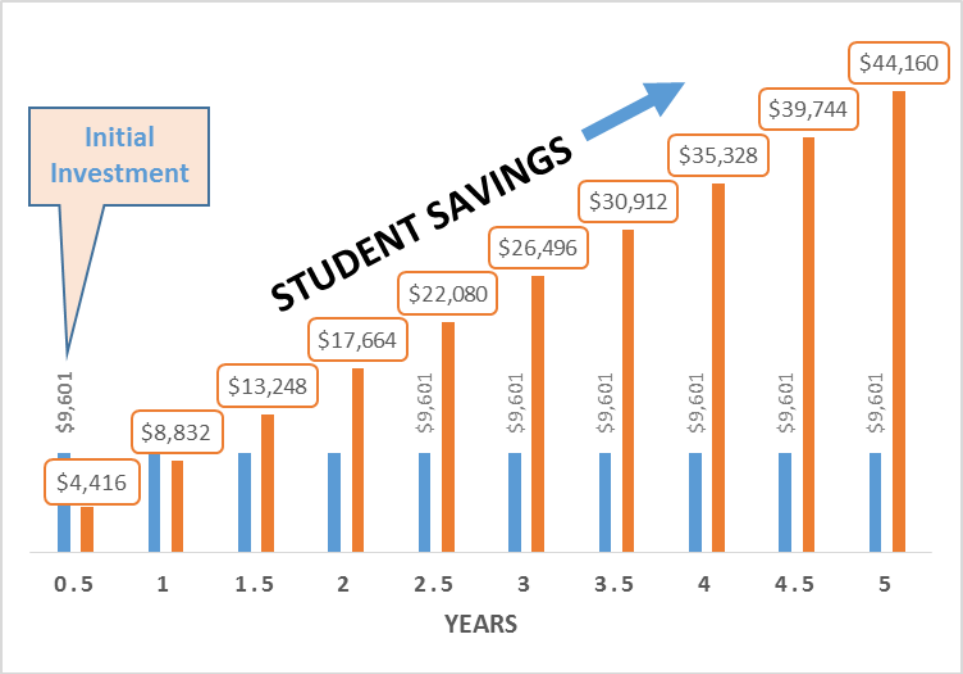

Figure 4. Initial investment vs. cumulative student savings per year.

4. Conclusions

The wide use and availability of high quality OER content can ease the economic burden of students throughout the United States and beyond. The literature supports the fact that good quality OER content is welcomed by students as an alternative to traditional textbooks. It also shows that when done well, OERs can enhance the educational experience of the end user.

Through the use of existing programs and resources within an academic setting and professional goodwill it is possible to create high quality peer reviewed OER content. In this case study, the use of library programs, undergraduate research grants, city wide youth employment programs and the opportunistic use of surplus funds, resulted in a well-rounded OER.

Searching outside of the author's own academic department can lead to collaborations with other disciplines for a specific purpose. The collaboration with faculty member from COMD led to hiring student designers to create visually engaging content. The use of the Designer-Director-Client model is a very good collaboration model to bring together professionals and near professionals from different disciplines to produce engaging visual content. This model should also work well in the creation of other types of media. This arrangement had the added benefit of fostering the general education experience of the students involved.

A comprehensive review process was one of the cornerstones to the creation of the referenced textbook. A review process from beginning to completion of the project included editorial, content and practicality reviews. The review process engaged users with varying degrees of expertise in the subject, including student end users, laboratory technicians and professionals in the field. This process provides quality control and legitimacy to the content presented within the manuscript.

This shoestring grassroots approach will result in a well-rounded, high quality, visually engaging textbook. The direct and indirect investment of monies will be recovered in student savings within 1.5 years after publication, and will surpass $35,000 (net) within a 5 year period, and much earlier if other institutions adopt the textbook.

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