Incorporation of Student-Generated Problems in an Online Textbook

Sr. Libby (Elizabeth) Osgood, University of Prince Edward Island

Libby Osgood is an Assistant Professor of Sustainable Design Engineering at the University of Prince Edward Island in Canada, where she teaches design, engineering mechanics, and is the coordinator of the Engineering Success Centre. She is a religious sister with the Congregation of Notre Dame. Her research interests include active learning pedagogy, service learning, social justice, faith and science, and Teilhard de Chardin.

Ms. Emma Bodil Stryhn Christensen, University College Absalon, Denmark

Emma Christensen is a bachelor student in engineering who began her studies at the University of Prince Edward Island and is now pursuing a degree as an engineer in machine technology at the University College Absalon in Kalundborg, Denmark.

Analiya Benny
Matthew Hutchinson
Gayla Cameron

Incorporation of Student-Generated Problems in an Online Textbook

Abstract: An open-source online statics textbook was developed to support students in an engineering statics course. Through the course, students were asked to develop and solve their own problems using real-world examples for one of the concepts in that assignment. The motivation for this request was to help students see statics concepts applied in their every-day lives, to express their creativity, to have them review the technical content of that week at a higher level, and to engage with one topic more deeply. Additionally, students were given to option to publish their examples in the online textbook, and 58% of the class submitted 59 real-world examples. A previous study found that 93% of the students thought the activity should be completed in future years, and that students were motivated to publish examples in order to support students in future years and learn the material. Four student assistants were hired to help create the textbook and digitize examples. This paper documents their experience and describes lessons learned for the development of open-source online materials.

Introduction

In recent years there has been a movement in Creative Commons, open-source software, Open Educational Resources (OERs), and Massive Open Online Courses (MOOCs) to foster a collaborative, community-centered mindset towards learning and education, remove the paywall and make education accessible to anyone with an internet connection. In the university environment, OERs have allowed expensive textbooks to be replaced with high-quality online resources. Because adaptation and customization of existing resources are welcomed (as defined in the license for each resource), instructors can tailor resources specifically for their course, thus filling a gap in what is currently available for students [1]. Studies have shown that the adoption of OER materials provides significant cost savings without sacrificing academic outcomes [2,3], and that students appreciate the variety and ease of access of the resources [4]. Additionally, OERs allow for more interactivity as well as having a smaller impact on the environment, reducing paper waste [5]. Lastly, OERs were shown to have more positive impact on historically underserved students, international students, and low-income students [3,6].

At the University of Prince Edward Island, an informal survey by the Student Union from Fall 2022 showed that 94% of the nearly 600 students would use an OER if it were available, with 69% of surveyed students rating the quality as a good or very good alternative to textbooks. For an Engineering Mechanics: Statics course at the same university, an instructor and four undergraduate student research assistants have developed an OER textbook [7], customized to the specific needs of the class in a sustainable design engineering program. Recent curricular changes to the degree replaced the physics class with a reintroduction of the statics course and situated the course in the first semester of the program, to be taken concurrently with the first calculus class.

An adapted textbook was needed to introduce fundamental mathematics concepts that would not be addressed until later semesters, such as vectors, dot products, and cross products. Existing textbooks reviewed these concepts rather than spent time on them. Additionally, the right hand rule and other helpful tools were not found in the textbooks. When an internal grant became available to adapt existing resources into an OER textbook, the faculty researcher saw an opportunity to tailor the necessary OER textbook to the course and to incorporate examples from students enrolled in statics courses into the OER, thereby allowing statics students to adopt creative problem solving, to connect the course material to the ‘real-world’, and to understand the course

content more deeply [8]. In each of the six homework assignments, statics students in Summer 2021 were tasked with creating and solving their own statics problem, incorporating theory found in that assignment to a real-world problem that they encountered. They later had the option to have their examples published in the OER, thus boosting both confidence and resumes. A previous publication describing the experience of the students who submitted problems for the textbook documented that 59 real-world examples were submitted for publication by 58% of the class, and that 93% of the students thought the activity should be completed in future years [8]. Students stated that they were motivated to publish examples in order to support students in future years and so that they could learn the material more deeply.

In theory-heavy engineering courses such as statics, homework problems are typically self-contained, structured, solvable problems that rely on memory and apply only to course material [9,10,12–14]. Students learn to search for sample problems to replicate the procedure [9], using memorization of concepts [10] instead of more complex learning activities of understanding or application [11]. Well-structured problems found in textbooks "do not resemble the ill-structured problems encountered in the everyday and professional contexts" [12]. MacNeill et al. contend that students' discomfort with open-ended problems stems from their inexperience, and that they would have more "confidence in dealing with ambiguity and complexity" if they have more experience with real-world problems [13]. One application of student-written problems asked students to solve a problem found on YouTube, from which students reported more confidence, a better understanding of the material, and finding connections between the course material and the real-world [14]. Similarly, students were asked to design their own thermodynamics experiments to practice self-guided problem-based learning [15]. According to MacKinnon and Archer-Kuhn, inquiry-based learning (such as these applications) is guided by students' own interests and curiosity, allowing students to embrace learning while the instructor becomes a facilitator [16]. Encouraging students to find and solve their own problems can allow them to ignite their interest in the material, which will encourage them to dig deeper and continue learning. According to Cavanagh, "Interest motivates learning, which makes you more of an expert on a subject matter" [17]. Thus through using self-created problems, statics students can learn the material more fully, see the concepts applied in the real-world, and gain confidence in solving ill-defined future problems, as documented in a previous study [8]. The purpose of this paper is to consider the effect on the student research assistants who digitized the problems for the OER. They, too, have the advantage of seeing the concepts in the real-world, learning the material more fully, and becoming more confident at solving ill-structured problems, through grappling with other students' examples.

Thus, the focus of this paper is (1) to document the experience of the four student research assistants who participated in the development of the OER resource and (2) to provide lessons learned for developing open educational resources.

Project Overview

This section contains details of the project execution, including descriptions and objectives for the two phases: (1) Development of the OER textbook, and (2) Incorporation of student problems.

In the first phase, developing the OER textbook, an internal university grant of $1,000 was awarded in April 2020, which allowed for an adaptation of existing material. Rather than create an entirely new textbook, OER statics and physics textbooks were adapted. A research student was hired in

the fall of 2020 to support the creation of the OER, using the Pressbooks platform. The student was recruited based on their performance in the Fall 2019 Statics course with the faculty researcher, for their organizational skills, and for their ability to work independently. Based on their course notes and experience, their first task was to decide which topics should be included in the OER textbook. This provided an independent assessment of what the faculty researcher thought should be included, and the two lists were very similar.

The objectives for this phase, shown in Table 1, are to allow students to save money on an expensive textbook, tailor the OER textbook with additional math concepts and other course content, and to provide meaningful experiences for the research student. The OER textbook was completed in time for a summer offering of Statics in 2021.

Table 1. Objectives for the two phases.

Objective	Phase 1	Phase 2
Statics students save money on an expensive textbook	x	
Tailor textbook content to the course	x	
Research students gain coding experience	x	x
Research students reinforce statics concepts	x	x
Research & statics students add publication to resume	x	x
Research & statics students see statics in world		x
Research & statics students develop problem-solving ability		x
Research & statics students develop creativity		x
Research & statics students increase self-confidence		x
Textbook is improved with examples applying information		x

The second phase, incorporating statics students' self-created problems into the OER textbook, was integrally woven through the summer offering of the statics course. In each of the six homework assignments, statics students were asked to create their own problem using concepts contained in that particular week. At the same time, they were informed of the possibility to publish the examples at the end of the semester. The problems were worth less than the structured problems, both because this was a new form of assessment that students were unfamiliar with, and because the value gained was in the creation of the problem more so than the assessment. At the end of the course after grades were submitted (reducing pressure to participate), statics students were contacted by email with the opportunity to submit the problems that they created to the OER textbook. Appendix A contains the rubric and a sample problem. The objectives for this phase can be found in Table 1 and include benefitting both statics and research students' educational and professional opportunities as well as improving the OER textbook.

Over the course of two years, three additional research students were hired to incorporate the statics students' examples into the Pressbook, reviewing for accuracy and to ensure all students had at least one problem incorporated. For those chapters with too few examples, the research students created examples. The research students were selected for their independence, coding ability (or willingness to learn coding), and understanding of statics concepts. An additional grant of $2,000 was provided in April 2022 to incorporate more student problems into the OER textbook. The project is expected to be completed by May 2023. The next section details the roles and responsibilities of each of the researchers.

Project Roles and Responsibilities

The responsibilities differ for each stakeholder in the development of the OER textbook and incorporation of problems. The specific tasks are listed in Figure 1, with the corresponding stakeholder. Though most of the tasks are chronological (from top to bottom in the figure), the Phase 2 tasks to incorporate problems span multiple years. Also, student researchers B and C worked simultaneously during the summer of 2021, and student researchers C and D were both working on the examples from summer 2022 to the present. Working together allowed the student researchers to learn from each other and discuss the accuracy of problems.

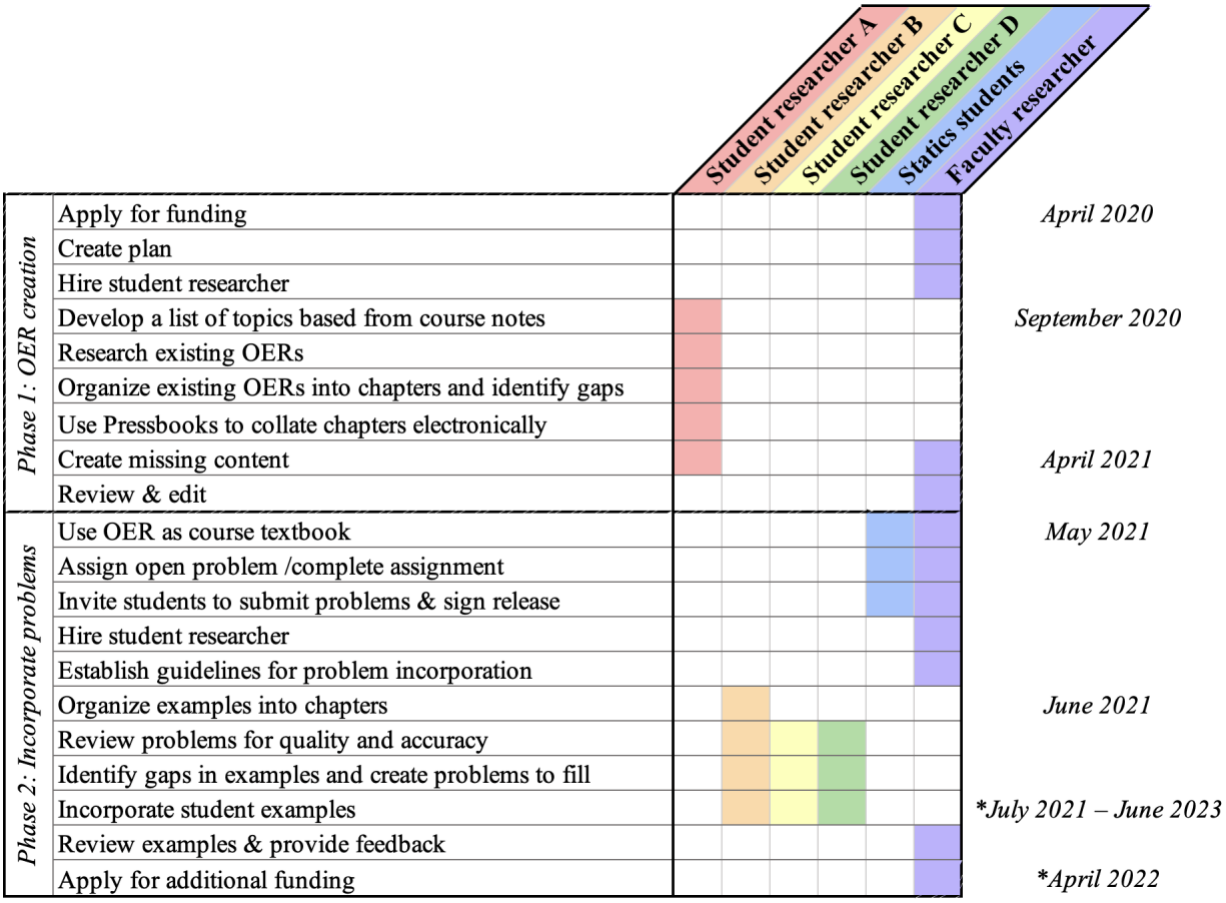


Figure 1. Distribution of Work: Tasks in the project organized by phase, denoting person who completed each task and approximate timing it was completed.

During the time they worked on the project, the four research students had completed their first-year courses but were not yet finished with second-year courses. They were selected for their proximity to the statics course to allow them to build on their recent experience, to reinforce their understanding of theoretical concepts, and because they had an appropriate level of expertise to accomplish this project. While many of the available research positions required more technical courses, this was an appropriate project for students early in their degree. Additionally, this opportunity provided them with research experience so that they could apply for more technical research positions in future years. The following four sections document the motivations, experience, responsibilities, and impact that each student researcher felt throughout the project.

Student Researcher A

The first student to work on the project researched OER resources and compiled relevant and necessary content into the statics book, as well as writing content that could not be found in other sources, such as the reaction forces. She wrote a few examples for the book, but most of the work was editorial by organizing the content into chapters. When she was first asked to help compile and write this OER book, she was extremely excited. Once she began working on it, she began to feel overwhelmed and found it quite daunting at the beginning. Although aspects of the development of the OER took numerous hours and became monotonous, she thoroughly enjoyed writing her own sections and examples. The process was more time consuming than she expected, but once she finished compiling and writing all the chapters, she had a great sense of pride and accomplishment.

Overall, she felt the project was properly planned, and resulted in a textbook that can be extremely useful for students. She believes that incorporating student examples gives the students a chance to develop and solve their own problems, which helps in the learning process. The opportunity to have their work included in a textbook also incentivizes the students to want to participate and do their best work for the submissions. She recognizes that there is a range in the complexity and quality of submitted problems, but they are all useful to convey content. She encourages professors to incorporate OERs and self-generated problems as it is financially economical for students and beneficial for their learning.

Student Researcher B

Student researcher B participated in developing the statics textbook in two ways. First, she created and submitted examples for use in the online statics book, because while taking the Statics course, she became proud of her self-created problems and the creative effort she had put into them. When the project was first introduced, she felt intrigued by the idea because she had never heard of something like this before (creating and publishing her own problems). She was also perhaps a bit nervous that she would not have a good enough understanding of the material to make good examples, but she gained more confidence over the course of the semester.

Next, she worked on turning her and her peers' submitted examples from paper to electronic form during a summer research job. She typed the text that was submitted along with the examples, created diagrams, checked the calculations, and wrote additional explanations where she felt it would aid textbook users' understanding of the example problems. She also chose which examples to include from the ones submitted based on content and difficulty.

She took the research position both because she wanted to help future students with a subject she was interested in and because she likes teaching and sharing her interests and knowledge with others. On the whole, she enjoyed making the diagrams, though it sometimes felt a bit tedious. It was rewarding to go through the examples she and her classmates had created and insert them in the textbook, and she enjoyed seeing the diversity in the questions. During her work, she chose two of her own to input. For her, it felt nice to have her own name in the book and to see her work among that of her peers' examples. When she revisits the book now, she is happy to see her classmates' names and work in a textbook that will help future generations of students. It makes her feel good to think she may help a future student understand this subject and ease a bit of stress over the course of their engineering degree.

When considering the impact of the experience, she strongly believes that creating your own questions for a textbook helps in your studies. It requires a deeper level of understanding of the material to be able to apply the given material to a new situation, and she believes it encouraged her and her peers to think about statics in contexts beyond what was presented in the classroom. She recollects that this was a point of importance for the teacher of the course, thus she reflects that doing the textbook was an effective way to ensure this was achieved in her classroom.

Student researcher B went on to study in a different program at another university where her engineering mechanics, dynamics exam was oral, and in her preparation for these exams she found it helpful to make creative examples for her presentation. For instance, instead of making a worked problem involving a ball dropping from a height, she considered a shoe being dropped from the CN Tower during a skywalk. She liked doing this as a way to make her studying more interesting, and to help her consider different aspects of physics problems - how is it different for a shoe to fall rather than a ball, or could it change depending on the type of shoe? This led her to consider air resistance in a different way than she would have if she had used a textbook example.

Student Researcher C

At the time this paper was drafted, student researcher C had incorporated 20 student-written examples into seven chapters of the OER textbook. She felt like this would be a good opportunity to start something academically relevant especially as a first-year student. She found that it was a good way to crawl out of her comfort zone and get something done.

At first, she found the work tedious to get adjusted to the rhythm of things, and she was too anxious to start. Eventually, the work did not feel as large of a load. At some point, she started feel proud of her work, too. Working with all problems which are real-life applications helped her learn and understand the material. However, it was more time consuming than she expected.

When she incorporated her own examples, she realized that real-life situations came with a lot of decision making. Deciding what information is relevant or what data to work with was a challenge. Creating her own problem and solving them offers a different point of view, a good way to exercise application of knowledge in a useful way, and a practice of creative and out of the box thinking. She realized that studies and everyday situations were related. It became clearer why she is learning these concepts in classes and where it applies. It also became easier to recollect concepts when making her own problems.

When considering the impact of the experience, she felt that her studies have been affected, especially because statics is a first-year course, and it is fundamental to is basic to many other courses in the following years. Working with all these creative problems from students opens a different perspective. Creating her own problem is a very good way of applying academic memory and understanding to everyday problems, which is a vital skill for an engineer, and it is a more fun way of studying than expected. Additionally, she gained some experience in latex coding.

Student Researcher D

Student researcher D reviewed and transcribed nine examples into five chapters of the OER textbook. His motivation to participate was because the creation of an open statics textbook falls directly in line with his critiques of academia. The high costs of tuition, fees, and textbooks create

a barrier in post-secondary education for non-traditional and less-privileged students. The creation of an open textbook for use in courses is a small step in the right direction of breaking down these barriers.

He found that the experience of participating on this textbook was almost entirely dependent on the example being worked on at the time. While many problems were boring and tedious to write out, some students provided examples which applied the concepts in creative and refreshing ways. Working on these creative problems provided a burst of inspiration to carry on and continue adding examples.

He found that this experience proved to be a great method into learning how other students think and work through problems. It has become apparent that perhaps a better method of determining ones understanding of a subject is the ability to develop problems which utilize the subject learnt rather than applying the subject to pre-determined questions. Going forward, he hopes to apply this concept to his studies to test whether the concept of creation rather than application in learning is fruitful.

Recommendations / Lessons Learned

During the development of the OER resource, there are two key lessons learned. First, for material that is adopted from other OERs (under the appropriate Creative Commons license), rather than creating a link in the Latex code, it is recommended to host the material (copy and paste) within the OER textbook that is being compiled. This ensures that if the address changes of the original page, the Pressbook is still available (instead of "content unavailable"). Secondly, it is important to state the creative commons license and attribution to the original site on every page and for each photo.

Promoting the practice of students creating their own examples in homework, student researcher C explains that creating student examples is more work and time consuming than just doing examples from the textbook, but it is a more efficient way of studying and above all, it stays in students' memories. Also, she suggests that offering students an option to include these problems in OER textbooks is a good motivation, and she supports the use of OERs because most students cannot afford a textbook. For them, it would be greatly useful if there were similar simplified textbooks that students can refer to for learning intensive courses like statics.

Student researcher B wholeheartedly encourages instructors to do any or all parts of this project. If they want to have students write their own problems as homework, she would encourage them to be sure to keep the weight of those homework problems low, to encourage students to take risks with their problems and be creative. She thinks students might be more inclined to copy an idea from a given problem and change the numbers if the weighting is too high. Alternatively, they could mark those questions based on creativity or effort rather than whether the answer is correct.

During the creation and incorporation of examples, the most challenging part of the process for converting written examples into an online format was the equations, so student researcher B recommends some sort of image-to-math tool that could scan pages and produce code for the equations as they would like them to appear in the book, such as 'MathPix'. Instructors could also request student to submit problems in online format, for example using equations in Microsoft Word.

Further, student researcher D explains that as the examples were created by students actively learning the course material, some examples, while presented well and with correctly-applied concepts, the problems contained inaccuracies or impossibilities. To correct this issue, a review portion of the submission process could be implemented. This would require the instructor to review each problem and, provide feedback on how it was solved and any concepts that the student may be missing and giving advice on how to correct their solving or edit their problem to be completely solvable using only the understanding of statics they have been provided. The student would then be able to resubmit the reviewed example for incorporation into the textbook while learning from their mistakes and perhaps giving them insight into the information they will gain from future courses. Though this demands more time of the instructor or marker, it can reinforce student understanding.

From the instructor's perspective it is recommended to include three images of each example: 1) find open-access images of the real-world application of the problem to anchor the problem in reality, 2) include simplified images to help bound the problem, and 3) create a free-body diagram / engineering sketch. Each example should clearly attribute the student who created the example (unless they requested anonymity). Adding bonus marks for digitization and the clarity of the problem can reduce the time required to input the problem.

Considering the project as a whole, the long duration is due to the intensive course workloads of the student researchers and competing research projects that are more engaging than the rigorous work required to input the examples. As stated by the student researchers, input student examples could be tedious, and it is suspected that it "feels" like doing homework. Thus, it is recommended to include a number of projects for the students to work on so they are not wholly focused on inputting student examples.

Conclusion

While many pedagogical practice papers focus on the experience of the instructor and perceived or measured perception of students, this article provides the perspective from the student researchers who developed the OER textbook and digitized hand-written examples from the statics students. As authors of the paper, the student researchers shared their motivation to work on this project, their experience throughout, and the impact of participating on their studies. The perspectives of the statics students who created the examples are documented in a previous study [8], and the experience for the instructor is inherently presented throughout this article.

OERs provide tailored, high quality, affordable learning tools to democratize education, reduce barriers to learning, and create additional opportunities for student researchers to participate in the process. Encouraging students to create their own problems helps to solidify course concepts, see theory in the real-world, have confidence to approach ill-defined problems, and increase creativity and interest in their studies. Future work will be to finish incorporating examples by June 2023, obtain additional reviews of the OER textbook, and expand for potential collaboration with other institutions. Additionally, a study could be performed to measure student reception of the OER.

Acknowledgment

We are grateful to the OER Development Grant from the University of Prince Edward Island and for the technical support of the Library staff, particularly the contribution from Megan

MacEachern. We would also like to thank the students who contributed problems for the OER textbook and hope this will be a useful tool for many students in the future.

References

[1] E. Collins, and G. Stone, "Motivations for textbook and learning resource publishing: Do academics want to publish OA textbooks?" LIBER Q. vol. 29, no. 1, pp. 1–19, 2019. https://doi.org/10.18352/lq.10266

[2] R. S. Jhangiani, and S. Jhangiani, "Investigating the perceptions, use, and impact of open textbooks: A survey of post-secondary students in British Columbia," Int. Rev. Res. Open Distrib. Learn. vol. 18, no. 4, Jun. 2017. https://doi.org/10.19173/irrodl.v18i4.3012

[3] H. Delgado, M. Delgado, and J. Hilton III, "On the efficacy of open educational resources: Parametric and nonparametric analyses of a university calculus class," Int. Rev. Res. Open Distrib. Learn. vol. 20, no. 1, Feb. 2019. https://doi.org/10.19173/irrodl.v20i1.3892

[4] C. Cooney, "What impacts do oer have on students? Students share their experiences with a health psychology OER at New York City College of Technology," Int. Rev. Res. Open Distrib. Learn. vol. 18, no. 4, Jun. 2017. https://doi.org/10.19173/irrodl.v18i4.3111

[5] N. Delimont, E. C. Turtle, A. Bennett, K. Adhikari, and B. L. Lindshield, "University students and faculty have positive perceptions of open/ alternative resources and their utilization in a textbook replacement initiative," Res. Learn. Tech. vol. 24, Jun. 2016. https://doi.org/10.3402/rlt.v24.29920

[6] J. J. Jenkins, L. A. Sánchez, M. A. K. Schraedley, J. Hannans, N. Navick, and J. Young, "Textbook broke: Textbook affordability as a social justice issue," J. Interact. Media Educ. vol. 2020, no. 2, p. 3, May 2020. http://doi.org/10.5334/jime.549

[7] L. Osgood, G. Cameron, E. Christensen, A. Benny, and M. Hutchison, Engineering Mechanics: Statics, 2021. https://doi.org/10.32393/EngnMech

[8] L. Osgood, "Publishing student-generated problems in an OER: Student perceptions", Int. J. Eng. Ped. vol. 12, no. 4, pp. 115–132, Jul. 2022. https://doi.org/10.3991/ijep.v12i4.30429

[9] C. S. Lee, N. J. McNeill, E. P. Douglas, M. E. Koro-Ljungberg, and D. J. Therriault, "Indispensable resource? A phenomenological study of textbook use in engineering problem solving: Phenomenology of textbook use in engineering problem solving," J. Eng. Educ. vol. 102, no. 2, pp. 269–288, Apr. 2013. https://doi.org/10.1002/jee.20011

[10] J. L. Newcomer, and P. S. Steif, "What students "know" about statics: Specific difficulties common among students entering statics," in 2008 38th Annual Frontiers in Education Conference, Saratoga Springs, NY, Oct. 2008, pp. S1C-1-S1C-6. https://doi.org/10.1109/FIE.2008.4720323

[11] B. S. Bloom, "Taxonomy of educational objectives: The classifications of educational goals," in Handbook I: Cognitive Domain. 1st ed. New York, NY: David McKay, 1956.

[12] N. Shin, D. H. Jonassen, and S. McGee, "Predictors of well-structured and ill-structured problem solving in an astronomy simulation," J. Res. Sci. Teach. vol. 40, no. 1, pp. 6–33, Jan. 2003. http://doi.org/10.1002/tea.10058

[13] N. J. McNeill, E. P. Douglas, M. Koro-Ljungberg, D. J. Therriault, and I. Krause, "Undergraduate students' beliefs about engineering problem solving," J. Eng. Educ. vol. 105, no. 4, pp. 560–584, Oct. 2016. http://doi.org/10.1002/jee.20150

[14] U. Asogwa, M. W. Liberatore, T. R. Duckett, and G. A. Mentzer, "Student attitudes when solving homework problems that reverse engineer youtube videos," in 2020 ASEE Virtual Annual Conference, Virtual, Jun. 2020. http://doi.org/10.18260/1-2--35220

[15] J. Alvarado, "Design your own thermodynamics experiment, a problem-based learning approach in engineering technology," in 2006 ASEE Annual conference, Chicago, IL, USE, Jun 2006. http://doi.org/10.18260/1-2--791

[16] S. L. MacKinnon and B. Archer-Kuhn, Reigniting Curiosity and Inquiry in Higher Education. Serling, VA: Stylus Publishing, 2023.

[17] S. R. Cavanagh, Spark of Learning: Energizing the College Classroom with the Science of Emotion, Morgantown, WV: West Virginia University Press, 2016, p. 114.

Appendix A: Assignment and Sample Problem

The students were given the problem shown in Figure 2 to guide the creation of their examples and Figure 3 shows a sample problem that was published in the OER textbook.

Problem 4 *(5 points)*

For this homework assignment, I want you to write your own sample problem that would be appropriate to include in Ch 1 or 2 of the open textbook (https://pressbooks.library.upei.ca/statics/) Sections 1.4, 1.5, 1.6, 1.7, 2.2, or 2.3 could produce good problems. It cannot be taken from an example online or from another book.

I want you to pick a section, look around you to find a real world problem that applies to that section, and solve it.

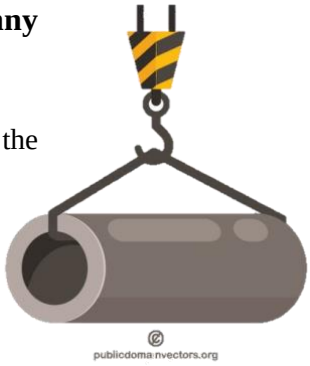
This is the big, open problem. We will have one problem like this on each assignment. By learning how to think critically and see examples of statics in the world, you will have shown a mastery of the course material. This problem will help you to do that, by writing your own examples. This problem will be graded using the following rubric:

	0 points	*1 point*	*Score (# / 1)*
Complexity	Too simple (1 step)	Complex enough (multiple steps)	
Related to topics	Not related to assignment topics	Part of assigned topics	
Practical application	Theory only (basic)	Concept applied to real-world or fictional scenario	
Imagery & Diagrams (hand drawn or link to open source image)	No diagrams or images provided	Appropriate visual aids	
Answer clarity	Doesn't explain steps (just numbers)	Appropriate detail for explanations	
Bonus: Digitized	Hand-drawn	Digital submission	Bonus point

If your examples are helpful and could assist future students, you will have the option to have them published in the open textbook and the credit will be given to you (or anonymous if you prefer). Since this is an open textbook, there is a creative commons license that means that other people can use your example as well. I'll ask you at the end of the semester if you want your examples to be considered for the textbook and will have you to sign a form acknowledging you understand this information.

Figure 2. Assignment problem with rubric, problem statement, and option to publish.

Example 2.4.1.2: Equilibrium Equation, Submitted by Analiya Benny

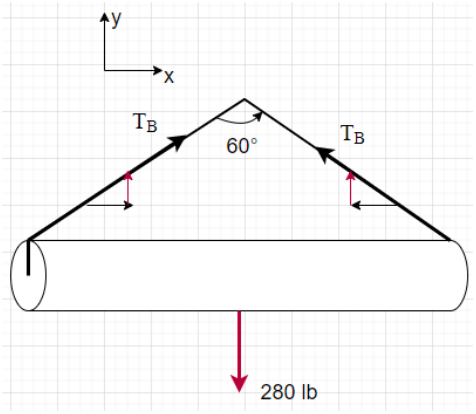


https://publicdomainvectors.org/en/free-clipart/Crane-with-a-

1. Problem

A 280 lb Pipe is being lifted by a crane. Find the magnitude of the tension on the cables, given that the forces on the cables are equal.

2. Draw



3. Knowns and Unknowns

Knowns: F = 280 lb, Θ = 60°

Assume equal tension in cables, (can confirm by labelling strings uniquely T_A and T_B)

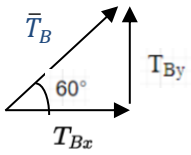
Unknowns: Magnitude of tension in $\bar{T}_B$

4. Approach

Componentize vectors and apply equilibrium equation.

5. Analysis

Componentize $\bar{T}_B$



$$T_{By} = |\bar{T}_B| \sin 60°$$

$$T_{Bx} = |\bar{T}_B| \cos 60°$$

Apply equilibrium equation in the y direction

$$\sum F_y = T_{By} + T_{By} - 280\ lb = 0$$

$$T_{By} = \frac{280\ lb}{2} = 140\ lb$$

Find magnitude of $|\bar{T}_B|$

$$T_{By} = |\bar{T}_B| \sin 60°$$

$$|\bar{T}_B| = \frac{T_{By}}{\sin 60°} = \frac{140\ lb}{\sin 60°}$$

$$\boxed{|\bar{T}_B| = 161.67\ lb}$$

6. Review

The total tension is larger than the y component, which makes sense. Could verify by calculating x component and using Pythagorean theorem: $T_{Bx} = |\bar{T}_B| \cos 60° = 161.67 \cos 60° = 80.8\ lb$

$$|\bar{T}_B| = \sqrt{{T_{Bx}}^2 + {T_{By}}^2} = \sqrt{(80.8\ lb)^2 + (140\ lb)^2} = 161.66\ lb \checkmark$$

Figure 3. Sample problem published in the OER textbook in Chapter 2 on particle equilibrium equations.