Publishing Student-Generated Problems in an OER: Student Perceptions

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Abstract—Fundamental engineering courses provide learning opportunities for students to develop problem-solving and creativity skills, connect theoretical course material to the real world, and solve complex, abstract problems such as those found in the workplace. Through a mixed-methods study of students in a statics course in a small Canadian university, we explored student motivation and perception of composing and publishing their own course-relevant problems in an open educational resource (OER) textbook. We found that generating and solving their own problems for each of the six homework assignments helped students to anchor theory in the real world, be creative, and understand the material more fully. In total, 93% of students in the course created at least one student-generated homework problem, and after the semester ended, 58% of students submitted a combined total of 59 high-quality, interesting, real-world examples to be included in the OER textbook. Of the 28 study participants, 26 students (93%) felt the activity should be repeated in future years. Students were motivated to publish examples in the OER textbook by a desire to help future students and gain an understanding of the material. Students found generating problems time-consuming but enjoyed expressing their creativity.

Keywords—statics, open-educational resource (OER), motivation, creativity

1 Introduction

Fundamental engineering courses such as statics and dynamics provide learning opportunities for students to apply the mathematics and physics concepts and equations that they learned previously to real-world situations. These courses provide an essential link between theory and application, encouraging students to see engineering in everyday situations, such as how a traffic light is suspended or what angle a ladder will start slipping.

While most engineering faculty embrace using real-world applications in their classroom [1], the degree to which the real world is incorporated varies. Typically in fundamental engineering courses, the real-world application is represented by examples and homework problems with succinct problem statements that are solved with a system model, free-body diagram, and mathematical model [2]. This formulaic, structured problem-solving approach, referred to as 'plug and chug,' allows students to focus on a specific topic and practice similar problems until that concept is understood. However, this approach insulates students, isolating them from the complexities and ambiguities of the real-world problems that they will experience in industry.

Self-guided problem-based learning activities offer students an opportunity to express their personal creativity in the activity. In a thermodynamics course, students designed experiments to develop their understanding [3]. One student-led activity entitled 'YouTube Fridays' encouraged students to select YouTube videos to discuss and evaluate the plausibility of video content [4]. This developed into students writing their own homework problems to evaluate course-specific YouTube videos [5]. Students reported confidence in problem-solving and their ability to connect course concepts to the real-world [5].

In a similar activity, students in a small university in Canada participated in a scavenger hunt wherein they found, developed, and solved their own problems that fit specific criteria [6]. The *student generated homework problems* helped students to model complex problems into simplified problem statements, see the role of engineering in the world, and express their creativity. This activity was reimagined in a statics course offered during the summer of 2021, when students had the option to publish the examples they created and solved (student generated problems) in an open educational textbook that was being developed.

Open educational resources (OERs) offer cost savings and convenience for students without sacrificing academic outcomes [7]. OERs offer students a variety of learning materials [8] and reduce financial barriers to education, particularly for international students [9] and historically underserved students [10]. Compared to traditional textbooks, OERs are better for the environment, easier to search for material, and more interactive [11]. Only 1.6% of 524 students in one survey considered OERs to be of lower quality, and 6.1% of students preferred a physical copy [11]. However, if cost was not a factor, a survey of students found that they were three times more likely to prefer a physical copy [7]. Faculty report that OERs improve the learning experience for students as they can fill the gap in what currently exists [12] and offer customizability for their courses [11]. However, faculty expressed concern over the time required to develop, adopt, or adapt OERs [11]. Developing an OER is particularly time-consuming for technical courses such as statics that require numerous examples, and correspondingly, existing OER statics textbooks contain a limited number of examples.

To support the development of an OER textbook for a statics course, students were invited to submit homework problems that they developed to be included as examples. This paper has two objectives:

1. Document the pedagogical practice of publishing student-generated homework problems in an OER textbook.
2. Study student perceptions on generation and publication of homework problems.

The next section justifies the incorporation of student generated problems in statics courses.

2 Literature review

The literature review is divided into two parts: (1) Establishing the need to incorporate creativity into engineering. (2) Presenting common errors in statics courses and how student generated problems could address these deficiencies.

2.1 Injecting creativity into engineering courses

Whereas workplace problems are less defined with no clear solution [13], the simplified 'plug and chug' problems found in many statics courses are classified by Jonassen as 'story problems' [14]. In story problems, students can avoid developing a true understanding of the concept by searching for keywords, matching keywords to equations, and solving for the unknown values [15]. These shortcuts allow short-term gains without developing long-term understanding that is necessary for advanced engineering courses. More complex questions such as 'design problems' in Jonassen's 11-point classification [14] can develop students' understanding through constructing conceptual models of the problem and applying solution plans [15]. Jonassen explains, "Because engineering students learn to solve problems that are unlikely to transfer to workplace problem solving, engineering educators must adopt new pedagogies if they are committed to enabling their graduates to become effective engineers" [15].

Asking more abstract questions creates opportunities for students to express their creativity. Given the complexity of today's problems, creativity is necessary to help promote a sustainable society [16]. A study of engineering students found that students who considered themselves highly creative were less likely to graduate with an engineering degree, while 90% of students who did not identify as creative completed their engineering degree [17]. The authors explained that "creativity is not appropriately taught or rewarded in some engineering curricula" [17]. By incorporating more creative pedagogical practices into fundamental engineering courses such as statics, more creative students may be encouraged to persist.

An education "based on listening and pure testable knowledge transfer" discourages students from activating their creativity [18]. This is not to say that story problem questions should be abolished, but rather they should be supplemented with opportunities to be creative. Domain-specific expertise is required for the development of creativity [19], so more abstract problems can build on the knowledge gained through straightforward story problems.

There is a need to embed complex, creative problems and activities that are anchored in the real world in fundamental engineering courses. One such activity uses an interactive web application of a dam for a soil mechanics course [20]. Students can manipulate the visual model to understand the concepts better. Science fiction videos were incorporated into engineering classes to transfer science theory into practical applications [21]. Students evaluated whether situations were plausible or realistic and grappled with the effect of engineers on society. Incorporating science fiction as a teaching tool makes the concepts interesting, enhances students' ability to retain information, and makes abstract ideas concrete [22]. By enhancing students' attitudes towards the topic, students naturally engage with the material more and develop a better understanding

[23]. Gamification redefines a course into a multi-level game, in which students are motivated to earn badges [24]. These examples of non-traditional pedagogical tools encourage participation in complex problems, offer real-world examples, and demonstrate creativity in the delivery of the activity.

2.2 Common errors in statics courses

In statics courses, students spend an insufficient amount of time analyzing the problem [25]. Instead, they search for keywords [15] and jump to the solution. By creating their own questions, students are forced to struggle with understanding the problem, simplifying complex elements, making assumptions, and approximating known values.

Documented problem-solving deficiencies include possessing inadequate knowledge, an inability to visualize forces, and inadequate math skills [26]. Steif and Dantzler developed the statics Concepts Inventory and identified common technical errors, such as incorrect free-body diagrams, replacing constraints with forces, friction, and equilibrium conditions [27]. One study found that students were inconsistent with applying equilibrium equations, and mistakes made in one context were not necessarily made in a different context [28]. Many of these errors stem from students' inability to model the problem, moving from abstract problem description to the concrete free-body diagram. Visualizing is one of the engineering habits of mind that were developed to describe essential problem-solving skills [29]. The ability to move from the abstract to the concrete (visualizing) can be developed by generating their own problems, as students are forced to spend time modeling and simplifying the real-world scenario.

A list of 16 epistemic engineering practices was developed from the literature [30], six of which are developed through student-generated problems: (1) considering problems in context, (2) applying math knowledge, (3) applying science knowledge, (4) constructing models, (5) persisting and learning from failure, and (6) seeing themselves as engineers. The first four criteria have previously been addressed. Student-generated problems offer opportunities to build resilience and reiterate designing the problem. After solving the student-generated problem and (likely) finding an outrageous solution, students must then redefine their assumptions and values to match a reasonable real-world result, reiterating the problem. Students are forced to analyze the validity of their answers and start again. This creates the opportunity to build resilience through small failures. Additionally, problem-creation helps students to see themselves as engineers as they start to identify engineering scenarios with each homework assignment. Eventually, they see engineering in the real world even when they are not intentionally seeking a problem for a homework assignment.

Students learn statics by relying on their memory and using textbooks to find similar problems to copy the approach [31]. This defines a need to include examples in OER textbooks to help students learn which approach to select to solve simple classroom problems. However, these should be supplemented with ill-defined problems that are more common in professional contexts [32]. The ill-defined problems have too many criteria to evaluate, leave out crucial information, have vague goals, and require learners to interpret the situation [32]. Because students are more familiar with structured problems, particularly common in high school settings, they are uncomfortable struggling with ill-defined problems [33]. Student-generated problems encourage students to embrace ill-defined problems because students are given the freedom to align problems with their interests. When students are more engaged, they are more willing to expend the additional time that complex problems require [33].

In a study on engineering students' beliefs about problem-solving, students found the confidence to solve problems from textbooks, the internet, memory, other people, and their own personal characteristics (conceptual understanding, intuition, and interest) [33]. They believed they would have more confidence if they had more experience with real-world problems, which are less predictable than the bounded classroom problems. They found textbooks were helpful resources to scaffold problem solving and provide examples, and they recognized the need for visualization [33]. Generating examples through homework problems provides students with an opportunity to practice creating and solving ill-defined problems, visualization, and persistence while enhancing a textbook for future engineering students. This pedagogical approach can help address common statics deficiencies found in the literature.

3 Method

3.1 Pedagogical practice methodology

On each of the six homework assignments, students were asked to create and solve sample problems demonstrating real-world applications of a concept from that chapter. They were informed that (if desired), the problems could be submitted for inclusion in the OER textbook. Each problem was worth 5% of the assignment and was graded based on the rubric shown in Table 1. After the semester was completed, students were invited by email to submit eligible problems (those that received a 5/5 or were revised to meet the criteria) for the OER textbook. Students provided written consent to publish their examples and indicated their desired form of attribution, whether to include their name or be listed as 'anonymous.' Students from the course were hired to input problems in the OER, which reinforced their individual understanding of the material and provided peer evaluations of the examples.

Table 1. Rubric for grading sample problems

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

3.2 Survey methodology

The instrument is shown in the appendix and consists of 17 items, including 1 demographic question on gender identity, 7 mixed-methods items, and 9 quantitative items. There are 2 items on OERs, 4 items on publishing in the OER, 5 items on student-generated problems, 3 broad course items, and 3 student-centric items. After the study was approved by a research ethics board, data were collected during the last lab of the course by research assistants rather than the instructor (to reduce pressure to participate). Participation was anonymous, and surveys were kept in sealed envelopes until after the course grades were submitted (to encourage voluntary participation).

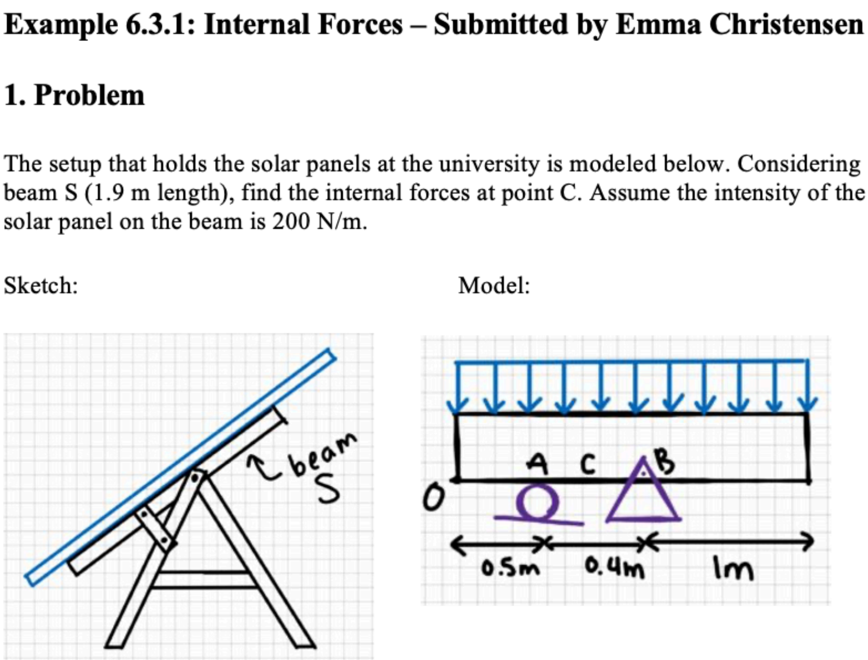
The participant sample includes 28 engineering students in a first-year course at a small Canadian university. In the sample, 29% of participants identify as female, 64% identify as male, 0% identify as non-binary, 3.5% preferred not to disclose, and 3.5% left the item blank. As this is a small, convenience sample, it is not intended to be representative of the large population of engineering statics students [34].

As an exploratory mixed-methods study, qualitative data were coded and converted into 9 quantitative themes. Descriptive statistics were found for the 24 quantitative dependent variables. Inferential statistics were performed between independent variables (gender, self-reported midterm and homework grades, and the number of problems generated) and both categorical variables (using Chi-squared tests) and continuous variables (using Mann-Whitney U-tests as data were not normal) [34].

4 Results

4.1 Pedagogical practice results

In total, 93% of students in the course created at least one student-generated homework problem, and 43% of students created the maximum allowable (6) student-generated homework problems. Of the 31 students who had at least 1 problem that met the criteria for publication, 18 students (58%) submitted at least one example for inclusion in the OER textbook; one student requested an anonymous attribution. Students submitted 59 problems in total, at an average of 3.3 problems per student (n=18, range=[1, 6]). Figure 1 shows a sample problem. The solution can be found in [35].



Example 6.3.1: Internal Forces – Submitted by Emma Christensen

1. Problem

The setup that holds the solar panels at the university is modeled below. Considering beam S (1.9 m length), find the internal forces at point C. Assume the intensity of the solar panel on the beam is 200 N/m.

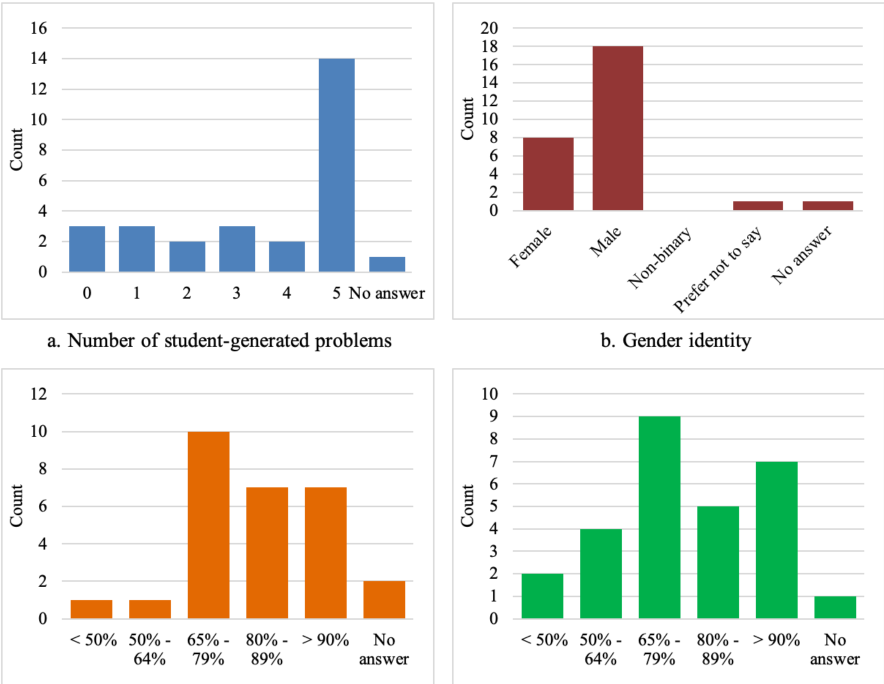
Sketch: Model:

Fig. 1. Sample student-generated problem [35]

4.2 Survey descriptive statistics

Of the 28 study participants, 26 (93%) felt the activity should be repeated in future years. Participants spent an average of 9 hours on each homework assignment, ranging from 2 to 25 hours. Figure 2 shows the distribution of responses for independent variables. Note: the maximum number of possible problems is reduced to 5 as the survey was completed before the final assignment was submitted.

The two items on OER usage and preference (item numbers 1 and 2 in Appendix B) revealed that students use a variety of textbooks during their first year in university, as shown in Table 2. Most students used an OER, purchased a new hardcopy, or purchased a digital copy (n=28) during university or high school. Considering the statics course used an OER textbook, the 71% result was lower than expected but demonstrated an honest response. The most preferred type of textbook was the OER (50%) because, as students explain, "it is free and accessible from anywhere, no weight in my backpack," "easy access," and "it is usually equally effective." The next most common preferences were used or borrowed physical copies (18% each), and the least preferred were digital rentals (4%). Concurrent with the literature, the qualitative responses indicated that the driving factor is the cost [15, 19]. Additionally, students appreciate a physical copy as in [11], citing it is "easier to read from and good for future reference." One student echoed the findings of [7], "although I would prefer not to spend money, I prefer to have a physical copy to write and highlight in, and having a used one saves money and shows me what previous students thought was important." Findings confirm a preference for OERs.



a. Number of student-generated problems

b. Gender identity

c. Homework grade (self-reported)

d. Midterm grade (self-reported)

Fig. 2. Independent variables responses

Table 2. Type of textbook use and preference (n=28)

	Used previously		Preference	
Purchased new hardcopy	13	(46%)	3	(11%)
Purchased used hardcopy	9	(32%)	5	(18%)
Borrowed a hardcopy	7	(25%)	5	(18%)
Purchased digital copy	13	(46%)	3	(11%)
Rented digital copy	5	(18%)	1	(4%)
Used OER online	20	(71%)	14	(50%)

Note: Students can select more than one option

For the items focused on publishing examples in the OER textbook (items 6, 7, 11, and 12 in the appendix), the sample of participants is reduced to those who created at least one problem (n_{prob}=24). The potential for publication was not found to be a motivating factor, as only 29% of participants (n_{prob}=24) indicated that they worked harder on the student-generated problems and 71% did not work harder. One student explained, "The idea of them being published made me NOT want to do it." Another stated, "I worked equally hard on both the textbook and other problems." Though in the minority, students who worked harder on the problems stated, "I want to be published" and "I wanted to have interesting questions that I found doable in the textbook."

When asked how many of their problems *would be included* in the OER, 75% of participants entered a lower number than the number of problems that they generated, indicating they did not expect to have all questions published (n_{prob}=24). Confoundingly, 12.5% of participants entered a substantially larger number to be published than the number they completed and 12.5% left the question blank. When asked what proportion of their problems they *wanted to be included* in the OER, 29% indicated 'none,' 50% indicated 'some,' 17% indicated 'all,' and 4% did not respond (n_{prob}=24). The 79% of participants who *wanted* 'some' or 'none' to be included reflects the 75% who forecasted that a lower number would be included. This indicates a more positive explanation of preference matching expectations rather than a lack of confidence that they will be included. One participant explained, "Some of mine were of lesser quality/too basic, but the others are interesting and therefore should be used." Another cited the time constraint, "They're too simple. I didn't have time to make them and solve them as I wish I could have."

Students were asked how it would feel to be published, and all of the 63% who responded (n_{prob}=24) expressed positive emotions. They explained, "Great! Gives me a sense of achievement", "proud," and "Since it is helping others, it will be nice." Helping other students learn was identified as a motivating factor.

Of the items focused on the pedagogical practice of student-generated problems (items 4, 5, 8, 9, and 10 in the appendix), participants spent an average of 14% of their homework time on the problems, ranging from 0 to 50% of the homework time (n=28). The number of student-generated examples (shown in Figure 2a) has an average of 3.5 out of 5 possible examples per participant (n=28). Of the participants who completed at least 1 problem (n_{prob}=24), 54% intended to make the problems of 'medium' complexity, followed by 25% who created 'easy' problems. Only 8% made 'very easy' problems, and conversely, 4% made their questions difficult, while 8% did not answer. This indicates students did not try to write the easiest problems to simply complete the assignment (or did not admit to doing so).

When asked about ease of creation, 54% (n=28) found it easier to create problems as opposed to solving standard problems. However, 68% of participants (n=28) felt they learned more from textbook problems. Combining these responses, 39% of participants held the majority for both of the previous responses. One of these participants explained, "Creating the problem was easier because I mostly focused on concepts I knew well." Though the student indicated this as a negative element, it meets the pedagogical intent to solidify knowledge and develop understanding (as discussed in the literature [13][3]). Next, 14% of participants were in the minority for both questions (the textbook problems were easier and learned more with the student-generated problems). A participant in this category explained, "The problems followed a standard formula whereas the textbook example was less formulaic." Finally, 39% of participants put the same response for both 'easier' and 'learned more' (28% indicated the textbook and 11% indicated the OER). One participant who selected the textbook problems explained, "Because I know it is 100% right", demonstrating a comfort level with the standard problems. One student left the 'learn more' item blank and stated, "I think both are good, can't decide."

The themes that arose from the qualitative data across the 7 mixed-methods items are shown in Table 3. The percentage indicates the number of participants that discussed that theme out of the number of participants who provided any comment (n=24).

Table 3. Themes derived from qualitative data

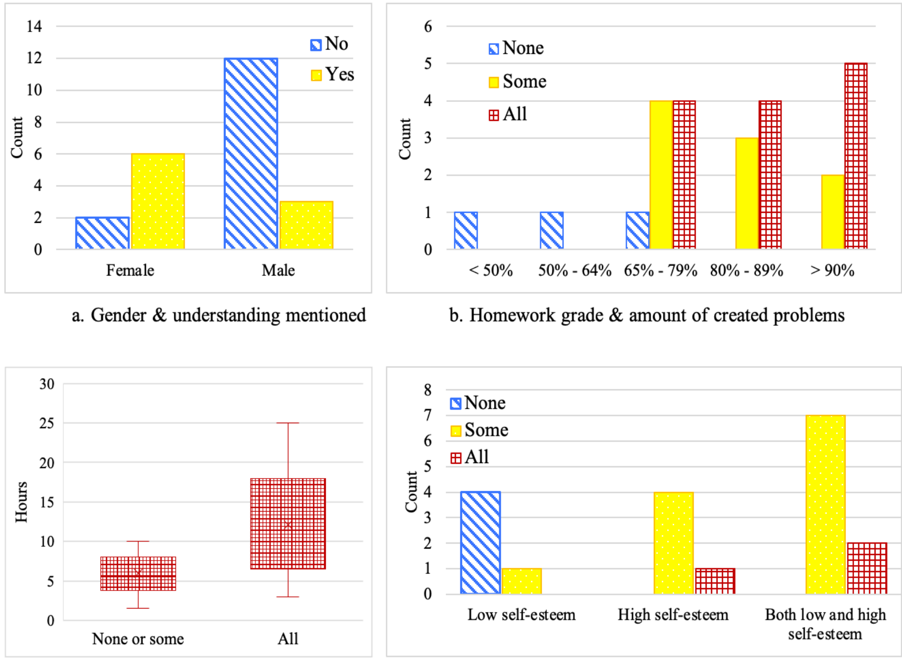
Theme	% of Participants	n	Comment
High engagement with survey	86%	28	Provided any comments
Self-esteem	83%	24	21% demonstrated high self-esteem 25% demonstrated low self-esteem 38% demonstrated both high & low
Mentioned time	42%	24	In items about student-generated problems
Mentioned personal learning	46%	24	In relation to both textbook problems and student-generated problems
Mentioned understanding	38%	24	In relation to student-generated problems
Desire to help others	33%	24	In relation to publishing in OER
Real-world application	17%	24	In relation to student-generated problems
Creativity	13%	24	In relation to student-generated problems
Publication	13%	24	Mentioned publishing favorably, unfavorably, or unaffected once each

4.3 Survey inferential statistics

A correlation was found between gender identity and whether the participant commented on understanding the problem ($\chi^2(2)=7.360$, $p<.05$). As shown in Figure 3a, participants who identify as female were more likely to comment on understanding than participants who identify as male.

Self-reported homework grades were correlated with the number of examples that were completed using a Chi-squared contingency test. ($\chi^2(8)=17.372$, $p<.05$). Participants who did not complete any examples scored less than 80% on homework, and participants who completed at least 1 example scored higher than 65% on homework, as shown in Figure 3b. Students who scored >90% on homework predominantly also completed all examples. As the student-generated problems were only worth 5%, the difference in grades cannot be explained only by skipping the student-generated problems but rather reveals a tendency to submit incomplete or poor assignments.

There were significant differences ($U= 43$, $p<.05$) between the amount of time spent on homework and whether participants completed all 5 student-generated problems (n=14, median=9.0 hours, $\bar{x}=12.1$ hours, $\sigma=7.8$ hours) or not (n=12, median=5.5 hours, $\bar{x}=6.0$ hours, $\sigma=2.8$ hours), as shown in Figure 3c. Non-parametric Mann-Whitney U-tests were employed instead of t-tests because the time spent on homework did not meet assumptions of normality [34]. Students who spent more time on homework were also more likely to create problems, with a large effect size (r=0.488). This indicates that students who completed all examples spent more time completing the assignments.



a. Gender & understanding mentioned

b. Homework grade & amount of created problems

c. Time on homework & amount of created problem

d. Self-esteem & whether they want examples included

Fig. 3. Inferential analyses by independent variables

Using a Chi-squared contingency test, we found that self-esteem correlated with whether participants wanted their examples included in the OER ($\chi^2(4)=14.285$, $p< .01$), shown in Figure 3d. Participants who did not want their examples included in the OER textbook exhibited low self-esteem (through their comments), and participants with high self-esteem wanted some or all of their examples included. This correlation reveals a need to individually reach out to students who may exhibit lower self-esteem to encourage them to submit examples.

5 Discussion

5.1 Efficacy of the pedagogical tool

Student generated problems require students to spend time understanding the concept and encourages them to develop their creativity. This section will discuss the themes documented in Table 3 with language from the student. Also, generating and solving their own problems connects their assignments to real-world applications, as one student explains: "As these questions involved applying our knowledge to real life, I found them to be much more effective. They incorporated both understanding and application so I found them to be both interesting and helpful," echoing the literature [3][13][22]. Students had to spend time understanding the concept instead of rushing to a solution, as one student explained, "Creating a textbook example helped me learn more as it made me think of all aspects of the problem from start to finish" (linking to [25][33]).

As a pedagogical tool, students expressed working harder on the problems because they were interested and able to express their creativity: "I worked harder because they were more interesting," and "I worked harder on them because they were fun and creative, whether my questions get published or not that is not on my mind when creating a problem," (linking to [2][33]). Publishing their examples seemed to be a beneficial by-product instead of the primary motivation, as one student explained, "I don't really care if they are [published] but they might help other students so that would be good." Motivations for publication were to help future students, and one student sought to help instructors as well, stating, "I like to be useful for future students/teachers." This aligns with the social responsibility identified in [36], which found that "' helping people' was the most important job attribute when [28% of participants] considered their future engineering careers". Also, OERs are intrinsically altruistic, as altruism is helping others without the expectation of reward [37]. In addition to altruism, students were motivated by a desire to understand the material, as one student explained, "I had to understand the equations and material to write my own." One student linked the themes of helping others and understanding the material, explaining "I hope that my examples can help others better understand the concepts as that is the ultimate goal."

One drawback of student-generated problems is that they are time-consuming, "I was more concerned about finishing the other problems in time, so I spent whatever time I had left on the examples." One student suggested the opportunity should be offered again, "but as a bonus," perhaps to mitigate the time demands. Additionally, recognizing the many demands on students' time can affect their desired grade, as one student explained, "I saved it for last because it wasn't as important and I work 50 hours a week so just wanted to finish the main parts". The problem could be weighted higher to match the additional time required or, inversely, weighted less to be less detrimental.

Because students were able to select which concepts to create problems for, as one student explained, "you could do simple or complex ones," a pedagogical improvement could be to reserve the exercise for particularly complex topics. Thereby, students are forced to learn the difficult concepts before applying them to a real-world problem, as echoed by a student, "I had to understand the equations and material to write my own."

One surprising theme that emerged from the data was noticeable self-esteem, as one participant used this word specifically. It was found that 83% of participants demonstrated a combination of low self-esteem, high self-esteem, or both, and this was correlated to whether students were likely to submit their problems for publication or not. One student identified that fear publication was a barrier to them creating any problems. Pedagogical practices should be inclusive rather than exclusionary, so the optional nature of publishing could be emphasized to reduce the fear of publication.

One advantage of this pedagogical tool was that students who submitted only one homework assignment and were not traditionally studious were able to benefit from the publication of their example. Reaching out to these students individually to encourage them to publish their one example created a positive connotation of what they were able to complete instead of an emphasis on the assignments they did not complete. These students expressed an eagerness to participate when contacted.

5.2 Limitations and future work

In this post-COVID-19 world, pedagogical tools are required that are compatible with distance learning [38] and in-person experiences. As a pedagogical practice, student-generated problems allow students to engage with real-world engineering in any context. Being confined to their homes forces students to be more attentive and creative in applying course concepts in a small space and requires no pedagogical modification.

Due to the small sample size of students in a summer course, these results are not intended to be representative of the larger population [34]. However, this sample size is valid as a pilot study to investigate the two pedagogical tools: the incorporation of student generated problems and giving students the option to publish these problems in an OER. The findings are encouraging, and a more expansive study could examine the efficacy of the two practices individually as well as the effect of combining the pedagogical practices. These practices are limited to statics courses and could be studied in other fundamental engineering courses such as dynamics and thermodynamics.

6 Conclusion

The first aim of this paper was to document the pedagogical practice of publishing student-generated homework problems in an OER textbook. Given that 93% of students created and solved at least one student-generated example for their homework, 58% of students submitted problems for publication, and 93% of participants indicated the activity should be repeated, there is merit to continuing this pedagogical practice.

The second aim of the paper was to study student perceptions of generation and publication of homework problems. It was found that students who submitted examples for the OER textbook were motivated by a desire to help other students and better understand the course concepts. Students commented on the effectiveness of the student-generated problems in understanding material, the opportunity for creativity, higher engagement, and real-world application. However, the student-generated problems were found to be time-consuming.

Students reinforced the findings in the literature that support OERs due to cost considerations, accessibility, effectiveness, and ease of use. Combing the enhancement of an OER textbook and supporting students' understanding of the material enabled students to create, solve, and publish their examples. For future implementations, it is recommended to repeat the following practices: (1) weight the student-generated problems lightly on homework due to the time demands, (2) emphasize the *option* to publish (rather than a requirement), (3) wait until after grades are submitted to personally invite students to publish (so as not to exert undue pressure), and (4) provide attribution options (as some students prefer anonymity). Resources are required to support the review and digitization of student-generated problems, but this too can be an educational opportunity to hire students to reinforce their knowledge of the course material. Student-generated problems could be adopted in widespread technical courses and are particularly useful in fundamental courses to help students see engineering applications in the real world.

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10 Appendix A: Sample assignment problem

For this homework assignment, I want you to write your own sample problem that would be appropriate to include in Ch ____ of the open textbook. It cannot be taken from an example online or from another book.

Pick a section, look around you to find a real-world problem that applies to that section, and solve it. 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.

11 Appendix B: Instrument and item

1. Which of the following types of textbooks have you used before in high school or university (not what your teachers for, but what you used). Select all you used before:
   - ☐ Bought a new Textbook from bookstore
   - ☐ Bought a used Textbook
   - ☐ Borrowed a Textbook (didn't buy)
   - ☐ Bought a digital or e-textbook online
   - ☐ Rented a digital or e-textbook for set duration
   - ☐ Used an online open textbook (for free)
2. Which do you most prefer (pick 1)? Please explain why. (briefly)

3. Now thinking only about the ENGN 1230 statics, how much time on average did you spend on each homework assignment (approximately)? __________ hours
4. What percent of that time was spent on the textbook examples? _____________%
5. How many textbook examples did you complete in your homework? (max 5). _____
6. How many of the examples do you think will be included in the open textbook? ____
7. Did you work harder on the textbook examples because they might get published?
   Yes No Please explain why. (briefly)
8. How difficult did you make your examples? (pick 1)
   Very easy Easy Medium Difficult Expert
9. Which did you find easier? (pick one): Please explain why. (briefly)
   - Completing the standard homework problems
   - Creating textbook example
10. Which helped you to learn more? (pick one): Please explain why. (briefly)
11. Do you want your examples included in the textbook? Please explain why. (briefly)
    None Some All
12. If you *do* want your examples to be included in the book, how does it feel to know thy may be seen by future students who will use the open textbook?
13. Would you recommend this be offered to future 1230 statics classes? Yes No
14. Do you have any other feedback on topics covered in this questionnaire?
15. On homework assignments, your grades were mostly:
    < 50 50–64 65–79 80–89 >90
16. On the midterm, your grade was:
    < 50 50–64 65–79 80–89 >90
17. Your gender identity is:
    Female Male Non-binary Prefer not to say In my own words