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Benefits of developing a personalised, flexible format engineering course book

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ABSTRACT: Text resources, like course books, can provide strong educational support for students when selected carefully and utilised effectively. While existing textbooks can be useful guides for instructors looking to develop a new course, it can be difficult to find a new text that compliments an existing course well. For this project, instructors studied the benefits of writing a personalised, flexible format course book for a first-year engineering (FYE) course. The developed course book presented engineering concepts in easier to understand language, provided examples and additional practice problems to illustrate problem-solving, and discussed student success topics. In this article, the author reports the considerations made while creating the book and the observed benefits from utilising the text within the classroom. The course book was well-received by students and a beneficial addition to the FYE course. Benefits of using the personalised book were: 1) the author was able to design the text to match the student population's mathematics and science backgrounds; 2) students appreciated access flexibility and accessed the book regularly throughout the semester via a variety of methods; and 3) because the text was free to students, there were no financial barriers or burdens for accessing the instructional resource.

Keywords: Course books, first-year engineering, flexible books

INTRODUCTION

A course textbook can have a significant effect on the learning of students [1]. When designed well and selected correctly, it can provide a strong support to student learning and help them develop a wider understanding of topics [2]. Textbooks can serve as preparation materials that students can read before coming to class, a resource for assigning and completing homework, an aid to supplement or clarify material covered in class, a study aid to prepare for examinations, and more.

However, just because a course has an accompanying text does not mean it will benefit student learning. If a text is not designed in an effective manner or not incorporated well into the course, it is easy for it to just become an expense with little positive contribution [3]. A poorly selected or utilised textbook can lead to student frustrations, especially given the typically high cost. Without an effective course text, students struggling with course material are limited in help resources. This problem is exacerbated for non-traditional students who need to predominantly study during evenings or weekends when instructors may not be available. Not all students have access to reliable Internet connections, while off campus, so these students can be dependent on physical resources like a textbook.

For this project, a course book was created for a first-year engineering (FYE) course. It was written in direct response to many student requests received on end of the semester course evaluations throughout a three-year period. In this article, the author reports the considerations made while creating the book and the observed benefits from utilising the text within the classroom.

The course book was written for a first-year engineering (FYE) course at a medium-sized university in the Midwest of the United States of America. The goal of the FYE course, ENGR 100, is to develop and strengthen students' understanding of mathematics and science concepts and engage them with the material by using engineering applications. Prior to this project, ENGR 100 did not have a designated course book. There was a recommended textbook, but students did not technically need to access the book in order to complete the course.

On course evaluations, students commented that they would try to use the recommended text when they were struggling, but they were often frustrated with how the book did not entirely align with the course and felt that the writing was difficult to understand, because they felt it assumed prior engineering knowledge. Because of this, students did not feel

that it was worth the cost. Consistently mediocre student feedback about the existing recommended textbook was a primary driving force behind the development of a personalised course book.

In addition to wanting a text that was more useful to students, the author also wanted to decrease the financial burden. Students in the fall 2019 semester of ENGR 100 reported spending an average of over $280 on textbooks for that single semester. With many students needing to work in addition to taking a full course load (80% of the fall 2019 class), it was important to the author that finances would not limit a student's access to the resource. One way to decrease the financial burden from textbooks is for students to purchase electronic copies. However, 73% of surveyed ENGR 100 students reported preferring to study with paper versions of textbooks over electronic copies. Because of this, the author wanted to ensure flexibility, so that students could access the course book in a manner best for them. This was especially important considering the observed number of students who do not have reliable Internet at home, because they commute daily from rural areas without strong Internet infrastructure.

METHODS

Course Book Design Considerations

The course book was written during the summer of 2019 by a FYE faculty member. The book was written using a common word processor software, so that the author could easily make future edits as needed. This is important, because courses constantly adapt and change what content is covered and what course goals are addressed. Maintaining the book in a format that is easily changed allows the author to adapt content to continually fit the needs of the course. The structure of the book directly mimicked the order the material is covered within the semester. This was done to help students navigate the book more efficiently and to make it easier for instructors to direct students to helpful sections. It also served to remind students how closely linked course content and book content was.

When writing the course book, emphasis was placed on including fully worked out example problems and practice problems at the end of each chapter due to strong evidence that practice problems are a highly effective way to learn and retain information [4]. The author wrote all explanations in a conversational tone instead of a technical tone that could be overwhelming to first-year students. The course book presented material in a variety of ways to increase understanding and retention of material for a wider variety of students. In the literature, students showed increased success in courses where instructors presented information using varied techniques [5].

Varied delivery methods not only keep students engaged, but also help reach a wider range of learning preferences. Engineering students often prefer learning to solve problems with standardised methods and prefer information presented in visual aids like figures [6]. To accommodate this, many types of figures and example problems with formalisms that distil complex problems down into consistent steps were included.

Each chapter started with an overview of the topic, which included descriptions of real-world applications and how each engineering degree offered at the University could potentially use the material in their future career. This helped students relate to, and understand, the importance of the material before they delved into the math in order to avoid the dreaded student attitude of, *when will we ever use this?* At the end of every new concept, a fully worked out example problem helped students understand how the new material could be applied. Every chapter also had a student success topic embedded into the text. For example, students were taught how to create their own formalisms to solve categories of problems. This made new material less overwhelming and help tackle new scenarios. At the end of each chapter, additional practice problems were listed to give students another opportunity to practice the new material. The solutions for the additional practice problems were provided at the end of the book. The solutions were purposely physically separated from the problem statements to encourage students to attempt these problems before reading the solution. A common trap seen with new students is they read the solution without trying the problem and assume they know the information just because the solution made sense as they read it.

When choosing the distribution format, flexibility was a top priority to eliminate access barriers like inconsistent or no Internet access at homes, cost, inability to carry around heavy physical texts, and reading style preference of electronic or paper forms [7-9]. The book was electronically posted to the ENGR 100 course Web site through the University learning management system (LMS). Students were then encouraged to either 1) access the book through the Web site each time they needed it; 2) download and save the file to a device, or 3) print out the book so that they had a paper copy. This gave the students flexibility to engage with the course book in the method they preferred and eliminate financial barriers.

Data Analysed

To study the effectiveness of the course book, there were two main data sources collected: usage statistics totalled at the end of the semester (16 weeks) and a student survey given during week 10. All reported data was collected during the fall 2019 semester. This semester, there were three lecture sections taught by three different instructors with an average of 40 students per section. Because the course book author taught one section, all data was not viewed until after final grades were submitted to minimise any biasing of the results.

Throughout the semester, ENGR 100 instructors kept an electronic copy of the course book posted to the course LMS page. The LMS tracked how many times students viewed the file throughout the semester. It only collected a straight count of views, not the duration. At the beginning of the semester, students were notified that this data was going to be collected and viewed after the semester was completed. This safeguard eliminated the possibility that instructors could be biased towards a student depending on their course book usage, and it also helped avoid students feeling like they needed to open the course book a lot just to look good to the instructor. The usage data was tallied as the number of views per student for each day of the semester, and the LMS calculated the number of views per hour of the day and the number of views per day of the week.

Although the usage statistics did provide helpful information about the overall usage trends, they may not fully capture how frequently students interacted with the text. First, if a student downloaded and saved the book to a device, then their recorded number of views would be lower than a student who accessed it through the Web site every time even though they may use the book just as often. Second, a student whose schedule allows them to study for longer periods of time may appear to access the book less frequently than a student who can only study in small bursts. They may be using the book the same amount overall, but one could have a visibly lower recorded usage.

The second data set collected was a survey completed by the students 10 weeks into the semester. Students completed the survey during the computer laboratory component and no instructors were present while it was completed. The survey asked students about their usage of the course book, what elements they used the most, their preference between electronic versus paper books, and requested feedback about perceived strengths and areas for growth.

RESULTS

During the assessment period, there were three sections of ENGR 100 that used the course book. Section 1 was taught by a veteran instructor who had previously taught the lecture four times. Section 2 was taught by the course coordinator course book author who had taught the lecture 11 times. Section 3 was taught by a new instructor who had not taught the lecture part of the class before, but was familiar with the course content. Enrolment was similar across all sections of the course with the number of students ranging from 37 students to 43 students (see Table 1).

Table 1: Course enrolment and course book views per student reported per section for the fall 2019 ENGR 100 class. This data was collected from the first day of classes through the last day of finals week.

		Section 1	Section 2	Section 3
Number of students enrolled		43	42	37
Total number of views for the semester		3699	4446	3834
Number of views per student	Average	88.1	105.9	103.6
	Standard deviation	36.6	35.3	53.1
	Minimum	25	45	23
	Maximum	189	196	281

The largest benefit of the new course book was that students used it and used it a lot. The number of views were collected and tallied by the course LMS. Students enrolled in Section 2 had the highest number of total views and average views per student (Table 1). It also had the smallest standard deviation. This was the section taught by the author, so the higher number of views could be a by-product of the author emphasising the book more or students feeling obligated to view the book more. However, all three sections viewed the book significantly more than the author originally anticipated. An interesting feature is the minimum number of views per student.

On the student survey given out 10 weeks into the semester, 34% of students reported that they had not used the course book yet. However, by the end of the semester all students had viewed it a minimum of 23 times. The instructors anticipated students using the course book more in the last part of the semester, because historically students have struggled with this material more. Section 3 had the highest maximum number of views per student with a student viewing the course book 281 times during the semester.

Although it is tempting to say that a student with a high number of views is a student who is engaging with the course book more, that is not necessarily true. As discussed previously, a limitation of the usage data collected by the LMS is that it does not record how long the student had the course book file open. Additionally, depending on how a student accessed the book, their usage count may be artificially low.

On the survey given in week 10, 31% of students reported accessing the book through the Web site every time they needed it, 22% saved an electronic copy to a device, only 8% printed out a paper copy to use, and 7% said they used a combination of electronic files and paper copies. The 37% of students that saved or printed the file could have artificially low views. Even though the number of views is not a perfect metric of how much a student engaged with the course book, the author found it extremely positive that all students within the course interacted with the book multiple times by the end of the

semester. On the survey, students commented that they liked having the option to access the book through many methods. There were two students who wished it was directly available in print format like a regular textbook. However, both students also commented that they understood that option would cost money, and the zero cost was more important to them.

In addition to wanting to understand how students were accessing the book, the author wanted to quantify what times of the day and what days of the week students were accessing the book. One of the motivations for writing the book was to give students a thorough instructional resource to access outside of traditional work hours. Most instructors are not consistently available to help students during the night and on weekends, but many ENGR 100 students report completing schoolwork during these times because of work, family and other obligations.

The three lecture sections showed similar trends across the week with usage primarily during the work week and only 7% of views on Saturday and Sunday. Although students did not regularly use the book on the weekend, many accessed it during the evening hours. An average of over 21% of views occurred between the hours of 19.00 and 07.00. This is a promising result, because it means that students who previously did not have a comprehensive course resource during instructor *off* hours are now able to get help on course material.

When developing the course book, one of the goals was to make it useful for a variety of study needs. By adding many example problems with fully worked out solutions, additional practice problems with solutions, and text written in a conversational tone, the author hoped to provide a useful resource for students to complete homework assignments, study for examinations, and help learn material covered in lecture that they needed additional time with. As shown in Figure 1, 10 weeks into the semester students reported predominantly using the course book to prepare for examinations and help complete weekly problem sets.

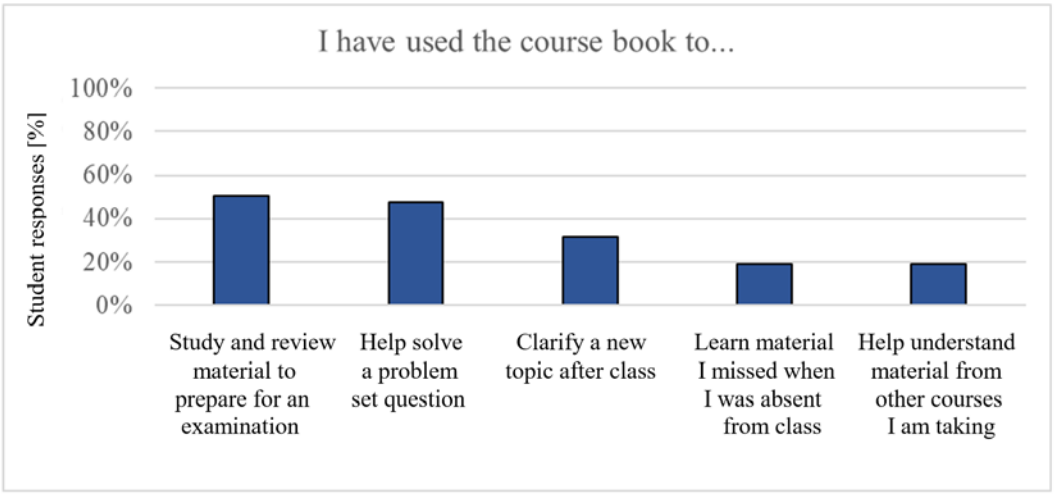

Figure 1: Reported reasons students used the course book during the fall 2019 semester. Students were able to select multiple options for this question.

In Figure 1, students could select more than one option. Over 51% of students reported using the course book to study for the course examinations, 47% of students used the course book to help solve the weekly problem sets, and over 32% of students used the book to help understand new material covered in lecture.

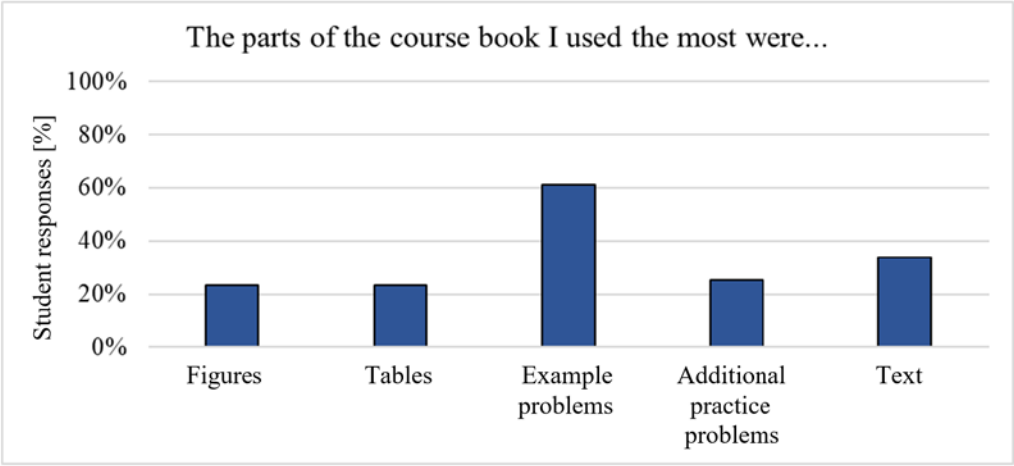

Figure 2: Elements of the course book that students reported using the most during the fall 2019 semester. Students were able to select multiple options for this question.

When asked what elements of the book students used, the example problems were the most used as shown in Figure 2. Over 60% of students reported that they used the example problems, and 34% of students used the written explanations (text). An unexpected result was that only 25% of students reported using the additional practice problems located at the end of each chapter. This was surprising because instructors announced to the class that the additional practice problems were given as examination review problems in previous semesters. The author assumed more students would access this component especially before examination time.

Each semester students are asked to rate the effectiveness of the course textbook as part of the end of the semester course evaluation conducted by the University. Students rate the book on a Likert scale of 1 = poor to 4 = excellent. The results of this survey from the fall semesters of 2016 through 2019 are shown in Figure 3.

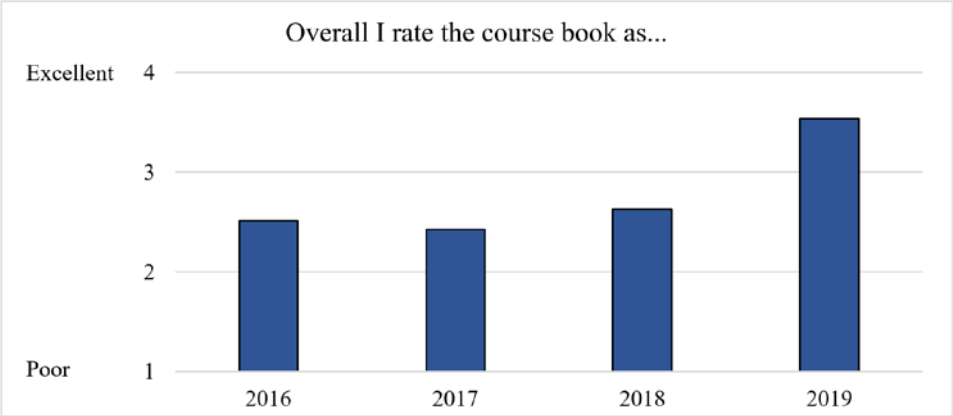

Figure 3: Course evaluation ratings of the ENGR 100 book during the fall semesters of 2016 through 2019.

From 2016-2018, the old ENGR 100 textbook was rated an average of 2.5, which is exactly between *fair* and *good*. Student comments about the old book usually focused on the cost and how the writing did not help them understand course material. The new course book rated at 3.5 (between *good* and *excellent*). With the wording of the survey question presented in Figure 3, it is not possible to separate how much of the rating jump was due to the students truly liking the new course book more versus students just liking that the new book was free. However, on the survey given 10 weeks into the semester, students were asked to respond to the prompt, …*I believe the strengths of the ENGR 100 course book are...* 82 out of 95 students provided responses to this question. Only four of the responses mentioned the price of the book as a strength, and three of those students also listed other components of the book as strengths. Students commented that the strengths of the course book were the *step-by-step example problems, making sure we have adequate resources/examples to fully understand the material*, and the *fun writing style*.

Moving forward, the author is continuously working to improve and adapt the course book to meet student needs. The course book is currently being reviewed by two upperclassmen students who took ENGR 100 as first-year students and have served as teaching assistants for the course. They provide a unique perspective, because they are familiar with the course material from a student and instructor perspective. These students have been asked to look for areas of growth in explanations and develop recommendations for example problems to add. It is the author's goal to treat the course book as a dynamic text that will continue to grow and change to meet student needs and address any changes to course content and goals.

CONCLUSIONS AND RECOMMENDATIONS

Overall, developing the course book was a positive and rewarding experience. Although it was a large time commitment and a daunting project, the author feels that it is an important part of the course and has made the student learning experience better. All students enrolled in the course viewed the course book many times throughout the semester. The book gave students an additional and substantial study aid to use in times when their instructors were not available, and students utilised and appreciated the flexible access format.

The largest benefit to designing a personalised, flexible textbook is that students used the book and used it often. Additional benefits were 1) the author was able to design the text to match the student population's mathematics and science backgrounds; 2) students appreciated access flexibility and accessed the book regularly throughout the semester via a variety of methods; and 3) because the text was free to students, there were no financial barriers or burdens for accessing the instructional resource.

REFERENCES

1. Krammer, H.P., The textbook as classroom context variable. *Teaching & Teachers Educ*., 1, **4**, 273-278 (1985).
2. Lockheed, M.E., Vail, S.C. and Fuller, B., How textbooks affect achievement in developing countries: evidence from Thailand. *American Educational Research Association*, 8, **4**, 379-392 (1996).

3. Moulton, J., *How do Teachers use Textbooks?* Health and Human Resources Analysis for Africa (1997).
4. Dunlosky, J., Rawson, K.A., March, E.J., Nathan, M.J. and Willingham, D.T., Improving students' learning with effective learning techniques: promising directions from cognitive and education psychology. *Psychological Science in the Public Interest*, 14, **1**, 4-58 (2013).
5. Felder, R.M. and Spurlin, J., Applications, reliability, and validity of the index of learning styles. *Inter. J. of Engng. Educ*., 21, **1**, 103-112 (2005).
6. Felder, R.M., Learning and teaching styles in engineering education. *J. of Engng. Educ.*, 78, **7**, 674-681 (1988).
7. Gadiraju, V., Panat, A., Poddar, R., Sherriff, S., Kececi, S. and Schulzrinne, H., Who Gets Broadband When? A Panel Data Analysis of Demographic, Economic, and Technological Factors Explaining U.S. Broadband Deployment. SSRN (2018).
8. Bliss, T., Hilton, J.I., Wiley, D. and Thanos, K., The cost and quality of online open textbooks: perceptions of community college faculty and students, *First Monday*, 18, **1** (2013).
9. Lindshield, B.L. and Koushik, A., Online and campus college students like using an open educational resource instead of a traditional textbook. *J. of Online Learning and Teaching*, 9, **1**, 26-38 (2013).

BIOGRAPHY

Rebecca Essig is an Assistant Professor of Engineering and First-Year Engineering Program Coordinator at Purdue University Fort Wayne, Indiana, USA. She graduated with her Bachelor of Science (2010), Master of Science (2013) and Doctor of Philosophy (2016) in civil engineering from the Lyles School of Civil Engineering at Purdue University, USA. Her research primarily focuses on the recruitment and retention of engineering students and increasing minority representation in engineering programmes.

Check about the Benefits Of Personalized eLearning and a case study for Instructional Designers.Â A pre-assessment can help us understand the baseline proficiency, and the learner can be given a personalized learning track that corresponds to the competency gaps. Alternatively, we can use a survey to assess where the learnersâ€™ interests lie and then offer a personalized set of recommendations on how to â€œconsumeâ€ this module (that is, which parts could be skipped and which should be taken with special attention). What Are The Approaches That Can Effectively Personalize eLearning? As I have highlighted, personalized eLearning can be crafted through a variety of measures that can help us cust For this project, instructors studied the benefits of writing a personalised, flexible format course book for a first-year engineering (FYE) course. The developed course book presented engineering concepts in easier to understand language, provided examples and additional practice problems to illustrate problem-solving, and discussed student success topics.Â When choosing the distribution format, flexibility was a top priority to eliminate access barriers like inconsistent or no Internet access at homes, cost, inability to carry around heavy physical texts, and reading style preference of electronic or paper forms [7-9]. The book was electronically posted to the ENGR 100 course Web site through the University learning management system (LMS). Personalized learning is an invitation for educators to create opportunities for learning that takes advantage of the digital skills most students already possess. Personalized learning is specically tailored to each studentâ€™s strengths, needs, and interests while ensuring the highest standards possible. is approach is a major paradigm shift from the traditional â€œone-size-ts-allâ€ approach to education.Â is book provides the essential information needed to implement personalized learning with technology and concludes with a step-by-step guide to planning, funding, and implementing a schoolwide personalized learning program. Please let us know what you think about the information in this book. Engineering programs, also seeking ways to prepare students for real-world engineering scenarios, usually run prob-lem-based learning (PBL) courses along-side traditionally taught engineering courses (see Cawley, 1989). A logical pedagogical approach, beneficial to foreign language and engineering departments alike, would combine both PBL and LSP tracks into one course. However, this is not always practi-cal, and we advocate here construction of PBYLSP modules that can be introduced into existing engineering courses. Moreover, only the students in the courses who choose the LSP track in their engineering 1. Develop flexible learning groups. 2. Use data to form flexible groups. 3. Plan lessons for flexible groups in a mixed-ability classroom.Â Personalized learning is everywhere in our ever-changing world of education.The potential in personalized learning is immense; educators see it as a way to address the learning needs of a student population that grows more diverse every day. In this book, we will look at the definition of personalized learning and its impact on students, particularly in groups, in todayâ€™s technology-infused classrooms. Objective 12. Build a communication network with parents.