SCHOOL OF
CHEMICAL ENGINEERING
College of Engineering, Architecture and Technology

ConocoPhillips Lectureship in Chemical Engineering Education

BEYOND READING: INTERACTIVE TEXTBOOKS FOR CHEMICAL ENGINEERING STUDENTS

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ConocoPhillips

ConocoPhillips
Lecture Series in Chemical Engineering Education
given at Oklahoma State University
by Matthew W. Liberatore
Trine University

Stillwater, Oklahoma
November 14, 2024

ConocoPhillips Lectureship

in Chemical Engineering Education
at Oklahoma State University
An annual lecture series in Chemical Engineering
co-sponsored by ConocoPhillips
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Stillwater, Oklahoma

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Professor of Chemical Engineering and Associate Director, Institute of Science and Technology
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Monsanto Company
St. Louis, Missouri
Industry-University Interactions

October 15, 1976
Dr. M. R. Lohmann
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Technology and Architecture
Oklahoma State University
Stillwater, Oklahoma
Looking Forward – Looking Back, An Old and New Problem of the Profession

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M.D. Anderson Professor of Chemical Engineering
University of Houston
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Complexity and Confusion in World Affairs, Challenge to Engineers and Educators

November 30, 1978
Dr. D. L. Katz
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University of Michigan
Ann Arbor, Michigan
Practice What You Teach

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Massachusetts Institute of Technology
Cambridge, Massachusetts
Rejuvenation of Chemical Engineering

November 14, 1980
Dr. Max S. Peters
Professor of Chemical Engineering
Dean Emeritus of the College of Engineering and Applied Science
University of Colorado
Boulder, Colorado
Politicians and Higher Education in Technical Society

November 6, 1981
Dr. Robert L. Pigford
Professor of Chemical Engineering
University of Delaware
Newark, Delaware
Merging Theory and Practice in Chemical Engineering Education

December 10, 1982
Dr. R. Byron Bird
Chemical Engineering Department
University of Wisconsin
Madison, Wisconsin
Book-Writing and Chemical Engineering Education: Rites, Rewards and Responsibilities

April 6, 1984
Dr. Robert C. Reid
Department of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts
The Graduate Experience

April 12, 1985
Dr. Neal R. Amundson
Department of Chemical Engineering
University of Houston
Houston, Texas
Reminiscences, Random Comments, and Landmarks

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Dr. John M. Prausnitz
Department of Chemical Engineering
University of California
Berkeley, California
Versatility and the Integration of Experience

April 17, 1987
Dr. Joe M. Smith
Department of Chemical Engineering
University of California
Davis, California
Chemical Engineering Education for Foreign Students – Blessing or Burden

April 8, 1988
Dr. Hendrick C. Van Ness
Department of Chemical Engineering
Rensselaer Polytechnic Institute
Troy, New York
Chemical Engineering Education – Will We Ever Get It Right?

April 11, 1989
Dr. Robert N. Maddox
School of Chemical Engineering
Oklahoma State University
Stillwater, Oklahoma
Chemical Engineering Design: Plant, Project, Process, Phreshman

April 27, 1990
Dr. Stuart W. Churchill
Department of Chemical Engineering
University of Pennsylvania
Philadelphia, Pennsylvania
Perspectives and Counterparts in Chemical Engineering Education

April 26, 1991
Dr. Rutherford Aris
Department of Chemical Engineering and Material Sciences
University of Minnesota
Minneapolis St. Paul, Minnesota
Chemical Engineering and the Liberal Arts Today

May 1, 1992
Dr. Richard M. Felder
Department of Chemical Engineering
North Carolina State University
Raleigh, North Carolina
The Myth of the Superhuman Professor

March 25, 1993
Dr. Stanley I. Sandler
Director, Center for Molecular and Engineering Thermodynamics
Department of Chemical Engineering
University of Delaware
Newark, Delaware
Technological and Societal Change and Chemical Engineering Education

April 22, 1994
Dr. Klaus D. Timmerhaus
Department of Chemical Engineering
University of Colorado
Boulder, Colorado
Education and Science – Do We Really Care Enough?

April 18, 1995
Dr. Geoffrey F. Hewitt
Imperial College of Science, Technology & Medicine
London, United Kingdom
People Processing – The Chemical Engineering Way

April 12, 1996
Dr. Bruce A. Finlayson
Rehnberg Professor and Chair
Department of Chemical Engineering
University of Washington
Seattle, Washington
Can Professors Use Technology to Teach Faster, Better, Cheaper?

April 25, 1997
Dr. H. Scott Fogler
Vennema Professor
Department of Chemical Engineering
The University of Michigan
Ann Arbor, Michigan
Teaching Critical Thinking, Creative Thinking, and Problem Solving in the Digital Age

February 20, 1998
Dr. Phillip C. Wankat
School of Chemical Engineering
Purdue University
Lafayette, Indiana
Educating Engineering Professors in Education

February 26, 1999
Dr. Thomas F. Edgar
Associate VP for Academic Computing and Instructional Technology Services
The University of Texas at Austin
Austin, Texas
Process Engineering in the 21st Century: The Impact of Information Technology

February 25, 2000
Dr. G. V. “Rex” Reklaitis
Professor and Head, School of Chemical Engineering
Purdue University
West Lafayette, Indiana
Preparation of Chemical Engineers for Manufacturing Leadership in the 21st Century

February 15, 2001
Dr. Ronald W. Rousseau
Professor and Chair, School of Chemical Engineering
Georgia Institute of Technology
Atlanta, Georgia
Striking a Balance in Teaching Today’s Students to Solve Tomorrow’s Problems

March 1, 2002
Dr. Edward L. Cussler
Chemical Engineering and Materials Science
University of Minnesota
Minneapolis, Minnesota
What Happens to Chemical Engineering Education?

April 25, 2003
Dr. Arvind Varma
Department of Chemical and Biomolecular Engineering
University of Notre Dame
Notre Dame, Indiana
Future Directions in Chemical Engineering Education: A New Path to Glory

November 5, 2005
Dr. Mark E. Davis
Warren and Katharine Schlinger
Professor of Chemical Engineering and Executive Officer of Chemical Engineering
California Institute of Technology
Pasadena, California
Adapting Chemical Engineering Education to Increasing Job Diversity

November 10, 2005
Dr. Timothy J. Anderson
Professor of Chemical Engineering and Associate Dean for Research
University of Florida
Gainesville, Florida
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February 8, 2007
Dr. Robert C. Armstrong
Chevron Professor and Department Head of Chemical Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts
Frontiers in Chemical Engineering Education

October 25, 2007
Dr. John P. O'Connell
Harry Douglas Forsyth Professor of Chemical Engineering
University of Virginia
Charlottesville, Virginia
Fundamentals: Wellspring for Adapting to Change October 24, 2008
Dr. Dianne Dorland
Professor and Dean
College of Engineering at Rowan University
Glassboro, New Jersey
Learning Strategies that Promote Teamwork

April 2, 2010
Dr. David T. Allen
The Gertz Regents Professor of Chemical Engineering
University of Texas
Austin, Texas
Green Engineering: Incorporating Sustainability Concepts into Engineering Education

April 7, 2011
Dr. Donald R. Woods
Professor Emeritus of Chemical Engineering
McMaster University
Hamilton, ON Canada
Ideas to Measure and Reward Efforts to Improve Student Learning

October 25, 2012
Dr. Ronald L. Miller
Professor of Chemical Engineering
Director, Center for Engineering Education
Colorado School of Mines
Golden, Colorado
Education Research- Does it Really Have Anything To Offer Classroom Instructors?

April 11, 2013
Dr. Michael J. Prince
Professor of Chemical Engineering
Bucknell University
Lewisburg, Pennsylvania
An Introduction to Active Learning for Busy Skeptics

October 13, 2015
Dr. Richard M. Felder
Hoechst Celaese Professor Emeritus
Department of Chemical and Biomolecular Engineering
North Carolina State University
Raleigh, North Carolina
The OSU ConocoPhillips Lectures on Chemical Engineering Education: A Half-Century of Recollections, Opinions, and Wisdom

October 18, 2016
Dr. Babatunde A. Ogunnaike
William L. Friend Chaired Professor Emeritus
Dean Emeritus of the College of Engineering
University of Delaware
Newark, Delaware
Optimizing In-Vitro Fertilization Treatment: A Pedagogical Case Study in Random Phenomena Analysis with Social Implications

September 25, 2017
Dr. Milo Koretsky
Professor of Chemical Engineering
Department of Chemical, Biological & Environmental Engineering
Oregon State University
Corvallis, Oregon
Back to the Future: Learning Chemical Engineering through Engagement in Disciplinary Practices

September 4, 2018
Dr. Lisa G. Bullard
Alumni Distinguished Undergraduate Professor
Director of Undergraduate Studies in the Department of Chemical and Biomolecular Engineering
North Carolina State University
Raleigh, North Carolina
Open the Front Door, Close the Back Door: The Impact of Culture on Recruiting and Retention

November 20, 2019

Dr. Stephanie Farrell
Interim Dean of Engineering at Rowan University
Rowan University
Glassboro, New Jersey
Practical, research-based strategies for making engineering classrooms more inclusive

March 29, 2022

Dr. Daniel A. Crowl
Professor Emeritus
Past Herbert H. Dow Professor
Chemical Process Safety
Michigan Technological University
Houghton, MI
Process Safety Education: An Evolution Not a Revolution

November 14, 2024

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Beyond reading: Interactive textbooks for chemical engineering students

Beyond reading: Interactive textbooks for chemical engineering students

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ConocoPhillips Lecture Series

Oklahoma State University

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Introduction

I want to thank the Oklahoma State School of Chemical Engineering and ConocoPhillips for this invitation and outstanding hospitality during my visit. To be included in the list of “legends” to deliver the ConocoPhillips Lectureship in Chemical Engineering Education is humbling. My interactions with OSU students, faculty, and staff found a world-class group using chemical engineering to solve important problems.

Learning and the textbook

Let’s start with the big picture, undergraduate chemical engineering education began more than a century ago, is established as one of the core engineering disciplines, and, I believe, is poised to both train and educate many, dynamic 21st century leaders. In my 20+ years as a chemical engineering professor, I have frequently thought about how students learn chemical engineering concepts and problem solving skills as well as how faculty can encourage learning. While I will save a deep dive into my philosophy as a chemical engineering professor – show up, work hard, fail forward – for another venue, some framing is needed to put a system boundary around this paradoxical story. I believe: **The textbook is a 20th century technology.** So why have I dedicated so many years to “writing” textbooks?

One thing that distinguishes chemical engineers is their ability to analyze a problem and create new solutions. These two verbs, analyze and create, are found in Bloom’s taxonomy. The six levels of Bloom’s taxonomy are (Table 1): Remember, Understand, Apply, Analyze, Evaluate, and Create [1]. Generations ago, university faculty could safely use their experience to recite and lecture about the lowest two levels – recalling facts and new terms as well as explaining these ideas and concepts. However, with the advent of Internet search over 25 years ago, the facts and terms became freely available to all. In more recent decades, many engineering educators emphasized problem solving when learning to be an engineer, which involved and still involves the apply, analyze, and evaluate levels of Bloom’s taxonomy. Finally, creating original work is normally limited to senior design, industry projects, or research and scholarly endeavors.

Here, I will frame the rest of this story about transitioning textbooks to an educational technology through three lenses: 1. Knowledge (Remember and Understand), 2. Skill development (Apply, Analyze, Evaluate), and 3. Mastery (Create).

Knowledge	**Remember** Recall facts and basic concepts
	Understand Explain ideas or concepts
Skills	**Apply** Use information in new situations
	Analyze Draw connections among ideas
	Evaluate Justify a decision or action
Mastery	**Create** Produce original work

Table 1: The mapping of 3 learning stages to the 6 levels of Bloom's taxonomy.

From reading to doing

More than a dozen years ago, I started on the path to becoming a textbook author with an overarching goal to have students "do" engineering as well as read about engineering. These chemical engineering textbooks, or more appropriately called tools, are currently available as interactive, web-native products sold by zyBooks, a Wiley brand [2-4]. The long road to this platform and format is outside the scope here. In brief, my authoring journey went from working with an agile startup to a large, 200+ year old publisher while remaining centered on making engineering textbooks with less text, more action.

Like any large writing project, e.g., design report or research proposal, an outline provides a framework to build the interactive content. Being fully and exclusively web-based, the interactive textbooks are modular by section. Thus, each section stands alone and can be reordered or reorganized by the professor. Each section or subsection generally follows four actions: Define, Demonstrate, Practice, and Challenge. Define is like most textbooks and introduces new concepts with definitions and simple examples. So yes, students need to read, but the blocks of texts are limited to a small number of relatively short paragraphs. Next, demonstrate converts figures, diagrams, or examples that are static in a traditional paper textbook into dynamic, interactive animations.

An example animation is included here to capture the sequential, step-by-step nature of these activities. While demonstrating an animation in a static publication is challenging, multiple panels (Figure 1) capture the visual framework. Students begin by clicking a Start button (not shown). In the first step of this animation, a multi-sentence problem statement appears near the top of the panel, while a caption annotates the action. The second step restates each sentence, and the associated drawing appears. This step takes about 10 seconds. The third and final step assembles the drawings into a process flow diagram.

Dividing visuals, diagrams, or figures into smaller steps or chunks aligns with the principles of cognitive load theory, which is normally difficult to do with static text and figures. Animations may be considered analogous to online videos, including those used in flipped classrooms. Our analytics have found that animations nominally take 30 seconds to 2 minutes to watch, which aligns with findings that shorter videos are more engaging [5]. In addition, many students watch these animations more than once, which we affectionately call reruns [5].

The last two actions in each section, Practice and Challenge, involve students solving problems, which aligns with the skill development levels of Bloom's taxonomy. After the reading and animations, students practice the new concepts by applying, analyzing, or evaluating through attempting and completing true and false, multiple choice, free response, or matching exercises. Finally, the homework problems with randomized numbers and/or content are called Challenge Activities, and they allow students to build skills and solve problems. Some Challenge Activities are embedded in each section and are scaffolded, so the problems start simpler and become longer and more challenging.

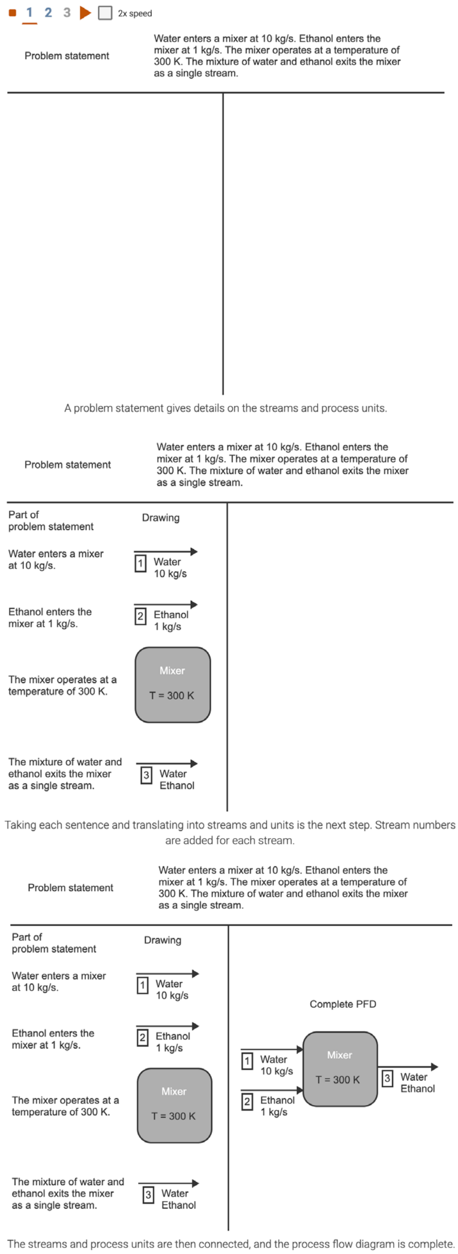

Figure 1: Static screenshots of a three-step animation from the Material and Energy Balances zyBook. Top. The problem statement appears. Middle. Each sentence of problem statement is translated into drawing. Bottom. Individual drawings are combined into process flow diagram (PFD).

These single concept problems to provide practice of the fundamentals, and our research verified the intended scaffolding using large data sets [6]. Additional end-of-chapter Challenge Activities combine multiple concepts similar to most chemical engineering textbooks [7].

Do chemical engineering students benefit from interactive textbooks?

The short answer is yes. Our research and resulting publications have examined students' interactions with the book from many different perspectives [8]. We have also correlated student behaviors with their individual performances on traditional, hand-written quizzes and exams. Some highlights are provided here.

First, we have repeatedly proven the hypothesis that the students read the textbook – when it's the interactive MEB zyBook [4]. After examining 600 students over 7 cohorts encompassing over 600,000 reading clicks, the median student reading rate was found to be 99% (Figure 2). In addition, the 1st quartile reading rate was 90%, so three quarters of students read nearly the entire book before the due date. Comparing with traditional textbook reading is difficult as published data are sparse. However, one multi-year study and large surveys of university students normally find 20 to 50% reading rates [9, 10]. Thus, the interactive format encourages students to engage with the material in a low-stakes environment, which allows them to build their knowledge and receive immediate feedback

Beyond basic knowledge acquisition through reading clicks, students also participate in auto-graded problems created by following the education framework known as deliberate practice. Deliberate practice involves focused, repetitive, and scaffolded exercises with immediate feedback—an approach well-suited to the auto-graded, interactive Challenge Activities. Students using these auto-graded problems generate large amounts of data, so this research falls into the category of big data or data analytics. More specifically, this research is known as learning analytics.

Our work has developed metrics to quantify scaffolding and deliberate practice [6]. By analyzing the number of attempts before and after a correct answer as well as the fraction of correct responses, insights into student persistence, practice strategies, and mastery of material have been published [6, 7, 11, 12].

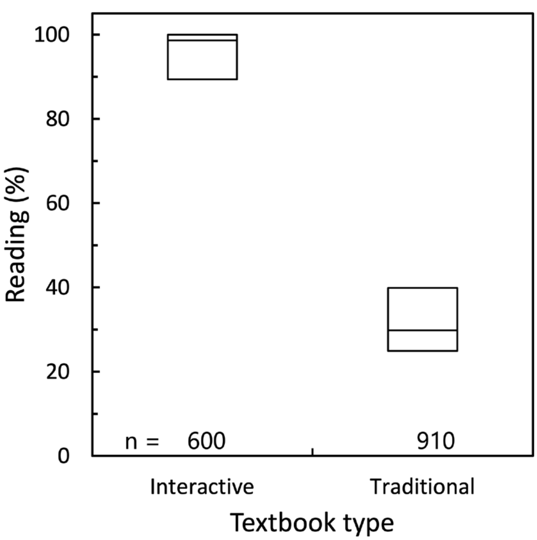

Figure 2: Reading participation for interactive versus traditional textbook; Data compiled from [11] and [9], respectively.

Important findings include students who engage in more deliberate practice tend to perform better on quizzes and exams, thus are developing stronger problem-solving skills. Two compilations of multiple cohorts of data provide some practical insights for professors adopting interactive textbooks with auto-graded homework.

First, as shown in Figure 3, we asked if the number of pre-exam homework problems were the right number to earn a good exam score. Students completing more pre-exam practice problems, i.e., multi-concept Challenge Activities, generally do better on the exam up to a point. Students doing extra problems beyond the number assigned do about equally well as students only doing the assigned number of problems. Thus, instructors can use this type of data to adjust students' workload from exam to exam and term to term.

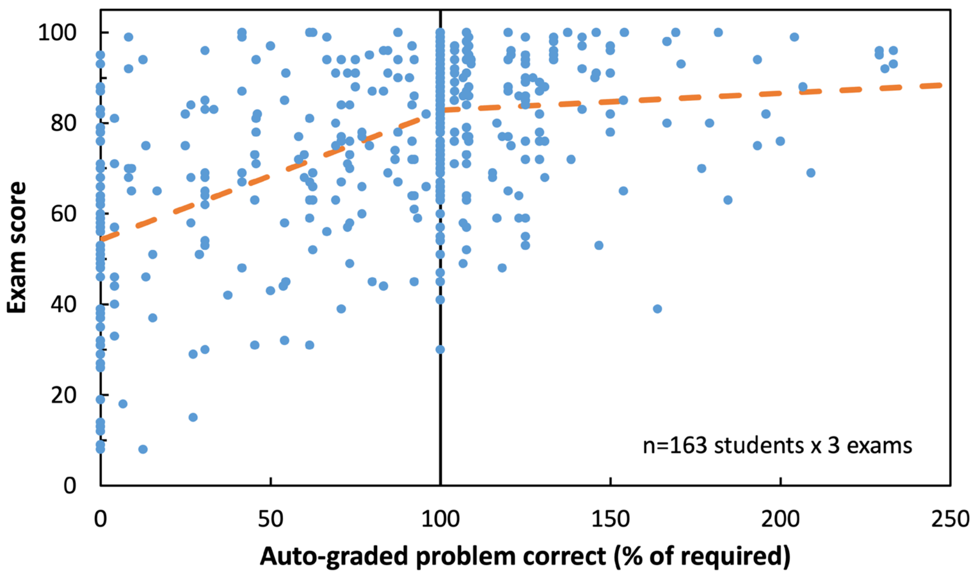

Figure 3: Scatter plot with linear correlations for fraction of end-of-chapter auto-problems correct versus exam score for 163 students in 2 cohorts. Each student took 3 midterm exams during the semester.

Next, we wanted to know if easier, in-section problems or harder, end-of-chapter problems more strongly correlated with quiz and exam grades. Not surprisingly, both problem types correlate with exam scores, but at different rates (Figure 4). While the end-of-chapter problems best mimic the exam problems, students' performance on the in-section problems correlates more strongly, i.e., slope is about 60% larger.

A sports analogy seems appropriate here. Comparing chemical engineering and basketball, these correlations imply that practicing single, fundamental skills (dribbling, shooting) is more important for exam (game) performance than and multi-concept problems (3-on-3 drills, 5-on-5 scrimmages).

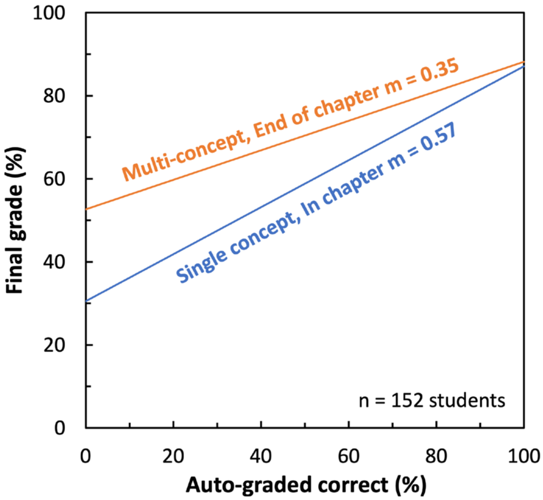

Figure 4: Linear correlations for fraction of end-of-chapter auto-graded problems correct versus exam score for 152 students in 2 cohorts.

I found this data quite surprising, and thus, we examined the trends for a second cohort and confirmed the finding [7, 12]. In summary, instructors can analyze students' success on Challenge Activities in real time, quickly identify common struggles, and intervene during the next class session.

To sum up, pre-class reading and auto-graded homework assignments align with principles of active learning and cognitive science, such as retrieval practice and spaced repetition. Therefore, students engage with new knowledge and develop skills before class, which is enhanced in the engineering classroom under the guidance of a professor. By embedding these learning principles into a textbook technology, I have created and continue to create a learning environment that supports many learners. Our research bridges the gap between educational theory and classroom practice to offer a scalable model for improving engagement and learning through real-time metrics.

Students creating creatively

In parallel with interactive textbook development, we have explored the pedagogical benefits of student-generated content in the form of homework problems that reverse engineer online videos. These visual scenarios are affectionately called YouTube problems, since YouTube is the primary source of the interesting, instructive, or surprising visual content. This student-centered approach brings unique real-world scenarios into any course. Thus, challenging students to reach that mastery learning level or highest level of Bloom's taxonomy (creating) cultivates innovation and gives students ownership of their budding engineering career.

Our NSF-supported research compared student-written YouTube problems to traditional textbook problems in the MEB course [8]. First, the YouTube problems were statistically similar in difficulty to traditional textbook problems. When students solved previously authored YouTube problems, they exhibited similar or better problem-solving skills as the expert-written textbook problems. Finally, students' learning attitudes related to connecting messy, real-world problems and their development as an engineer improved over the course of a single semester.

How will AI change chemical engineering textbooks?

Large language models and generative artificial intelligence, which I will simply call AI here, are altering many things in our daily lives, and chemical engineering education is also adapting. For example, YouTube problems are now drafted by students prompting AI as an intermediate milestone (Figure 5). Then, the final problem and solution are submitted and owned by students, which adds a critical analysis component. Examples and rubrics of both traditional and AI-assisted YouTube problems are shared in the MEB zyBook [4], on a YouTube channel [13], and as a card on Engineering Unleashed [14]. Feel free to adapt this pedagogy for your courses. Since AI has been useful to the students to overcome writers block for a single paragraph problem statement, will AI alter how textbooks are authored for chemical engineering?

While I do not have the gift of prophecy, I will briefly speculate how AI and chemical engineering textbooks and education may change. We will certainly have chemical engineering-trained chatbots and related AI tools for chemical engineers and chemical engineering students, such as [15]. These AI tools will continue to make mistakes, which should be relatively easy for an expert engineer to spot. Thus, the challenge for chemical engineering faculty is to continue developing students' foundational engineering and critical thinking skills. Then, our graduates can spot errors or inconsistencies in AI-generated work. Right now, I see AI as an 80/20 tool where I feel I need to finish, correct, and reconfigure about 20% of most AI responses. This human intervention allows me to add my human experience, intuition, and soul into the final product.

Since most chemical engineering textbooks remained static and word-centric for the last decade, the incentives are lacking for chemical engineering faculty to tackle large projects, like textbook authoring. Unlike patents, textbooks do not directly benefit the university. Since faculty generally own their original course content, which may not be true for online courses, the university only benefits from the prestige of having a textbook author/professor. Prestige is difficult to measure compared with tuition, overhead, graduation rate, or other mission-centered activities. Should we just prompt a chemical engineering-trained AI to write a textbook for each course? These AI books would be free to students and royalty-free, which are potential benefits. However, would students read the AI-authored books if they are mostly text and static figures? I do not see this generation of students gravitating to text-heavy textbooks. Next, could AI author an interactive, student-centered chemical engineering textbook? While this task would likely need significant prompting right now, employing the educational best practices that were discussed earlier should be possible. I expect to see new AI-originated chemical engineering content, including games and simulations, in the next few years.

I want to conclude this conjecture related to AI by posing some ethical questions. Should AI be used if the tool uses pirated chemical engineering textbooks as its training set? This issue seems beyond the control of individual authors or publishers right now. Also, does using AI to solve problems in the engineering world require another level of safety review?

For example, are physical properties used in AI-based calculations measured property values or made up by the AI? This topic will be quickly evolving, and faculty will have to listen to their alumni and advisory boards on how best to prepare chemical engineering students for these new workplace challenges.

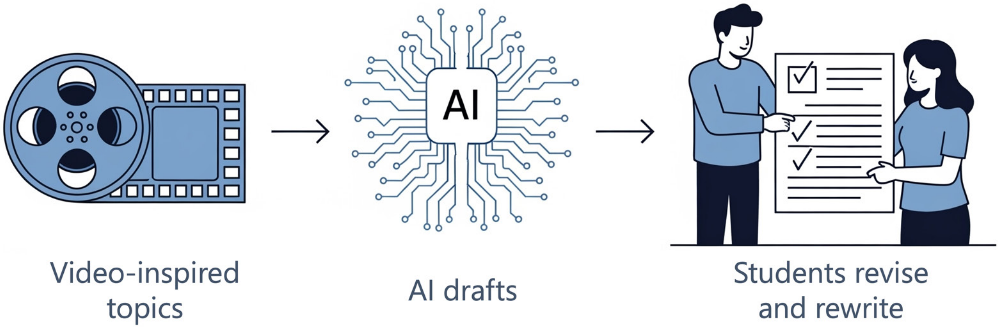

Figure 5: Graphic generated by AI to summarize a pedagogy where students use videos to inspire the creation of new chemical engineering homework problems. Draft problems were authored by AI in recent semesters.

Student-centered educational tools are the present and future

In conclusion, our challenge as chemical engineering professors is creating learning materials that shift students from passive consumption to active construction of both knowledge and skills. I believe our interactive textbooks capture this philosophy by engaging students outside the classroom. Combined with student-centered activities during class time, chemical engineering courses shift from acquiring knowledge to building the skills of a chemical engineer. Based on our research, these approaches enhance learning outcomes, cultivate a sense of agency in students, and prepare students for the difficult, open-ended problems that face humanity in the 21st century. Thank you again to Oklahoma State Chemical Engineering, ConocoPhillips, and everyone participating in the talks or reading this compilation. Please reach out to me if you want to discuss the future of chemical engineering education, which is going to be exciting, student-centered, and technology-enhanced.

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SCHOOL OF
CHEMICAL ENGINEERING
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Daniel D. Burkey is the Castleman Term Professor of Engineering Innovation, Associate Dean of Undergraduate Education and Diversity, and the Graduate Director of the Engineering Education Ph.D. Program at the University of Connecticut. Dr. Burkey holds his B.S. in Chemical Engineering from Lehigh University in Bethlehem, PA, his M.S.C.E.P. and Ph.D. in Chemical Engineering from the Massachusetts Institute of Technology, and an M.A. in Educational Psychology from the University of Connecticut. Prior to UConn, he held positions at Northeastern University and at GVD Corporation in Cambridge, MA. Since joining UConn in 2010, Dr. Burkey's area of research has focused broadly on engineering education, and specifically on moral and ethical development of engineering students, process safety education, and game-inspired educational techniques. Dr. Burkey currently serves as a Director of the Education Division of AIChE, where he runs the Future Faculty Mentoring Program. He is a past program chair of the ASEE Chemical Engineering Division and serves as an assistant editor of the journal Chemical Engineering Education. In 2020, he was inducted into the Connecticut Academy of Science and Engineering (CASE) for his contributions to engineering education in the state. In addition to his many teaching awards, Dr. Burkey is also the recipient of the 2020 AICHE Education Division Innovation Award, the 2021 ASEE Corcoran Award for the best paper in Chemical Engineering Education in the previous year, and the 2023 David Himmelblau Award from the CAST Division of AIChE for innovations in computer-aided chemical engineering education. He was inducted as a Fellow of AIChE in 2024.

THE INTERSECTION OF THE TECHNICAL AND BEHAVIORAL: NOVEL, GAME-BASED APPROACHES TO TEACHING COMPLEX ENGINEERING TOPICS

Game-based educational techniques can be an interesting and novel approach to active learning in engineering courses. Because games often exist within their own rule sets, they can allow students to explore scenarios and make choices that they wouldn't otherwise make because they are appropriate within the context and the rules of the game. In this talk, we discuss two different projects involving game-based learning. In the first, we explore multiple game-based approaches to teaching engineering ethics to first-year engineering students in a multidisciplinary setting. At the beginning of the semester, students are given a baseline survey to quantify the sophistication of their ethical reasoning. Over the course of the semester, different game-based interventions are given to the students, and the survey instrument again is used to determine any changes in their ethical reasoning. The game-based interventions by their nature allow students to explore ethical reasoning in the context of behavioral ethics. In the second project, we discuss the development and use of a digital educational environment to explore process safety judgments with senior chemical engineering students. Our research team developed a survey instrument to gauge the sophistication of student thinking about process safety. Students completing the survey instrument and then completing similar scenarios in the game show statistically significant differences in the types of responses they make, indicating that different reasoning modes may be activated by the game due to its more authentic and realistic portrayal of the material. textbooks and other new technologies in engineering education.

Sept. 29 | 3:00 PM | 170 Architecture
Reception to follow in the Gallery