Leveraging AI to Improve Student Outcomes*

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*All figures generated using ChatGPT
(except for pictures of Chicago!)

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Outline

- Introduction
- AI in Graduate School Operations – Student Facing
- AI in Graduate Education – Teaching and Learning
- AI Tutors
- Summary



Leveraging AI
Introduction

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Introduction

- They are coming for us!!
  - New York Times, June 7, 2025: "OpenAI, the maker of ChatGPT, has a plan to overhaul college education – by embedding its artificial intelligence tools in every facet of campus life. The company envisions 'AI-native universities' where students have personal AI assistants from orientation to graduation. Leah Belsky, OpenAI's vice president of education said, 'Our vision is that, over time, AI would become part of the core infrastructure of higher education.' The initiative is part of a competitive effort among tech giants to dominate the educational sector with AI. However, the long-term educational benefits and potential drawbacks of AI integration remain uncertain. Belsky said, 'The challenge is, how do you actually identify what are the use cases for AI in the university that are most impactful?'"

Introduction

- I come at the AI revolution from a STEM perspective
  - I tend to embrace new technologies with a mix of curiosity and criticality.
  - STEM-based pedagogy – technology in education AND practice.
    - This is true for ALL our disciplines!
- AI/ML has been around for many years – why all the rage now?
  - Combination of massive amounts of training data, e.g. the internet, and huge computers for training models and inference.
  - What's new is LLMs, GPTs, and AGI with broad applicability beyond numerical data (ML), i.e. text, images, videos.

Introduction

- The promise (propaganda?) of AI:
  - AI will take over tedious tasks to allow humans to focus on higher-level creative work.
    - For example, AI as *analyst* and human as *strategist*.
  - AI will replace many white-collar jobs and knowledge workers.
- The reality of AI:
  - Yes, AI does hallucinate, which requires an expert to diagnose.
  - It is equally confident in giving correct and incorrect answers.
    - We are experiencing a laser-printer moment… on steroids.
  - AI is NOT inherently creative insofar as it is trained on existing knowledge and data, i.e. the ”human archive” (this is somewhat controversial).

Leveraging AI
Graduate School Operations

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Operations and Student Support

- Potential avenues for use of AI in Graduate School functions:
  - Student facing
    - Administrative student support – enhance timeliness and accuracy of information via chatbots.
    - Policies and procedures – develop best practices.
    - Teaching and learning – enhance student outcomes relative to learning objectives.
    - Academic student support and student success, e.g. AI tutors, real-time student monitoring (academic, health, behavioral, disciplinary, etc.), proactive and personalized interventions, personalized learning pathways.
  - Faculty facing…
  - Administrative-staff facing…

Operations and Student Support

- Importance of accurate and timely data for data-informed decision making
  - This should be the guiding priority for AI implementation in administrative tasks.
  - Need to focus equally on quantity and quality of data for it to be useful to AI.
  - Emphasize data gathering with a clear purpose for insights and actions it will produce.
  - The one guarantee I can make is that you will not regret any efforts to improve data accuracy and availability.

Operations and Student Support

- Questions for AI Adoption:
  - Will it enhance service and communication, e.g. response times, accuracy of information, specificity of information, personalization, etc.?
    - Will it promote a “cohort-of-one” approach to student success.
  - Will it facilitate more meaningful human interactions with students?
  - Will it boost curiosity, creativity, critical thinking, and productivity?
  - Will it improve the *process*, the *product*, or both?
  - Will it make current processes more efficient or enable new functionality and capabilities?
  - Will it enhance data-driven decision making?

Leveraging AI
Graduate Education

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Graduate Education

- More than any previous technology, AI is a rapidly moving target with advancements and new use cases every day.
  - Any time such a disruptive technology arises, we must return to our learning objectives to reinforce what it is that we really want the student outcomes to be and how to assess them.
    - Does it enhance or detract from the LOs?
    - Does it make it easier or harder to accomplish the LOs?
    - Does it alter the LOs in any way?
    - Does it aid in the assessment of the LOs?
    - This is why backwards design is so essential!!

Graduate Education

- AI-proof learning objectives:
  - Skills-based LO:
    - “Solve first-order linear differential equations using integrating factors.”
  - Outcomes-based LO:
    - “Apply differential equations to model and analyze real-world phenomena such as population growth or cooling processes.”
  - AI-proof LO:
    - “Critically evaluate the assumptions and limitations of a differential equation model and propose justified modifications to improve its real-world applicability.”
- While the AI-proof LO is much harder to assess, this gets to the heart of what we want students to get out of a course or program.

Graduate Education

- Can you use AI to help flip the traditional fundamentals-methods-applications teaching paradigm, particularly in STEM?
  - How to use AI to develop awareness and motivate students' interest in a topic before delving into the fundamentals and methods?
  - Demonstrate applications and highlight unusual or intriguing behaviors of a system or process to develop a curiosity and critical thinking about what is happening, e.g. through case studies, coding, etc.
  - Start with the *why* before delving into the *how*.
  - AI allows students to gain a sense of accomplishment very quickly.
  - Allows learners to understand how to use AI and appreciate its limitations while motivating them to learn more about the underlying fundamentals and methods.

Graduate Education

- Effect of AI on talent pipeline:
  - If AI were to replace entry-level writers, coders, and graphic artists, who will be tomorrow's editors, software engineers, and marketers?
  - How will we develop creativity and critical thinking skills to better utilize AI?
  - Who will be the experts that develop new domain-specific AI tools and critically evaluate their results?
  - Who will be left to identify hallucinations?

Leveraging AI

AI Tutors

Welcome to the Wild West!!

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Chegg Stock Price

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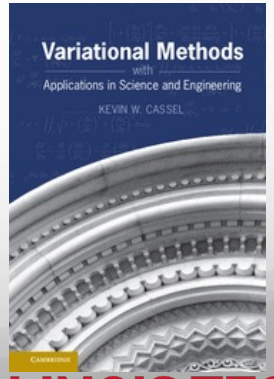
AI Tutors

- That's the good news; the bad news is that Chegg's stock is down 99% because students have found more "effective" alternatives using AI.
- As you go from K-12- to undergraduate- to graduate-level, there are fewer and fewer AI tutor options.
  - I am not aware of any currently available options that are designed for graduate education.
  - Thus, we are limited to general-purpose AI, such as ChatGPT, Perplexity, Claude, etc.
  - It is straightforward to train any of these on specific course content.
  - BUT they are not designed to serve as a tutor in the best sense of the term.

AI Tutors

- Demo of ChatGPT, Perplexity, and Claude for standard math problem.
  - Solution technique for Bernoulli first-order ordinary differential equation
    - Excellent supplement to a textbook – explains method, shows details, and gives example.
    - Of course, students will use to *replace* the textbook!
- Demo of ChatGPT, Perplexity, and Claude for graduate-level math problem.
  - Variational calculus example – Exercise 2.5 from my book
    - All three gave different and incorrect solutions.
    - All three presented their solutions as correct!!
    - Only ChatGPT trained on my book gave the correct solution.



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AI Tutors

- Thus, we have time on the graduate side until viable AI tutors are available.
- To see what may be coming, however, keep an eye on UG AI tutors
  - Worth Considering: Cognii, MathGPT, Tutello, Khanmigo
  - Beware of tAI (www.learn-tai.com)!!
    - Directly connects to LMS course content at request of individual students.

  - No where is it more essential to:
    1. Understand the limitations of AI.
    2. Focus on what *should* be done, not what *could* be done.

AI Tutors

- Questions for AI Adoption:
  - Is it simply replacing Chegg, or is it enhancing healthy learning practices and academic student support?
  - Was it developed by a current or recent student (likely Chegg replacement) or a group of educators (worth considering)?
  - Will it enhance service and communication?
  - Will it facilitate more meaningful human interactions with students?
  - Will it boost curiosity, creativity, critical thinking, and productivity?
  - How will it change the role of TA and traditional tutoring centers?

Leveraging AI
Summary

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Summary – Proceed with Caution

- Graduate school operations:
  - Use AI to augment, not automate, job functions
  - Embrace AI as a creative partner
  - Use AI to generate possibilities, not answers
  - Focus on using AI to enhance the process, not produce a product
  - As leaders, we must model good use of AI

Summary – Proceed with Caution

- Graduate education:
  - "AI-proof" learning objectives.
  - If AI is going to replace the lower rungs on the corporate ladder, then we will need to fill this gap.
    - Remember that we have always had students do many things that they will not do on the job; this is an integral part of education.
  - Take advantage of AI to intrinsically motivate students through applications, case studies, etc. before focusing on fundamentals and methods.
  - Highlights the role of instructor as mentor, not just knowledge guru.
    - It is our job to be the intrinsic motivators that inspire our students.
  - As leaders, we must model good use of AI.

Summary – Proceed with Caution

- AI-tutors:
  - As a first pass, evaluate AI tutors based on who is behind it and who is it targeted to (students or educators).
    - An AI tutor should focus on aiding learning and process, not giving answers.
    - Was it developed by a current or recent student who is marketing to students?
    - Was it developed by group of educators marketing to educators?
  - AI tutors are only in their infancy – follow closely.
  - As leaders, we must model good use of AI.

Final Caution

- It is getting increasingly difficult to determine what the training data is for AI models:
  - ChatGPT 3.5 (11/22) – essentially trained on the internet as of 9/21.
  - Recent models are more numerous and increasingly opaque.
- Even more so than the internet, AI is likely the first technology that has such a profound effect on education for which students are far better prepared than our faculty in terms of use cases and practice using the technology.
- At some point, we are going to need to address the traditional grading system that serves as an extrinsic motivator and replace it with a system that is linked directly to learning objectives and student outcomes, which should be intrinsically motivating.

Thank you!

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